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ANNUAL REPORT
of the Director of the
METEOROLOGICAL OFFICE
presented by the Meteorological Committee
to the Secretary of State for Air

for the year
April 1, 1947 to March 31, 1948



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Secretary :—Mr. R. J. Williams

The Committee met on October 30, 1947.

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Secretary :—Dr. W. A. Harwood

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The Royal Society of Edinburgh

The Royal Meteorological Society

The Scottish Home Department

The Department of Health for Scotland

The Department of Agriculture for Scotland

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Professor P. A. Sheppard

Professor O. G. Sutton

Professor Sir Geoffrey Taylor, F.R.S.

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

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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.

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Sir Edward Appleton

Professor P. M. S. Blackett

Professor S. Chapman

Lord Cherwell

Professor T. G. Cowling

Professor G. M. B. Dobson

Sir Alfred Egerton

Mr. E. Gold

Professor H. W. Massey

Professor E. A. Milne

Sir Geoffrey Taylor

Sir George Thomson

The Astronomer Royal

The President of the Royal Astronomical Society

The Director of the Meteorological Office

The Committee met on May 5 and October 31, 1947.

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ANNUAL REPORT
of the Director of the Meteorological Office
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for the year April 1, 1947 to March 31, 1948.

§ I. INTRODUCTION

During the past year further important progress has been made towards placing the Meteorological Office on a peace-time basis, and the reorganization of the Office in accordance with the terms of the White Paper on the Government Scientific Service (Cmd. 6679) is almost completed. In view of the increased responsibilities of the Office, the Headquarters has been strengthened by the appointment of a Principal Deputy Director, three Deputy Directors and nine Assistant Directors. The recruitment of staff has again presented a difficult problem, and it is anticipated that during the next year or so the available personnel will not be sufficient to meet all requirements. The Meteorological Committee has therefore approved a scale of priorities for the allocation of man power among the user Departments.

Various steps have been taken to make the service provided by the Meteorological Office for the general public closer and more effective. Apart from the forecasts and warnings broadcast by the B.B.C., a system has been introduced for providing the control offices of British Railways with advance notification of weather likely to interfere with the operation of passenger and goods services. In another scheme arrangements have been made to provide snow warnings to County Surveyors and Divisional Road Engineers throughout the country. Further measures designed to assist the national economy are contemplated and discussions are taking place with the Departments concerned.

The international scheme for the establishment of 13 weather stations in the North Atlantic is proceeding. The British Ocean Weather Service was inaugurated on July 31, 1947, at the London Docks, when the ceremony of renaming the first ship, *Weather Observer*, was performed by the Secretary of State for Air. The remaining three British ships were commissioned at intervals of approximately two months, and by about the end of January the two stations for which the United Kingdom is responsible were in continuous operation. The weather ships have already shown their value both for weather forecasting and for assisting the navigation of transatlantic aircraft.

The Colonial Meteorological Services in Bermuda and British West Africa and the Service in Iraq, which came under Air Ministry control during the war, have been handed back to the local Governments, and arrangements are also in hand for the Air Ministry to relinquish control of the British East African Meteorological Service. All assistance necessary is being given to these and other Colonial Meteorological Services to enable them to function efficiently.

The Meteorological Office has continued to take a leading part in the important work of the International Meteorological Organization. Several members of the Office attended the meetings of the Technical Commissions of the Organization which were held in Toronto at the end of the summer and the Conference of Directors which was held in Washington immediately afterwards. In order to increase the status of the International Meteorological Organization and to place it on a more official basis, it was decided at Washington to replace the International Meteorological Organization by a World Meteorological Organization supported by an intergovernmental convention. It was also decided that

the World Meteorological Organization should seek affiliation as a Specialised Agency to the United Nations.

