

M.O. 553

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, 1950 to March 31, 1951



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METEOROLOGICAL COMMITTEE

Appointed by the Secretary of State for Air

Chairman :—Mr. A. M. Crawley, M.B.E., M.P. (Parliamentary Under Secretary of State for Air)

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Members :—Mr. W. J. Bigg, C.M.G. (Colonial Office)

Professor Sir David Brunt, F.R.S. (British Universities)

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Mr. W. B. Foden, C.B. (Air Ministry)

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

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

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

Major General K. F. MacK. Lewis, C.B., D.S.O., M.C. (War Office)
(from December 15, 1950)

Captain R. F. Nichols, R.N. (Admiralty) (from December 23, 1950)

Captain J. H. Quick (Ministry of Transport)

Major General S. B. Rawlins, C.B., C.B.E., D.S.O., M.C. (War Office)
(to December 15, 1950)

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Mr. H. R. Smith, C.B. (Scottish Office)

Mr. G. W. Stallibrass (Ministry of Civil Aviation)

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

Captain F. M. Walton, R.N. (Admiralty) (to December 23, 1950)

Secretary :—Mr. R. J. Williams

The Committee met on June 1, 1950.

ADVISORY COMMITTEE ON METEOROLOGY FOR SCOTLAND

Appointed by the Meteorological Committee

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

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

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

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

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

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Mr. James Paton, M.A., B.Sc. (Royal Meteorological Society)

Dr. R. G. Peters, M.D., D.P.H. (Department of Health for Scotland)

Professor W. M. Smart, D.Sc. (University of Glasgow)

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

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

Secretary :—Mr. R. A. Watson, B.A.

The Committee met on June 15, 1950.

METEOROLOGICAL RESEARCH COMMITTEE

Appointed by the Secretary of State for Air

Chairman :—Professor G. M. B. Dobson, F.R.S.

Members :—Dr. G. E. Bell (Ministry of Civil Aviation)

Professor Sir David Brunt, F.R.S.

Professor S. Chapman, F.R.S.

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

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

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

Captain R. F. Nichols, R.N. (Admiralty)

Sir Charles Normand, C.I.E., D.Sc.

Professor P. A. Sheppard

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

Professor Sir Geoffrey Taylor, F.R.S.

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

GASSIOT COMMITTEE

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

Professor Sir David Brunt (Chairman)

Sir Edward Appleton

Professor P. M. S. Blackett

Professor T. G. Cowling

Professor G. M. B. Dobson

Mr. E. Gold

Professor H. W. Massey

Professor E. A. Milne

Sir Charles Normand

Professor F. A. Paneth

Professor P. A. Sheppard

Professor O. G. Sutton

The Astronomer Royal

The President of the Royal Astronomical Society

The President of the Royal Meteorological Society

The Director of the Meteorological Office

There was one meeting of the Committee during the period under review.

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, 1950, to March 31, 1951

§ 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.

Control of general policy is exercised by the Meteorological Committee of which the Under Secretary of State for Air is Chairman. The members of the Committee consist of representatives of practically all the Government Departments for the meeting of whose requirements the Meteorological Office is responsible, and also include representatives of the Royal Society and of the Royal Society of Edinburgh.

The general functions of the Meteorological Office are :—

- (i) Provision of meteorological services for the Army, Royal Air Force, Civil Aviation, Ministry of Supply and the Merchant Navy.
- (ii) Liaison with the Naval Weather Service of the Admiralty and provision of basic meteorological information for use by that Service.
- (iii) Meteorological services for 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) Organization and distribution of magnetic and seismological information from certain British observatories.
- (vii) Research in meteorology and geophysics.

The Meteorological Office takes a leading part in international co-operation in meteorology. The Director of the Meteorological Office was the President of the International Meteorological Organization and the President of the World Meteorological Organization for its first Congress (see § 6, p. 41). Other international organizations in the activities of which the Meteorological Office participates are the International Civil Aviation Organization and the International Union of Geodesy and Geophysics. The General Secretary of the latter is the Principal Deputy Director of the Meteorological Office.

The cost of the Meteorological Office is borne on Air Ministry Votes. Appendix V shows the provision made in the Air Estimates for expenses and receipts of the Meteorological Office for the financial year 1951-52.

§ 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 required for the dissemination of information relating to the services provided.

(vi) To carry on research work on forecasting problems with a view to increasing the accuracy of the forecasts and extending the period for which forecasts can be provided.

During the year an important change was made in the arrangements for broadcasting forecasts on the B.B.C. Home Service. The land area forecasts were replaced from November 19 by regional forecasts supplied by meteorological offices at selected outstations directly to the B.B.C. Regional Headquarters. By this means it was possible to provide more detailed forecasts and to take better account of local needs, especially with regard to agricultural operations.

An illustrated pamphlet entitled "Your weather service" was produced by the Central Office of Information on behalf of the Meteorological Office and published on February 21, 1951. It describes in popular language the organization and functions of the Office, and a large first edition was sold out within a few days.

Arrangements were made for the publication of an overseas supplement to the *Daily Weather Report*, to commence on January 1, 1951. The object is to allow the daily publication of surface and upper air observations made at British meteorological offices overseas.

A daily *post-factum* examination of the 24-hr. forecasts issued to the public was maintained at the Central Forecasting Office. On those occasions on which the forecast was not accurately fulfilled, the technical reasons were investigated in collaboration with the Forecasting Research Division.

(b) Reporting stations.—During the year the number of stations making synoptic reports decreased by six to a total of 163. Most of these stations are on airfields, and are manned by Meteorological Office staff, but the number also includes 46 auxiliary stations where the observers carry out their observing duties on a part-time basis ; 19 auxiliary stations report regularly in the full synoptic code and 27 in the shorter AERO code. Observers responsible for these auxiliary stations are recruited from many different professions. With experience they become highly skilled in the making of weather observations and carry out their duties with efficiency and enthusiasm.

The closing of some airfields and the opening of others has left certain areas (particularly in Scotland) with inadequate numbers of synoptic reporting stations. The situation has been improved by the opening of a new station at Glenmore Lodge, Inverness-shire, and further action is in hand.

(c) **Ships' reports.**—*Voluntary ships.*—The Voluntary Observing Fleet consists of the following classes of observing ships :—

(i) “ Selected ” ships, which make meteorological observations at standard synoptic hours. Meteorological instruments, instructions and logbooks are supplied to these ships. The observations are transmitted by wireless in the international code to meteorological centres for all oceans. The observations are also entered in logbooks which, when completed, are sent to the Marine Branch for climatological study. Approximately 500 ships, including 4 trawlers, co-operate in this manner.

(ii) Supplementary ships, which make observations in an abbreviated form at the main synoptic hours. These ships are supplied with a thermometer and screen, and, if required, a mercury or aneroid barometer ; these instruments are sufficient for reporting in the abbreviated code. The present number of supplementary ships is about 25 (which includes 11 trawlers), but it is hoped to recruit up to 50 in the near future. Supplementary ships do not invariably send radio weather messages, but have been asked to do so in areas where shipping is relatively sparse.

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

(iv) Eight light-vessels, which have been “ recruited ” to provide observations of wind, visibility, air and sea temperature twice daily, at 0600 and 1500 G.M.T. These observations are passed to the nearest coastguard station by radio-telephony and thence by telegram to the Central Forecasting Office, Dunstable. Four of these light-vessels make and report observations of waves.

About 105 ships' reports, three fourths of which were from British ships, were received daily at the Central Forecasting Office ; 52 per cent. of these reports were received within one hour of the time of observation. Rapid transmission is ensured by a direct teleprinter line between the Central Forecasting Office and the Post Office wireless station at Burnham-on-Sea.

Radio weather messages from ocean weather ships operated by other nations in the North Atlantic and from other foreign “ selected ” merchant ships have been received regularly throughout the year.

Arrangements were made for “ selected ” British whalers to co-operate with the Anglo-Scandinavian Expedition to the Antarctic, by providing synoptic reports at the standard hours. Reports were sent by W/T via South Africa, where they were also found very useful.

Four captains of “ selected ” ships were presented with barographs by the Director for their long and excellent service to the Meteorological Office.

Ocean weather ships.—During the year each of the 4 British ocean weather ships completed 3 years' service as a weather ship. This year saw the implementation of the scheme whereby a Netherlands ship will carry out 5 periods of duty at Station J, thereby permitting the “ lay up ” of each British ocean weather ship annually for survey, repairs and overhaul.

Station J, in position 52° 30' N., 20° 00' W., was manned on every day of the year except two, when the Netherland ship proceeded to Londonderry to land a sick man. Station I, in position 59° 00' N., 19° 00' W., was manned throughout the year by a British ship apart from occasions, totalling 8 days, when the vessel returned to Londonderry to land sick men. Although technically on station, the ship was moved on occasions to position 61° 00' N., 14° 00' W., for special operations.

The ships carried out a full programme of meteorological work, including surface and upper air observations, which were transmitted to the Central Forecasting Office by point-to-point W/T communication. Periodic search and rescue exercises have been carried out at frequent intervals in co-operation with aircraft of Coastal Command, with the aim of keeping the ships' companies conversant with search and rescue organization and drill. During these exercises mail and newspapers are invariably dropped by the aircraft, and urgently required spare parts for the radio were also dropped on occasions.

The weather ships' navigational aids are regularly used by both civil and Royal Air Force aircraft flying over the North Atlantic Ocean ; 3,534 aircraft have made use of the facilities provided by the ships during the year. Radio contact has been made frequently with ocean weather ships of other nations.

Special trials were carried out aboard the ships to determine and improve the accuracy of the 277(P) radar. Special observations were made to obtain data about rainfall, visibility and wave height at sea, and temperature and humidity in the lower levels of the atmosphere.

Mr. D. M. Houghton of the Imperial College of Science and Technology, London, sailed in *Weather Observer* on her 25th voyage, and carried out experiments with temperature-gradient equipment.

Mr. C. A. Halstead of Glasgow University sailed for a voyage in *Weather Watcher* to study the operation of the "Loran" long-range navigational aid at an ocean weather station.

By arrangement with the British Trust for Ornithology, four ornithologists made a voyage in ocean weather ships during the summer of 1950, as follows :—

Mr. A. Darlington sailed in *Weather Explorer*.

Mr. F. R. Allison sailed in *Weather Explorer*.

Mr. M. L. R. Romer sailed in *Weather Observer*.

Mr. M. A. Barras-Smith sailed in *Weather Watcher*.

During the period in which the steam trawler *Milford Viscount* was missing, *Weather Observer* maintained a listening watch on 141 m. with negative results. At the official inquiry the weather reports were quoted as evidence of the rough weather which *Milford Viscount* must have encountered.

Much credit is again due to all hands aboard the weather ships for maintaining the observational and communications routine under conditions which often involve discomfort and hardship and call for considerable ingenuity.

(d) **Meteorological flights.**—Routine meteorological reconnaissance flights have continued to be made by R.A.F. aircraft, operating over the eastern Atlantic from Aldergrove and Gibraltar, and over the Indian Ocean from Negombo (Ceylon). The flights from Gibraltar were discontinued in March.

Halifax aircraft were used for the flights from Gibraltar, but from January 15, 1951, Hastings aircraft were used for all flights from Aldergrove.

Routine vertical ascents for the purpose of obtaining temperature and humidity at a number of levels, together with detailed information of cloud structure, have been made from several alternative bases in the United Kingdom by Mosquito aircraft of Fighter Command. Similar ascents have also been made from Singapore. The routine vertical ascents which were established in the British Zone of Germany in June 1946 ceased in July 1950.

(e) **Radio-sonde and radar wind stations.**—Measurements of pressure, temperature, humidity and wind in the upper atmosphere are made four times daily

at eight stations in the United Kingdom, at the two British ocean weather stations, and at eight overseas stations under British control. Shortage of staff has prevented the full programme of ascents, particularly those for wind measurement, being maintained at all stations.

Measurements of pressure, temperature and humidity in the upper atmosphere are made by means of the Kew Mark II radio-sonde, and upper winds are determined by radar observations using the GL.III type of radar equipment. Routine ascents have been supplemented by special observations required for investigating both the technique of upper air sounding and general meteorological problems of the higher atmosphere. In particular, efforts are being made to achieve greater accuracy of measurements and to obtain observations at greater heights. The Ministry of Supply has co-operated in the development of new equipment of greater range and accuracy.

Special ascents have been made regularly in order to determine winds above the levels usually reached by the routine soundings. Heights greater than 100,000 ft. have been achieved on a number of occasions, the maximum being 110,000 ft.

The new combined radio-sonde and thunderstorm station at Hemsby was almost completed by the end of 1950, and the thunderstorm-location unit at Dunstable was transferred to Hemsby during January 1951. It is intended to move the radio-sonde unit from Downham Market to Hemsby later in 1951.

The training of new staff in radio-sonde work has continued at Downham Market.

Ozone spectrophotometers have been allotted to four stations, Camborne, Downham Market, Aldergrove and Lerwick, as part of the European network for determining the ozone content of the atmosphere and the relationship between variations in the amount of ozone and synoptic conditions.

(f) **Thunderstorm location.**—The four stations engaged in the direction finding of atmospheric ("Sferic") have continued in operation, but the observations formerly made at Dunstable have been transferred to Hemsby. Special observations have been made, on behalf of scientists at Cambridge and London Universities and at the National Physical Laboratory, for use in investigations on the propagation and wave form of long radio waves. This work has been additional to the routine observations made for synoptic purposes.

