

M.O. 537

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, 1949 to March 31, 1950

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METEOROLOGICAL COMMITTEE

Appointed by the Secretary of State for Air

Chairmen :—Mr. Geoffrey de Freitas, M.P. (to March 1, 1950) (Parliamentary Under Secretary of State for Air)

Mr. A. M. Crawley, M.B.E., M.P. (from March 2, 1950)
(Parliamentary Under Secretary of State for Air)

Vice-Chairman :—Professor S. Chapman, F.R.S. (Royal Society)

Members :—Mr. W. J. Bigg (Colonial Office)

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

Air Chief Marshal The Hon. Sir Ralph A. Cochrane, K.C.B.,
K.B.E., A.F.C. (Air Ministry) (from March 1, 1950)

Professor G. M. B. Dobson, F.R.S. (Royal Society)

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

Mr. H. M. Garner, C.B. (Ministry of Supply)

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

Mr. W. E. B. Griffiths, O.B.E. (Ministry of Civil Aviation)

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

Sir Ben Lockspeiser (Ministry of Supply)

Captain J. H. Quick (Ministry of Transport)

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

Sir Edward Salisbury, K.B.E., F.R.S. (Ministry of Agriculture and Fisheries)

Mr. H. R. Smith (Scottish Office)

Air Marshal Sir Hugh Walmsley, K.C.I.E., C.B., C.B.E., M.C.,
D.F.C. (Air Ministry) (until February 28, 1950)

Captain F. M. Walton, R.N. (Admiralty)

Secretary :—Mr. R. J. Williams

The Committee met on May 26, 1949.

COMMITTEE OF THE METEOROLOGICAL OFFICE, EDINBURGH

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., M.A., D.Sc., F.R.S.E. (University of Aberdeen)

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

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

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

Mr. James Paton (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, D.Sc., LL.D. (Royal Society of Edinburgh)

Secretary :—Mr. R. A. Watson, B.A.

The Committee which had been in abeyance since 1939 was reconstituted in 1949 and met on June 9, 1949. Membership was enlarged to include one member for each of the Scottish Universities.

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.

Mr. H. M. Garner, 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)

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

Professor P. A. Sheppard

Professor O. G. Sutton, F.R.S.

Professor Sir Geoffrey Taylor, F.R.S.

Captain F. M. Walton, R.N. (Admiralty)

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, *viz.* Meteorology, Terrestrial Magnetism, Atmospheric Electricity, Seismology and the cognate subjects.

Professor Sir David Brunt (Chairman)

Sir Edward Appleton

Professor P. M. S. Blackett

Lord Cherwell

Professor T. G. Cowling

Professor G. M. B. Dobson

Mr. E. Gold

Professor H. W. Massey

Professor E. A. Milne

Professor F. A. Paneth

Professor P. A. Sheppard

Professor O. G. Sutton

Sir George Thomson

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, 1949, to March 31, 1950

§ 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 Meteorological Branch 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 the important work of the International Meteorological Organization, the present President of which is the Director of the Meteorological Office. Other international organizations which include representatives of the Meteorological Office 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 1950-51.

§ 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.

The collection and dissemination of weather reports and other meteorological messages is effected partly by teleprinter and partly by wireless telegraphy. In addition, a radio-telephony broadcasting service, AIRMET was in operation until March 14, 1950, mainly to provide weather information for the small airfields where there is no meteorological office (see p. 10).

During the year under review a new edition of the Meteorological Observer's Handbook was prepared, incorporating changes in observational practice introduced on January 1, 1949, as a result of resolutions of the Conference of Directors at Washington in 1947. The opportunity was taken to revise and re-arrange the whole Handbook.

From January 1, 1950, an expanded version of the upper air section of the *Daily Weather Report* was introduced, with the new title *Daily Aerological Record*. From the same date the main features of the British and International Sections were combined in a single publication for which the title *Daily Weather Report* was retained. Some progress was made in the preparation of a cloud atlas for the use of airborne observers.

The service of weather forecasts for general public purposes was augmented from July 29 by the inclusion of televised weather charts, with spoken forecasts, in the B.B.C. evening television programmes.

A daily *post factum* examination of 24-hr. forecasts was maintained at the Central Forecasting Office in order to determine the forecasting problems most commonly giving rise to errors, and hence most pressing for research.

(b) Reporting stations.—Little change in the total number of stations in the British Isles making regular synoptic observations occurred in the past year, and the number now stands at 169, of which 53 are classified as full synoptic reporting stations. To supplement the observations received from meteorological offices some 44 auxiliary reporting stations are maintained, particularly in remote districts of the country. At these stations part-time observers undertake to make regular observations according to a programme.

Observations from the auxiliary stations are transmitted in code by telegraph or telephone to the nearest convenient station on the meteorological teleprinter network. Eleven stations report regularly in the full synoptic code and 33 in the shortened AERO form. In addition, 2 stations have the responsibility of only maintaining wind records from Dines anemometers.

Observers responsible for these auxiliary stations are recruited from many widely differing professions. They carry out their meteorological duties with enthusiasm, and as the result of experience over a considerable number of years they have become well skilled in the practice of making weather observations.

During the year 1 station was equipped with a searchlight for the accurate determination of cloud height at night. New anemometers, giving a direct reading of wind speed and direction, have been installed at 3 stations.

(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. When completed, the logbooks are sent to the Marine Branch for climatological study. Approximately 500 ships co-operate in this manner.

(ii) Supplementary ships, which make and transmit observations in an abbreviated form at the main synoptic hours. Where the ships' own meteorological equipment is considered adequate no instruments are supplied. In other cases thermometers or an aneroid barometer may be lent to the ship. The present number of supplementary ships is about 30, and these have been asked to make radio weather messages in areas where shipping is relatively sparse.

(iii) About 80 coastal vessels (MARID ships), which are equipped with sea thermometers and canvas buckets. They make and transmit 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 and thence by telegram to the Central Forecasting Office. Four of these light-vessels make and report observations of waves.

About 120 ships' reports, three fourths of which are from British ships, are received daily at the Central Forecasting Office. Rapid transmission is ensured by a direct teleprinter line between Dunstable 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 during their season in the Antarctic.

Ocean weather ships.—During the year each of the 4 British ocean weather ships completed 2 years' service as a weather ship (18 voyages). Station I at position 60° 00' N., 20° 00' W., and Station J at position 53° 50' N., 18° 40' W. were occupied practically continuously throughout the year. From May 24 to June 9, Station I was diverted to 61° 00' N., 13° 00' W. to co-operate with a flight of jet aircraft. Other breaks of a few days were occasioned by diversions to co-operate in search and rescue arrangements or to land sick men.

The ships have carried out a full programme of meteorological work, including surface and upper air observations which are transmitted to the Central Forecasting Office by point-to-point W/T communication. Periodic

air/sea 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 air/sea rescue organization and drill.

The weather ships' navigational aids are regularly used by both civil and Royal Air Force aircraft flying over the North Atlantic Ocean; 4,265 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.

Oceanographers from Cambridge University carried out highly successful seismic experiments aboard *Weather Explorer* using depth charges to determine the thickness of the bottom sediment. Newspaper correspondents and a navigation school instructor made a voyage as passengers in one of the ships.

On April 13, 1949 *Weather Explorer* went to the assistance of the S/T *Mayflower* ashore on Sandra Island. The ship refloated undamaged. On May 25 *Weather Observer* went to the assistance of Danish S.S. *Erik Boye*, in distress 70 miles from Myggenæs. She located the distressed vessel but as two other trawlers were then standing by she returned to station. In July *Weather Observer* carried out a search, lasting 6 days, to look for traces of a Royal Air Force aircraft lost while carrying out a meteorological reconnaissance flight. On November 1 *Weather Watcher* went to the assistance of S/T *Red Crusader* ashore east of Islay; the crew were rescued by a lifeboat.

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 require considerable ingenuity.

(d) Meteorological flights.—Routine meteorological reconnaissance flights have continued to be made by aircraft of Coastal Command operating from Aldergrove and Gibraltar, but those from St. Eval and flights by aircraft of Bomber Command operating from Binbrook were discontinued in the autumn.

A new series of meteorological reconnaissance flights over the Indian Ocean, operating from Negombo (Ceylon) started in June 1949.

Halifax aircraft used by the flights at Aldergrove and Gibraltar are to be replaced by Hastings aircraft which are expected to be capable of longer flights. Modifications to the first batch of Hastings aircraft are proceeding, and delivery is expected to begin in June 1950.

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 one of several alternative bases in the United Kingdom by Mosquito aircraft of Fighter Command. Similar ascents have also been made from a station in the British Zone of Germany and from Singapore.

The meteorological flights established by the United States Air Forces in the United Kingdom in 1948 have been withdrawn.

(e) Radio-sonde and radio-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, in the two British ocean weather ships, and at eight overseas stations under British control. Shortage of staff has prevented the full programme of ascents being maintained at some 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 equip-

ment. 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 improve the value of the results by achieving greater accuracy of measurement and to obtain observations to greater heights. Steps are also being taken, with the co-operation of the Ministry of Supply, to develop new equipment of greater range and accuracy.

Some special ascents with an experimental type of balloon have reached heights of 100,000 ft.

A site has been chosen at Hemsby, near Great Yarmouth, to which it is intended to transfer the radio-sonde unit at Downham Market and the thunderstorm-location unit at Dunstable.

The radio-sonde unit at Downham Market has continued as a training centre for new personnel.

(f) Thunderstorm location.—The four stations engaged in the direction-finding of atmospherics ("Sferic") have continued in operation. The new sets installed at all four stations have given very satisfactory results.

The frequency of routine observations for synoptic purposes has been increased, and in addition special observations have been made on behalf of scientists at Cambridge and London Universities for use in investigations of long-wave propagation and wave forms. The visual method of observation continues in use for routine purposes, but photographic records are also made on selected occasions.

A trial was carried out during February 1950 using an additional station temporarily established at Malta and connected to the United Kingdom "Sferic" network by a radio-teleprinter link. The trial showed that it was practicable to operate an extended network in this way, and that the use of a base-line 1,200 miles long improved the accuracy of "fixes" in the Mediterranean, the eastern Atlantic and parts of Europe.

Work is proceeding on the problem of determining the distance of a storm by observations made at a single receiving station, but significant results have not yet been obtained.

(g) Meteorological communications.—*Land-line communications.*—As a result of operational requirements a few re-arrangements have been made in the stations connected to the first-channel teleprinter broadcast from Dunstable, but the total number of recipients has only altered from 160 to 156. The second-channel broadcast carrying supplementary data is fed to 57 sub-centres and important airfields. Since these are connected to the Central Forecasting Office by Duplex circuits it has now been found unnecessary to arrange for hourly "breaks" in the second-channel broadcast. The elimination of "breaks" has resulted in the speedier re-issue of certain data. It has been arranged to concentrate hourly reports from all "Master" aerodromes at two Air Traffic Control Centres for transmission to Dunstable and re-broadcast on the first-channel with priority.

An important change was introduced on October 1, 1949, when responsibility for the issue of the North Atlantic teleprinter broadcast was transferred from Prestwick to Dunstable. This broadcast contains reports from North America, the Caribbean Sea, Greenland, Iceland, and Atlantic ships, together with analyses, upper air data and landing forecasts required by about 12 recipients, including the Admiralty, who compile charts covering the Atlantic and eastern North America.

The continental teleprinter broadcast has been maintained according to an internationally agreed schedule. Small changes in the method of compilation of bulletins have been introduced to facilitate the onward transmission of the bulletins by Paris over the radio-teletype circuit to New York.

Radio communications.—In 1946 the International Meteorological Committee recommended that responsibility for the broadcast of European reports should be shared between Great Britain, France, Italy, and U.S.S.R., and that surface stations should be divided into two categories, A and B, in order to make it possible to obtain, with only two W/T receivers, an even distribution of reports from the whole area covered by the four transmissions. At a meeting in Stockholm in April 1949, the Sub-commission for Transmission of Weather Information expressed the view that there was a requirement for a fifth broadcasting station in order to save a receiving station which only required "A" reports from changing frequency, and to speed up the re-issue of such data. Since the contents of the broadcast from the fifth station would be similar to the continental broadcast from Rugby it has been recommended that the latter should be remodelled so as to meet the needs of European countries as well as those of other regions. The new arrangements are likely to be introduced shortly. No major changes have been made to the contents or schedules of the issues made by the GFA (sub-continental broadcast) or GFL (national broadcast giving upper air data) W/T transmitters. In order to meet the increasing need by the Forecasting Research Division of data from the whole of the northern hemisphere, the programme of W/T interceptions has been enlarged, and extensive trials have been made to determine the best selection of broadcasts which can be covered by the 25 receivers now in use.

As the result of an international decision nominating Paris as the European centre responsible for the reception by radio-teletype and re-diffusion within Europe of North American data, transmission of these reports by Dunstable on GFT ceased on October 1, 1949 when Paris took over the frequencies using transmitter FXO.

The re-allocation of broadcasting frequencies provided for in the Copenhagen plan was brought into effect on March 15. Owing to the many claims for frequencies within the broadcasting band it was found impossible to make any provision for the AIRMET radio-telephony broadcast in this band. The AIRMET service therefore temporarily ceased to operate at 1800 G.M.T. on March 14. Evidence of the usefulness of AIRMET to aviation, farming and educational interest has continued to accumulate, and it is hoped to restore this service as soon as possible.