The Office has lost by retirement a number of staff of long and outstanding service. Of these, special mention should be made of Mr. E. Gold, C.B., D.S.O., F.R.S. and Mr. R. Corless, C.B.E., M.A. Mr. Gold served in the Meteorological Office for 41 years, during the last seven of which he was the Deputy Director. He was a conspicuous figure in international meteorology, and was, for 27 years, President of one of the Technical Commissions of the International Meteorological Organization. Mr. Corless, who retired after nearly 40 years' service, held many important posts in the Office and was appointed an Assistant Director in 1939.

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 1948-9.

§ 2. ORGANIZATION

(1) Headquarters

The final stages in the reorganization of the Meteorological Office have largely concerned with the higher direction of the work. The new internal organization of the Office is shown in Appendix I, and a list of the Directorate and Heads of Branches is given in Appendix II. The chain of responsibility and the distribution of duties are described in the following paragraphs :—

(i) *The Director* is assisted by a Principal Deputy Director, three Deputy Directors and nine Assistant Directors.

(ii) *The Principal Deputy Director* is responsible for the organization and general administration of the Office and co-ordinates the work of the three Deputy Directors. In addition, the Assistant Director in charge of the Personnel and Supply Division is directly responsible to the Principal Deputy Director.

(iii) *The Deputy Director (Forecasting)* is in charge of the Central Forecasting Office at Dunstable and is responsible for the collection and distribution of synoptic data, the issue of basic analyses and forecasts, and for research work connected with the problems of forecasting. The Central Forecasting Office also supplies forecasts to the Press, the B.B.C. and Government Departments and meets the requirements of public utility undertakings, industry and other interests. The work of the Deputy Directorate is divided among three divisions, the Forecasting Division, the Division responsible for the collection of data and for communications, and the Division engaged on research in forecasting.

(iv) *The Deputy Director (Services)* is responsible for the provision of meteorological facilities for the Army, the Royal Air Force, the Ministry of Civil Aviation, the Ministry of Supply, the Ministry of Agriculture and Fisheries, and the Merchant Navy. He also supervises the work, including research, of the Climatology Branches and controls the Library. The Deputy Directorate is organized in three Divisions and a Marine Branch. In one Division, the Assistant Director (Services) is responsible for the meteorological requirements of the Army, the Royal Air Force and the Ministry of Supply; another Division is responsible for civil aviation requirements and the third Division deals with matters concerning climatology and agriculture. The Marine Superintendent is responsible for all questions of maritime meteorology, including the requirements of the Merchant Navy and the administration of British ocean weather ships.

(v) *The Deputy Director (Research)* is responsible for the co-ordination of all research within the Meteorological Office. He actually supervises this work except for that which is concerned with forecasting and climatology. The Deputy Director (Research) also has charge of the arrangements connected with

the Meteorological Research Committee and is responsible for liaison with outside bodies on questions relating to research and development. In addition he controls the observatories and other research stations of the Meteorological Office as well as the Branch Office at Edinburgh. In this Deputy Directorate there are three Assistant Directors, one of whom deals with general research, another with instrument development and a third with special investigations.

(2) Branch Meteorological Office, Edinburgh

The Edinburgh Office has continued to act as a centre for the organization of the climatological and rainfall stations in Scotland, and for the administration of the observatories of Eskdalemuir, Lerwick and, until its closure, Aberdeen. The telegraphic reporting stations and such auxiliary stations as are not attached to airfields are also administered by Edinburgh.

§ 3. SYNOPTIC METEOROLOGY

(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 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.

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, is in operation, mainly to provide weather information to the small airfields where there is no meteorological office.

During the year under review the change to civilian status of the section dealing with wireless receptions and transmissions has been completed, and a civilian Signals Officer was appointed in January 1948 to take charge of both the wireless and teleprinter communications services. As described more fully later in this report, the wireless transmitting programme was substantially increased during the year by the broadcasting from Rugby of a collective report of European data, and by the manning of a point-to-point link with the British ocean weather ships.

The organization of the Central Forecasting Office was modified in March 1948 as part of the general reorganization of the Office under the Barlow Scheme. It now comprises the Forecast Division and the Assistant Directorate of Observations and Communications and the Assistant Directorate of Forecasting Research, all under the Deputy Director of Forecasting. The Assistant Director of Observations and Communications administers the Synoptic Services Branch and the Upper Air Branch. The Assistant Director of Forecasting Research administers two Branches responsible for research on problems of short-range forecasting and long-range forecasting respectively.