(g) **Meteorological communications.**—*Land-line communications.*—The meteorological teleprinter network within the United Kingdom now distributes basic data, by means of the first-channel broadcast, from Dunstable to 155 stations, and supplementary data, by second-channel broadcast, to 58 subcentres and important airfields. The subcentre at Inverness was closed on April 28, 1950, and its satellite stations were transferred either to Prestwick or to Pitreavie. No important changes have taken place in the operation of the North Atlantic teleprinter broadcast to selected recipients compiling Atlantic charts. The meteorological teleprinter network controlled by the United States Air Force Headquarters in Great Britain has expanded, and a certain number of airfields receive data from the Central Forecasting Office, Dunstable, via this network. Plans for integrating the meteorological circuits interconnecting Air Traffic Control centres with the Dunstable broadcast channels are being considered in connexion with a proposal to replace the existing 14 collecting centres by a smaller number of regional offices.

The teleprinter exchange of data between the Central Forecasting Office and continental centres has continued to function satisfactorily. Since September 1950 Italian data have been received from Rome by through-switching at Paris, and the continental circuits have been extended to include

Oslo, Stockholm and Helsinki via Copenhagen. Schedules for the transmission of data over the Scandinavian circuits were the subject of a meeting held in the British Zone of Germany in August 1950.

Trials of facsimile transmission of weather charts have been carried out by land-line between Dunstable and London Airport by sending three charts daily. Small charts of size 8 in. × 10 in. are sent in approximately 6 min. It is hoped that a contract may be placed in the near future for the development of a machine to meet the Meteorological Office specification. This provides for the transmission of charts 18 in. × 22 in., and will permit reception of transmissions made by other meteorological services.

A tentative plan has been drawn up for improved telecommunications rooms suitable for use in any permanent building which may replace the present Central Forecasting Office.

A check in December 1950 showed that approximately 480,000 message groups per day are handled at the Central Forecasting Office; this includes both teletypewriter and radio traffic.

Radio communications.—In consequence of the international recommendation of 1949, referred to in last year's Report, new schedules for the continental broadcast from Rugby were introduced on June 1, 1950. The change enables this broadcast to meet the needs of European countries as well as those of other regions. No change has been made in the contents or schedules of the GFL transmissions giving British upper air data.

In an attempt to collect as much data as possible for the construction of northern-hemisphere charts a number of changes have been made in the programme of reception of the more distant meteorological broadcasts. The need is being felt for space for a better aerial array at Dunstable. In particular, with the present arrangement, reception from Tokyo is unsatisfactory, and as a temporary measure it has been arranged that certain broadcasts from Tokyo are received at Singapore and retransmitted to Dunstable over a R.A.F. radio-teletypewriter circuit.

American data are normally received via Paris, but a radio-teletype receiver is in operation at Dunstable to permit reception of data either direct from New York or from the relay station in the Azores, depending upon ionospheric conditions.

Efforts to obtain an allocation in the medium- or long-wave bands for the radio-telephony broadcast (AIRMET) have proved unsuccessful so far. It has therefore not been possible to restore this service, despite the strong representations which have been made by aviation, agricultural and other interests.

The radio interception of reports from British and foreign ocean weather vessels in the Atlantic Ocean continues to be satisfactory.

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

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

(a) British Broadcasting Corporation.—*Sound.*—Daily weather bulletins for the general public and for shipping have been maintained. The section of the 5.55 p.m. bulletin previously concerned with land-area forecasts was superseded on November 19 by separate regional forecasts issued from each of the six B.B.C. regional transmitters. In addition a daily weather bulletin for western Europe has been prepared for broadcast on the B.B.C. European Service in English, since September 1.

Television.—The daily broadcast of meteorological charts and forecasts from the London and Birmingham television studios was maintained without change.

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

(c) *Road Research Laboratory.*—Forecasts and warnings of drifting snow or ice formation on roads in London and the Home Counties were supplied on similar lines to those of the previous year.

(d) *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. The special meteorological unit at the Headquarters of the British Electricity Authority was maintained.

(e) *Belfast Harbour Power Station.*—Special week-end temperature forecasts were issued throughout the year.

(f) *North of Scotland Hydro-Electric Board.*—Warning messages relating to snowfall and marked changes in temperature were supplied on appropriate occasions.

(g) *Gas undertakings.*—Warnings of expected fluctuations in meteorological elements affecting day-to-day requirements for gas were issued as in previous years.

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

(i) *Agriculture and horticulture.*—*Frost warnings* were supplied on appropriate occasions to County Branch Officers of the National Farmers' Union for dissemination to fruit growers and market gardeners.

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

(j) *Flood warnings.*—Forecasts of conditions liable to result in flooding, or in substantial increases of river flow, have been supplied to the Thames Conservancy Board and the Yorkshire Ouse and Great Ouse Catchment Boards.

(k) *Docks and inland waterways.*—Warnings of persistent frosts, likely to produce ice on canals in the Wolverhampton area, were supplied on appropriate occasions.

(l) *Road engineers and automobile clubs.*—Warnings of the onset of meteorological factors associated with adverse road conditions were supplied to various Government Departments, local authorities and motoring associations. A greatly increased use was made of snow warnings to assist local authorities with snow-clearance schemes.

(m) *Mines.*—Warnings of sharp falls in barometric pressure were issued to two Welsh Collieries, in connexion with experiments on a colliery warning system.

(n) *Factories and other commercial undertakings.*—Special forecasts have been supplied, as in previous years, of weather conditions affecting industrial processes.

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

(p) *Sport and recreation.*—Many special forecasts were issued on request in connexion with various sports and recreations.

(q) **Festival of Britain.**—Daily forecasts of the prospects of snow, rain or frost were supplied in connexion with constructional work on the Festival of Britain sites in London.

(r) **High-level flights.**—As a result of the development of high-flying aircraft, forecasts have been issued of winds at levels up to 50,000 ft.

(s) **General Public.**—Numerous forecasts have been supplied, on request or by pre-arrangement, by the meteorological offices specified in the Post Office Guide.

(3) Services to the Royal Air Force

(a) **General.**—There was no major change in the organization of meteorological services to the Royal Air Force. At each R.A.F. operational Command Headquarters at home and overseas a Chief Meteorological Officer is provided as meteorological adviser to the Air Officer Commanding in Chief and his staff officers. Similarly at most R.A.F. Group Headquarters a Senior Meteorological Officer acts as adviser and has a continuous 24-hr. forecasting section. The Group meteorological office acts as “parent” to a number of subsidiary meteorological offices which are located at R.A.F. operational stations and provide limited forecasting facilities, depending on the activities of the individual stations. In this way about one half of the staff of the Meteorological Office is employed at R.A.F. stations, primarily, if not solely, to meet the requirements of the R.A.F.

With the expansion of the Defence Services a number of new offices were opened later in the year, particularly in Fighter and Flying Training Commands. Moreover, the re-equipment of auxiliary squadrons with jet aircraft involved additional meteorological commitments, and efforts have been made to provide forecasting services at airfields from which R.Aux.A.F. jet aircraft operate, by detaching staff, mainly at week-ends, from neighbouring meteorological offices.

In the British Zone of Germany, the policy was continued of using German forecasters and assistants at R.A.F. and civil aviation stations, under the supervision of British staff.

Little change occurred in the Middle East area, but the financial responsibility for meteorological services in Libya and Eritrea was transferred to the local Administrations, while technical control remained with the British Meteorological Office.

In the Far East some strengthening of the meteorological organization was necessary owing to the increased activities of the military forces in Malaya, and to the continuing risk of a state of emergency in Hongkong.

(b) **Organization.**—International Civil Aviation Organization sub-area broadcasts or R.A.F. broadcasts of weather reports and landing forecasts have continued to be made from stations in the United Kingdom, the British Zone in Germany, the Middle East and Gibraltar. Meteorological facilities have been provided for the R.A.F. R/T Flight Information Service in the United Kingdom. TALK-TO-MET facilities whereby meteorological information is supplied direct to overflying aircraft by R/T have continued at Shaibah and El Adem, and have been used by civil as well as service aircraft.

In view of the increasing use of jet aircraft, and the limited number of radar wind stations in the Middle and Far East, efforts were made to extend upper air observations by pilot balloons to greater heights, and some success has been achieved.

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

(d) **Miscellaneous activities.**—In addition to the meteorological facilities normally provided, extra services were furnished for Exercises, the Battle of Britain Fly-Past, long training flights by pilots of the R.A.F. Flying College Manby and of Shawbury, flights by reinforcement jet aircraft to the Far East, the transatlantic flight of a Canberra aircraft, and the R.A.F. Display at Farnborough. During the autumn exercise full meteorological facilities were provided at centres in Fighter Command, and forecast services, mainly at week-ends, were made available at four stations in Home Command. Many R.A.F.V.R. (Meteorological Section) personnel undertook duties during the exercises, and a number of Royal Observer Corps sections supplied special weather reports to our collecting centres.

Discussions on the meteorological problems connected with the operation of jet aircraft have been held, and arrangements are being made for the issue twice daily by the Central Forecasting Office of analyses and forecasts of winds and temperatures at the 200-mb. and 150-mb. levels.

Investigations into weather conditions suitable for photographic reconnaissance from high levels are being made.

Reports of turbulence at high levels and of condensation trails from jet aircraft continue to be obtained from R.A.F. pilots.

Assistance was given in trials of radar cloud-warning equipment in the Far East.

(e) **Meteorological instruction for the Royal Air Force.**—Meteorological instruction has continued at a large number of schools in Flying Training and Home Commands, at Operational Conversion Units and at stations in R.A.F. Commands at home and overseas. Advice has been given on syllabi for meteorological courses.

Arrangements were made for the production of a simple three-dimensional model of a typical depression as a visual aid for class-room use, and assistance has been given in the production of meteorological film strips.

Authority has been obtained for each forecaster at the R.A.F. Flying College, Manby, to make up to three flights a year, on the Manby–Malta–Gibraltar–Manby flights. The main object is to allow the forecaster to give meteorological instruction in flight.

(4) **Services for Civil Aviation**

(a) **Organization.**—Meteorological facilities were provided in the United Kingdom and overseas in conformity with the recommendations of the Regional Air Navigational meetings of the International Civil Aviation Organization.

Main meteorological offices at Gloucester, Preston, Prestwick and Uxbridge continued to provide information for their associated Air Traffic Control centres. Half-hourly weather reports and hourly landing forecasts for the use of aircraft in flight were broadcast by radio-telegraphy from these four offices.

The meteorological office at Inverness (Raigmore) was closed on April 15, 1950, when the Air Traffic Control Office there ceased to operate. The main responsibility for Air Traffic Control was then assumed by Prestwick for the north-west area. The requirements of the Air Traffic Control subcentres in

Scotland, which were opened by the Ministry of Civil Aviation to take over part of the work previously performed by Raigmore, were met by the existing meteorological offices at Dyce and Grimsetter.

The special needs of jet aircraft were studied, and necessary modifications of standard meteorological procedures were worked out in preparation for the introduction into service of Comet aircraft.

(b) Services provided in the United Kingdom for trunk routes.—Civil aircraft operating on the trunk routes, including the North Atlantic, continued to be served by the meteorological offices at London Airport, Prestwick, Bovingdon and Hurn.

London Airport.—Civil air operations continued to develop at London Airport. Forecasts were provided for routes with near and distant European and Mediterranean terminals, and also for North Atlantic routes. Most of the forecasting service previously given by Shannon, for flights between London and North America, was taken over by London airport.

Prestwick.—The meteorological office here continued to provide forecasts and briefing for transatlantic flights and for flights to and from various European centres, and to supply meteorological information to the Prestwick Oceanic Air Control and the Scottish Air Traffic Control centre.

The office ceased to act as the main meteorological communicating centre for the exchange of meteorological information between Canada and the United Kingdom.

Hurn.—Besides meeting the requirement as a main diversion airfield for London Airport, the office assisted in the training of Air Traffic Control Officers.

(c) Services provided in the United Kingdom for internal and European routes.—Meteorological offices were maintained at 22 aerodromes in the service of airlines operating on routes within the United Kingdom and to European terminals.

The telephone conferences held to co-ordinate technical opinion on weather conditions in the London area were increased to four daily.

In consequence of British European Airways' decision to operate aircraft carrying no radio operator, a series of V.H.F. radio-telephony meteorological broadcasts was instituted on Area Control frequencies. These broadcasts were made half-hourly from Preston, Prestwick and Uxbridge, and contained weather reports in plain language.

A revised meteorological organization was agreed with the Irish Meteorological Service and brought into operation on Dublin-United Kingdom routes. Special arrangements were made for the provision of meteorological information for British European Airways helicopter services between Liverpool and Cardiff.

At the invitation of the International Air Transport Association a representative of the Meteorological Office was present as an observer at the fourth meeting of the Association's Meteorological Panel for the Europe-Mediterranean Region.

At the request of the States of Jersey arrangements were made for the meteorological office at Jersey aerodrome to be connected to the United Kingdom meteorological teleprinter network.

(d) Services provided overseas.—*British West Indies.*—At a conference in Trinidad early in 1951 it was agreed that a Unified British Caribbean Meteorological Service should be formed under a Director who would be directly

responsible to the respective local Colonial governments. Pending the appointment of a Director the offices located in the Caribbean continued to function under the control of the Meteorological Office.

(e) **Examinations.**—Forty examinations were held in meteorology for the Commercial Pilot, Senior Commercial Pilot, Airline Transport Pilot and Flight Navigator Licenses, and for Instrument Ratings' and Air Traffic Control Officers' primary courses; 629 candidates were examined.

(f) **Special work.**—Experiments to decide the best way of determining how much of a runway, or its lighting system, a pilot will be able to see when landing in poor visibility were continued at London Airport; similar experiments were started at Northolt. Work began at London Airport on the related problem of determining how much of the aerodrome lighting system a pilot will be able to see when making an approach to a runway in poor visibility.

Information was provided on the weather factors affecting the use of an aerodrome for the inquiry, conducted by Lord Brabazon, into the relative responsibilities of the captain of an aircraft, the operator and the aerodrome authority in bad-weather conditions.