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

The following are amongst 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 on similar lines to those of the previous year.

Television.—A daily broadcast of meteorological charts and forecasts was instituted on July 28, 1949, covering the London and south-east England areas. This broadcast was extended in December to include the Midlands area when the television service from Birmingham commenced.

(b) Railways.—The issue of forecasts and warnings of fog, snow and frost was continued on similar lines to those of the previous year. Forecasts relating to icing of conductor rails were extended to electrified systems in the

Liverpool and Newcastle areas. Some experimental work on the conditions for ice formation on rails was instituted in collaboration with the London Transport Executive. Selected British Railway offices in Yorkshire were supplied with forecasts of week-end weather conditions at coastal resorts.

(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.—Forecasts of meteorological factors, such as temperature, wind, cloud, affecting electricity loading, have been issued daily to Grid Control Centres. Special week-end forecasts were issued on Fridays. A meteorological unit is provided at the Headquarters of the British Electricity Authority to assist in interpreting forecasts received from the Central Forecasting Office and to investigate the special meteorological problems affecting the demand for electricity.

(e) Belfast Harbour Power Station.—Week-end forecasts of meteorological factors affecting electricity loading were issued weekly 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 companies.—Warnings of various types of weather change have been issued to gas undertakings to assist in meeting abrupt variations in the demand for gas resulting from such changes.

(h) Film companies.—Special weather forecasts for the Greater London area have been issued twice daily, with emphasis on the meteorological factors which are of particular importance in photography and sound recording. Similar forecasts for other areas were provided on request.

(i) Agriculture.—Forecasts for farming activities in selected districts in south-west England have been supplied to eight district centres controlled by the Ministry of Agriculture and Fisheries. Reports from a selection of stations in Scotland have been supplied to the Scottish Department of Agriculture for use in connexion with broadcasts of potato-blight warnings. During the harvest season, notifications of spells of fine weather were supplied to a number of inquirers.

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

(k) Road engineers and automobile clubs.—Warnings of the onset of fog, snow, glazed ice, and marked temperature changes have been supplied to the Ministry of Transport, Ministry of Food (Milk Division), Royal Automobile Club and to various Country and City Surveyors and Divisional Road Engineers.

(l) Mines.—Warnings of sharp falling tendencies in barometric pressure have been issued to Point of Ayr Colliery, north Wales. These were in connexion with experiments on a colliery warning system based on the relationship between the rate of change of barometric pressure and the efflux of gas in mines.

(m) Factories and other commercial undertakings.—Special forecasts have been supplied to many factories, firms and commercial undertakings to meet their particular requirements in regard to weather conditions affecting industrial processes.

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

(o) **Sport and recreation.**—A special forecasting service for pigeon racing has been instituted. Many special forecasts were issued on request in connexion with various sports and recreations.

(p) **General Public.**—Forecasts have been supplied on request by telephone from meteorological offices specified in the Post Office Guide.

(3) Services for the Royal Air Force

(a) **General.**—Although there were many minor changes due to the re-deployment of Royal Air Force units during the year, the total number of meteorological offices remained substantially the same. There was a reduction of two in the number of 24-hr. forecast centres maintained for the R.A.F. in the United Kingdom, the centre at Headquarters No. 47 Group being amalgamated with that at Headquarters No. 46 Group, and the centre at Headquarters No. 11 Group with that at the Air Traffic Control Centre, Uxbridge.

In the British Zone of Germany the increased meteorological commitments entailed by the Berlin air-lift continued until August 1949, when these operations were suspended. The consequent reduction in aircraft operations was counter-balanced subsequently by an increase in R.A.F. trunk services to Gibraltar, the Middle East, the Far East and Rhodesia.

The risk of a state of emergency in Hongkong necessitated the provision of staff and radio-sonde equipment for supplying additional meteorological information to the Military Forces stationed in the Colony.

(b) **Organization.**—International Civil Aviation Organization procedures have now been adopted for the supply of meteorological facilities for the R.A.F. on trunk routes between the United Kingdom and the continent, Gibraltar, the Middle East and the Far East.

Meteorological sub-area broadcasts have been made from Gloucester, Hamburg, Cologne, Malta, Uxbridge and, on a restricted scale, Watnall. Landing forecasts have been added to the broadcasts of weather reports issued from certain stations of the Middle East Air Force.

TALK TO MET facilities at Istres ceased at the end of March 1949, on the withdrawal of British meteorological staff, but forecasts and other meteorological information continue to be supplied to Istres by Gloucester and Malta for the benefit of R.A.F. aircraft in transit. TALK TO MET facilities have continued at Shaibah and El Adem.

The facilities for the exchange of information between the ground and aircraft in flight were extended by the introduction of the R.A.F. R/T Flight Information Service in January 1950, at five Air Traffic Control centres and at 17 R.A.F. airfields. Arrangements were made for a collective of "Master" aerodrome reports to be issued hourly by Dunstable immediately after the Regional QFF messages.

Radio receivers for the reception of AIRMET broadcasts and meteorological equipment (barometers, wind speed and direction indicators, and cloud search-lights) have been provided for units in Reserve Command.

The transfer of Royal Auxiliary Air Force squadrons to Fighter Command, and their re-equipment with jet aircraft, has resulted in a requirement for the establishment of meteorological offices at a number of airfields where such facilities are not available.

(c) Royal Air Force Meteorological Policy Committee.—No meeting of this Committee has been held during the past year.

(d) Miscellaneous activities.—Meteorological facilities were provided for flying training and for flights on internal and trunk routes. Special arrangements were made for R.A.F. exercises, including joint exercises with the Royal Navy and with the Royal Egyptian Air Force, for the Battle of Britain Fly Past, for Goodwill tours, and for long training flights to the Middle East and other destinations. During exercises Sector Operations centres in Fighter Command have been manned and use has been made of Royal Observer Corps personnel for the supply of additional weather reports.

Arrangements were made for reports to be obtained from R.A.F. pilots of turbulence at high levels, of condensation trails from jet aircraft, and of misting of windscreens on jet aircraft on rapid descent from high levels to near the ground.

Radar cloud reporting equipment has been in operation at Changi, Singapore.

(e) Meteorological instruction for the Royal Air Force.—Regular courses of meteorological instruction were given by meteorological officers at a number of schools in Flying Training Command, including the Central Navigation and Control School, the R.A.F. College, and the R.A.F. Flying College, where a meteorological office was established on the re-organization of the R.A.F. Empire Schools. At some of the schools shortage of officers made it necessary for the meteorological instruction to continue to be given by qualified R.A.F. Navigation Officers. Meteorological instruction was given also at the Operational Conversion Units and other R.A.F. stations in Bomber, Coastal, Fighter and Transport Commands, and at some R.A.F. stations overseas. Meteorological lectures were given to Squadrons of the Royal Auxiliary Air Force Reserve Flying Schools and Reserve Command Centres.

The Meteorological Office member of the R.A.F. Central Examination Board conducted examinations in meteorology for pupils at the Flying Training Schools and at the Air Navigation Schools.

Two meteorological officers have been posted to the Rhodesian Air Training Group to undertake meteorological lectures at the training schools and to give meteorological advice.

Arrangements have been made for the training of members of the R.A.F.V.R. (Meteorological Branch); each Senior Meteorological Officer at the main meteorological offices in the United Kingdom is to be responsible for the training of members who reside within a prescribed area.

(4) Services for Civil Aviation

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

New meteorological offices were opened at Stansted and Grimsetter, replacing those at Gatwick and Hatston respectively.

The office at Whitchurch, Bristol was closed, its place being taken by a new office opened at Filton primarily for R.A.F. requirements.

The main meteorological office at Preston (Barton Hall) continued to provide information for the Air Traffic Control centre serving the Northern England Flight Information Region.

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

The aircrews of British Overseas Airways Corporation flying boats operating from Southampton Docks were briefed by forecasters detached daily from Southampton Airport (Eastleigh).

London Airport.—Civil air operations continued to develop at London Airport and the need for increased meteorological facilities made it necessary to enlarge the meteorological office accommodation. Forecasts were provided for routes with near and distant European and Mediterranean terminals and also for North Atlantic routes.

The supply of meteorological information to a number of operating agencies at the airport was continued by means of the local meteorological teleprinter system installed in 1948.

Prestwick.—The meteorological office 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 Central Scottish Air Traffic Control Centre.

The office continued to act as a main meteorological communications centre for the interchange of meteorological information between Canada and the United Kingdom.

Plans were agreed upon and are now being put into effect for combining the Meteorological Communications Centre with the Prestwick airfield meteorological office.

Bovingdon and Hurn.—Small meteorological offices continued to meet requirements at these main diversion airfields from London Airport. Bovingdon also provided meteorological information for a number of private charter companies based there.

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

The co-ordination of technical opinion on the effect of current weather situations on conditions at the various air terminals was ensured by telephone conferences held three times daily between the duty forecasters at major meteorological offices in the London area serving civil aviation.

The scheme for supplying Air Traffic Control centres with forecasts of hourly values of minimum sea-level pressure in order to maintain terrain clearance and the vertical separation of aircraft operating over the United Kingdom, was modified by the sub-division of the Flight Information Regions into eight Altimeter Setting Regions.

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

(d) Services provided overseas.—*British West Indies.*—Forecasting offices were maintained at Piarco (Trinidad), Oakes Field (Nassau) and Palisadoes (Jamaica), and smaller offices supervised by Trinidad were provided at Grenada and Barbados.

The main function of these offices is the supply of meteorological information for air-route operations within the region. These operations increased considerably during the year. In addition forecasts and climatological data are provided for other local activities such as agriculture, the press, broadcasting services, etc.

(e) **Examinations.**—The new I.C.A.O. Licence Regulations were introduced in April 1949, and from that date candidates were examined in meteorology for the Commercial Pilot, Senior Commercial Pilot, Airline Transport Pilot, and Flight Navigator Licences. Re-arrangement of the examination programme involved the setting of seven additional examination papers during the year.

(5) Services for the Royal Navy*

Close liaison has been maintained with the Naval Meteorological Service through the Naval Liaison Officer appointed to the Meteorological Office.

By arrangement with the Admiralty, meteorological information for naval purposes was supplied by a number of meteorological offices at home and overseas. In addition to routine and occasional information supplied to local naval authorities, the preparation of analyses and forecasts for broadcast to H.M. ships was continued at Gibraltar, Habbaniya and Aden. Similar commitments were undertaken by Negombo (Ceylon) from December 12, 1949. Other meteorological offices, such as that at Malta, continued to supply basic meteorological data to shore offices of the Naval Meteorological Service.

During joint R.N. and R.A.F. Exercises the Area Combined Headquarters at Plymouth, Pitreavie and Londonderry have been manned and full meteorological information provided for R.N. and R.A.F. staff. During such exercises arrangements have been made for the provision of weather reports by H.M. ships and selected land stations, as required.

Routine forecasts for certain areas of the South China Sea were supplied twice daily from April to October 1949 by Changi (Singapore) to the Naval Liaison Officer at Advanced Headquarters, Kuala Lumpur.

(6) Services for the Army

The meteorological office at the School of Artillery, Larkhill, has supplied information for artillery and sound-ranging purposes, and has given meteorological instruction to courses held at the School, and advice on special problems including the preparation of a section of the revised text-book of gunnery and ballistics. Other artillery requirements at Practice Camps and at an Army exercise were met either by the temporary attachment of meteorological staff or by a near-by meteorological office.

Close liaison has been maintained with the Royal Military Academy, Sandhurst, and advice has been given on instruction in meteorology by the Science Department of the Academy.

The Meteorological Office continued to be represented on a number of War Office committees and working parties.

In overseas commands meteorological information for sound-ranging, calibration trials and practice shoots has been supplied to the Artillery as required. Other army formations have been supplied with climatological and other meteorological information.

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

(7) Services for the Ministry of Supply

Meteorological offices have been maintained to provide information for the special work of the establishments at Shoeburyness, Aberporth, Pendine, Porton and Windscale. Forecasting offices were maintained also at Boscombe Down, Defford, Felixstowe, South Farnborough and West Freugh. Special forecasts and warnings have been supplied to the Atomic Energy Research Establishment Harwell, in connexion with special investigations.

The Meteorological Office continued to be represented on a number of Ministry of Supply committees.

(8) Services for the Merchant Navy and Fishing Fleets

The Central Forecasting Office prepared shipping bulletins and gale warnings for broadcast by the B.B.C., the former at 0655 (except Sundays), 0755, 1255 and 1755 clock times and the latter as soon as possible after issue. The B.B.C. transmissions were repeated by various coastal stations. The bulletins broadcast twice daily from Wick included ice warnings for the Iceland area. During the season special East Anglian and Hebridian fishing forecasts were appended to shipping forecasts. Changes in the shipping forecast areas and their names are shown in Appendix IV.

Twice daily, at 0930 and 2130 G.M.T., a North Atlantic shipping bulletin was broadcast by the Admiralty and Portishead. The contents were modified, from January 1, 1949, to include storm warnings (Beaufort force 10 and above) in accordance with a resolution of the International Meteorological Organization.