(b) **Reporting stations.**—The number of stations in the British Isles making regular synoptic observations has been reduced to 174; of these 84 provide reports in the full synoptic code, whilst the remainder supply

abbreviated reports. Reports from Aberdeen University (which go back to 1868) ceased on December 31, 1947, and for synoptic purposes this station has been replaced by Dyce.

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

Selected ships. Meteorological instruments, instructions and logbooks are supplied to these ships for making meteorological observations at standard synoptic hours. The observations are transmitted by wireless in the international code to meteorological centres for synoptic work. When completed, the logbooks are sent to the Marine Branch for climatological study.

Supplementary ships 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.

Certain coastal vessels (MARID ships) are equipped with sea thermometer and canvas buckets. They make and transmit observations of sea temperature in home waters for the benefit of the forecast service.

Light vessels. Certain light vessels 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.

The number of voluntary observing ships increased steadily during the year from 695 to 761. A direct teleprinter line between Dunstable and the Post Office wireless station at Burnham-on-Sea was installed in September, and this has resulted in reports from ships being received more quickly than when they were passed via the Central Telegraph Office, London. The number of reports received monthly is approximately 2,400.

(ii) *Ocean weather ships.*—Progress has been made in implementing the international agreement to establish 13 weather stations in the North Atlantic Ocean. Surface and upper air observations are now received regularly from seven stations, and another station is expected to be in operation by the end of April, 1948. The United Kingdom is responsible for two stations—Station I at position 60° 00' N. 20° 00' W., and Station J at position 53° 50' N. 18° 40' W.

The British Ocean Weather Service came into being on July 31, 1947, when the ceremony of renaming the first ship, *Weather Observer*, was performed by the Secretary of State for Air at London Docks. Four ships are required for the full operation of two stations and the remaining three British ships were commissioned as follows :—

Weather Recorder—October 4, 1947

Weather Watcher—November 27, 1947

Weather Explorer—February 4, 1948.

The primary duty of ocean weather ships is to provide meteorological observations, but they have other important functions as well. The ships maintain nearly constant positions, and are thus able to act as radio beacons to transatlantic aircraft, which can check their navigation and adjust their courses accordingly. Aircraft can ask the ships for the latest information about the upper winds and other conditions on their route ahead. The ships are also intended and specially equipped to go to the rescue of aircraft or ships in distress. On January 11 the *Weather Recorder* rescued the crew of the Norwegian steamer *Veni* off the Scottish coast.

During the past winter the four vessels experienced weather of great severity, and every credit is due to the crews and meteorological personnel who have maintained the observational routine in conditions involving much hardship.

(d) **Meteorological flights.**—Meteorological flights are undertaken by the Royal Air Force. Routine reconnaissance flights are made at fixed times on a

specified track. Other reconnaissance flights, known as PAMPA sorties, are carried out when observations are urgently required from areas where rapid development is expected. Vertical flights, made in fighter aircraft, are primarily intended to measure the variation of temperature, cloud and humidity with height.

The distribution of meteorological flights in Home Commands is shown in Appendix IV. The code names and the tracks of the routine flights are also given.

A meteorological squadron of Coastal Command is responsible for the flights made from Aldergrove and Gibraltar, but other reconnaissance sorties are carried out by Bomber and Coastal Commands under a scheme whereby front-line squadrons undertake meteorological work as part of their duties.

Daily ascents at West Malling and at Coltishall began on May 1, 1947, and continued for the remainder of the period. The flights are made by Mosquito aircraft of Fighter Command. Aircraft ascents have also been made at Wahn in the British occupied zone of Germany. These were made twice daily until the end of November when the frequency was reduced to one daily.

In addition to the flights described above, meteorological air observers took part in special flights of an investigational nature.