Arrangements were agreed with the Ministry of Civil Aviation for the training and certification of Air Traffic Control Officers who are required to report weather observations at certain civil aerodromes where there are no meteorological observers.

Detailed reports were prepared on the meteorological aspects of the aircraft accidents at Mill Hill on October 17, 1950, and London Airport on October 31, 1950, and representatives of the Meteorological Office gave evidence at the subsequent public inquiries.

Early in 1950 a committee was appointed to review the meteorological arrangements for civil aviation. The committee met several times during the year under the chairmanship of the Controller of Ground Services, Ministry of Civil Aviation, and included representatives from both the Air Ministry and Ministry of Civil Aviation. Evidence was taken from the Airways Corporations and the United Kingdom Associations and Guilds concerned with civil aviation. The report of this committee states that it found nothing fundamentally wrong with the existing system. Indeed it found among the representatives of the Corporations and of the Pilots' Associations a sincere respect for the Meteorological Service of this country and a general confidence in the accuracy of its forecasts.

The report also contained a number of recommendations on points of minor character, most of which have been adopted.

(5) Services for the Royal Navy*

Basic meteorological information, analyses and forecasts have continued to be provided for the Navy by main meteorological offices overseas. Cyclone warnings for an area of the Indian Ocean were provided by Negombo.

During joint R.N. and R.A.F. Exercises the Area Combined Headquarters have been manned, and meteorological facilities provided for R.N. and R.A.F. personnel. The Area Combined Headquarters was also supplied with meteorological information during a Western Union Exercise. There was an exchange of weather reports between land stations and H.M. Aircraft Carriers during the Exercises.

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

(6) Services for the Army

The meteorological office at the School of Artillery, Larkhill, has supplied information for artillery purposes, and has given meteorological instruction to courses held at the School, and advice on special problems. Other artillery requirements at Practice Camps, at Stanford Primary Training Area, and at an Army Exercise, were met either by the temporary attachment of meteorological staff or by the provision of information from a near-by meteorological office. Meteorological facilities for the Army have also been provided in Overseas Commands.

The Meteorological Office continued to be represented on a number of War Office committees, and close liaison has been maintained with branches of the War Office.

Assistance in matters concerning meteorological instruction has been given to the Science Department, Royal Military Academy, Sandhurst.

A syllabus in meteorology for the training of personnel of Royal Pioneer Corps Smoke Companies was prepared for submission to the Director General of Military Training, War Office.

(7) Services for the Ministry of Supply

No change in the existing meteorological offices provided at Ministry of Supply establishments has occurred.

Requests were received from the Ministry of Supply for the provision of radio-sonde equipment at Shoeburyness and of radio-sonde/radar wind equipment at Aberporth. After discussions, it was agreed to explore the possibility of using existing Army radar equipment at Aberporth for radar wind observations, and to use the existing network of radio-sonde stations for determinations of temperature and pressure.

Visits have been made to Eskmeals, Cumberland, to select a site for the meteorological office to be established there, and to make recommendations for its design.

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

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

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

(9) Services for the Commonwealth

(a) **Middle East area.**—*Malta.*—The Meteorological Office has continued to maintain a forecasting service at Luqa and a radio-sonde/radar wind unit at Qrendi. Meteorological facilities have been provided for all R.A.F. and civil aviation services. The exchange of meteorological information with neighbouring countries continues to increase.

Cyprus.—The Meteorological Office has continued to maintain a forecasting service and a radio-sonde/radar wind unit at Nicosia and three reporting stations in Cyprus. Meteorological facilities have been provided for all R.A.F., military and civil aviation services. Technical advice on the operation of climatological stations maintained by the Cyprus Government and on artificial rain-making, has been given to the Director of Public Works.

Aden.—A forecast service and a radio-sonde/radar wind unit have been maintained at Khormaksar to meet the meteorological requirements of the R.A.F., of shipping and, to an increasing extent, of civil aviation. A number of meteorological reporting stations along the south Arabian coast and on Kamaran Island continue to be maintained.

British Somaliland.—The meteorological reporting station at Hargeisa was handed over to the local administration, while that at Berbera was closed in December 1950.

Pakistan.—A forecasting service was maintained at the R.A.F. Staging Post, Mauripur, to meet the requirements of the Royal Air Force and of the Royal Pakistan Air Force. The teleprinter channel linking the meteorological office at Mauripur and the Pakistan Meteorological Department at Karachi has been improved, thus facilitating the exchange of information between the two services.

(b) **Far East area.**—*Ceylon.*—Forecasting facilities for all R.A.F. and civil aviation services operating in and through Ceylon have continued to be provided by the British meteorological office at Negombo. A meteorological reporting station has been maintained at Trincomalee.

From March to September 1950, forecasters of the Ceylon Meteorological Service were attached to the meteorological office, Negombo, for periods of three months' practical training in forecasting; afterwards two Cingalese forecasters undertook roster duties at Negombo. Basic synoptic data are supplied to Colombo Observatory so that the staff there can have practice in the plotting and use of synoptic charts.

Close liaison has been maintained with the Ceylon Meteorological Service, and it is expected that the latter will take over the commitments for civil aviation and responsibility for the national meteorological broadcast during the coming year.

Male.—Assistance has been given to the Maldivé Islands authorities in the maintenance and operation of an upper wind observing station at Male.

Malaya.—The Meteorological Office continues to be responsible for meeting the requirements of the R.A.F., and maintains offices at Changi, Tengah, Seletar and Butterworth. Negotiations for the Malayan Meteorological Service to undertake the commitments for the R.A.F. have been continued.

In view of the requirements for jet aircraft, arrangements were made for radar wind observations in Singapore with an Army radar set operated by Army personnel. The balloons and targets are prepared and released by Meteorological Office staff, who also compute the winds from readings supplied

by Army personnel. Hydrogen is provided by the Director, Malayan Meteorological Service. A modification for use on the radar set has been supplied to enable the wind observations to be made to greater heights with fewer staff.

Nicobar Islands.—A meteorological reporting station has been maintained at Car Nicobar.

Hongkong.—A small complement of Meteorological Office staff has been maintained to assist the Royal Observatory in meeting the requirements of the Army and Royal Air Force.

Radio-sonde equipment and stores were sold to the Director, Royal Observatory, Hongkong, on October 1, 1950. Upper air soundings are being made at 2300 G.M.T. (0700 Hongkong time), daily.

(c) *British West Indies.*—The United Kingdom continued to operate the meteorological service in the British West Indies pending the appointment of a director of the British Caribbean Meteorological Service (see p. 14).

(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 has continued to be responsible for the provision of meteorological services in the British Zone of Germany and in Berlin, to meet the needs of the British occupational forces, the High Commission and civil aviation.

In addition, control is exercised over the German Zonal Meteorological Service, which provides a basic network of reporting stations and meets the needs of the German economy. This control is exercised by the Chief Meteorological Officer through an officer located in Hamburg at the Headquarters of the German Service, Meteorologisches Amt für Nordwestdeutschland.

The meteorological communications centre at Quickborn/Pinneberg was handed over to Meteorologisches Amt für Nordwestdeutschland in October 1950, but responsibility for the western European teleprinter network remaining with the Chief Meteorological Officer.

The Chief Meteorological Officer has been a member of an Allied working party and is now a member of an Allied Meteorological Board, under the General Committee of the Allied High Commission. These organizations were created, after negotiations between the British, French and American authorities, to bring about the fusion of the German meteorological services in the three western zones of Germany.

Austria.—A small meteorological office has been maintained at Schwechat (Vienna) with a British officer in charge of Austrian forecasters and assistants. This officer also acts as British representative at meteorological meetings of the Occupying Powers.

(b) *Middle East area.*—*Libya.*—In consequence of the discussions with the Foreign Office, mentioned in last year's Report, financial responsibility for the provision of basic meteorological services in Tripolitania was assumed, with effect from April 1, 1950, by the British Administration in Tripolitania, and a similar arrangement in regard to Cyrenaica is in process of completion. Technical control continues to be exercised by the Director of the British Meteorological Office through the Chief Meteorological Officer, Middle East Air Force. Staff based on the United Kingdom will continue to fill posts in the new organization for which suitably trained candidates of local origin are not available.

The organization described in last year's Report was maintained, with forecasting offices at Castel Benito and El Adem and small networks of reporting stations in Tripolitania and Cyrenaica.

Egypt.—The British Meteorological Office continued to be responsible for the provision of meteorological facilities for British Military Forces in the Canal Zone. Close liaison was maintained with the Egyptian Meteorological Service.

Sudan.—Two forecasters and two assistants continued to be provided at Khartoum, primarily to meet R.A.F. requirements.

Control of the meteorological W/T organization at Khartoum was transferred from the Air Ministry to the Sudan Government Posts and Telegraphs Department on May 1, 1950.

Somalia.—The meteorological service in the former Italian Somaliland was handed over to the Italian Government which bought most of the Air Ministry meteorological equipment there.

Eritrea.—Financial responsibility for meteorological services in Eritrea was transferred from the Air Ministry to the British Administration on April 1, 1950, technical control remaining with the Meteorological Office. Forecasting staff at Asmara continue to be provided by the Meteorological Office.

Trans-Jordan.—Some meteorological equipment was sold to the Arab Legion, Trans-Jordan.

The reporting station at Amman has been maintained.

Iraq.—The Meteorological Office continued to maintain forecasting services at Habbaniya and Shaiba.

Close liaison was maintained with the Iraqi Meteorological Service, and some assistance continued to be rendered to that Service by the British offices at Habbaniya and Shaiba. Early in 1951 it was agreed that the Iraqi Meteorological Service, Baghdad, would cover meteorological commitments for civil aviation at Basra between the hours of 1900 G.M.T. and 1000 G.M.T. the next day.

Persian Gulf.—The forecasting service and radio-sonde/radar wind unit at Bahrein and the reporting station at Sharjah have been maintained. There has been a steady increase in the use being made by civil aviation of meteorological facilities at Bahrein.

(c) *Far East area.*—Liaison has been maintained with the meteorological services in the Far East area.

§ 3. CLIMATOLOGICAL SERVICES RENDERED BY THE METEOROLOGICAL OFFICE

The Climatology Division is situated at Harrow. It is concerned with British Climatology (including the British Rainfall Organization), World Climatology, Agricultural Meteorology, and Upper Air Statistics, and is also in charge of the Meteorological Office Central Library. Marine Climatology is the responsibility of the Marine Branch.

The meteorological office, Edinburgh, is responsible for collecting climatological and rainfall data from stations in Scotland, and the majority of inquiries for climatological information for Scotland are also answered from that office; but statistics for publication are prepared at Harrow for the whole of Great Britain and Northern Ireland.

(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 ; with the preparation of publications containing summaries of these observations ; and with replying to climatological inquiries from the general public, commercial and industrial firms, and Government Departments.

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

Crop weather stations are maintained in co-operation with the Ministry of Agriculture and Fisheries.

Climatological and rainfall stations are maintained by private observers, or by municipal or other local authorities, almost in every case without payment by the Air Ministry. Great public spirit is shown by those who participate in the operation of these stations, often at personal inconvenience because of the necessity for regular readings each day at fixed times. Some of the climatological stations make additional reports for daily publication in the Press under a Health Resorts Scheme.

Additional rainfall records have been made available from ten stations in Northern Ireland by the engineering staff of the Government of that country.

Special attention has been given to increasing the accuracy of the returns, both by inspection and correspondence, and to ensuring that the observations conform to standard requirements. With this object in view, instructional courses for observers were also resumed at the Training School.

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

(d) Publications.—Several series of publications, suspended during the war, are still in arrears.

The *Monthly Weather Report*, which contains full monthly and annual summaries of observations at synoptic and climatological stations, has been issued regularly.

Monthly Frequency Tables of upper winds, clouds and visibility have been published up to August 1947. From January 1948 the monthly publication of these tables ceased. The data for January 1948 onwards will be issued as an annual volume for certain selected stations, while the data for the remainder of the stations will be published every five years.

British Rainfall.—The arrears of publication caused by the war have now been overtaken, although printing difficulties are still encountered. A volume covering the three war years 1943-45 was published in October 1950, and *British Rainfall 1948* appeared in January 1951. The volume for 1949 is with the binders and that for 1950 is in preparation.

The *Observatories' Year Book*, containing the geophysical records of the observatories, has not been published since the volume for 1937.

(e) Special Work.—*Climatological Atlas of the British Isles.*—Publication of this work is expected shortly. The volume includes 52 pages of text and 56 pages of maps and diagrams. The ready co-operation of His Majesty's Stationery Office and of the Air Ministry Survey Production Centre in this important work is gratefully acknowledged.

Hydrology.—The ever-increasing requirement by industry, agriculture and domestic users for adequate supplies of water justifies a closer study of what happens to precipitation after it reaches the ground. A special section is in process of formation to co-ordinate the available information on hydrology and to carry out further investigations in collaboration with other interested departments and establishments.

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

(i) the Rainfall, Run-off and Floods Committee of the Institution of Civil Engineers.

(ii) the Hydrological Research Group of the Institution of Water Engineers.

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

(iv) the British Rainfall Fund Committee of the Royal Meteorological Society.

(v) a technical panel of the Sub-Committee on Land Drainage of the Central Advisory Water Committee.

(vi) the Study Committee on Basic Design Temperatures for Space Heating Installations of the Institution of Electrical Engineers.

Inland Water Survey Committee of the Ministry of Local Government and Planning.—Details of the general monthly rainfall 1937 to 1945 were prepared for areas for which run-off data were available, for inclusion in a report on the "Surface Water Resources of Great Britain" in continuation of those published for the seasonal years 1935-36 and 1936-37. The Assistant Director (Climatology) sat on this Committee as an assessor.