A message giving an analysis of pressure and frontal systems was issued daily at 1130 G.M.T.

Forecast centres near ports issued local 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 Dominions, Colonies, etc.

(a) Mediterranean—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, and to provide meteorological facilities for all R.A.F. and civil aviation services operating in and through Malta.

Cyprus.—The Meteorological Office has continued to maintain a forecasting service at Nicosia, a radio-sonde/radar-wind unit at Nicosia and a small network of reporting stations in Cyprus, and has provided meteorological facilities for all R.A.F., military and civil aviation services operating in and through Cyprus. Since July 1949 a daily broadcast has been made of a general weather outlook, in English and Greek, mainly for the benefit of farmers.

Aden.—A meteorological office was maintained at Khormaksar. In addition to work for the R.A.F., this office is responsible for the issue of forecasts for shipping in adjacent sea areas and of forecasts for aviation.

During the year there has been an appreciable increase in the number of scheduled air services operating through Aden. The question of extending the forecasting services for shipping is under consideration.

(b) India area.—Pakistan.—Close liaison has been maintained with the Pakistan Meteorological Service. A meteorological office continues to be maintained at the Royal Air Force Staging Post, Mauripur, and has provided forecasting facilities for the Royal Air Force and for the Royal Pakistan Air Force. A direct teleprinter link between this office and the Pakistan Meteorological Department at Karachi facilitates the exchange of information between the two services.

India.—Close liaison has been maintained with the Indian Meteorological Service.

Ceylon.—All forecasting facilities for the R.A.F. and civil aviation services operating in or through Ceylon have continued to be provided by the Air Ministry meteorological office at Negombo. The meteorological office at Koggala was transferred to Trincomalee in December 1949.

Officers of the Ceylon Meteorological Service have been given training at the Meteorological Office Training School and at other meteorological offices in the United Kingdom. It is expected that the Ceylon Meteorological Service will soon be able to undertake some of the meteorological commitments for civil aviation.

Assistance has been given to the authorities in the Maldives to establish and operate an upper wind reporting station at Male.

(c) Far East area.—Malaya.—Little change has occurred in the meteorological organization in Malaya, where the Meteorological Office is responsible mainly for the provision of meteorological facilities for the R.A.F. while the Malayan Meteorological Service is responsible for other commitments. Air Ministry meteorological offices are maintained at Changi, Seletar, Tengah, Sembawang and Butterworth. Arrangements are being made for the majority of our commitments in Malaya to be undertaken by the Malayan Meteorological Service.

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

Hongkong.—Meteorological Office staff were posted to Hongkong to assist the Royal Observatory in the establishment of a radio-sonde station, to train locally engaged staff in radio-sonde work, and to supply meteorological information to Army units.

(d) British West Indies.—The United Kingdom continued to be responsible for the meteorological organization in the British West Indies (see p. 14).

(e) Falkland Islands.—Up to the end of 1949 the United Kingdom continued to maintain a small forecast office and a radio-sonde unit at Port Stanley. On January 1, 1950 the forecast office was transferred to the administration of the Governor to become part of the newly formed Meteorological Service of the Falkland Islands and Dependencies. The radio-sonde unit, however, remained the responsibility of the United Kingdom.

Weather reports from a number of stations in the Falkland Islands and Dependencies continued to be collected and broadcast by radio-telegraphy three times daily from Port Stanley.

(10) Services in Foreign Countries

(a) **European area.**—*Germany.*—The Meteorological Office has continued to be responsible for the provision of meteorological facilities in the British Zone of Germany, and in Berlin for the use of all British occupational forces, the Control Commission, and civil aviation. Increasing use has been made of German meteorological staff who work under the control of British staff. In addition, supervision was exercised over the German Zonal Meteorological Service, which provides a basic network of reporting stations and meets the needs of the German economy.

In the early part of the year the main effort of the British meteorological service was concentrated on the continuous supply of information for the Berlin air-lift. With the cessation of this operation in August 1949 some reduction in the British meteorological organization became possible.

Close liaison has been maintained with American and French meteorological services in the western zones of Germany.

Austria.—A British meteorological officer remains in charge of the meteorological office at Schwechat (Vienna), the remainder of the staff being Austrians, and acts as British representative at meteorological meetings of the Occupying Powers.

France.—Meteorological reports and forecasts are exchanged between Istres and the British offices at Gloucester and Malta for the benefit of R.A.F. aircraft flying between the United Kingdom and the Middle East.

(b) **Mediterranean—Middle East area.**—*Libya.*—The meteorological organization was maintained with forecasting offices at Castel Benito and El Adem and small networks of reporting stations in Tripolitania and Cyrenaica. Discussions are being held with the Foreign Office regarding responsibility for the maintenance of a meteorological service in Libya.

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, primarily to meet the needs of the Royal Air Force, at Khartoum. The forecasting office was moved from the town to the airfield in June 1949.

Somalia.—A small network of meteorological reporting stations, manned by locally engaged meteorological assistants, has been maintained. Arrangements are being made for the meteorological service in the former Italian Somaliland to be handed over to the Italians.

Eritrea.—The forecasting office at Asmara and a network of reporting stations have been maintained to meet the requirements of the British Military Administration, the Royal Air Force, and civil aviation. Meteorological advice has been given to the Anti-Locust Research Centre in Eritrea.

Iraq.—The Meteorological Office has continued to maintain forecasting offices at Habbaniya and Shaibah. Many of the commitments for civil aviation were undertaken by the Iraqi Meteorological Service from December 1949, but some assistance continued to be rendered by our Service. The meteorological office at Margil was handed over to the Iraqi Service in November.

Persia.—Liaison has been maintained with the Director of Civil Aviation, who controls the meteorological service in Persia. Arrangements were made for a Persian forecaster from Mehrabad (Teheran) to be given training at the Air Ministry meteorological office at Ismailia.

Persian Gulf.—All meteorological facilities at Bahrein and Sharjah have continued to be provided by the Meteorological Office. At the former place a forecasting office and radio-sonde/radar-wind station is maintained and at the latter a reporting station.

(c) *Far East area*.—Liaison was maintained with the Burma Meteorological Department, the Indo-China Meteorological Service, the Meteorological Department of the Royal Thailand Navy, and the Meteorological and Geophysical Department of Batavia.

§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 Central Meteorological Office 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, summarising 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*.—Details were given in the last Report of the five classes of stations contributing climatological observations. These are 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. Their number has increased during the year, especially at Experimental Husbandry Farms.

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.

Special attention has been given to increasing the accuracy of the returns, both by inspection and correspondence, to ensure that the observations conform to standard requirements. A large number of new barometer correction cards have been prepared for use at climatological and synoptic stations. Recommendations have been made in a number of cases for replacing obsolete or defective rain-gauges and measures by modern equipment.

(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, but publication of the *Weekly Weather Report* has not yet been resumed, the last issue covering the year ending February 1939.

Monthly Frequency Tables of upper winds, clouds and visibility have been published up to January 1947. 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 quinquennially.

British Rainfall.—A volume covering the three years 1940–42, about the size of a pre-war annual volume, was published in November 1949; the companion volume for 1943–45 is in the hands of the printer. *British Rainfall* for 1946, the first post-war volume, was published in January 1949, and that for 1947 in February 1950. The volume for 1948 is with the printer and that for 1949 is in preparation. The lag due to the war has thus been substantially reduced.

The *Observatories' Year Book*, containing the geophysical records of the observatories, has not been published since the outbreak of war.

(e) **Special work**.—*Climatological Atlas of the British Isles*.—The text has been completed and sent to the printer. Work has proceeded on the preparation of the maps and diagrams which are the principal features of the atlas. The basic maps and diagrams are completed and from these copies suitable for the printer are being prepared. 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.

Rainfall maps of Great Britain.—The Ordnance Survey has published maps showing the average annual rainfall over Great Britain on a scale of about ten miles to one inch. The isohyetal lines were copied from maps prepared in the Meteorological Office on a scale of two miles to one inch.

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.

Inland Water Survey Committee of the Ministry of Health.—Details of the general monthly rainfall were prepared for areas for which run-off data were available for inclusion in a report on the "Surface Water Resources of Great Britain".

(f) *Inquiries.*—A great many requests have been received for various kinds of climatological information in connexion with law cases, water supply and flooding problems, town planning, etc., and also 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. Requests for information on humidity, visibility and snowfall were especially frequent.

Rainfall data were supplied to the Ministry of Health and the Geological Survey, and to numerous engineering firms in connexion with water supply and hydro-electric schemes. Evidence on rainfall was given in Edinburgh before a Select Committee of Parliament on behalf of the promoters of the Kirkcaldy Corporation (Water) Draft Order. In a number of cases in Civil Courts evidence was provided on many aspects of climate or in respect of 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 Lee Conservancy Boards. Weekly, quarterly and annual summaries of the weather have been sent to the Registrar-General for England and Wales, and similar information has been supplied each quarter and year to the Government of Northern Ireland. Weekly summaries of the data from crop-weather stations have been prepared for circulation by the Ministry of Agriculture and Fisheries under the crop-weather scheme. Data for Northern Ireland have been 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 has been consulted by authorities interested in housing and town planning, tourist attractions, hydro-electric schemes, seaweed and peat utilization. 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 summarising climatological observations at a number of stations overseas and with preparing reports, memoranda and tables on weather conditions in all parts of the world.

(a) *Overseas stations.*—Stations in operation at the end of 1949 numbered 85, distributed as follows :—Europe 6, Asia 17, Africa 45, South America 1, oceanic islands 16.

The collection of reprints of the meteorological summaries from the Colonial Blue Books has continued, and, with the help of the Colonial Services, material for the "Notes" for the war years has been collected. Annual summaries

for issue with the reprints of the years 1939 to 1947 have been prepared for six stations from their manuscript returns. The Meteorological Services of Hongkong, Malaya, British East Africa, Rhodesia and Nyasaland, and Fiji are now publishing their own meteorological data independently of the Blue Books, and reprints for those countries will not be issued in future.

With the co-operation of the Dominion and Colonial services, the publication in the *Meteorological Magazine* of a table of monthly data for some 35 stations in the British Commonwealth has continued. It has been decided, however, that, since monthly means for the greater part of the world are now issued in the CLIMAT broadcasts, the further publication of the table is not justified, and it will cease with the data for December 1949 which will be published in the June 1950 number of the Magazine.

(b) **Réseau Mondial.**—Owing to shortage of staff no further progress has been made with the volumes for 1933–39. Data have been received from Bulgaria (Sofia) for 1936–45, from ten stations in the Argentine for 1935–47, from the Irish Republic (Valentia) for 1940–48 and from Gambia (Bathurst) for 1939–42.

(c) **Naval handbooks.**—Work has continued on the revision of Volumes I and II of “Weather in the Mediterranean” on the lines set out in last year’s report.

The handbook on “Weather on the west coast of tropical Africa” was issued in June 1949.

(d) **Admiralty Pilots.**—Six Pilots have been revised during the year. Lt.-Cdr. Langworthy, R.N. has continued to act as the liaison officer of the Admiralty for climatic work.

(e) **Special work.**—The study of the distribution of vapour pressure over the world has continued. Provisional charts for a representative month in each season have been plotted but await final examination.

(f) **Inquiries.**—Many varied and interesting requests have been received from Government Departments, commercial firms, aviation companies, astronomers and research workers for information about the climate of all parts of the world. Over 4,000 tables of temperature and humidity have been issued.

(3) Marine Climatology

(a) **Collection of observations.**—On the average some 45 ships’ logbooks of weather reports have been received each month in the Marine Branch. Logbooks and upper air data have been regularly received from ocean weather ships at Stations I and J. By courtesy of the United States Air Force, data have also been regularly received from Japanese ocean weather ships in the western Pacific and microfilm copies of observations made at all other North Atlantic ocean weather stations.

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

(i) Observations from logbooks received from British “selected” ships and weather ships and from Naval logbooks have been punched on Hollerith cards.

(ii) Meteorological data have been extracted from German Hollerith cards for the North Atlantic. Over 200,000 cards have so far been handled.

(iii) On behalf of the Indian Government, the British Tabulating Co. (Hollerith) were allowed to duplicate some 792,000 cards of data for the Indian Ocean.

(iv) Duplication of data in the North Atlantic by the Netherlands Meteorological Service is continuing. Three batches of cards have already been shipped, comprising 1,654,000 cards.

(v) The tabulation of data in the southern hemisphere (sent monthly to the United States) comprised 28,062 observations.

(vi) The tabulation of Indian Ocean southern hemisphere data sent monthly to Indonesia for the period January to July 1949 comprised 4,852 observations.

(vii) A summary of weather at ocean weather ship Station I during 1948 was prepared.

(viii) Charts of monthly mean sea temperature for the North Atlantic were completed.

(c) Currents and ice.—The preparation of current charts of the north-eastern part of the Pacific Ocean, eastward of long. 160° W. was begun.

Current charts for the south-west Pacific Current Atlas are being drawn.