(e) **Radio-sonde and radio-wind stations.**—Measurements of upper air pressure, temperature and humidity have been made with British radio-sonde transmitters throughout the period. The form of the transmitter has been modified with the introduction of the Mark II pattern, which is more suitable for production in quantity.

Upper winds have been determined throughout the period by a radar method whereby the position of a reflector carried by a balloon is plotted at intervals of one minute. The determination of wind is usually combined with a radio-sonde ascent, the balloon carrying aloft both the radar reflector and the radio-sonde transmitter.

Apart from temporary reductions in programme, due to shortage of supplies and staff, soundings have been made four times daily at the six stations: Larkhill, Lerwick, Downham Market, Aldergrove, Fazakerley and Penzance and twice daily at Stornoway and Leuchars. The network was augmented from September onwards by the ocean weather ships commencing a programme which has now reached four soundings daily at positions $60^{\circ} 00' N.$ $20^{\circ} 00' W.$ and $53^{\circ} 50' N.$ $18^{\circ} 40' W.$

Overseas, regular observations of one or two daily temperature and wind soundings have been made at Gibraltar, Malta, Nicosia, Lydda and Habbaniya throughout the twelve months, and at Bahrein, Nairobi and Falkland Islands since the summer. Soundings commenced at Benina (Libya) in February, and a radio-sonde station is being set up at Aden.

(f) **Location of thunderstorms.**—The number of observations of atmospheric ("Sferic") has been increased to 12 daily, the period covered being from 0700 to 2200 G.M.T. A new combined sferic/radio-sonde station is in course of erection at Camborne in Cornwall, and when completed, the sferic station at St. Eval will be closed. With the assistance of the National Physical Laboratory, two new sferic sets of greatly improved performance have been installed at Dunstable and Irvinestown. Two more are expected from the manufacturers shortly. Provision is made in them for a duplicate display tube so that "flashes" may be photographically recorded on a moving film as well as observed visually. The new equipment and technique has already resulted in improvement in the accuracy of locating the thunderstorms.

(g) **Meteorological communications.**—(i) *Teleprinter communications.*—The meteorological teleprinter system has two channels. The first is devoted to basic data and the second to weather analysis and forecasts. The number of

stations and units connected to the " Channel 1 " teleprinter broadcast from Dunstable is now 230, whilst the " Channel 2 " broadcast is supplied to 42 recipients. Many additional circuits have been provided for the supply of information required for special aviation requirements between selected stations and centres such as the Air Traffic Control Centres at Uxbridge and Gloucester. The Greenwich time signal is being relayed over the meteorological teleprinter network at 30 minutes past each hour.

Following upon recommendations made at a meeting of western European delegates at Utrecht in March 1947, American weather reports received via Prestwick have been re-broadcast to Paris, Frankfurt, de Bilt, Brussels and the British Air Forces of Occupation (B.A.F.O.) during a period of 15 minutes every hour, whilst a separate " continental " switchboard has been installed at Dunstable to facilitate the broadcast of material conforming to an internationally agreed schedule. Meteorological teleprinter circuits in Norway are expected to be connected to B.A.F.O. via Copenhagen during 1948.

(ii) *Wireless telegraphy*.—Two additional transmissions from Dunstable have been introduced, making a total of five. The high-power long-wave transmitter (GBR) at Rugby is " keyed " from Dunstable and provides an inter-continental broadcast which was agreed at the meeting of the International Meteorological Committee in July 1946. The long-wave transmissions are supplemented by simultaneous transmissions on four shorter wave-lengths. A transmitter keyed from Dunstable has also been provided for point-to-point working with the British ocean weather ships. No important changes have been made in respect of the other three transmissions mentioned in the last report.

Broadcasts from Delhi, Manila and Guam are now being intercepted to provide data for the northern hemisphere circumpolar charts which are constructed daily at Dunstable. In all, 35 broadcasts are now received regularly at main synoptic hours.