(f) *Inquiries.*—A great many requests were received for various kinds of climatological information in connexion with law cases, water supply and flooding problems, town planning, etc., and also with the work of agricultural, industrial and research organizations, both within Government Departments and outside. Many of these inquiries involved considerable investigation and the presentation of data in special ways to suit particular needs.

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

Monthly reports on the rainfall of the Thames and Lea Valleys have been supplied to the Metropolitan Water Board, Thames Conservancy and Lea Conservancy Boards. Weekly, quarterly and annual summaries of the weather were sent to the Registrar-General for England and Wales, and similar information was supplied each quarter and year to the Government of Northern Ireland. Weekly summaries of the data from crop weather stations were prepared for circulation by the Ministry of Agriculture and Fisheries under the crop weather scheme. Data for Northern Ireland were supplied regularly to the Irish Republic.

Monthly, quarterly and annual summaries of weather in Scotland were prepared by the meteorological office, Edinburgh, for the Registrar-General for Scotland, and, in connexion with plans for post-war development in Scotland, the office was consulted by authorities interested in housing and town planning, tourist attractions, hydro-electric schemes, and the utilization of seaweed and peat. Close touch was maintained with agricultural research and water supply organizations.

(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.

(a) **Overseas stations.**—Stations in operation at the end of 1950 numbered 89, distributed as follows :—Europe 6, Asia 23, Africa 37, South America 2, West Indies and other oceanic islands 15. In addition, by courtesy of the Directors of the Meteorological Service of New Zealand and of the British West African Meteorological Service respectively, manuscript returns were received from 10 islands in the Pacific Ocean and from 6 stations in west Africa. Manuscript returns were also received from 6 stations in the Falkland Islands and the Dependencies for the years 1948 and 1949.

Modifications of the forms for sending in monthly meteorological data were prepared for use at overseas stations from January 1951 ; on these forms all times are given in the local zone time appropriate to the station.

The collection of meteorological summaries from the colonial territories was continued. Annual summaries from manuscript returns for 1939 to 1947 for 6 stations were manifested for issue with other colonial printed returns for those areas. Some progress was made in the preparation of the "Notes". Copies of meteorological summaries were received from 6 colonies for 1948 and from 9 for 1949.

The table of monthly data for stations in the British Commonwealth which formerly appeared in the *Meteorological Magazine* was discontinued after publication of the annual table for 1949. The need for the table has diminished now that monthly means for the greater part of the world are issued in CLIMAT broadcasts ; these W/T broadcasts are made monthly by most countries, and the data are available for study in the Meteorological Office Library at Harrow.

(b) **Réséau Mondial.**—Owing to lack of staff no further progress was made with the volumes for 1933-39. No data were received during the year.

(c) **Naval handbooks.**—Work on the revision of Volumes I and II of "Weather in the Mediterranean" was nearing completion by the end of the year. Work was begun on a handbook of "Weather in the Black Sea" as a supplement to "Weather in the Mediterranean."

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

(e) **Falkland Island Dependencies.**—At the request of the Governor of the Falkland Islands the Office has undertaken the general supervision of the work of summarizing and preparing for publication the arrears of climatic data up to the end of 1950 from the stations of the Falkland Islands Dependencies. Mr. H. E. Carter was specially appointed by the Colonial Office for the work and will take up his duties on April 1, 1951.

(f) **Special work.**—The study of the distribution of vapour pressure over the world was continued ; provisional charts were prepared for January, April, July and October.

Monthly charts of the average pressure distribution over the northern hemisphere, based as far as possible on mean-of-day values for the period 1901-30, were prepared for internal use in the Office.

Data from the monthly CLIMAT broadcasts were tabulated month by month, and charts of the mean pressure distribution and its departure from normal over a large part of the northern hemisphere were plotted.

Climatic tables were prepared for publication in various *Meteorological Reports* and a large number of temperature tables were supplied also to the Ministry of Civil Aviation.

A large number of visitors from many parts of the world were shown the work of the Branch.

(g) **Inquiries.**—Many varied and interesting requests were received from Government Departments, commercial firms, aviation companies, astronomers and research workers about the climate of all parts of the world. Main interest was shown in temperature and humidity, and nearly 2,000 tables of these elements were issued.

(3) Marine Climatology

(a) **Collection of observations.**—On the average some 55 ships' logbooks of weather reports have been received each month in the Marine Branch. Logbooks and upper air data have been received regularly from ocean weather ships at Stations I and J. Microfilmed weather data (surface and upper air) have been received from all the Atlantic and Pacific ocean weather stations. Special arrangements have been made with the Netherlands whereby copies of original records of observations made at Station J are supplied.

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

(i) Observations from logbooks received from British voluntary observing ships and weather ships and from Naval logbooks have been punched on Hollerith cards. The total number of observations punched was 344,757 not counting the repunching of 8,000 German cards received in a damaged condition.

(ii) Duplication of data from the North Atlantic by the Netherlands Meteorological Service is continuing. Four batches of cards were shipped, comprising 2,158,867 cards.

(iii) The tabulation of data extracted from the logbooks of British "selected" ships in the southern hemisphere and sent monthly to the United States for a special research project comprised 38,792 observations.

(iv) The tabulation of Indian Ocean southern hemisphere data sent monthly to Indonesia comprised 19,632 observations.

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

Work on the surface-current atlas for the western South Pacific Ocean is nearing completion.

An investigation is in progress of the meteorological conditions preceding the occurrence of ice on the north-west coast of Iceland. It is hoped to develop a method of forecasting ice in this area.

(d) **Admiralty Pilots.**—The sections relating to currents have been entirely rewritten for new editions of eight Admiralty Pilots, and generalized current charts have been prepared for these. Sections relating to ice in two Pilots have also been rewritten. The revision of the meteorological sections of Pilots required during the year has been co-ordinated with the World Climatology Branch and meteorological charts have been prepared for these publications.

(e) **Special work.**—Papers were prepared on :—

(i) Diurnal variation of pressure in the Mediterranean Sea.

(ii) Comparison of bucket and intake methods for measuring sea temper-

atures, based on data obtained from British ocean weather ships and from merchant ships.

(iii) Seasonal variation of the axes of low-latitude pressure and divergence patterns over the oceans.

(iv) Seasonal changes in the mean pressure distribution over the world and some inferences about the general circulation.

Work is continuing on the following :—

(i) Some measurements of diurnal variations of air temperatures over the free oceans.

(ii) Variation of mean upper wind velocity and momentum with height for the area between the British Isles and 20°W.

(f) **Inquiries.**—Considerable information, including statistical tables and charts of marine data, was prepared for other Government Departments, the Naval Weather Service and various shipping companies. Much of the above was concerned with legal inquiries and investigations into shipping casualties.

(4) Agricultural Meteorology

The Agricultural Meteorology Branch is responsible for the application of existing meteorological data, facilities and knowledge to agricultural problems, and also for research into fundamental questions such as microclimate, the relationships between weather and crops, pests, diseases, husbandry, land utilization, etc.

(a) **Liaison with other organizations.**—The close liaison with officials of the Ministry of Agriculture has been maintained at headquarters, provincial and county level. All the experimental husbandry farms and experimental horticulture stations have been visited, and the Branch assists in both the planning and conduct of field experiments at these stations.

Weekly weather summaries were issued to all Provinces of the National Agricultural Advisory Service, the total circulation being about 500 copies ; these summaries proved to be of great value in presenting a succinct picture of weather on a county scale for the use of specialists in connexion with current investigations and surveys.

Many visits were made to Research Institutes and Universities, and lectures were given to students, research staffs, scientific societies, and growers' associations.

A special visit was made to Scotland to meet representatives of the Department of Agriculture, universities and research establishments, and much preliminary work was done with the intention of extending agricultural meteorological facilities in that country.

In addition to the annual meteorological display at the National Farmers' Union Market Produce Show at Southampton, assistance was given to the Ministry of Agriculture exhibits there dealing with fruit plantations and bulb storage. A special wind tunnel, showing the effect of a hedge on the diminution of wind in an orchard, was displayed at the Science of Weather Exhibition at South Kensington.

Further liaison with the National Farmers' Union resulted in the dissemination of frost forecasts and hill snow warnings by the Forecasting Division to farmers through the medium of the National Farmers' Union County Secretaries.

(b) **Special work.**—Acting in co-operation with the Plant Pathology Laboratory a system of potato blight warnings was arranged during the summer of 1950, using the network of synoptic reporting stations, which advised the

pathologists when periods of warm humid weather occurred. In a year when blight was both early and widespread, reaching epidemic proportions in some areas, the warning system worked very well, and not only was much valuable produce saved but considerable information was obtained concerning the spread of the disease and its dependence on weather.

Papers have been prepared on the rainfall variability over the main horticultural areas of England, namely Kent, the Vale of Evesham, the Fens, Somerset, and the Hampshire and Sussex coast.

Research concerning temperatures under glass continued at Cheshunt and Botley experimental stations, and concerning hillside microclimate at Wye. Assistance was given to experimental work concerning glass-house climate at Chichester, and is planned for similar problems at Beyfordbury and Kirkham.

Assistance was given to the National Fruit Trials at Wisley in regard to frost prevention experiments there, using water sprays. The initial results were encouraging and the experiment will be repeated in 1951.

Much information was co-ordinated on the subjects of shelterbelts (in co-operation with the Commonwealth Forestry Bureau), night minimum radiation temperatures, and relative humidity in connexion with grain storage (in co-operation with the National Institute of Agricultural Engineering).

Help and advice were given (with the aid of the British Climatology Branch) to the University of Wales and the University of Reading in regard to the planning of microclimatic investigations in the Dovey Valley and the Thames Valley respectively.

(c) **Inquiries.**—Many inquiries were received and dealt with concerning a wide variety of agricultural problems. The advice required generally included climatic information, the interpretation thereof, and the selection, siting, and validity of instruments. Subjects dealt with in this manner included questions concerning crop summaries, land utilization, photoperiodicity, shelterbelts, spore dispersion, “strangles” disease in sugar beet, aphid flights, frost prevention, potato blight, transit conditions of fruit, flowers and vegetables, and aircraft spraying against tsetse-fly.

(5) Upper Air Climatology

(a) **Collection of observations.**—Monthly returns of daily observations made by radio-sonde and aircraft were received from 25 radio-sonde stations and 5 aircraft stations, and of radar winds from 25 stations. The Office controls 8 radio-sonde stations in the British Isles, 4 in the British Zone of Germany, 7 in the Mediterranean and Middle East, 2 on ocean weather ships in the Atlantic, and one in the Falkland Islands. Returns were received from Valentia, Nairobi and Hongkong through the courtesy of the Directors of the Irish Republic Meteorological Service, the British East African Meteorological Department and the Royal Observatory, Hongkong, respectively.

The values were entered both on forms and on Hollerith cards. The scheme by which observations were carefully checked before being punched greatly increased the accuracy of the records. A further improvement was effected by the appointment of a Hollerith-punch operator at Fazakerley; it is hoped eventually to centralize all punching in one place as this is found to be the most efficient method.

Satisfactory methods for producing summaries of data on Hollerith machines were evolved, and by using spare capacity of equipment at the Post Office and the War Office good progress was made in tabulating arrears of data.

The appointment of a machine operator enabled the assistants to give more time to computing. A revised wind code, introduced at the beginning of January 1951, will greatly reduce the time required to summarize wind data.

Frequency tables of upper wind in 1948 at three stations in the British Isles and at the two ocean weather ship stations were prepared for publication in an annual volume.

Proposals were under consideration for the form of publication of 5-year frequency tables of temperature, humidity and wind, and specimen tables for one station were prepared.

The data from the CLIMAT TEMP broadcasts were tabulated month by month, and mean charts of the temperature and height of the standard isobaric surfaces over the world were drawn from these data, supplemented by any others that were available. Many of the data were received by air mail by courtesy of the Directors of overseas meteorological services.

(b) **Special work.**—The volume on “Upper winds over the world” was published in August as *Geophysical Memoirs* No. 85.

Research was directed to the preparation of world charts, for four mid-season months, of the average upper air temperature at the standard isobaric surfaces, and its standard deviation. For the compilation of these charts, data were extracted from manuscript returns and from publications, and were also obtained by application to various overseas services where unpublished data were known to exist. In December 1950 provisional charts were drawn for January and were circulated for comment both within the Office and to certain meteorologists and meteorological services overseas. Similar charts for April were nearing completion by the end of the year.

In view of their special interest, reports were prepared on the preliminary results of upper air observations over Nairobi and over the Falkland Islands. A note was also written on the first year's observations of temperature and humidity at the British ocean weather stations, I and J. Articles on other interesting features apparent from the compilations were contributed either to the Meteorological Research Committee or to the *Meteorological Magazine*.

(c) **Inquiries.**—A considerable number of requests for upper air data were received during the year. They were mainly for averages, frequencies and extremes of temperature, relative humidity and wind speed. Much interest was shown also in conditions at the tropopause.

In addition a number of inquiries were received (mainly from other Branches of the Office) on statistical problems.

§ 4. RESEARCH AND DEVELOPMENT

(1) Co-ordination of Research

(a) **Meteorological Research Committee.**—The programme of research is formulated and periodically reviewed by the Meteorological Research Committee (see p. 4). The bulk of the work is necessarily carried out within the establishments of the Meteorological Office. Valuable assistance on special items is received from research establishments of the Ministry of Supply, from the National Physical Laboratory and the Clarendon Laboratory, Oxford. Experience of the past three years indicates that a larger staff than was allowed initially for the research organization of the Office would be an advantage.

The constitution and functions of the Meteorological Research Committee are set out in the Report for August 1945 to March 1947. During the year under notice two meetings of the Committee were held.