The sections relating to currents and ice have been entirely rewritten for new editions of eight Admiralty Pilots and generalised current charts have been prepared for these. The revision of the meteorological sections of Admiralty Pilots has been co-ordinated with the Climatological Branch and meteorological charts have been prepared for these publications.

(d) Special work.—Work on the harmonic analysis of monthly mean sea temperatures on the North Atlantic was completed. The results will be published as a *Geophysical Memoir*.

Papers were prepared on :—

(i) Relation between the surface and gradient wind velocity over the North Atlantic and the deviation between the mean vector wind and the mean isobars in the tropics.

(ii) Formation, characteristics, and occurrence of waterspouts over the oceans.

(iii) Diurnal variation of sea and air temperatures, wind velocity and cloud amount over the ocean.

(iv) Temperature and humidity lapse rates near the surface of the ocean.

(v) Variation of wind with height in the lower levels over the ocean.

Work is continuing on the following :—

(i) Diurnal variation of pressure in the Mediterranean.

(ii) Comparison of bucket and intake methods for measuring sea temperatures from ocean weather ship data.

Special weather maps were constructed for the Ministry of Transport Examination for Masters and Mates.

The “ Marine Observer’s Handbook ” is in the press. The manuscript of “ Meteorology for Mariners ” is nearing completion.

(c) **Inquiries.**—Much information, including statistical tables and charts of marine data, was supplied for use within the Meteorological Office as well as for the Naval Meteorological Service, other Government Departments and various shipping companies. Most of this information was required for inquiries arising out of shipping casualties.

(4) **Agricultural Meteorology**

The Agricultural Meteorology Branch is responsible for, first, the application of existing meteorological data, facilities and knowledge to current agricultural problems, and, secondly, for research into the fundamental problems of micro-climate, ecoclimate, and the relationships between weather and crops, pests, diseases, animal behaviour, husbandry, etc.

(a) **Liaison with other organizations.**—The major feature of the work during the year has been the increased liaison with the National Advisory Service of the Ministry of Agriculture and with research stations and experimental farms.

Constant personal liaison with officials of the Advisory Service is maintained in the south-west Province, where an officer of the Branch is stationed. In addition all the other provincial headquarters have been visited, *viz.* Reading, Cambridge, Derby, Wolverhampton, Aberystwyth, Leeds and Newcastle, and co-operation has been established on the following lines :—

- (i) The issue of a weekly weather summary for its own area to each headquarters for distribution at provincial and county level.
- (ii) The supply of critical climatic summaries for local areas in connexion with specific experiments or with proposed land utilization.
- (iii) Advice on the choice, siting, and use of instruments for field experiments.
- (iv) Help in the provision of relevant data for display at Agricultural Shows and local demonstrations.

Liaison has been also established with the National Institute of Agricultural Botany at Cambridge, the Plant Breeding Station and the Department of Animal Health at Aberystwyth, the Plant Pathology Laboratory at Harpenden, the National Institute of Agricultural Engineering at Silsoe, the Building Research Station at Gaston, and with Rothamsted, East Malling and many other research stations and institutes.

(b) **Special work.**—Special attention has been given to evaporation. Use has been made of a method, due to Dr. H. L. Penman of Rothamsted, of calculating the theoretical monthly evaporation and transpiration for 43 stations in England and Wales during 1949.

The experiment at Kew on random errors of standard observations mentioned in the last Report was concluded, and the results are being examined statistically.

Experiments in hillside climatic variations at Wye College, and in temperature variations under Dutch-lights at Cheshunt are continuing. With the co-operation and assistance of the Ministry of Agriculture's experimental farms and horticultural stations, important field experiments on frost liability, shelter-belts, and ploughing depths are planned for the coming year.

Memoranda on applied climatological subjects are in course of preparation, including summaries of elements such as soil temperatures, accumulated temperatures, dry spells, rainfall variability, evaporation and transpiration.

In extension of the forecast services for agriculture (see p. 11), special forecasts were arranged for agricultural shows, volunteer agricultural camps, spraying officers, labour officers, and land reclamation officers.

A special meteorological exhibit was displayed at the Bath and West Agricultural Show in co-operation with the National Agricultural Advisory Service, dealing with the siting of orchards. Another was arranged for the Southampton Market Produce Show demonstrating the general work of the Office and its application to agriculture.

(c) Inquiries.—Many inquiries were dealt with during the year in relation to current agricultural problems and projects. Climatic data were summarised in a form appropriate for application to each problem and advice was given in the correct interpretation of such data. Subjects dealt with in this manner include questions concerning the siting of orchards, the planning of shelter-belts and windbreaks, food storage, grain drying, haymaking methods, Dutch-light and cloche protection, cattle ranching, bee-keeping, frost liability, and irrigation.

(5) Upper Air Statistics

(a) Collection of observations.—The collection of monthly returns of daily observations by radio-sonde and aircraft and the punching of Hollerith cards have continued. At the end of the year observations of temperature were being received from 24 radio-sonde stations and 5 aircraft stations, and of radar winds from 24 stations. Arrangements have been made also for data from Japanese ocean weather ships to be tabulated regularly.

Reports from aircraft were extended by the introduction of a new form for recording cloud, icing, visibility, condensation trails and turbulence ; this was brought into use on July 1.

Much effort, attended with considerable success, has been directed towards improving the accuracy of data both by the issue of special tables for computing humidity mixing ratios and by the introduction at the end of 1949 of a scheme by which all Hollerith returns are carefully checked before they are sent in from stations.

Further efforts have been made to economise time and labour by the use of special forms for computing wind parameters, by the introduction of special tables for computing mean values of temperature and by the preparation of a card index of manuscript data.

The use of Hollerith methods for producing wind frequencies has been further investigated, but a final solution applicable to small numbers of cards has not yet been reached.

(b) Special work.—The text of "Upper winds over the world", written last year, was prepared for the printer. On its completion research was directed towards the production of world charts showing the average monthly upper air temperatures at standard isobaric surfaces and their standard deviations for a representative month in each season. Preliminary work has included the preparation of frequency summaries and mean values from the returns for British stations, and a special study of conditions at the 200-mb. level which shows many features of interest.

An analysis has been made of the upper air temperature observations for 1948 from the British ocean weather ships in the North Atlantic. Extreme temperatures have also been extracted from sounding balloon ascents in the British Isles, Sweden, Germany, India and Java.

(c) **Inquiries.**—Inquiries covered a wide field. Requests for daily observations or for monthly summaries were received from the Meteorological Services of Australia, British West Africa, India, Egypt and Israel. These were met chiefly by printing data from the Hollerith cards or by microfilming the manuscript data. Other inquiries have related to the frequencies of very low temperatures, the frequency and magnitude of discontinuities, and information required for planning air routes for civil aviation.

§ 4. RESEARCH AND DEVELOPMENT

(1) Co-ordination of Research

(a) **Meteorological Research Committee.**—The general lines along which research should be developed are formulated by the Meteorological Research Committee. The work is mainly carried out within the Meteorological Office, but invaluable assistance is given by other bodies such as the Clarendon Laboratory, Oxford, the National Physical Laboratory, and Research Establishments of the Ministry of Supply. Within the Office research organization work has again been hampered by shortage of staff, but in one section improved accommodation became available towards the end of the period under review.

The constitution and functions of the Meteorological Research Committee are described in the Report for August 1945 to March 1947. Two ordinary meetings of the Committee were held during the year.

Most of the detailed work of the Committee was carried out through three Sub-Committees appointed in March 1948 to deal with three main sections of research.

The Chairmen of these Sub-Committees were the same as last year :—

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

Two of the Sub-Committees met four times during the year, and the other three times. In all about sixty papers were considered. Approved papers were circulated to interested outside institutions, and selected papers were passed for communication to the appropriate scientific society or journal.

(b) **Joint Meteorological Radio-Propagation Sub-Committee.**—One meeting of this Sub-Committee, under the chairmanship of the Director of the Meteorological Office, was held in December 1949. Work in this field has included the preparation of a comprehensive report upon the structure of the lowest 350 ft. of the atmosphere based upon temperature and humidity observations at Rye, Sussex (see p. 31). The handbook on the effect of meteorological factors on radio propagation, mentioned in last year's report, has been prepared in draft form. During its preparation three radio-meteorological problems were investigated in order to clarify the handbook, viz. the formation of radio ducts over land due to nocturnal cooling, the rate of growth of ducts over the sea and the relation between duct height and wave-length. Papers dealing with these problems are being submitted for publication.

(c) **Collaboration with the Royal Society.**—The Gassiot Committee of the Royal Society has continued to supervise certain long-term investigations, of importance in atmospheric physics, which are in progress elsewhere than in the Meteorological Office. A few of these investigations are briefly summarised below.

The measurement of atmospheric ozone.—The instrument used for measuring the amount and vertical distribution of ozone has been re-designed, and in its new form gives greatly increased accuracy, so that it will be possible to make a day-to-day study of the vertical distribution and diurnal variation of ozone. The investigation of the relationship of these two factors to the conditions shown on the weather chart will be carried out at Oxford.

Studies of the infra-red solar spectrum.—High-altitude observations, from aircraft, of the solar spectrum in the infra-red, are being made by Mr. R. M. Goody at South Farnborough, and yield measurements of the water-vapour content at high levels in the atmosphere. Extensive series of observations of nitrous oxide have shown that this gas occurs mainly at low levels. Measurements of atmospheric radiation near the ground have been continued by Dr. G. D. Robinson, and Professor T. G. Cowling has done some work on the computation of atmospheric radiative heating.

Sampling the upper air by condensation in liquid hydrogen.—An apparatus has been designed at Oxford, under the supervision of Professor F. E. Simon, suitable for use on a sounding balloon, and observations have also been made from a Halifax aircraft at 6 Km. above the ground. It is hoped to extend the height of sampling up to 12 Km.

Photochemistry of the atmosphere.—Theoretical and experimental investigations of the emission of gases likely to be present in the upper air have been actively pursued during the last year. This work is making progress, but final results will probably require a continuation of the work for some years.

(d) Other activities.—Representatives 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, on the Atmospheric Pollution Research Committee and the Road Research Board Joint Committee on Soils of the Department of Scientific and Industrial Research, and at meetings of other Government Departmental Scientific Committees. Liaison has been maintained with research activities in the Dominions, Colonies and other countries.

During the summer of 1949 a number of university students were attached to various Meteorological Office research establishments for several weeks to gain acquaintance with the work in progress.

(e) Research programme.—The following is a summary of the main items on which work is proceeding. Most of these items are necessarily broken down into component and contributory lines of investigation :—

(i) Development of 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) Improvements in accuracy of short-range forecasts.
- (viii) Extension of weather forecasts to cover three or four days.
- (ix) Investigation of the temperature and water content of the troposphere and lower stratosphere under varying conditions.
- (x) Investigation of tropopause conditions and the exchange of air between troposphere and stratosphere.
- (xi) Microclimatology near the ground including heat and water exchange, as affecting agriculture.

(2) Instrument Development

(a) General instruments.—The installation of 14 photo-electric visibility meters for operational trials was completed. The experience gained has enabled work to be started on an improved instrument better adapted for routine use.

The Ministry of Civil Aviation urgently need a method of estimating the distance at which airport approach lights can be seen from the air. An instrument for determining slant visibility up to 200 ft. at night by measuring the light scattered from a searchlight beam was installed at Farnborough, but the low incidence of fog during the winter prevented adequate trials. As an alternative approach to this major problem, a start has been made on the development of instruments for the measurement of the height of the top of a fog layer with the aid of a tethered balloon.

A manually operated photo-electric hygrometer, using the expansion of carbon dioxide as the cooling agent, was constructed for the Norwegian-British-Swedish Antarctic Expedition.

The instrument for measuring the vertical component of the wind in connexion with the proposed Severn Bridge was re-designed for remote recording, using magstrip transmission for vertical and horizontal wind direction and a cup generator anemometer for horizontal wind speed. The latter is connected to a special recording voltmeter, which may be of more general use at out-stations, where these anemometers are at present used only with a dial indicator.

Considerable progress was made in the development of equipment for measuring radiation. An instrument for recording the intensity of daylight illumination was installed at Victory House; it consists of a photo-cell, with special filters, connected to a thread recorder. A bi-metallic type of radiation recorder was developed in collaboration with a firm of instrument makers, and the first six are being installed at selected stations. Mountings for diffuse and total solarimeters of the thermopile type are being made for four stations.

The programme for the development of improved balloons was intensified. Some 2,000-gm. balloons have proved suitable for high-altitude sounding (see below). Experimental batches of balloons made from different rubber mixes are being tested under tropical conditions to determine which will best withstand exposure to bright sunshine and high temperatures.

(b) Aircraft instruments.—For use in high-speed aircraft a thermometer with a thermistor element is being developed, which will measure the temperature of the air after it has been subjected to full adiabatic compression. The thermometer can be made to indicate or record temperature on a linear scale.

A fully automatic frost-point hygrometer, with a thyratron system of control, is in an advanced state of development. A similar instrument using another method of control, which has been developed by a firm of instrument makers, has been tested in the laboratory and is now undergoing flight trials by the Meteorological Research Flight. Special apparatus has been installed in the Harrow laboratories to facilitate the testing of aircraft hygrometers at very low humidities.