CLIMAT reports for stations in the British Isles, Norway, Sweden, Iceland and the two ocean weather vessels are broadcast at the beginning of each month on GFA, whilst a selection of such reports for European countries is included in the Rugby broadcasts. It is intended to install a radio-teletype receiver at Dunstable to receive American reports transmitted by this system from New York.

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

The more important developments which have occurred since the last report are summarised below :—

(a) **British Broadcasting Corporation forecasts**.—A forecast for France, Holland and Belgium has been supplied for inclusion in the European Service of the B.B.C. twice daily since March 1, 1947. Since August 20 a full set of forecasts similar to those issued at 0655, 0755 and 1755 has been broadcast by the B.B.C. at 1255.

(b) **Railway forecasts**.—Special forecasts have been sent to the Southern Railway since November 24, referring specially to icing on conductor rails. These have since been extended to cover the other electrified lines in the London area. A general system of weather warnings for British Railways was introduced on January 8, 1948.

(c) **Upper air forecasts**.—A forecast 500-mb. contour chart has been constructed since June 1 for the benefit of London airport.

(d) **Snow warnings**.—Since February 6, 1948, snow warnings have been sent to County and City Surveyors and Divisional Road Engineers.

(e) **Miscellaneous forecasts.**—There has been a steady increase in the number of forecasts to public authorities, business concerns and private individuals. The number of inquiries dealt with during the year at headquarters alone was 21,726.

(3) Services for the Royal Air Force

(a) **General.**—There was further gradual reduction in the number of meteorological stations necessary to meet the requirements of the Royal Air Force. In the United Kingdom this was accompanied by some changes in location and grouping. Overseas, the main commitments at the end of the period were with the British Forces of Occupation (Germany), in the Mediterranean and Middle East area (including British bases in Iraq, the Persian Gulf and Pakistan), Ceylon and Far East Air Command, and including the maintenance of adequate meteorological facilities at Air Traffic Control Centres and main airfields along the trunk route to the Middle and Far East. Changes made during the year and the position in March 1948 are described in the sections of this report dealing with services in the Dominions, Colonies and foreign countries.

Despite the reduction mentioned, the commitments remain substantially greater than before 1939. Moreover, the requirements for meteorological service are more exigent : flying in all types of weather, at all hours, over greater distances and at higher speeds necessitate more continuous, more specialised and more closely co-ordinated meteorological service.

The meteorological staff serving with the Royal Air Force have largely reverted to civilian status.

(b) **Organization.**—The further development of the Air Traffic Control Service and the introduction by the Royal Air Force of procedures of the International Civil Aviation Organization necessitated augmented meteorological facilities at Air Traffic Control Centres at home and overseas and at airfields on the British trunk routes overseas. The meteorological arrangements for long-distance transit flights by the Royal Air Force are being aligned to those used internationally on corresponding civil air routes.

A Chief Meteorological Officer was appointed in December 1947 to Headquarters Flying Training Command to act as adviser to the Commander-in-Chief and his staff on meteorological requirements in the Command.

The network of upper air observations along and near the trunk routes was increased by the establishment of radio-sonde stations at Aden, Bahrein (Persian Gulf), Benina (Libya), and Eastleigh (British East Africa).

Arrangements have been made for meeting the meteorological requirements of the squadrons and schools of Reserve Command, R.A.F.

Arrangements are being made to enable meteorological offices at Royal Air Force formations in the United Kingdom to receive AIRMET broadcasts.

Photo-electric equipment, for the determination of visibility at night, is being installed at a number of stations.

(c) **Royal Air Force Meteorological Policy Committee.**—The Committee, which consists of representatives of the Air Staff, R.A.F. Commands, the Meteorological Office and certain Air Ministry Divisions, met four times during the year. The subjects dealt with included :—

Maintenance of meteorological reconnaissance units and the supplementary flights made for the same purpose by Commands at home, in Germany and the Far East.

Requirements of Reserve Command.

Meteorological problems associated with the operation of high-speed aircraft.

Flights by meteorological officers.

Allocation of meteorological staff to meet the current requirements of Commands.