As in recent years, much of the detailed work of the Committee was carried out through three Sub-Committees, each of which consisted of a selection of members of the main Committee together with co-opted outside specialists and members of the Meteorological Office. The Chairmen of the Sub-Committees were :—

Instruments development	Prof. P. A. Sheppard
Synoptic and dynamical research	Sir Charles Normand
Physical research	Prof. G. M. B. Dobson

Twelve meetings of Sub-Committees were held during the year to consider papers describing the results of research, to review progress, and to make recommendations to the main Committee. Some seventy technical reports and memoranda were dealt with. Approved papers were circulated to interested outside institutions and individual workers, and arrangements were made for selected papers to be communicated to a scientific society or journal. The arrangements for the issue of papers were modified to avoid some difficulties which had been experienced—partly owing to the delays in publication—and to facilitate reference by other authors to Meteorological Research Papers.

Difficulty is still being experienced in recruiting sufficient Scientific Officers qualified to undertake the research work of the Meteorological Office.

(b) Joint Meteorological Radio Propagation Sub-Committee.—This Sub-Committee of radio-physicists and meteorologists, under the chairmanship of the Director of the Meteorological Office, met in November 1950. Among the items considered was a Meteorological Office report on an investigation of the vertical gradient of the modified atmospheric refractive index up to 350 ft. above the ground, based on three years' continuous recordings of humidity and temperature at Rye, Sussex. The Sub-Committee also discussed the progress of recent collaborations between the Telecommunications Research Establishment of the Ministry of Supply and the Meteorological Office in analysis of the radio and meteorological data obtained during experiments made near Canterbury, New Zealand, a few years ago.

(c) Collaboration with the Royal Society.—The Gassiot Committee of the Royal Society has continued to supervise a number of long-term investigations, of importance in atmospheric physics, which are in hand elsewhere than in the Meteorological Office. The Air Ministry grant-in-aid is to be extended to a further five years from April 1951 and at an increased rate of £5,000 a year. Theoretical physics, laboratory experiments and high-level observations in the atmosphere are involved in this programme of research, selected items of which were outlined in the last Report. During the year the Gassiot Committee's plan for the investigation of atmospheric ozone, under the direction of Sir Charles Normand was advanced in the United Kingdom by the provision of modern spectrophotometers to three of the upper air sounding stations of the Meteorological Office, where measurements of the amount of ozone (which occurs mainly at high levels in the atmosphere) will be made near to the time of measurement of pressure, temperature and wind at great heights.

Infra-red spectrophotometric measurement, from aircraft of the Meteorological Research Flight, of the absorption of solar radiation in the stratosphere has been delayed by instrumentation difficulties. It is to be expected that this method, on which Mr. R. M. Goody, Cambridge University, has been working, will very shortly permit of successful determination of the water vapour content in the stratosphere.

(d) Other activities.—Members of the Meteorological Office have served on the British National Committees for Geodesy and Geophysics and for Scientific Radio, on the Gust Research Committee of the Aeronautical Research Council and the Meteorological Research Committee, on the Atmospheric Pollution Research Committee, and on the Road Research Board Joint Committee on Soils of the Department of Scientific and Industrial Research, and have attended meetings of other Government Departmental scientific committees. Liaison has been maintained with research activities elsewhere within the Commonwealth and in other countries.

During the summer of 1950, as in the previous year, a number of university students spent some weeks at Meteorological Office research establishments to gain acquaintance with the problems under investigation.

(e) Research programme.—The main items on which work is to proceed are summarized below. Many of these items comprise a group of related investigations.

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

(ii) Development of instruments and technique for use on aircraft in exploring the physical processes of turbulence in the atmosphere in clouds or in clear air.

(iii) Development of simpler and more economical methods of measuring upper winds by radar.

(iv) Application of radar methods for detecting cloud, precipitation, turbulence and icing regions.

(v) Exploration of the physical structure of rain-producing clouds.

(vi) Investigation of meteorological factors affecting ice accretion on aircraft.

(vii) Formation, persistence and dispersal of radiation fog.

(viii) Improvements in accuracy of short-range forecasts.

(ix) Extension of weather forecasts to cover three or four days.

(x) Investigation of the temperature and water vapour content of the troposphere and lower stratosphere under various conditions.

(xi) Investigations of tropopause conditions and the exchange of air between troposphere and stratosphere.

(2) Instrument Development

(a) General instruments.—Operational trials on a modified photo-electric visibility meter have continued. Most of the troubles experienced in the earlier model have been overcome, and the instrument now appears capable of providing a simple and reliable method of measuring visibilities in the range 300–3,000 yd., both by day and night.

Field trials of four methods of measuring air-to-ground visibility are being carried out. These are :—

(i) Measurements of the variation of fog density with height using a small photo-electric visibility meter carried on a tethered balloon.

(ii) Direct observations of “rocket” flares of known intensity.

(iii) Observations, either direct or using a visibility meter, of a balloon-borne light.

(iv) Measurements from two points on the ground of the apparent intensity of the light scatter from a searchlight beam.

Considerable progress has been made on the development of a precision aneroid suitable for use at sea and with field meteorological units.

A satisfactory recorder for use with the cup generator anemometer has been developed. The complete unit has about the same sensitivity as the pressure-tube anemograph. A single-pen wind direction recorder using "magslip" remote transmission has been developed. A similar recorder, together with the cup generator recorder, is being used in the special Severn Bridge bi-directional anemographs.

The programme of work on the improvement of balloons has continued. Reports of tests of experimental batches at tropical stations were studied and plans were made for further tests.

(b) Aircraft instruments.—Several aircraft thermometer elements of experimental design have been made, and are undergoing tests with a view to producing one having a constant speed-correction factor at all heights. Arrangements have been made to obtain a thermometer of a type known as the sonic suction pyrometer, used to measure the temperature of hot gas streams. This thermometer, in which the gas is drawn across a flat thermocouple element at sonic speed, has the advantage of rapid response and stability under varying conditions. It will be adapted for measuring air temperature from aircraft.

The fully automatic frost-point hygrometer has been greatly improved. A similar instrument purchased from a firm of instrument makers has been tested in flight and is being modified at the Clarendon Laboratory, Oxford.

(c) Radio-sonde and radar wind instruments.—Good progress has been made in the development of the radar-sonde theodolite, particularly in the engineering design of the transponder and in experimental work on the ground equipment.

In order to reduce the risk of damage to overhead electric power lines, the Mark II radio-sonde has been adapted so as to use a much shorter aerial and a modified form of radar reflector is also being developed. A new type of conducting mesh, consisting of knitted wire, for use in reflectors has been produced.

Experiments and theoretical work have been undertaken with a view to evaluating the errors of the Mark II radio-sonde due to solar radiation, which become important at high levels. A precise knowledge of these errors should enable the diurnal variation of temperature in the upper air to be determined with greater certainty.

The research programme of high-altitude radio-sonde and radar wind ascents with 2-Kg. balloons was continued. More than 60 successful ascents from two stations were made, the highest sounding reaching 110,000 ft. The results of this series of soundings are now being studied.

(3) Forecasting Research

The following list summarizes the more important forecasting research activities.

(i) The increasing importance of high-altitude flying directed attention to several aspects of upper air conditions. Numerous cross-sections of

the atmosphere gave more information on the structure of frontal regions and of the strong winds, including those known as jet streams, in the upper troposphere. Tests of methods of forecasting winds at the 200-mb. level were carried out, and a special study was made of the short-period variations in the height of the tropopause.

(ii) The basic synoptic problem—the development and movement of depressions and anticyclones and of associated flow patterns in the upper atmosphere—was attacked in various ways. Methods of computation, derived from the fundamental dynamical equations, were tested; a specific test was made of a formula, introduced in America by Professor C. G. Rossby, for the movement of large-scale waves; a method of calculating the change in the topography of the 500-mb. surface, suggested by Dr. J. G. Charney (United States) was examined; a formula for cyclonic and anticyclonic development, due to Dr. R. C. Sutcliffe, was put on a computing basis. There is some promise in the computational methods although so far it is not possible to improve, on the average, upon estimates made by the experienced forecaster.

(iii) Circumpolar, northern hemisphere, synoptic charts for sea level and for 500 mb. were maintained twice daily and were introduced into the routine procedures of operational forecasting. Experimental forecasts for four days ahead were made twice weekly in order to gain knowledge of the standard of accuracy which can be expected at present. At the same time, by the regular study of the hemispheric (extratropical) changes of circulation and temperature distribution, much information was gained on the way in which different types of weather evolve and on the relations between the weather of the British Isles and that of other parts of the hemisphere. Some interrelations are obvious, but the mechanism is evidently very complex and progress in extended-period forecasting seems likely to be slow.

(iv) Some progress was also made in the study of radiation fog and of rainfall, in association with depressions and fronts.

(4) Research in Physical Meteorology

No substantially new commitments were undertaken during the year. A résumé of some of the main activities at Headquarters and research stations is given below.

(i) The use of measurements of the liquid water in convective cloud in America, together with theoretical considerations and laboratory data on the temperatures at which small drops freeze spontaneously, resulted in deductions concerning the occurrence of high rates of ice accretion on aircraft in low latitudes.

A study was made, based on available experimental evidence, of the rate of evaporation of raindrops in falling through the atmosphere. The effects of evaporation on the size distribution of the drops, the liquid content of the air, the rate of rainfall and the radar response received from falling rain were assessed. The effect of the evaporation of raindrops on the temperature and humidity of the air near the earth's surface were also evaluated.

A further study of the drop-size distribution in cloud was completed.

(ii) An examination of the occurrence of condensation trails (produced by aircraft of the Meteorological Research Flight) and the frost-point temperatures observed at the corresponding levels has disclosed that condensation trails can occur in air of much lower humidity than was believed likely.

(iii) Humidity observations obtained by the Meteorological Research Flight in the upper troposphere and lower stratosphere were analysed in relation to the weather situation. Though some features of the humidity régime at the levels mentioned seem to be broadly in accord with recent concepts of the ascent and descent of the air in cyclonic and anticyclonic systems, the observational material is as yet insufficient to enable firm conclusions to be reached.

(iv) Investigation of some further occasions when aircraft experienced turbulence in clear air at great heights broadly confirmed a conclusion reached in an earlier report, namely that such turbulence occurs in the vicinity of jet streams, though the details of the causal mechanism are not yet apparent. Further insight may be gained from a study of horizontal and vertical smoke trails laid by aircraft on occasions of turbulence, and also from study of simultaneous records of a rapid-response thermometer and of acceleration during level flight.

(v) The Meteorological Research Flight, which is located at the Royal Aircraft Establishment, Farnborough, made some 80 ascents by Mosquito aircraft to explore the humidity and temperature structure in the upper troposphere and lower stratosphere. Most of these ascents are now made near to an upper air sounding station and at the time of a radiosonde ascent. With use of an automatically recording rapid-response thermometer it is proposed to investigate the structure of the boundary between troposphere and stratosphere.

Increased attention was given to the eddy structure of the atmosphere as revealed (on a scale of the order of hundreds of feet) by the indications of an ultra-rapid electrical thermometer, devised for this purpose and (on a scale of the order of 10 to 30 miles) by the patterns shown by readings of temperature and humidity made at close intervals of time during the flights.

The two Halifax aircraft of the Flight were replaced by Hastings aircraft, for use in flights in the troposphere. Known and anticipated requirements, for information concerning the atmosphere at levels above those attainable by the Mosquito aircraft, make the provision of a suitable jet aircraft a matter of some urgency.

(vi) The investigation of cloud and precipitation by using radar equipment operating on wave-lengths of 10 and 3 cm. continued at the Meteorological Office station at East Hill. Co-operation with aircraft from the Royal Aircraft Establishment, flying under the radar control of East Hill, yielded further important information on the structure of, and the vertical currents in, cumulus and cumulonimbus cloud. A further report on the results of this work was distributed. Exploration of the physical characteristics of clouds producing precipitation was carried out by East Hill in conjunction with the Meteorological Research Flight. A report on this investigation is in preparation.

Radar observations, largely recorded photographically, at East Hill have given valuable information concerning the phases of development in thunderstorms, and the proportion of time during which severe icing is liable to be experienced in showery weather by an aircraft flying on a single heading at a height above freezing level.

(vii) At Cambridge, the Meteorological Office unit attached to the University School of Agriculture was to a large degree occupied with the construction and assembly of the additional special equipment needed for the extended field investigations of the vertical exchanges of heat and

water vapour near crops, other than grass, growing on different soils. During the year, measurements of the aerodynamic drag of a grassland surface were made in a wider range of atmospheric conditions, for the purpose of more complete verification of the basis of the method for evaluating natural evaporation from observations of wind speed and humidity at two or more heights above the ground. Incidental to this work, but of wider interest, determinations were made of the effect of hedges on the flow of air in their vicinity, upwind and downwind.

As mentioned on p. 33, work on atmospheric microstructure near the earth's surface is in progress at Kew Observatory.

A report was prepared, and distributed, reviewing two different approaches to the problems of estimating natural evaporation from meteorological data; one approach relies basically on the performance of an open water tank, while the other is that which has been developed in the work of the unit at Cambridge and depends on aerodynamic principles which have provided satisfactory quantitative interpretations of various diffusion phenomena in the lower atmosphere in adiabatic conditions.

(viii) A study of the physical processes relevant to the formation of radiation fog is being planned. The proposals include special determination of horizontal (and oblique) visibility at a series of levels in conjunction with the measurements of air temperature and humidity on 350-ft. masts at Rye.

(ix) Discussion of three years' humidity and temperature measurements, made at four levels up to 350 ft. at Rye, gave rise to papers on the mathematical treatment of turbulence in the lower atmosphere.

The dispersion of air masses due to eddies was examined by using synoptic charts, and formed the subject of a report.