Flight tests are also in progress on an electrical method of measuring raindrop size developed at the Telecommunications Research Establishment. In this method the momentum exchange, when the drops strike a microphone, is used to measure their sizes.

(c) Radio-sonde and radar-wind instruments.—A contract has been placed with a firm of electronic engineers for the development of the radar-sonde theodolite on the principles worked out by the Telecommunications Research Establishment, and a detailed plan has been prepared. It is intended to make use of automatic following and computing techniques.

Equipment has been designed to enable the range indication of the GL.III radar set used for the measurement of upper winds to be extended to three times the original scale range. This will enable measurements to be made to greater heights in strong winds.

Modifications of the standard radio-sonde and the radar reflector are being developed with a view to reducing the risk of damage to overhead electric power lines by equipment descending after flight.

The development of experimental sounding balloons of improved type referred to on p. 28 enabled some very successful combined radio-sonde and radar-wind ascents to be made. Very good observations of temperature and wind up to heights of about 100,000 ft. were obtained on five occasions. These experiments are being continued on a semi-operational basis.

(3) Forecasting Research

The Forecasting Research Division moved into the "Napier Shaw Laboratory" in January 1950. This new building, alongside the other buildings of the Central Forecasting Office, Dunstable, was specially designed for its purpose and combines offices and laboratories with storage space for past records.

The following list summarises the more important forecasting research activities.

(i) In a study of temperature changes in the troposphere it was shown that, in the British Isles, the actual local change is generally much less than would be expected from the horizontal movement of the air alone, less than half as great on the average. The compensation, due to both vertical movement and non-adiabatic processes, has a correlation coefficient of -0.7 with the change due to horizontal movement. It was also shown that, in selected cases, cold air moving from Iceland to the British Isles may be warmed by as much as 10°C . in 24 hr. through much of the troposphere as a result of heat and moisture received from the sea surface.

(ii) The thermal structure of various types of secondary depressions, developing on occlusions and cold fronts, was studied. Some regularities, likely to be helpful in forecasting, were discovered.

(iii) A form of hydrodynamical instability, which has received much attention in some countries, was critically examined and led to the conclusion that it has no practical value in forecasting at present.

(iv) Circumpolar charts for much of the northern hemisphere continued to be prepared twice daily. Average and extreme monthly values of the 1000-500-mb. thicknesses were prepared as a routine, and are proving practically useful.

(v) Amongst other studies in which some progress was made are the following : physical processes governing the type and height of the tropopause ; the structure of frontal regions including their relation with the very strong winds at high levels known as jet streams ; forecasting the formation and clearance of radiation fog ; the value of " circulation indices " for the northern hemisphere and the theory of long waves in the circumpolar W-wind belt.

(4) Research in Physical Meteorology

The broad features of activity resemble those mentioned in the previous report but very substantial progress has been made in this work in the year under review. A summary of the chief items which have engaged attention at Headquarters and research stations is given below.

(i) An assessment was made, based on relevant observational data and theoretical consideration, of the probable maximum liquid water content at different temperature levels in convective cloud. This information has application in measures to prevent ice accretion on aircraft.

Most of the relatively few measurements of the size of cloud droplets show that the diameters are predominantly within the range 5 to 40 microns. The reason for this has not been established hitherto. Recent theoretical study of the growth of a water droplet round a salt nucleus indicates that the size attained by a cloud droplet before it is carried out of a cloud by turbulent diffusion is in reasonable agreement with the measured values of mean droplet size in clouds, and that the calculated maximum drop size attained by the time the drop falls out of the cloud under the influence of gravity is of the same order as the largest cloud-drop measurements.

(ii) A war-time investigation of the circumstances in which condensation trails are formed by piston-engined aircraft was extended to the case of jet aircraft ; it appears that the atmospheric characteristics necessary for the formation of condensation trails are similar for piston engines and current British jet engines.

(iii) Additional observational data on bumpiness or gustiness experienced by the aircraft of British European Airways Research Flight and by R.A.F. aircraft were utilised in further study of the meteorological factors associated with turbulence in clear air at heights of 20,000 ft. or more. Partial relationships were confirmed between the occurrence of bumpiness and meteorological parameters, but it appears that further progress must await other lines of attack which are under consideration.

(iv) The Meteorological Research Flight, which is located with the Royal Aircraft Establishment, Farnborough, made further high-level ascents in Mosquito aircraft in exploration of the temperature and humidity structure in the upper troposphere and lower stratosphere. A report on the high-level humidity data so obtained in recent years has been distributed.

The Flight continued the study of the physics of cloud and precipitation, though largely without the aid of specialised instruments, and has investigated the behaviour and nature of atmospheric nuclei which are caught by the spider-web technique adopted by M. Dessens and of certain nuclei collected by other techniques.

The structure of the eddy motion in the free atmosphere, especially as it is indicated by temperature variations, is under investigation. For this purpose an ultra-rapid electrical resistance recording thermometer for use on aircraft has been developed.

Further attention was given to the variation with flight level of the speed correction which needs to be applied to readings of air temperature taken in flight.

(v) Interesting and valuable results continue to be derived from the radar observation of cloud and precipitation in various meteorological situations by the Meteorological Office station at East Hill. The 10-cm. wave-length installation has recently been augmented by 3-cm. equipment. An essential feature of part of the work which has been in progress is co-operation between the ground radar station and both Royal Aircraft Establishment aircraft flying in the vicinity of East Hill to explore the turbulence in convective clouds and aircraft of the Meteorological Research Flight engaged in investigating general physical processes in cloud.

An interim report on the investigation of turbulence in cumulus and cumulonimbus cloud has been distributed, and contains valuable information concerning the structure and vertical currents in such cloud, with a discussion of their application to flying.

A subsequent report relates to the dimensions of cumulonimbus clouds, as deduced from radar observation and simultaneous observations made from aircraft. This work is also relevant to the assessment of turbulence and icing risks to aircraft in cloud of this type.

(vi) The Meteorological Office unit attached to the School of Agriculture, Cambridge University, carried out additional observational work which led to general verification of the technique (referred to in the last Report) for evaluating natural evaporation, from a clayland pasture, in terms of wind speed and humidity measurements at two or more heights within 2 m. above the surface. Preparations are in hand to extend the investigation to other crops and other soil surfaces. The basis of the method depends on considerations of an aerodynamic character, and this circumstance has resulted in a preliminary determination by this unit of the aerodynamic drag of a grassland surface.

As mentioned on p. 32 studies on the exchange of heat and water vapour in the vicinity of the earth's surface are in progress at Kew Observatory.

(vii) The special equipment at Rye for recording, primarily, humidity and temperature and, secondarily, wind at a series of heights up to 350 ft. was maintained in operation, though with interruptions due to overhaul and repair. Important results concerning the daily and seasonal variation of humidity with height have been obtained and will be published shortly.

(viii) Research relating to condensation of water vapour in the atmosphere was in progress at the Clarendon Laboratory, Oxford, on behalf of the Meteorological Office and under the direction of Professor G. M. B. Dobson.

(5) Work of the Observatories and Geophysical Research

(a) Kew Observatory.—No major changes were made in the standard observations, autographic recording and the tabulation of results in meteorology, solar radiation, atmospheric electricity and seismology.

Meteorological observations and records.—The sphere of the sunshine recorder, apparently unchanged for more than 50 years, was replaced after a year's comparison of two instruments.

Special readings of air, grass and earth temperatures at four adjacent sites (for the investigation of random errors of observation, mentioned in the last Report) ceased at the end of 1949.

Measurement of solar radiation.—Autographic records were obtained of direct total solar radiation and of the radiation transmitted by two filters passing different spectral regions (all at normal incidence), and also of the total and diffuse radiation received on a horizontal surface.

A more sensitive daylight illumination recorder, which is brought into action at a fixed low degree of illumination by a photo-electric relay, was on trial. For comparison purposes a daylight illumination recorder of the type in use at Kew in recent years was installed at the Meteorological Office, Kingsway, London, towards the end of the period.

Atmospheric electricity.—The photographic records of the current discharged at a point, which date from July 1932, were discontinued at the end of 1949.

Seismology.—The three Galitzin instruments were standardised during the year. Some 330 earthquakes were recorded and the records analysed.

Facilities continued to be provided at the observatory for the preparation of the *International Seismological Summary*.

Other investigations.—These were mainly concerned with the transfer of heat and water vapour near the earth's surface. Resumption of work with the vertical-profile equipment mentioned in the previous Report resulted in details of mean temperature (for 30-min. periods) from 30 cm. below the surface to 2 m. above, with simultaneous radiation measurements and wind and humidity from the surface to 2 m., for about 30 occasions. One of the deductions from a study of the observations is that in certain circumstances the temperature of the lowest layer of air is directly controlled by radiation rather than by convection. Values of evaporation deduced from the vertical-profile observations were compared with the evaporation from a tank of standard design.

The inclusion of measurements of short-period fluctuations of wind and air temperature in the above investigation is proposed. The necessary apparatus is being developed, including a 9-in. wind tunnel for the calibration of hot-wire anemometers.

(b) Edinburgh Meteorological Office.—Photographic magnetic records obtained at Eskdalemuir and Lerwick have been systematically examined in a study of geomagnetic phenomena associated with the occurrence of solar flares reported from the Royal Observatories at Edinburgh and Greenwich, radio fade-outs notified by Cable and Wireless Ltd., and data supplied from time to time by the Cavendish Laboratory, Cambridge, concerning sudden phase anomalies in very long long-wave radio transmission.

At the request of the Association of Terrestrial Magnetism and Electricity of the International Union of Geodesy and Geophysics arrangements were made for three-hourly magnetic range-indices (*K*) for Eskdalemuir and Lerwick to

be assigned for several years prior to 1940. Normal returns of magnetic character figures and indices and of the times of "sudden commencements" were made to the Association during the year.

(c) **Eskdalemuir Observatory.**—The standard procedure of observing and recording meteorological, magnetic and atmospheric electric elements, and of reducing the data so obtained remained unchanged. All magnetic storms during the period were recorded completely. Magnetic information was supplied to mining journals, individuals and institutions as in previous years.

In the summer of 1949 a series of comparisons was carried out between the observatory standard instrument for horizontal magnetic force (Schuster-Smith Coil) and a recently acquired set of three quartz horizontal-force magnetometers (Q.H.M.).

Four officers of the Ceylon Meteorological Service were given training in magnetic and atmospheric electrical work.

(d) **Lerwick Observatory.**—The normal observational work in meteorology, terrestrial magnetism, aurora and atmospheric electricity continued.

A revised value of the azimuth of the fixed mark used in observations of magnetic declination was adopted from January 1, 1949, after consideration of determinations made by the Ordnance Survey in 1948.

Upper air soundings were carried out four times daily. No temperature soundings were missed, but failure in radar equipment caused considerable loss of wind soundings in May. Additional soundings on selected occasions, and using specially large balloons, were initiated in 1950 with the object of reaching heights of about 100,000 ft.

(6) Special Investigations

Among the large number of problems which have absorbed the attention of the Division for Special Investigations may be mentioned two which have occupied much time. One was related to the installation of new radar devices at London Airport for which it was necessary to determine how frequently weather over the British Isles would seriously interfere with such devices. In the other case data were required for a new method of assessing permissible pay loads for the different types of aircraft when taking off from various airports. These data involved a special calculation of the frequencies of temperature for a great many places.

The effect of wind and temperature on high-flying aircraft is a problem which is receiving continuous attention in anticipation of the operation of Comet and other jet aircraft.

A report has been prepared giving data of the frequency of equivalent head-winds which aircraft are expected to experience on about 120 air routes covering the greater part of the world. The data embrace the heights of 10,000 to 40,000 ft.

§ 5. ORGANIZATION

(1) Structure

(a) **Headquarters.**—Some minor changes were made in organization. They consist of :—

(i) The transfer of responsibility for the Division dealing with Climatology and Agriculture, and for the Marine Branch from the Deputy Director of Services to the Deputy Director of Research.

(ii) The transfer of responsibility for instrument testing and provisioning from the Assistant Director of Personnel to the Assistant Director for Instrument Development.

The headquarters structure as thus revised is shown in Appendix I and a list of the Directorate, Heads of Divisions and Branches is given in Appendix II.

(b) Branch Meteorological Office, Edinburgh.—There has been no change in organization during the year.

(2) Staff

(a) Complements.—Recruitment of civilian staff in established officer grades was continued through the open competitions conducted by the Civil Service Commission. As a result of these competitions 52 officers accepted established appointments during the year, of whom 40 were candidates already in the Meteorological Office. In addition 2 temporary appointments were made. By the end of the year, when many of the newly appointed officers had been trained, the difficulties in meeting commitments which shortages of staff had hitherto imposed were appreciably alleviated. The temporary appointments of 16 Poles who accepted civilian appointments in 1947 were extended for another year.

During the year 179 assistants were given established appointments, all except 11 of whom were already temporary assistants in the Meteorological Office. Resignation of temporary assistants continued to be heavy, and the percentage of airmen who did not accept re-instatement in civilian appointment as assistants on release from National Service was 35 per cent. Recruitment of temporary assistants at the highest possible rate was continued throughout the year. By the end of the year assistants in training, who numbered 181, slightly exceeded the number of vacant posts. On the other hand the replacement of assistants resulted in a continual movement of staffs at units, and imposed a handicap on efficiency which was increased by the fact that the replacements were relatively inexperienced.