Provision at Malta and Shaiba of facilities, to enable overflying aircrew to discuss the weather situation with the duty forecaster by radio-telephony. This arrangement has already proved successful at the R.A.F. Staging Post, Istres.

(d) Miscellaneous activities.—In addition to the provision of service for normal training flying and scheduled flights on trunk routes, special arrangements were made in connexion with larger-scale R.A.F. and joint R.A.F.-Naval exercises, long distance flights (*e.g.*, from the United Kingdom to America and South Africa), and the trials of pilotless aircraft operating at supersonic speeds near the Scilly Islands.

Meteorological assistance was given for some experimental flights using pressure-pattern navigational technique carried out by the Empire Air Navigation School and operational Commands. Memoranda on the meteorological aspects of this subject were issued to all concerned.

Meteorological staff were associated with further trials by a Transport Command aircraft on the detection of dangerous storm cloud by means of radar equipment.

A memorandum on the intertropical front was issued for the guidance of staff serving in the tropics. Meteorological officers made a number of flights between Ceylon and Malay to obtain first-hand experience of conditions in that area.

In connexion with the photographic operations of the Royal Air Force in the United Kingdom, information was supplied upon the frequency of occurrence of amount of cloud below a specified height, visibility above a certain range and snow cover.

Instructions were issued on the statistical information to be furnished to the Royal Air Force in relation to planned flying and servicing, and the procedure for the issue and distribution of gale and other warnings was revised.

A paper on the accuracy of the values of heights obtained by use of the Mark II height and airspeed computer for various vertical distributions of temperature was prepared for the Scientific Adviser, Air Ministry.

(e) Meteorological Instruction for the Royal Air Force.—Meteorological officers gave the regular courses of meteorological instruction at the Empire Air Navigation School, at the Cadet College and also at the Transport Command Initial Conversion Unit. Though meteorological officers gave lectures and also instruction of more informal character at other schools in Flying Training Command, shortage of staff prevented the full commitment being undertaken. In these circumstances meteorological instruction is given by qualified R.A.F. navigation officers. In operational Commands there was considerable demand for meteorological instruction, associated partly with the training programmes and partly with the categorization of members of aircrew.

New or revised syllabuses were prepared for the basic training courses, and for use at Advanced Flying Schools and the School for Air Traffic Control Officers. Examinations were conducted as hitherto by the meteorological member of the Central Examination Board.

A draft of the revised (3rd) edition of the "Meteorological Handbook for Pilots and Navigators" was passed to Air Training Staff for comment. Revision of the publication "How to Avoid Flying Accidents due to Weather", now to be entitled "Weather Hints for Aviators", was prepared. The meteorological section of the proposed R.A.F. "Glossary of Terms" was produced.

The film "Meteorological Service", produced in collaboration with the Deputy Directorate of Films, was completed.

(4) Services for Civil Aviation

(a) **Organization.**—Among the important problems which claimed attention during the year were the unification of R.A.F. and civil facilities on trunk routes and at the Air Traffic Control Centres in the United Kingdom, in-flight refuelling procedure and the implementation of the International Civil Aviation Organization (I.C.A.O.) recommendations. There were numerous conferences at the Ministry of Civil Aviation and members of the Meteorological Office staff also attended meetings of the Anglo-French Joint Standing Committee in Paris and of the South African Air Transport Council in Salisbury (Southern Rhodesia).

Meteorological offices were opened at Bovingdon (diversion airfield for London Airport and Northolt) and at Turnhouse, Gatwick and Woolsington to provide service for air routes between United Kingdom and various European terminals.

A scheme has been devised whereby the various control centres broadcast meteorological information for their area every half hour. Transmissions are now being made from London Airport, Ringway, Gloucester and Prestwick.

(b) **Service 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 Prestwick, London Airport, Poole, Hurn and Bovingdon.

Prestwick.—The main responsibilities of Prestwick continued to be forecasting and briefing for transatlantic flights and for flights to and from various European centres, and the collection and distribution of meteorological information relating to the North Atlantic region.