(5) Work of the Observatories and Geophysical Research

(a) **Kew Observatory.**—Observation, recording and tabulation of the usual meteorological elements required for climatological and synoptic purposes, of solar radiation, of daylight illumination, and of the atmospheric electrical potential gradient continued unchanged. The three Galitzin seismographs and one vertical-component instrument of short period were maintained in good order and the records tabulated.

Meteorological observations and records.—Some consideration has been given to the possibility of supplementing (and ultimately replacing) the north-wall screen photothermograph, erected in 1869, by a recording electrical or other thermometer in an aspirated screen on the lawn.

In June 1950, the Observatory became responsible for the supply of meteorological information for the Registrar-General's weekly return, in replacement of data no longer available from the Royal Observatory at Greenwich. Some changes were introduced in the nature of the data supplied.

Measurement of solar radiation.—Continuous records were obtained of solar intensity at normal incidence, and of total and diffuse radiation on a horizontal surface, standardization readings being made with an Ångström pyrheliometer on all suitable occasions. The recording of solar radiation transmitted through two filters, passing different spectral regions, was in abeyance. Trials were made of a method of instrumental integration of solar-radiation intensity.

Records, standardized photometrically, of the illumination of a horizontal opal glass surface exposed in the open, were maintained continuously. A close

check was kept on the performance of a similar instrument exposed in Kingsway, London. The more sensitive (supplementary) illumination recorder, mentioned in the last Report, has proved reliable.

Lengthy intercomparisons of Ångström and silver-disc pyrheliometers were made, using a laboratory source of radiation. This investigation is to be continued. Several bimetallic radiation recorders were calibrated.

Seismology.—The records of 373 earthquakes were analysed and the particulars issued in the *Monthly Seismological Bulletin*. The epicentres were located in 83 cases.

Other investigations.—These have mainly concerned the study of fluctuations of wind and temperature near the ground, for the primary purpose of obtaining measurements of the vertical flux of heat due to convective processes. The equipment used consists of a Simmons hot-wire anemometer and resistance thermometers of very fine platinum wire, in conjunction with galvanometers with a period of one tenth of a second. Longer-period galvanometers are also to be used in future. The investigation is in its initial stages. On two of the occasions of these fluctuation measurements, vertical profile and heat balance measurements (as mentioned briefly in the last Report) were also taken.

A number of sensitive cup anemometers were converted to the recording pattern, for use at other research stations of the Office. Thermo-electric earth thermometers are under construction for use in investigations at Rye and for the Anti-Locust Research Association.

Apart from inquiries dealt with relating to the customary climatological items, more specialized advice on evaporation, illumination, seismology and solar radiation was furnished at the request of organizations and individuals.

(b) *Edinburgh Meteorological Office.*—An increase in scientific-officer staff enabled more attention to be given to investigations in geomagnetism. Studies of geomagnetic “sudden commencements” recorded at Lerwick, of the geomagnetic effects at Eskdalemuir and Lerwick associated with solar flares, and the relationship with allied ionospheric phenomena formed the subjects of papers prepared for publication.

In accordance with international arrangement, three-hourly magnetic range-indices (*K*) for Eskdalemuir and Lerwick, and also particulars of “sudden commencements” and solar-flare effects, were forwarded at regular intervals to De Bilt. The *K* indices for both the Scottish observatories are utilized in the evaluation of a “planetary” index of magnetic disturbance.

At the request of the International Association of Terrestrial Magnetism and Electricity, the *K* indices for Lerwick and Eskdalemuir were measured (those for Eskdalemuir at the Observatory) for the Polar Year 1932–33, as were those for the station maintained by the British Expedition to Fort Rae, north-west Canada, during the Polar Year. These data were published in Bulletin 12d of the International Union of Geodesy and Geophysics—Association of Terrestrial Magnetism and Electricity, 1950.

(c) *Eskdalemuir Observatory.*—The standard procedure of observing, recording and reducing meteorological, magnetic and atmospheric electrical elements continued unchanged.

Radiometers for registering the total and diffuse radiation received on a horizontal surface were installed in the course of the year.

All magnetic storms during the period were recorded successfully. Hourly values of magnetic declination were contributed to weekly mining journals, while prints or tracings of magnetic records were supplied to institutions or individuals on request.

In connexion with the international comparison of magnetic standards, organized by the International Association of Terrestrial Magnetism and Electricity, measurements of magnetic horizontal force, by means of quartz fibre magnetometers sent from the Danish Meteorological Institute, were compared with measurements made with the Observatory standard instrument (Schuster-Smith coil magnetometer) in the summer of 1950. Good agreement was found between the international travelling instruments and the Observatory standard.

(d) Lerwick Observatory.—The normal observational and recording work in meteorology, terrestrial magnetism, aurora and atmospheric electricity was maintained. Hourly meteorological reports were transmitted to the Central Forecasting Office by teleprinter.

The night sky recorder was brought into use again after a period of overhaul.

Records of atmospheric pollution were maintained on behalf of the Department of Scientific and Industrial Research.

As at Eskdalemuir, comparisons were carried out between travelling quartz-fibre magnetometers, sent from Copenhagen, and the Observatory coil instrument, and revealed very satisfactory agreement.

Upper air soundings using radio-sonde and radar wind equipment were made at the four standard hours daily. No radio-sonde sounding was omitted, but a number of wind soundings were missed (mainly in November) owing to failure of ground equipment. Several special high-level soundings were made, three to heights exceeding 100,000 ft.

(6) Special Investigations

In the past year the Division for Special Investigations was concerned with the provision of meteorological information for the forthcoming trial flights by the Comet and other high-altitude jet aircraft. In pursuit of this, consideration was given to the accuracy with which forecasts of winds could be made on Commonwealth air routes, and, as a background to such forecasts, revised normal wind charts are being constructed, season by season, from the most up-to-date data, and are being sent out to the stations concerned. In a similar manner, through the help of the Climatology Division, normal upper air temperature charts (to 50,000 ft.) are being issued for guidance.

The discussions of the International Commission for Air Operations have been concerned with the effects of air temperature on take-off efficiency of aircraft. For this a large amount of data has been provided for various airfields.

Maps of normal upper winds over the world have been provided to the Festival of Britain authorities so that they may be formed into a three-dimensional model for exhibition in the Dome of Discovery.

§ 5. ORGANIZATION

(1) Structure

(a) Headquarters.—There has been no change in the organization of Headquarters during the year.

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

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

A 25-year tenancy of accommodation at 6 Drumsheugh Gardens, the

property of the British Medical Association, ended in May 1950. The Office has been transferred to 26 Palmerston Place, which has been acquired for the purpose.

(2) Staff

(a) **Complements.**—As in the two previous years the recruitment of civilian staff for established officer grades was continued through the open competitions conducted by the Civil Service Commissioners. As a result of these competitions 36 officers accepted established appointments during the year of whom 24 were candidates already in the Meteorological Office. In addition, 3 temporary appointments were made. At the end of the year many of the newly appointed officers were still under training and the officer strength was insufficient to meet all requirements.

During the year 135 assistants were given established appointments, all of whom were already temporary assistants in the Meteorological Office. Resignation of assistants continued to be heavy, and the proportion of airmen meteorologists who did not accept re-instatement in civilian appointment as assistants on release from National Service was 35 per cent. Recruitment of temporary assistants continued throughout the year. At the end of the year there were 129 assistants in training, making the total strength of assistants slightly in excess of the establishment. Numerous resignations and call-up for National Service resulted in a continual movement of assistants, and a consequent loss of efficiency.

(b) **Strength of staff.**—The strength of staff on March 31, 1951, is shown in the table below. For the purpose of comparison, the strength a year ago is also indicated.

	March 31, 1950	March 31, 1951
Scientific Officer Class or equivalent	157	160
Experimental Officer Class or equivalent	614	613
Nautical Officers	7	8
Assistant Class	1,481*	1,470*
Radio (Meteorological) Mechanics	57	49
Locally entered Staff (overseas) ...	283	203
Clerical and Typing Staff	76	70
Miscellaneous	20	28
Total	2,695	2,601

* Excluding non-effective meteorological airmen undergoing service training.

(c) **Uniformed personnel.**—The number of airmen serving in the trade of Meteorologist on engagements under National Service Acts on March 31 1951, was 293. They were held against the civilian establishment of assistant,

Class "H" Reservists.—A national service airman is deemed to be enlisted in Class "H" of the Reserve following his discharge from whole-time service unless he volunteers and is accepted for part-time service in an auxiliary or Volunteer Reserve. During the year 77 airmen meteorologists were placed in Class "H" Reserve; 21 of these, who found employment outside the Meteorological Office, will be called on for 15 days' continuous training in each of the second and subsequent years of their service as "H" Reservists.

Royal Air Force Volunteer Reserve (Meteorological Section).—The strength of this Reserve on March 31, 1951, was 72 officers and 38 airmen and airwomen. All but two officers had previous meteorological experience before joining.

Mr. J. L. Galloway was appointed Chief Meteorological Officer of the Section with the rank of Squadron Leader.

The annual 15 days' continuous training was again carried out mainly at major forecasting offices attached to units of the Royal Air Force. At the end of the year over 90 per cent. of strength were considered capable of filling posts, appropriate to their rank, in an emergency.

A scheme was introduced whereby each reservist's non-continuous training (i.e. short periods of attachment at week-ends and other convenient times) was arranged directly between the reservist and the Senior Meteorological Offices of his locality. In this way programmes of work have been arranged for reservists which give useful assistance to the Office.

Air Meteorological Observers.—As a result of the decision announced in last year's Report, to recruit Air Meteorological Observers from among assistants serving on engagements under the National Service Acts, 18 assistants were trained and joined Meteorological Reconnaissance Flights. It is with great regret that the loss of two of these assistants in the course of their duty is to be reported.

It is now possible to introduce the long-term policy of recruiting Air Meteorological Observers from amongst assistants who have had at least two years' experience in the Meteorological Office. It is intended that they should undertake regular engagements in the Royal Air Force lasting two years and six months, returning on completion of their engagements to their civilian employment in the Meteorological Office.

(d) Training of staff.—*Organization of training.*—There have been no important changes in the organization for training during the year.

Course for Scientific Officers.—The normal course lasts for 4 months, and during the year training was given to 4 Scientific Officers. A condensed course was given to a Senior Scientific Officer.

Initial course for Forecasters.—This course lasts 12 or 15 weeks according to the previous experience of the trainee. Improved facilities for the reproduction of charts has allowed a considerable increase to be made in the amount of practical work. During the year 4 forecasting courses have been held and the number of staff trained was 40. Of these, 26 were former Scientific Assistants of the Meteorological Office.

Advanced course for Forecasters.—This is a 6-weeks course, and is concerned primarily with the application to forecasting of upper air data. Four courses have been held for a total of 23 officers.

Initial course for Scientific Assistants.—This is an 8-weeks course. Sixteen courses have been held during the year and 225 assistants have been trained.

Refresher course for Assistants.—Five courses each lasting 3 weeks took place and 68 assistants attended.

Courses for Voluntary Observers.—Two courses each lasting 4 days were held for the purpose of giving general instruction on the making of weather observations. The courses were attended by 27 observers who contribute climatological statistics to the British Climatology Branch (see §3(1)).

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

Officers for Colonial Meteorological Services	5
Persian Meteorological Service	3
Thai Meteorological Service	1

External training.—Staff of the Office are given assistance in pursuing external studies in order to obtain qualifications above the basic minimum required for entrance to their particular class. Thus Scientific Assistants are encouraged to study for the Intermediate B.Sc., and Assistant Experimental Officers for a science degree in subjects related to their work. Facilities granted to those whose course of study is approved include the payment of fees and time off, with pay, to attend classes and examinations.

The external study scheme was introduced in August 1948, and has already begun to show good results. During the past year, 2 Assistant Experimental Officers passed the B.Sc. (Special) examination in Mathematics with 2nd Class Honours and 21 members of the staff were successful in the Intermediate B.Sc. examination.

(e) **Technical discussions.**—The Monday afternoon meetings for the discussion of recent meteorological research papers or of research work in progress in the Office were held once a month from October 1950 to March 1951.

These meetings are attended by members of the staff, and, on invitation, by staff of other Government departments and University research workers interested in the subject under discussion. The procedure is for an opener to give a description of the paper or research work, after which a general discussion is held.

The subjects discussed and the openers were :—

October 9, 1950	Recent United States work on ice accretion	Mr. G. A. Corby
November 13, 1950	Electrification of thunderstorms	Dr. G. D. Robinson
December 11, 1950	Upper air climatology of the southern hemisphere ...	Mr. L. S. Clarkson
January 8, 1951	Measurement of upper wind	Dr. D. N. Harrison
February 12, 1951	Temperature and humidity gradients of the first 100m. of the atmosphere at Rye ...	Mr. A. C. Best
March 12, 1951	Significance of vorticity in dynamical meteorology ...	Mr. J. S. Sawyer

At the first three meetings recent papers were discussed and at the remaining three research work in progress in the Office was considered.

(3) Supply of Instruments

(a) **Provision and production of equipment.**—During the year 4,545 orders and contracts have been placed. The total expenditure was £223,163. During the same period £48,105 was received by the sale of equipment and for services rendered, e.g. testing and inspecting instruments for manufacturers and others.

Production of equipment has been fairly good. Difficulties due to a shortage of parachutes and radar reflectors were, eventually, overcome. The shortage of maximum thermometers, reported last year, has also been overcome, but the difficulty in getting supplies of spare parts for radar wind equipment still persists, although the situation is now somewhat easier.

(b) **Issue of equipment.**—Regular supplies of instruments and stores have been issued to maintain meteorological offices at home and overseas. Ozone photo-electric spectrophotometers have been issued to Aldergrove, Camborne and Downham Market. Advice has been given to inquirers as to the best sources of supply of equipment.