(b) Strength of staff.—The strength of staff on March 31, 1950, is shown in the table below. For the purpose of comparison, the strength a year ago is also indicated.

	March 31, 1949	March 31, 1950
Scientific Officer Class or equivalent	158	157
Experimental Officer Class or equivalent	575	614
Nautical Officers	7	7
Assistant Class	1,407*	1,481*
Radio (Meteorological) Mechanics	61	57
Locally entered Staff (overseas) ...	273	283
Clerical and Typing Staff	71	76
Miscellaneous	25	20
Total	<u>2,577</u>	<u>2,695</u>

(c) Uniformed Personnel.—By the end of the 1939-45 war most of the staff of the Office were in uniform, having been mobilised into the Meteorological Branch of the Royal Air Force Volunteer Reserve; the last of the members mobilised during the war were released in 1949.

* Excluding non-effective meteorological airmen undergoing disciplinary training.

There remained in uniform airmen meteorologists serving on engagements under the National Service Acts. They numbered 336 on March 31, 1950.

It was noted in last year's Report that a Meteorological Section of the re-constituted Royal Air Force Volunteer Reserve had been formed. The strength of this Reserve on March 31, 1950 was 65 officers and 30 airmen and airwomen.

It had been planned that meteorological observations on meteorological¹ reconnaissance flights should be undertaken by navigators in the post-war air force. Shortages of navigators have prevented this policy being carried out completely. It has been decided, therefore, to introduce a separate aircrew category of Air Meteorological Observer. As a short-term measure Air Meteorological Observers will be recruited from among assistants serving on engagements under the National Service Acts. Recruitment had begun by the end of the year under review.

(d) Training of staff.—*Organization for training.*—A separate branch is responsible for the general training of members of the scientific and technical grades of the Office, and also for the arrangements by which staff are encouraged to improve their academic qualifications by means of external studies.

As a rule meteorology is a fresh subject to new staff, and on entry therefore they are given a course of theoretical and practical instruction at the Meteorological Office Training School. This is followed by a period of further practical training at outstations. The course at the Training School also includes lectures in "background" subjects arranged by the Civilian Training and Education Branch of the Air Ministry. The purpose of these talks is to give staff a better understanding of the functions and activities of the Civil Service in general and of the Air Ministry and the Meteorological Office in particular.

During the past year two new types of course have been introduced : (i) advanced forecasting courses which are designed to prepare forecasters of the Experimental Officer Class for duties of higher technical responsibility ; and (ii) refresher courses for assistants, the object being to revise and improve the scientific knowledge of assistants who have gained several years' experience in routine duties.

Course for Scientific Officers.—The normal course lasts for four months, and during the year training has been given to 2 Senior Scientific Officers, 1 Scientific Officer and 1 Officer of the Colonial Meteorological Service.

Initial courses for Forecasters.—These courses last for 12 or 15 weeks according to the previous experience of the individual. Compared with the last Report, the main change in the syllabus has been the introduction of additional work in climatology. During the year six forecasting courses have taken place and the number of staff trained was 61. Of these 43 were formerly assistants in the Office who had been either successful in the Civil Service Competition for Assistant Experimental Officers or selected by the Department for promotion to the higher class.

Advanced courses for Forecasters.—These courses last for 6 weeks, 4 weeks being spent at the Training School and the final 2 weeks at a main forecasting office where practice is obtained in carrying out duties of higher responsibility. The instruction which is given at the Training School has an administrative as well as a scientific purpose and lectures are given on supervisory duties, staff control and welfare. In the scientific part of the course the opportunity is taken to revise the basic theory but the emphasis is on practical work. Five advanced courses have been held for a total of 38 officers.

Initial courses for Assistants.—Eighteen initial courses were held and altogether 243 assistants were trained.

Refresher courses, each of 3 weeks' duration, were held for older assistants and were attended by 40 assistants.

Radio-sonde courses.—Courses of training in radio-sonde technique have been arranged at Downham Market for 13 officers and 42 assistants. A special course, lasting 5 weeks, was arranged for 4 officers of the Ceylon Meteorological Service.

Courses for Air Observers.—The training of aircrew personnel of the Royal Air Force in the technique of making meteorological observations from aircraft continued at Aldergrove in co-operation with the meteorological reconnaissance squadron which operates from that station. Two navigators and 10 air-gunners were trained during the year.

Special course for Instructors in Meteorology.—A special one-week course was arranged for Instructors in Navigation Schools of the Ministry of Education who are called upon to teach meteorology to those taking Masters' and Extra-Masters' Certificate. Fourteen Instructors attended the course which was arranged in conjunction with the Ministry of Education.

Courses for Voluntary Observers.—Four courses, each lasting 2½ days, were held for the purpose of giving general instruction on the making of weather observations. The courses were attended by 52 observers, all of whom contribute climatological statistics to the British Climatology Branch (see p. 19).

Training of Dominion, Colonial and foreign personnel.—A number of requests have been received from other Governments for the Meteorological Office to provide courses in forecasting for personnel recruited to their Meteorological Services. During the year the following officers were trained :—

Colonial Office (for Colonial Meteorological Services)	...	2
Ceylon Meteorological Service	4
Persian Meteorological Service	1
Belgian Meteorological Service	1

External training.—The main objects of the external training scheme are to help assistants to obtain the Intermediate B.Sc. and Assistant Experimental Officers to qualify for a science degree in a subject related to the work of the Office. The concessions granted to those whose course of study is approved include the payment of fees and of certain travelling expenses incurred through attendance at lectures. Time off with pay may also be allowed for private study or for attending classes. The response to the scheme has been good and 162 assistants and 29 staff of the Experimental Officer Class have been granted concessions.

(e) *Technical discussions.*—The Monday meetings of the Office staff and other specialists for the discussion of recently published papers or of research work in progress were held once a month from October to March.

A lively discussion followed the opener's presentation of the subject on all occasions.

The subjects discussed, followed by the name, in brackets, of the opener were :—

- (i) United States Thunderstorm Project (Mr. F. E. Coles).
- (ii) Recent climatic fluctuations based on Prof. Ahlmann's paper in the *Geographical Journal*, July 1948 (Mr. R. F. Zobel).

(iii) Chapters in Scherhag's "Die neue Methoden der Wetteranalyse und Wetterprognose" (Mr. J. L. Galloway).

(iv) Researches on evaporation made by the Meteorological Office unit at Cambridge (Mr. F. Pasquill).

(v) Measurement of night visibility (Mr. G. J. W. Oddie).

(vi) Researches on the formation of secondary depressions (Mr. J. S. Sawyer).

By courtesy of Professor Sir George Thomson, F.R.S., the meetings were held in the physics lecture theatre of the Imperial College.

(3) Supply of Instruments

(a) Provision and production of equipment.—During the year 4,018 orders and contracts have been placed. The total expenditure was £288,759. During the same period £38,585 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 better than last year, but maximum thermometers and spare parts for radar sets are still difficult to obtain in the quantities required. Although the shortage in maximum thermometers may soon be overcome, the shortage in spare parts for radar equipment is likely to continue for some time longer.

(b) Issue of equipment.—Regular supplies of instruments, stores and other equipment were issued to maintain meteorological offices at home and overseas. A new item of equipment has been introduced which extends the range indications of the radar sets used for obtaining upper winds to 96,000 yd. The device has been fitted to three radar-wind sets; the remaining sets will be fitted as soon as possible.

Demands for equipment dealt with in the year numbered 9,705 as compared with 10,279 last year. Included in these demands are some from Commonwealth, Colonial and foreign Governments and from co-operating observers who obtain their instruments from official stocks on repayment terms. Equipment has been lent to other Government Departments and public authorities for particular investigations. The number of loans made during the year was 65.

The following issues are worthy of special mention.

(i) Radio-sonde equipment to New Zealand, Hongkong and the Falkland Islands.

(ii) Miscellaneous items of equipment for the following expeditions :—

Norwegian-Swedish-British Antarctic Expedition.
Cambridge University Spitsbergen Expedition.
Oxford University North-East-Land Expedition.
Durham University Katla Expedition.

(iii) Miscellaneous instruments to universities and colleges as follows :—

Durham, King's College.
Birmingham, Department of Geography.
Cambridge, Low-Temperature Research Station.
Cambridge, Institute of Agricultural Botany.
Wye Agricultural College.

(iv) Miscellaneous instruments to Government Departments and other authorities such as :—

Ministry of Fuel and Power.
Ministry of Food
Atomic Energy Research Establishment.
National Physical Laboratory.
Ordnance Survey.

(c) Testing and calibrating.—*General instruments and aircraft instruments.*—The total number of instruments tested, excluding balloons, was 57,617. The number of balloons of all sizes received and submitted to a 5 per cent. check was 294,974.

Radio-sonde.—The total number of calibrated radio-sonde transmitters received from the makers was 33,830. Of these, 6,314 were checked for calibration before acceptance. In addition, 1,833 radio-sondes recovered after flight were overhauled and recalibrated in the Office for further use. The radio-sondes were also tested in large numbers for general efficiency.

Experiments have continued in developing a method which will increase the rate of calibration of radio-sondes.

Various chemicals have been tested with the aim of developing an economical and safe method of calibrating radio-sondes at temperatures down to -150° F.

(4) Library and Publications

(a) Library.—*Accessions.*—The intake of publications continued to increase. The number of publications, exclusive of *Daily Weather Reports*, which were taken into the library totalled 7,768. This may be compared with the annual pre-war total which ranged between 4,500 and 5,000. Efforts were made to acquire all important papers on applied meteorology, many of which appeared in the journals appropriate to the allied subjects. This was made practicable by requests to authors and by photographic copying of the papers concerned.

Microfilms of marine data are being collected in the library for use with the library microfilm viewer. Several publications now out of print or otherwise unavailable were also received in microfilm form.

A new departure has been the accession of film strips for lecture purposes; 17 film strips have been acquired. In addition 200 new lantern slides and numerous photographs were added to the library collections.

Exchange of Publications.—Work on the resumption of exchanges with other meteorological services and institutions was continued throughout the year. Numerous publications were received as extensions of exchange agreements to meet the needs of specialist branches and of overseas stations of the Office, notably those forecasting for “hurricane” or “typhoon” areas.

The issue of publications to British societies and institutions was reviewed with the object of restricting issues to those considered essential.

The number of overseas exchange agreements now totals 286.

Repair of war-time omissions.—Most of the war-time publications not received have now been acquired for the library. These include a large number of Japanese periodicals carrying English or German abstracts.

Publications which have been received surplus to the library's requirements have been sorted prior to listing. It is proposed during the next year to circulate this list to those services and institutions whose holdings suffered directly or indirectly through the war.

Co-operation with other British libraries.—The National Central Library was provided with the final list of holdings of German periodicals. The British Union Catalogue of Periodicals at the British Museum was provided with a complete list of the holdings of all periodicals, and a similar list was provided for the "World List of Scientific Periodicals". Close co-operation was maintained with the Science Library, the National Central Library and the Libraries of the Royal Meteorological Society, Royal Geographical Society and the Department of Scientific and Industrial Research. The last-named was provided with the translated titles of papers appearing in current numbers of the Russian periodical *Izvestia* (Academy of Sciences U.S.S.R., Section of Geography and Geophysics).

The library was accepted as a corporate member of "Aslib" on the terms applicable to Government departments.

Loans.—The number of publications issued on loan rose to 10,067 as compared with 9,058 in 1948-49; 82 publications were obtained from the National Central Library and re-issued on loan; 75 publications were issued on loan to outside borrowers requesting publications through the National Central Library.

Four hundred and eighty-six lantern slides were issued on loan to members of the staff and 125 to members of the public.

Bibliographies.—Bibliographies were prepared on a wide variety of subjects including, the climate of the West Indies; temperature data for countries served by the national airways; disruption by lightning; the origin of Abyssinian rainfall; air-mass analysis; frozen soil; climatological atlases; artificial precipitation; and many others.

The library's subject bibliography was microfilmed as a safeguard against loss of the original. A negative copy of the microfilm was sold to the American Meteorological Society.

An annotated version of the revised Universal Decimal Classification, which was introduced into the library on January 1, 1950, was distributed to external recipients of the *Monthly Bibliography of Meteorological Literature* and was distributed internally as a Meteorological Office Order.

Inquiries.—These covered the usual very wide field and were received from a variety of outside bodies as well as from large numbers of Meteorological Office staff. The outside inquirers included the British Broadcasting Corporation; La Società Edison, Milano; Chambers Encyclopaedia; British Electricity Authority; British European Airways; William Dawson and Sons Ltd.; Sound Stills, Ltd.; and the British Rayon Research Association.

In addition to the more usual requests for selected bibliographies the following inquiries typify the different fields covered: daily magnetic data for the Polar Year for as many parts of the world as possible; weather in Finnish waters and its effect on bird migration; loading of the air with solid matter in sand, dust and snowstorms and with water in fog; the distribution function of wind speeds and the correlation between speeds occurring at finite time intervals; the variation of sunlight with latitude and consequent visual differences in colour; specific heat and density of wind-packed snow in connexion with the melting of snow on radar aerials.