Towards the end of the year responsibilities were increased by the establishment of the South-West Scottish and Northern Ireland Air Traffic Control Centre.

London Airport.—Every effort has been made to keep pace with the growing demand for forecasting and briefing services. Forecasts are now issued regularly for routes to numerous locations in Europe and to Almaza, Ankara, Damascus, Azores, etc. Attention has also been given to meeting the requirements of the operating agencies' Flight Control Centre.

Poole.—This station was maintained to provide facilities for the British Overseas Airways Corporation flying-boat operations to the Far East via the Mediterranean.

(c) **Services provided in the United Kingdom for internal and European routes.**—Forecasting offices were maintained at 19 airfields to provide facilities for air lines operating on the routes within the United Kingdom and to European terminals. Wind-speed and direction indicators were installed in control towers at all civil airfields.

The meteorological section of the "Air Pilot" was revised in co-operation with the Ministry of Civil Aviation and passed for printing.

(d) **Services provided overseas.**—(i) *Bermuda.*—The Air Ministry relinquished control of the service on July 1, 1947. Certain United Kingdom based staff have, however, remained in Bermuda pending a decision on the future of the Meteorological Service. Their main responsibilities have been the supply of forecasts to the Royal Navy, to British Overseas Airways Corporation for their flying boat service to Baltimore, and to the local Government.

(ii) *Trinidad, Nassau, Jamaica.*—The United Kingdom is responsible for the meteorological organization in the West Indies, and stations at Piarco, Oakes Field and Palisadoes have provided forecasts for all air routes operating from these airfields.

(iii) *West Africa.*—The west African Meteorological Service reverted to the

administrative control of the west African Governments on October 1, 1947. A small number of British staff remained during the transitional period to enable the service to fulfil its obligations, which include the provision of meteorological facilities for international air routes operating through Kano, Accra and Lagos.

(iv) *Portugal*.—The United Kingdom forecasting officer was withdrawn from Lisbon in January 1948.

(v) *Azores*.—Forecasting and briefing at the airfield at Santa Maria were provided by British staff seconded to the Portuguese Government. They were replaced gradually by Portuguese staff between December 1947 and February 1948, and by the end of March the number of British staff had been reduced to three.

(e) *Examinations*.—The number of candidates examined for various licences during 1947 was as follows :—

“ B ” licence (weekly examination)...	...	...	...	1,421
2nd Class Navigator's Licence (monthly examination) ...	...	...	...	2,436
1st Class Navigator's Licence (bi-monthly examination)...	...	...	...	414
				4,271
			Total	4,271

This total represents an increase of 1,672 over the preceding year.

Syllabuses and standards of examination were revised in order to conform with the requirements of the new series of licences arranged by I.C.A.O.

To ensure uniformity in examinations held under Royal Air Force and civil standards, consultations have been held and test papers exchanged with the Empire School of Air Navigation, Royal Air Force.

(5) Services for the Navy*

Liaison with the Naval Meteorological Service has been improved by the appointment of an officer of that service as liaison officer at the Headquarters of the Meteorological Office. Cdr. T. R. Beatty, O.B.E., R.N., took up this appointment in January 1948.

The Director of the Naval Meteorological Service continues to be a member of both the Meteorological Committee and the Meteorological Research Committee. By arrangement with the Admiralty, meteorological information for naval purposes was supplied by a number of Meteorological Office stations at home and overseas. In addition to occasional or routine information furnished to local Naval authorities, the preparation of messages of collective reports, analyses and forecasts for broadcast to H.M. ships was continued at Gibraltar, Malta, Aden, Nairobi, Ceylon, Singapore and Hongkong.

(6) Services for the Army

The meteorological section maintained at the School of Artillery, Larkhill, provides the information required for artillery and sound-ranging purposes, instruction to the courses held at the School and advice on special problems. Mobile detachments of the section served with Army Units on exercises. A meteorological section was attached to the Artillery Training Establishment, British Army of Occupation of the Rhine, until August 1947 when it was withdrawn owing to shortage of staff. Thereafter meteorological information was provided from the nearest source in the area. Other occasional artillery requirements, both in the United Kingdom and overseas, were met by similar arrangements.