Demands for stores dealt with in the year numbered 10,814 as compared with 9,705 last year. Included in these demands are some from Commonwealth, Colonial and foreign Governments and from co-operating observers who are allowed to buy their instruments from official stocks. Equipment has been lent to other Government Departments and public authorities for particular investigations. The number of loans made during the year was 79.

The following issues are worthy of special mention :—

Radar wind equipment to New Zealand and west Africa

Marine barographs to the Norwegian Meteorological Institute for use in whaling factory ships

Mercury-in-steel thermographs to the London Transport Executive for investigation into the icing of conductor rails

Anemographs to the West Indies for the survey of potential airfields

Equipment for six stations in the Falkland Islands Dependencies

Thermographs for tests in the new House of Commons

Equipment for the Hampshire Agricultural Show at Southampton

Equipment to the Council of Field Studies at Malham Tarn

Equipment to Durham University Exploration Society for expeditions to the Frostesen Ice Cap (Norway), Hagavatu (Iceland), and the Cairngorms of Scotland

Equipment to Mr. W. H. Crase for an expedition to the Himalayas (Kashmir)

Instruments to the University of Birmingham for microclimatological work in Worcestershire

Instruments to the Department of Geography, Aberystwyth, for a climatological survey of the River Dovey.

Instruments to the Imperial College of Science, London, for an investigation into turbulence in the region of the Scilly Islands

Equipment in connexion with the international radio-sonde comparisons at Payerne, Switzerland.

(c) Testing and calibrating.—General instruments and aircraft instruments.—The total number of instruments tested, excluding balloons was 117,355. The number of balloons of all sizes received and submitted to a 5 per cent. check was 290,157. A number of improvements in instruments have been devised, notably in the moving parts of the bimetallic thermograph to reduce friction, in the switch gear of the radio-sonde transmitter, and in the method of wrapping batteries prior to radio-sonde flight.

The total number of calibrated radio-sonde transmitters received from the makers was 20,101. Of these 1,682 were checked for calibration before being accepted. In addition 7,361 were recalibrated from stock, and 7,256 recovered after use were overhauled and recalibrated in the Office for further use. Large numbers of radio-sondes were also tested for general efficiency.

A new apparatus for calibrating radio-sondes has been designed by two members of the experimental staff. It is now being manufactured and installed, and will, it is hoped, come into use in the middle of 1951.

A pamphlet on the testing of meteorological equipment is in course of preparation.

(d) Maintenance of radar wind equipment.—Inspections of the radar wind equipment at stations in the United Kingdom have been carried out periodically.

At the request of the Director of the Meteorological Services of the Irish Republic the radar wind equipment at Valentia was also inspected on two occasions during the year.

Besides giving advice to the operational stations on the maintenance of their equipment and repairing and testing used instruments, the radar maintenance section has carried out work as follows :—

(i) Instructions on how to modify the range scale to give indications up to 96,000 yd. have been issued to all operating stations.

(ii) A method of stabilizing frequency by means of an auxiliary-heater, has been devised.

(iii) Four radar wind equipments for issue overseas have been completely overhauled.

(iv) Scales of issue of spare parts for radar wind equipment, and of tool kits for Radio (Meteorological) Mechanics have been prepared and issued.

The section has taken responsibility for the training of newly recruited Radio (Meteorological) Mechanics.

(4) Library and Publications

(a) **Library.**—*Exchanges of publications.*—The resumption and modification of pre-war exchange agreements with other services and independent institutions was completed. The number of overseas exchange agreements now totals 292.

Accessions.—The total intake of publications for the year, exclusive of *Daily Weather Reports*, totalled 7,899. These included 496 photographic copies of papers that had appeared originally in series not taken by the Library. Because papers of meteorological interest are thus scattered over the whole field of publications in applied science, the task of maintaining a comprehensive collection is extremely difficult.

Microfilms of marine and upper air data were collected and have been used extensively. In addition the library acquired 53 microfilm copies of papers that had gone out of print.

444 lantern slides, 268 photographs, and 9 film strips were added to the collections maintained for lecture purposes.

Repair of war-time omissions.—Gaps in most series were filled. A start has been made on the arrears of binding that have accrued since 1939.

Co-operation with other British libraries.—The National Central Library check lists of German non-serial publications so far issued have been scrutinized and annotated to give any additions held. The *Monthly Bibliography* showing accessions into the Meteorological Office Library was supplied to the Library of Congress, Washington, the Library of the Scott Polar Research Institute, Cambridge, and to several other libraries not primarily meteorological in content.

Co-operation was maintained with the Science Library and the National Central Library as well as with the libraries of the Royal Meteorological Society and the Royal Geographical Society.

Much of the work of the Meteorological Office Library depends now, however, not so much on co-operation with the libraries of learned societies or independent institutions, as on the closest possible co-operation with other Government information services and libraries such as those of the Ministry of Supply and the Department of Scientific and Industrial Research. This is doubtless due to the great increase in government-sponsored research.

The Meteorological Office Library continued to classify literature to be published in the *Quarterly Journal of the Royal Meteorological Society*.

The Library continued as a corporate member of the Association of Special Libraries and Information Bureaux under the terms applicable to Government departments.

Loans.—The number of publications issued on loan increased to a total of over 12,000 exclusive of those publications borrowed for reference in the Library and of *Daily Weather Reports*. The present monthly average is now six times the average of immediately before the war and ten times the average of the middle thirties.

The arrangements whereby the Library selects publications of special interest to members of the staff were continued; translations and abstracts were provided as necessary.

Under the inter-library loan scheme 69 publications were lent to other libraries through the National Central Library and more than 250 publications were borrowed. In addition, over 400 requests were made to the Science Museum Library. These figures emphasize the wide "scatter" of literature referred to earlier.

Lantern slides for lecture purposes loaned to staff numbered 466 and to members of the public, 101. These facilities were also extended to include film strips and films as required.

Bibliographies.—The *Monthly Bibliography of Meteorological Literature* was amended to include annotations wherever titles were considered inadequate. The interval between receipt of publications and their inclusion in the bibliography was reduced from 7 to 3 months. Bibliographies were issued for the months August 1949 to December 1950 inclusive.

A microfilm copy of the Library subject index of meteorological literature was sold to the United States Weather Bureau.

Selected bibliographies were provided on request. The wide variety of subjects included standing waves in relation to gliding; frozen soil; tropical thunderstorms; air-flow characteristics over rough ground and over mountainous country; dew ponds; air conditioning; and ultra-violet radiation absorption.

Inquiries.—A very large number of inquiries were received. Many of these were of the routine type of request for climatological data or publications. The remainder were of a most varied nature and included: deviation of gases from the perfect gas laws; tracks of depressions; information in connexion with exhibits proposed for the Festival of Britain; effects of precipitation on radar performance; atmospheric pollution; gust frequencies in connexion with oscillations of television repeater towers; the "blue" sun and moon observed in Great Britain on September 26, 1950; magnetic information; effects of insolation on cattle; variation of solar light energy with latitude.

(b) Publications.—*Geophysical Memoirs and Professional Notes.*—Two *Geophysical Memoirs*, one a world-wide survey of the mean distribution of upper winds, and the other a description of the Kew observations of solar radiation, and one *Professional Notes* were published.

Meteorological Reports.—Four *Meteorological Reports* were published, two of which dealt with the application of upper wind information to the planning of air routes, the third with the use of upper air information in tropical forecasting, and the fourth with the aviation meteorology of north Africa. A fifth, *Meteorological Reports* No. 9 "Ice accretion on aircraft" is in the press.

Meteorological Magazine.—The *Meteorological Magazine* was published regularly until the September number, when the printer terminated his contract. H.M. Stationery Office had difficulty in arranging a new contract and the price of each magazine has had to be increased to 1s. 6d., starting with the November issue.

The articles published have included papers on methods of forecasting the formation of fog, the relation between atmospheric and lightning, the history of Lerwick and Eskdalemuir Observatories, the vertical shear of wind in the upper air, and the ablation of a snowfield in the Scottish Highlands ; detailed reports of the discussions held in the Meteorological Office on one Monday a month during the winter were a special feature.

Marine publications.—Publication of the *Marine Observer* was continued with the four quarterly numbers for April, July and October 1950 and January 1951.

The seventh edition of the “ Marine observer’s handbook ” was published. The book was completely re-written to take account of changes in observing practice due to the introduction of the Washington Code.

A second edition of the “ Decode for use of shipping ” was published.

Two atlases were reprinted :—“ Monthly meteorological charts of the eastern Pacific Ocean ” and “ Monthly meteorological charts of the Indian Ocean ”.

A second edition of the “ Marine observer’s guide ” is in the press.

Work on a new atlas—“ Quarterly surface current charts of the western South Pacific Ocean ”—is nearing completion.

Other publications.—The “ Meteorological glossary ” (with additional new terms) and the “ Observer’s primer ” have been reprinted.

Publications in the press include the “ Climatological atlas of the British Isles ”, the “ Observer’s handbook ”, the Naval handbook, “ Weather in the Indian Ocean, Vol. II, Part 1 Red sea ”, “ Handbook of statistical methods in meteorology ” by C. E. P. Brooks and N. Carruthers, and “ A century of London weather ” by W. A. L. Marshall.

§ 6. INTERNATIONAL CO-OPERATION

(1) International Meteorological Organization and World Meteorological Organization

The Director attended a meeting of the International Meteorological Organization at Lausanne in May 1950, in his capacity as President. Advantage was taken to visit Payerne, where trials were in progress, under the aegis of the International Meteorological Organization, to compare the performance of various types of radio-sonde.

The Final Conference of Directors of the International Meteorological Organization, which opened in Paris on March 15, 1951, was presided over by the Director, who was also elected President of the World Meteorological Organization, the first Congress of which began in Paris on March 19. Commander C. E. N. Frankcom, as President of the Commission for Maritime Meteorology of the International Meteorological Organization, also attended both meetings.

The Meteorological Office was also represented at the following meetings :—
Commission for Aeronautical Meteorology Meeting, Paris, April 1950—
Mr. W. R. Galloway
Joint Sub-Commission for Experimental Aerology Meeting, Payerne,
April and May 1950—Dr. D. N. Harrison and Mr. H. E. Painter
Sub-Commission for the Study of Clouds and Hydrometeors Meetings,
Paris, June 1950 and January 1951—Mr. C. K. M. Douglas
Commission for Maritime Meteorology, Panel Meeting, Dublin, May
1950—Cdr. C. E. N. Frankcom (President of the Commission).

(2) International Civil Aviation Organization

Representatives of the Meteorological Office attended the following meetings :—

Second Caribbean Regional Air Navigation Meeting, Havana, April 1950
Special Airworthiness/Operations Divisions Meeting on Performance,
Paris, September 1950
Second Middle East Regional Air Navigation Meeting, Istanbul, October
1950
Special Meteorological Meeting of African, Indian Ocean, European,
Mediterranean and North Atlantic Regions, Paris, November 1950.

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

Air Traffic Control European—Mediterranean Special Meeting on
Altimeter Setting, Paris, April 1950
Communications Division Fourth Meeting to be held in Montreal, April
1951.

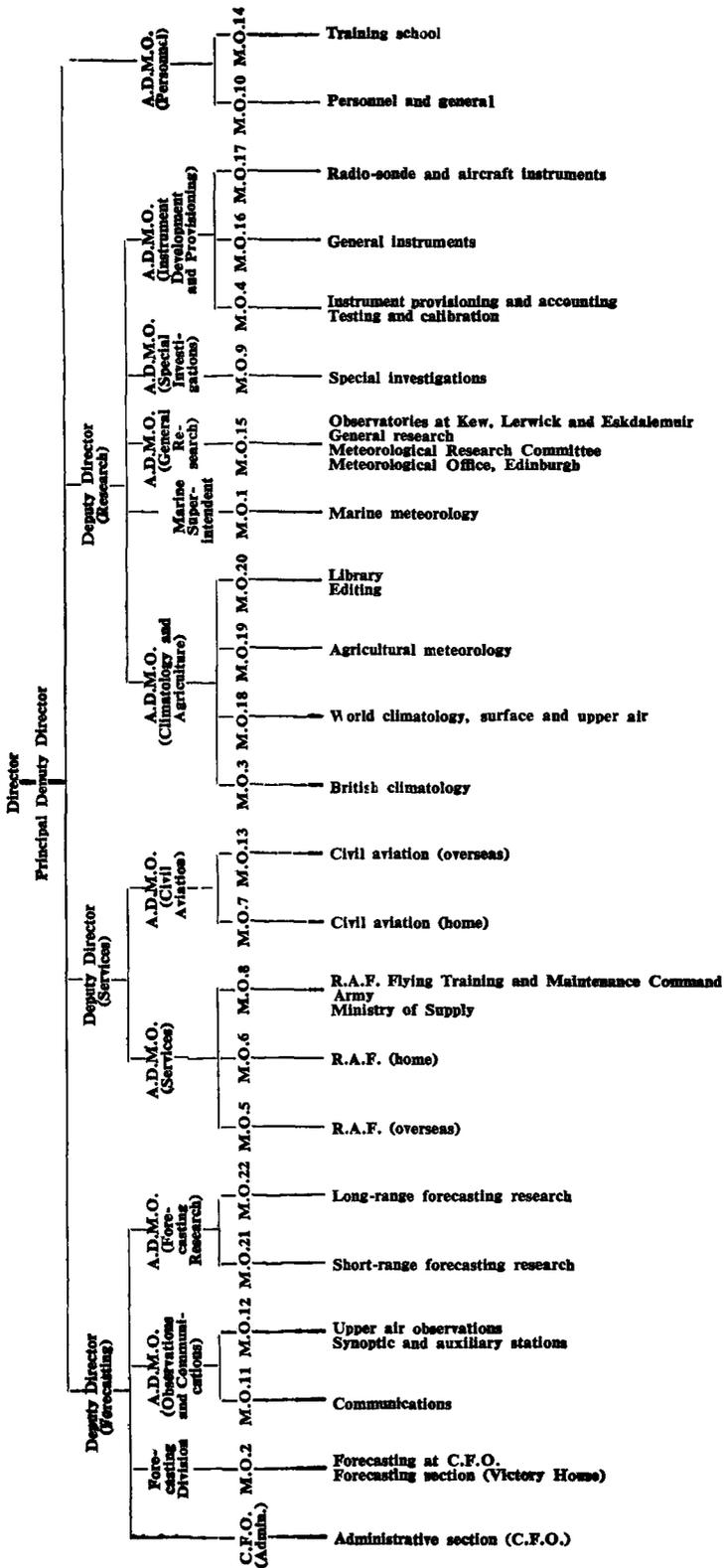
(3) International Union of Geodesy and Geophysics

Preparations are well advanced for the ninth General Assembly of the Union, which is to be held in Brussels in August 1951.