(b) Publications.—Geophysical Memoirs and Professional Notes.—Two *Geophysical Memoirs* and four *Professional Notes* were published. Nearly all sale copies of Geophysical Memoir No. 84 "Atmospheric electricity in

disturbed weather" by Sir G. C. Simpson were sold in six weeks. Several *Geophysical Memoirs* including "Upper winds over the world" by C. E. P. Brooks, C. S. Durst, N. Carruthers, D. Dewar and J. S. Sawyer are in the press.

Meteorological Reports.—Two *Meteorological Reports* were published. One of these, No. 3, "Theoretical aspects of pressure pattern flying" by J. S. Sawyer, dealt with the application of meteorological information in aerial navigation and the other was concerned with the aviation meteorology of the Mediterranean.

Meteorological Magazine.—The *Meteorological Magazine* was published throughout the year. The articles published have dealt with subjects as diverse as the synoptic meteorology of Antarctic waters, noctilucent clouds, and the variation of atmospheric humidity with height in the stratosphere. It was decided to discontinue publication of the British Commonwealth climatological table in the Magazine when all the data for 1949 have been published.

Marine publications.—Publication of the *Marine Observer* was continued with the four quarterly numbers for April, July and October 1949 and January 1950.

Two new atlases—"Monthly mean sea surface temperatures of the North Atlantic" and "Quarterly surface current charts of the western North Pacific with monthly chartlets of the China Seas"—were published.

A reprint of "Monthly mean sea surface temperatures of Australian and New Zealand Waters" was issued.

A new edition of the "Marine Observer's Handbook" is now in final proof stage.

Other Publications.—Of publications other than those in regular series special mention may be made of the important work, "Meteorology of air-fields" by C. S. Durst, and of the Naval Handbook, "Weather on the west coast of tropical Africa."

Publications in preparation for printing or in the press include the "Manual of meteorological statistics" by Dr. C. E. P. Brooks and Miss N. Carruthers, and "A century of London weather" by Mr. W. A. L. Marshall.

The "Meteorology Glossary" is being reprinted with the addition of a number of terms called into existence by the developments of the last ten years.

A colour scheme based on subjects, such as synoptic meteorology, climatology, etc., for the Linson cloth binding of larger publications was adopted.

§ 6. INTERNATIONAL CO-OPERATION

(1) International Meteorological Organization

A meeting of the Regional Commission for Europe (R.C. VI) was held in London in June–July 1949. The Meteorological Office was represented by the Director and a number of the Staff. Some important decisions were taken to improve the regional application of the codes and procedures approved at the Washington Conference in the autumn of 1947.

A representative of the Meteorological Office attended the meeting of Regional Commission IV on hurricane warnings in the Caribbean Area held at Barbados in August 1949.

The Marine Superintendent, as President of the Maritime Commission of the International Meteorological Organization, has conducted much corres-

pondence on matters requiring international consultation. Considerable progress has been made in international discussions concerning an international marine Hollerith card and an international nomenclature for sea ice.

(2) International Civil Aviation Organization

Close liaison has been maintained with the International Civil Aviation Organization. Representatives of the Meteorological Office attended the following meetings :—

North Atlantic Meteorological Telecommunications Meeting, London, April 1949.

Joint Support Greece Sub-Committee, London, April 1949.

Joint Support Denmark Sub-Committee, London, April 1949.

Second Conference on North Atlantic Ocean Stations, London, April 1949.

Joint meeting of I.C.A.O. Meteorological Division and I.M.O. Commission for Aeronautical Meteorology, Paris, February 1950.

The Conference on North Atlantic Ocean Stations was called to consider the revision and renewal of the agreement signed in London in 1946. A new agreement was concluded to secure the continued provision, financing, maintenance and operation of ocean weather stations in the North Atlantic. The new agreement provides for 10 ocean weather stations, as follows :—

Station	Operated by
A, 62°00' N. 33°00' W.	Netherlands and United States
B, 56°30' N. 51°00' W.	Canada and United States
C, 52°45' N. 35°30' W.	United States
D, 44°00' N. 41°00' W.	United States
E, 35°00' N. 48°00' W.	United States
H, 36°00' N. 70°00' W.	United States
I, 59°00' N. 19°00' W.	United Kingdom
J, 52°30' N. 20°00' W.	United Kingdom
K, 45°00' N. 16°00' W.	France
M, 66°00' N. 2°00' E.	Norway, assisted financially by Belgium, Denmark and Sweden.

Stations I and J were moved to the new positions on March 25, 1950.

(3) International Union of Geodesy and Geophysics

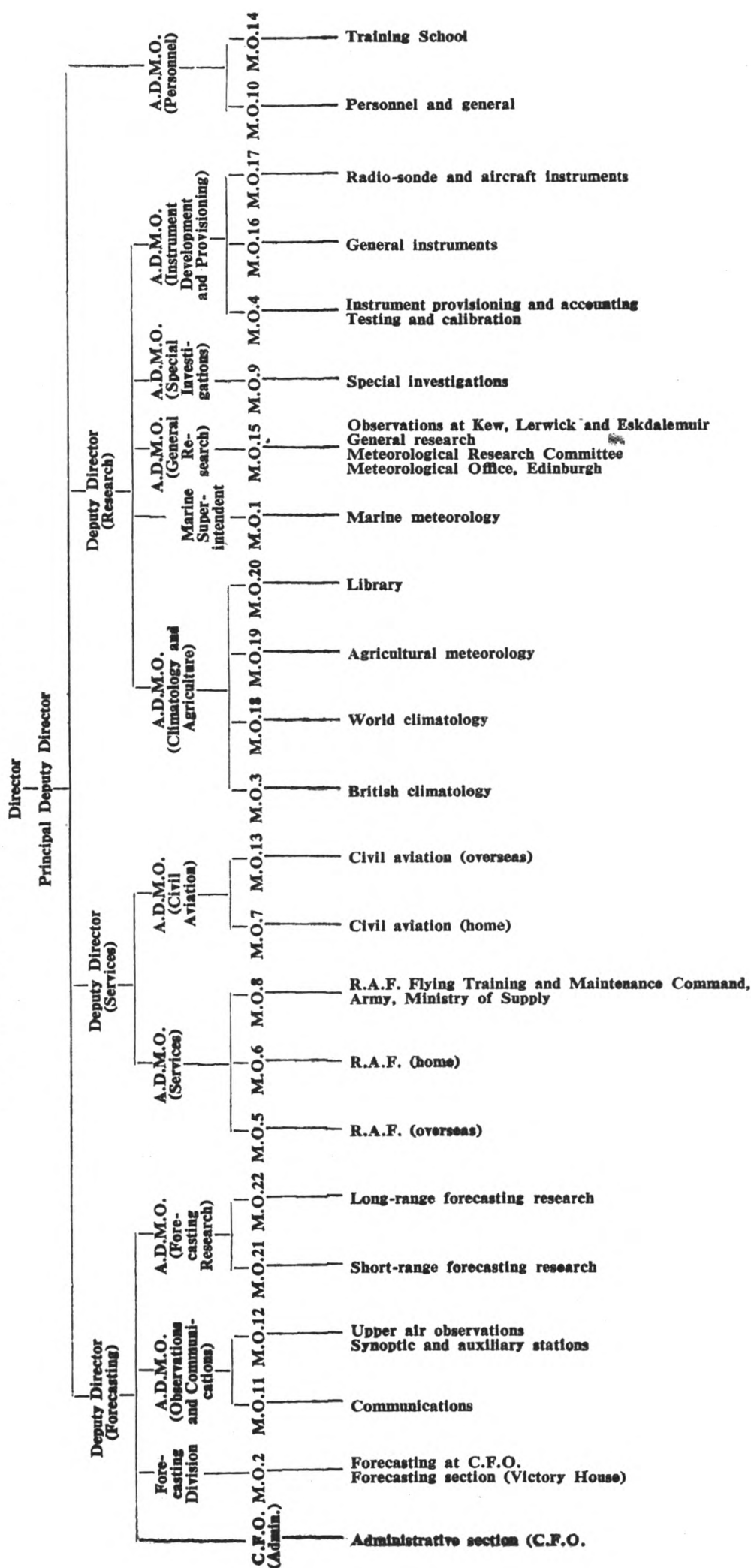
In the period between triennial General Assemblies, the next of which will be in Brussels in August 1951, the various constituent associations of the Union are concerned with carrying out the programmes of international scientific work agreed upon at the last Assembly.

In meteorology, the International Ozone Commission under Sir Charles Normand has been given a U.N.E.S.C.O. grant for a new spectrograph, the Associations of Meteorology and Hydrology have jointly submitted proposals for establishing an International Institute for the Arid Zones, and the Association of Geodesy has advised on a standard value of gravity for reduction of barometer readings. Continuing its work on the inter-comparison of geomagnetic standard instruments at the world's principal magnetic observatories, the Association of Terrestrial Magnetism and Atmospheric Electricity has made arrangements to include the Meteorological Office observatories at Eskdalemuir and Lerwick in its programme.

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.

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

APPENDIX III

CLASSIFICATION OF BRITISH STATIONS WHICH REPORT TO THE BRITISH CLIMATOLOGICAL BRANCH

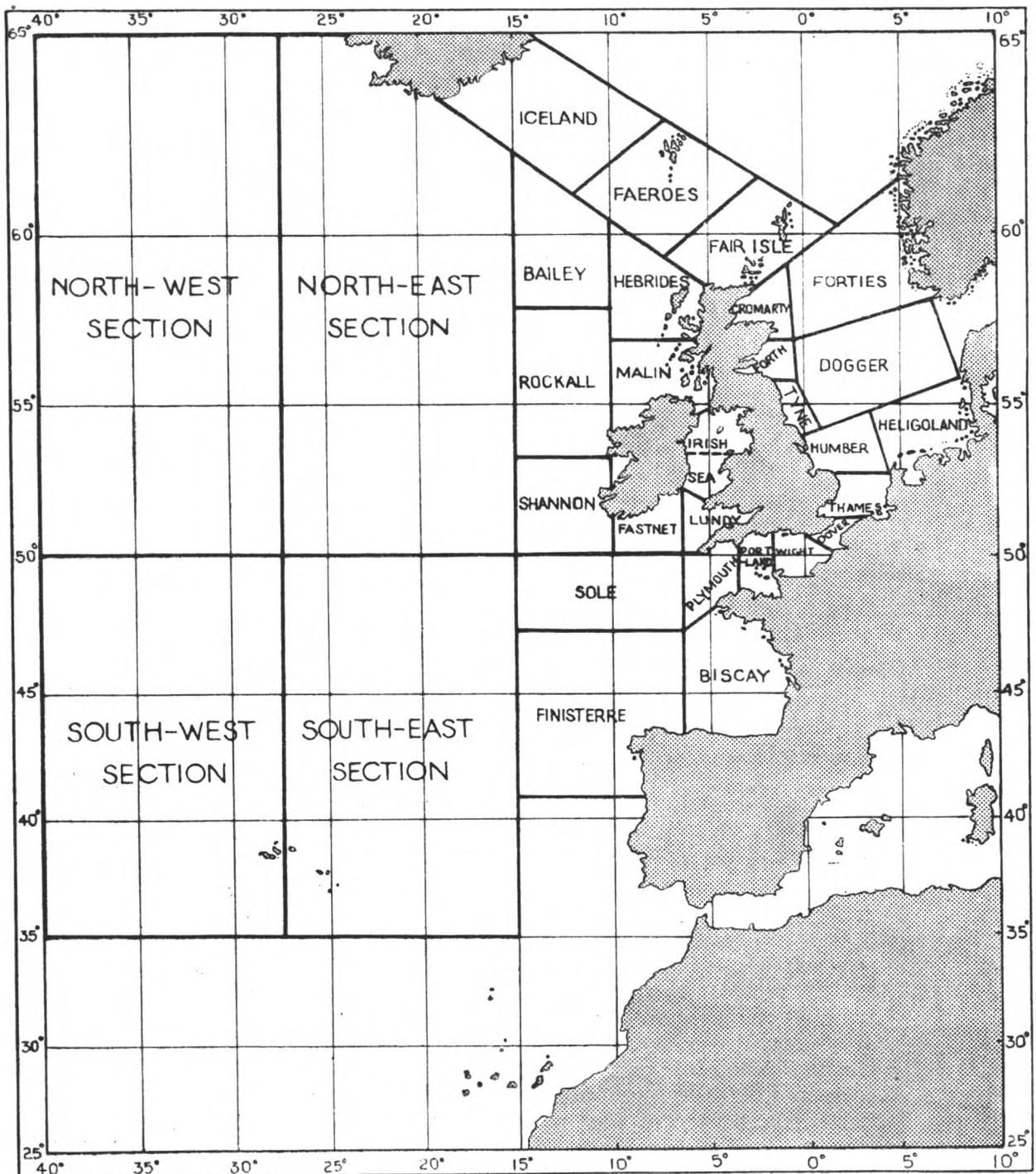
	Stations					Autograph records		
	Observatories	Synoptic	Crop-Weather	Climatological	Rainfall	Sunshine	Rainfall	Wind
Scotland, N.	1	6	0	8	152	12	8	2
Scotland, E.	0	6	2	35	349	30	13	3
Scotland, W.	1	4	1	23	368	19	11	5
England, N.E.	0	6	2	17	300	21	12	5
England, E.	0	6	8	16	464	22	21	6
England, Midlands	0	9	6	33	1,038	36	35	2
England, S.E.	0	11	5	45	733	41	47	12
London District	2	1	0	11	40	4	4	2
England, S.W... .. .	0	8	6	26	507	31	9	3
England, N.W.	0	5	1	18	455	20	24	5
Wales, N.	0	2	1	11	172	8	6	1
Wales, S.	0	4	3	10	256	15	8	2
Isle of Man	0	2	0	1	10	3	1	1
Scilly and Channel Isles	0	1	0	2	13	2	0	1
Northern Ireland	0	3	0	5	73	3	4	1
TOTAL	4	74	35	261	4,930*	267	203	51