U.N.E.S.C.O. gave further grants to the Union in 1950 and 1951 for work on the distribution of ozone in the atmosphere, for geomagnetic studies and the publication of indices of magnetic disturbance, and for the compilation of earthquake data in the *International Seismological Summary*. Accommodation for this seismological work is provided by the Meteorological Office at Kew Observatory.

Dr. J. M. Stagg continues to be General Secretary of the Union.

APPENDIX I
ORGANIZATION OF THE METEOROLOGICAL OFFICE



APPENDIX II

DIRECTORATE OF THE METEOROLOGICAL OFFICE AND HEADS OF BRANCHES

DIRECTOR

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

PRINCIPAL DEPUTY DIRECTOR

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

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

CLASSIFICATION OF BRITISH STATIONS WHICH REPORT TO THE BRITISH CLIMATOLOGICAL BRANCH

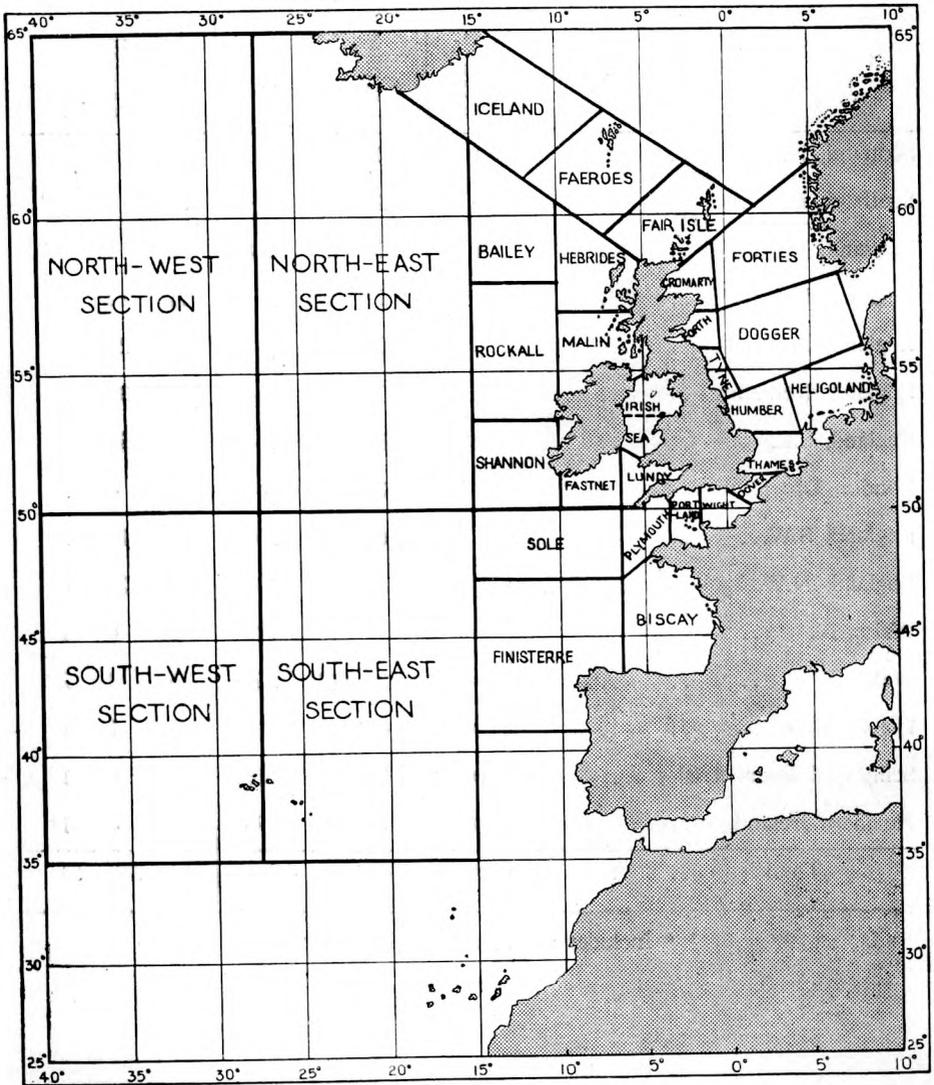
	Stations					Autograph records		
	Observatories	Synoptic	Crop weather	Climatological	Rainfall	Sunshine	Rainfall	Wind
Scotland, N.	1	6	0	9	145	12	9	2
Scotland, E.	0	5	2	42	344	35	14	3
Scotland, W.	1	4	2	25	368	22	11	6
England, N.E.	0	6	2	20	309	21	12	5
England, E.	0	7	10	21	478	28	23	6
England, Midlands	0	12	10	36	1,014	46	39	2
England, S.E.	1	14	8	51	761	52	51	13
London District	0	3	0	13	41	7	4	3
England, S.W... .. .	0	8	6	30	509	32	11	3
England, N.W.	0	6	1	21	443	24	26	6
Wales, N.	0	2	1	10	175	9	6	1
Wales, S.	0	4	2	13	263	16	7	2
Isle of Man	0	2	0	1	10	4	1	1
Scilly and Channel Isles	0	0	0	3	13	3	0	1
Northern Ireland	0	3	0	8	75	5	4	1
Total	3	82	44	303	4,948*	316	218	55

* Includes stations in earlier columns.

APPENDIX IV

CHART SHOWING THE AREAS USED IN GALE WARNINGS AND WEATHER BULLETINS FOR SHIPPING

effective from November 1, 1948



APPENDIX V

PROVISION IN AIR ESTIMATES FOR METEOROLOGICAL SERVICES

The approximate cash provision in Air Estimates, 1950-51, 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	213,800	3
1b	Salaries, wages, etc. of civilians at meteorological observatories and outstation offices and in ocean weather ships	1,190,000	4
1c	Pay, etc. of airmen employed as air meteorological observers and meteorologists and of air force personnel of the meteorological research flight ..	52,700	1
1d	National insurance contributions	3,600	1
1e	Pay, etc. of meteorological personnel of the Royal Air Force Reserve	6,000	2
1f	Superannuation allowance and gratuities	9,000	10
1g	Conveyance of personnel; travelling allowances and expenses	69,500	5
2	<i>Equipment and Supplies</i>		
2a	Meteorological equipment	290,000	7
2b	Radio, radar and electrical equipment for meteorological services	30,000	7
2c	Conveyance of meteorological equipment	12,000	5
2d	Mechanical transport vehicles for meteorological services	38,000	7
2e	Solid fuel, electricity, gas, water and sanitary services for meteorological observatories and outstation offices	4,300	6
2f	Liquid fuel, lubricants, etc. for aircraft of the meteorological research flight and for vehicles required for meteorological services	16,700	6
2g	Liquid fuel for ocean weather ships	20,000	6
2h	Miscellaneous equipment and services for aircraft of the meteorological research flight	40,000	7
2i	Miscellaneous equipment and services for ocean weather ships	41,000	7
2j	General stores for meteorological services	1,600	7
2k	Food and ration allowance for air force personnel; food for crews of ocean weather ships	29,000	6
2l	Clothing, clothing allowances and laundry services for airmen; clothing for crews of ocean weather ships	8,500	7
3	<i>Works services for meteorological observatories and outstation offices</i>		
3a	Capital expenditure	41,000	8
3b	Maintenance expenditure	18,000	8
4	<i>Telecommunication services for meteorological purposes</i>	60,000	9
5	<i>Flights by civil aircraft for meteorological purposes</i>	11,000	9
6	<i>Miscellaneous effective services (other than telecommunications)</i>	18,300	9
	GROSS TOTAL	£2,224,000	

Item	Service	Provision	Vote
		£	£
7	<i>Deduct—Appropriations in aid</i>		
7a	Receipts in respect of salaries, wages, etc. of meteorological staff	270,000	4
7b	Receipts in respect of movement of meteorological staff	15,000	5
7c	Receipts in respect of non-effective benefits of meteorological staff lent to other governments	6,000	10
7d	Receipts relating to meteorological equipment	75,000	7
7e	Payments by airmen for issues of clothing and footwear	1,500	7
7f	Receipts for meteorological services ..	7,500	9
			375,000
	NET TOTAL		£1,849,000

APPENDIX VI

PUBLICATIONS

The publications prepared by the Meteorological Office are generally issued by His 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 or signed for press 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, 1951).
- Daily Weather Report*, containing weather maps for the northern hemisphere, British Isles, etc. and data (to March 31, 1951).
- Meteorological Magazine* (to January 1951).
- Monthly Weather Report*, with a summary for the year (to December 1950).
- Monthly Frequency Tables*, being summaries of observations of horizontal visibility, height of base of low cloud, and speed and direction of surface and upper winds in the form approved by the International Commission for Air Navigation (to August 1947).
- Seismological Bulletin*. A diary of seismological disturbances recorded on the Galitzin aperiodic seismographs at Kew Observatory, Richmond (to February 1951).
- Marine Observer* (quarterly) (to January 1951).
- British Rainfall*, 1943 to 1945 (in one volume) and 1948. A report on the distribution of rain in space and time over Great Britain and Northern Ireland as recorded by about 5,000 observers.
- Facsimile weather charts for permanent retention*, November 22 to 23, 1949.
- Annual Report and results of meteorological observations*, 1942 to 1945 (in one volume). Southport Auxiliary Observatory. By George A. Lidster.

Occasional

- International meteorological code adopted by the International Meteorological Organization, Washington, 1947. Decode for the use of shipping, incorporating the code for weather reports from and to ships and the analysis code for use of shipping. 2nd edition, 1950.
- Marine Observer's Guide. Information for the use of the voluntary observing fleet of the British Commonwealth of Nations co-operating with meteorological services. 2nd edition, 1951.
- Marine Observer's Handbook. 7th edition, 1950.
- Observer's Primer, being short instructions in the method of taking and reporting readings of temperature and rainfall, specially prepared for meteorological observers in British Crown Colonies. 4th edition, 1950.
- Geophysical Memoirs* :—
- Vol. X :—
85. Upper winds over the world. By C. E. P. Brooks, D.Sc., C. S. Durst, B.A., N. Carruthers, B.Sc., D. Dewar, B.Sc., and J. S. Sawyer, M.A.
- Vol. XI :—
86. Solar radiation at Kew Observatory. By J. M. Stagg, M.A., D.Sc.

Meteorological Reports :—

Vol. I :—

5. Aviation meteorology of the route Castel Benito—Cairo.

Vol. II :—

6. Equivalent headwinds. Application of upper-wind statistics to air-route planning. Compiled by J. S. Sawyer, M.A.
7. Equivalent headwinds on some of the principal air routes of the world.
8. Upper air analysis and tropical forecasting. By R. A. S. Ratcliffe, B.A.

Professional Notes :—

Vol. VII :—

102. Sandstorms on the northern coasts of Libya and Egypt. By E. A. Lunson, B.A.

The publication of the following books or papers by members of the staff during the year may also be mentioned.

SIR NELSON K. JOHNSON, K.C.B., D.Sc. :—

Services rendered to the community by the Meteorological Office. Contribution to the symposium on meteorology and the community. "Centenary proceedings of the Royal Meteorological Society", London, 1950, p. 229.

Vertical distribution of atmospheric humidity near the ground. *Nature, London*, 167, 1951, p. 109.

A. H. R. GOLDIE, M.A., D.Sc., F.R.S.E. :—

? A fundamental property of atmospheric circulation. *Nature, London*, 165, 1950, p. 481.

The average planetary circulation in vertical meridian planes. Contribution to symposium on the general circulation. "Centenary proceedings of the Royal Meteorological Society", London, 1950, p. 175.

C. E. P. BROOKS, D.Sc. :—

Climate in everyday life. London, 1950.

R. C. SUTCLIFFE, Ph.D. and A. G. FORSDYKE, Ph.D., D.I.C. :—

The theory and use of upper air thickness patterns in forecasting. *Quart. J. R. met. Soc., London*, 76, 1950, p. 189.

A. W. BREWER, Ph.D. and F. J. SCRASE, Sc.D. :—

Meteorological measurements. *Quart. J. R. met. Soc., London*, 77, 1951, p. 3.

C. E. N. FRANKCOM, R.N.R. :—

Weather wise. Part I, *Mar. Obs., London*, 20, 1950, p. 29 ; Part II, *Mar. Obs., London*, 20, 1950, p. 74.

J. K. BANNON, B.A. :—

Shear frequencies in the upper troposphere and lower stratosphere over England. *Met. Mag., London*, 79, 1950, p. 161.

A. C. BEST, M.Sc. :—

Empirical formulae for the terminal velocity of water drops falling through the atmosphere. *Quart. J. R. met. Soc., London*, 76, 1950, p. 302.

C. J. BOYDEN, B.A. :—

Transatlantic flying from Prestwick Airport. *Mar. Obs., London*, 20, 1950, p. 82.

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