* 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 :—

Vote	Service	Provision
		£
1	Pay, etc., of airmen*	59,000
	National insurance contributions	3,600
2	Pay, etc., of personnel of the Royal Air Force Volunteer Reserve (Meteorological Section)	7,000
3	Salaries, wages, etc., of staff at headquarters of the Meteorological Office	182,500
4	Salaries, wages, etc., of civilians at meteorological observatories and outstation offices and in ocean weather ships	1,195,500
5	Conveyance of personnel; travelling allowances and expenses	65,500
	Conveyance of meteorological equipment	16,000
6	Food and ration allowances for airmen; food for crews of ocean weather ships	28,000
	Solid fuel, electricity, gas, water and sanitary services for meteorological observatories and outstation offices	4,000
	Liquid fuel, lubricants, etc. for vehicles required for meteorological services	2,000
	Liquid fuel for ocean weather ships	23,500
7	Meteorological equipment	325,000
	Radio, radar and electrical equipment for meteorological services	26,000
	Mechanical transport vehicles for meteorological services	19,000
	Miscellaneous equipment and services for ocean weather ships	41,000
	General stores for meteorological services	1,200
	Clothing, clothing allowances and laundry services for airmen; clothing for crews of ocean weather ships	8,100
8	Works services for meteorological observatories and outstation offices :—	
	Capital expenditure	36,500
	Maintenance expenditure	17,500
9	Telecommunication services for meteorological purposes	70,000
	Other miscellaneous effective services	13,000
10	Superannuation allowances and gratuities	6,500
	GROSS TOTAL	£2,150,400
	Deduct—Appropriations in aid :—	
4	Receipts in respect of salaries, wages, etc., of meteorological staff	£ 296,000
5	Receipts in respect of movement expenses of meteorological staff	14,000
7	Receipts relating to meteorological equipment	69,000
	Payments by airmen for issues of clothing and footwear	1,400
9	Receipts for meteorological services	9,000
10	Receipts in respect of non-effective benefits of meteorological staff lent to other governments	2,000
		391,400
	NET TOTAL	£1,759,000

* A number of posts within the Meteorological Office outstation establishment are filled by airmen of the trade of meteorologist.

APPENDIX VI

PUBLICATIONS

The publications prepared by the 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 the 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 (January 1 to March 31, 1950).

Daily Weather Report, issued in three sections (British, International and Upper Air) to December 31, 1949, and as a single publication (similar to the former British Section) from January 1 to March 31, 1950.

Marine Observer (to January 1950).

Meteorological Magazine (to March 1950).

Monthly Weather Report, with a summary for the year (to December 1949).

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 January 1947).

Seismological Bulletin. A diary of seismological disturbances recorded on the Galitzin aperiodic seismographs at Kew Observatory, Richmond (to February 1950).

British Rainfall, 1940 to 1942 (in one volume) and 1947. 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. May 22 to 30, 1948.

Annual Report and results of meteorological observations, 1940, 1941 and 1947. Southport Auxiliary Observatory. By George A. Lidster.

Occasional

Monthly sea surface temperatures of the North Atlantic Ocean.

Percentage frequencies of various visibility ranges at certain places in the British Isles between the years 1927 and 1936.

Geophysical Memoirs :—

Vol. X :—

83. Wind at 100,000 ft. over south-east England. Observations and a discussion of the monsoon theory of wind at great heights. By R. J. Murgatroyd, B.Sc. (Eng.) and C. J. B. Clews, Ph.D.
84. Atmospheric electricity during disturbed weather. By Sir George Simpson, K.C.B., F.R.S.

Meteorological Reports :—

Vol. I :—

3. Theoretical aspects of pressure-pattern flying. Compiled by J. S. Sawyer M.A.
4. Aviation meteorology of the route Marseilles-Castel Benito.

Professional Notes :—

Vol. VI :—

- 98. Rainfall in east Scotland in relation to the synoptic situation. By R. F. M. Hay, M.A.
- 99. Possible effects of heavy rain on aircraft. By J. S. Sawyer, M.A.
- 100. Prediction diagrams for radiation fog. By W. C. Swinbank, B.Sc.

Vol. VII :—

- 101. Climates of Addu Atoll, Agelega Islands and Tristan da Cunha. By E. V. Newnham, B.Sc.

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. :—

Milestones in a century of meteorology. *Weather, London, 5, 1950, p. 87.*

E. G. BILHAM, B.Sc., D.I.C. :—

New version of the humidity slide-rule. *Met. Mag., London, 79, 1950, p. 65.*

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

On the dynamics of cyclones and anticyclones. *Weather, London, 4, 1949, pp. 346, 393.*

Organization of research in the Meteorological Office. *Met. Mag., London, 78, 1949, p. 93.*

A. H. R. GOLDIE, M.A., D.Sc., F.R.S.E. and J. K. BANNON, B.A. :—

The stratosphere. *Met. Mag., London, 78, 1949, p. 98.*

C. E. P. BROOKS, D.Sc. :—

Causes of climatic fluctuations. *Quart. J. R. met. Soc., London, 75, 1949, p. 172.*

Climatic fluctuations and the circulation of the atmosphere. *Weather, London, 5, 1950, p. 113.*

C. K. M. DOUGLAS, B.A. :—

Pressure irregularities of August 23-24, 1944. *Met. Mag., London, 78, 1949, p. 309.*

C. S. DURST, B.A. :—

The fine structure of wind in the free air. *Quart. J. R. met. Soc., London, 74, 1948, p. 349.*

Relation of surface winds to pressure gradients. *Met. Mag., London, 78, 1949, p. 157.*

C. S. DURST, B.A. and N. E. DAVIS, B.A. :—

Jet streams and their importance to air navigation. *J. Inst. Navig., London, 2, 1949, p. 210.*

C. S. DURST, B.A. and G. H. GILBERT, B.Sc. :—

Constant-height balloons—calculation of geostrophic departures. *Quart. J. R. met. Soc., London, 76, 1950, p. 75.*

F. J. SCRASE, M.A., Sc.D. :—

Measurements of wind and temperature up to 100,000 ft. by radio-sonde and radar. *Met. Mag., London, 78, 1949, p. 284.*

R. C. SUTCLIFFE, B.Sc., Ph.D. :—

The general circulation—a problem in synoptic meteorology. *Quart. J. R. met. Soc., London, 75, 1949, p. 417.*

- C. E. N. FRANKCOM, R.N.R. :—
Weather wise. *Mar. Obs., London*, 20, 1950, p. 29.
- A. C. BEST, M.Sc. :—
The size distribution of raindrops. *Quart. J. R. met. Soc., London*, 76, 1950, p. 16.
- A. F. CROSSLEY, M.A. :—
Equivalent headwinds on air routes. *J. Inst. Navig., London*, 2, 1949, p. 195.
On the relation between wind and pressure. *Quart. J. R. met. Soc., London*, 74, 1948, p. 379.
- R. FRITH, M.A., Ph.D. :—
Artificial nucleation of clouds. *Met. Mag., London*, 79, 1950, p. 5.
- R. FROST, B.A. :—
Atmospheric turbulence. *Quart. J. R. met. Soc., London*, 74, 1948, p. 316.
A note on polar air-mass modification. *Proc. roy. Soc., London*, A, 198, 1949, p. 27.
- J. GLASSPOOLE, M.Sc., Ph.D. :—
The average rainfall over the Irish Sea. *Mar. Obs., London*, 19, 1949, p. 172.
Seasonal weather sequences over England and Wales. *Met. Mag., London*, 78, 1949, p. 193.
- A. H. GORDON, M.S. (Pasadena) :—
Analysis of weather conditions at station "Jig" in July, 1948. *Mar. Obs., London*, 19, 1949, p. 158.
- S. T. A. MIRRLEES, M.A., B.Sc. :—
Notes on southern hemisphere circulation. *Met. Mag., London*, 78, 1949, p. 315.
- F. PASQUILL, B.Sc., F. INST.P. :—
Eddy diffusion of water vapour and heat near the ground. *Proc. roy. Soc., London*, A, 198, 1949, p. 116.
A portable indicating apparatus for the study of temperature and humidity profiles near the ground. *Quart. J. R. met. Soc., London*, 75, 1949, p. 239.
- G. D. ROBINSON, B.Sc., Ph.D. :—
Notes on the measurement and estimation of atmospheric radiation.—2. *Quart. J. R. met. Soc., London*, 76, 1950, p. 37.
- J. S. SAWYER, M.A. :—
An approximate method of estimating the flight path which gives the least time of flight at a given level between two points. *Quart. J. R. met. Soc., London*, 75, 1949, p. 275.
Formation of secondary depressions in relation to the thickness pattern. *Met. Mag., London*, 79, 1950, p. 1.
Preliminary classification of anticyclones by means of the thickness pattern. *Met. Mag., London*, 78, 1949, p. 189.
Recent research at Central Forecasting Office, Dunstable. *Quart. J. R. met. Soc., London*, 75, 1949, p. 185.
The significance of dynamic instability in atmospheric motions. *Quart. J. R. met. Soc., London*, 75, 1949, p. 364.
- L. L. ALEXANDER :—
Report on an earth tremor in East Anglia on May 28, 1948. *Met. Mag., London*, 78, 1949, p. 135.

- J. K. BANNON, B.A. :—
The angular deviation of the wind from the isobars at Liverpool. *Quart. J. R. met. Soc., London*, 75, 1949, p. 131.
- B. W. BARLOW, B.Sc. :—
Halo phenomena of July 20, 1949. *Met. Mag., London*, 78, 1949, p. 282.
- J. E. BELASCO, M.Sc., Ph.D. :—
Rainless days of London. *Quart. J. R. met. Soc., London*, 74, 1948, p. 339.
- K. L. CALDER, B.Sc. :—
The criterion of turbulence in a fluid of variable density with particular reference to conditions in the atmosphere. *Quart. J. R. met. Soc., London*, 75, 1949, p. 71.
Eddy diffusion and evaporation in flow over aerodynamically smooth and rough surfaces: a treatment based on laboratory laws of turbulent flow with special reference to conditions in the lower atmosphere. *Quart. J. Mech. appl. Math., London*, 2, 1949, p. 153.
- D. D. CLARK, M.A. :—
High altitude research with rockets. *Weather, London*, 4, 1949, p. 176.
- J. M. CRADDOCK, M.A. :—
A note on cumulonimbus photographed near Singapore on March 5, 1947. *Met. Mag., London*, 78, 1949, p. 290.
The development of cumulus cloud: results of observations made in Malaya. *Quart. J. R. met. Soc., London*, 75, 1949, p. 147.
- J. CRICHTON, M.A., B.Sc., F.R.S.E. :—
The K-index of geomagnetic activity at Eskdalemuir 1940-47. *J. Geophys. Res., Baltimore*, 54, 1949, p. 275.
- R. W. GLOYNE, B.Sc. :—
Meteorology and agriculture—some practical problems. *Quart. J. R. met. Soc., London*, 75, 1949, p. 309.
- W. H. HOGG, M.Sc. :—
Frequency of radiation and winter frosts during Spring in Kent. *Met. Mag., London*, 79, 1950, p. 42.
- H. JAMESON, D.Sc. :—
Storminess near Socotra at the beginning of the south-west monsoon. *Mar. Obs., London*, 19, 1949, p. 113.
- G. J. JEFFERSON, M.Sc. :—
Temperature rise on clear mornings. *Met. Mag., London*, 79, 1950, p. 33.
- E. KNIGHTING, B.Sc. :—
Elements of anomalous radio propagation. *Met. Mag., London*, 79, 1950, p. 74.
- H. H. LAMB, M.A. :—
Scientific results of the "Balaena" expedition 1946-47. *Met. Mag., London*, 78, 1949, p. 104.
- F. H. LUDLAM :—
The composition of coagulation-elements in cumulonimbus. *Quart. J. R. met. Soc., London*, 76, 1950, p. 52.
- K. MILBURN and E. W. BARLOW, B.Sc. :—
Ocean currents. *Mar. Obs., London*, 19, 1949, p. 225.

A. E. PARKER, B.Sc. :—

Relation between upper wind structure and rainfall at fronts. *Met. Mag., London*, 78, 1949, p. 247.

W. E. SAUNDERS, B.Sc. :—

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