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

The Meteorological Office participated in the proceedings of the War Office Committee on the Accuracy of Field Artillery Fire. Arising from this, the accuracy of the forecasts of upper wind is being investigated.

(7) Services for the Ministry of Supply

At the Artillery Ranges, Shoeburyness, at Aberporth, Pendine and Porton, meteorological sections have provided the information for the special work of their respective establishments.

The Meteorological Office continues to be represented on Ministry of Supply Committees.

(8) Services for the Merchant Navy and Fishing Fleets

The Central Forecasting Office prepares shipping bulletins for broadcast by the B.B.C. at 0655 (except Sundays), 0755, 1255 and 1755 clock times. Gale warnings are broadcast on the Light Programme of the B.B.C. as soon as possible after issue. The various coastal stations also repeat the B.B.C. transmissions of shipping forecasts and gale warnings.

Twice daily, at 0900 and 2100 G.M.T., a North Atlantic shipping bulletin is broadcast by the Admiralty and by Portishead. The message contains a general inference and forecast, an analysis of the pressure distribution and a selection of reports from shore stations and ships.

(9) Services for the Dominions, Colonies, etc.

(a) **Mediterranean-Middle East area.**—(i) *Cyprus.*—The Cyprus Government maintains about 75 auxiliary climatological and rainfall stations manned by voluntary observers, but the synoptic network of five stations and the forecast section at Nicosia airfield are maintained by the Air Ministry Meteorological Office, who provides all meteorological facilities for the Royal Air Force and for civil aviation services operating in and through Cyprus.

(ii) *British East Africa.*—The Air Ministry is still in nominal control of the meteorological service in British East Africa, but arrangements are in train for the local Governments to assume full responsibility. Meteorological Office staff are assisting the service until replacements can be recruited by the Colonial Office.

(iii) *British West Africa.*—The meteorological service in British West Africa reverted to local control on October 1, 1947. The service has been reorganised in accordance with plans prepared by the Meteorological Office.

(iv) *Palestine.*—The Air Ministry forecast section moved with the Royal Air Force from Lydda to Aqir in June 1947, and to Ein Shemer in mid January 1948.

(b) **Indian area.**—(i) *India and Pakistan.*—Close liaison has been maintained with the Indian and Pakistan Meteorological Services. In the initial stages of partition assistance was given to the two Dominions in preserving the continuity of meteorological arrangements. All Air Ministry meteorological equipment in India was transferred to the Indian and Pakistan Governments at agreed prices.

(ii) *Ceylon.*—The Meteorological Office continues to provide all forecasting facilities for the Royal Air Force and for civil aviation in Ceylon, forecast sections being maintained at Negombo and Koggala. It is understood that arrangements are to be made for Cingalese officers to be trained as forecasters in the United Kingdom.

(c) **Far East area.**—(i) *Burma.*—Burmese forecasters and assistants commenced training at the Royal Air Force Meteorological Section, Mingaladon,

at the end of August 1947. Arrangements were made for the withdrawal of Air Ministry meteorological personnel from Burma by the end of 1947, and for the sale of equipment to the Burma Meteorological Department, which assumed responsibility for the provision of all meteorological facilities in Burma from December 1, 1947. One British officer is remaining temporarily to assist the Burma Meteorological Department at Mingaladon.

(ii) *Malaya*.—Singapore Area Control Centre was transferred from Changi to Kallang on October 15, 1947, when the Malayan Meteorological Service undertook responsibility for meteorological duties at the Area Control, including wireless broadcasts and receptions. Arrangements were made for the Meteorological Office to remain responsible at Changi, Seletar, Tengah and Butterworth, other commitments in Malaya being undertaken by the Malayan Meteorological Service. Much assistance, particularly in the loan of equipment, stores and publications, is still being given in the rehabilitation of the Malayan Meteorological Service.

(iii) *Hongkong*.—Forecasters of the Royal Observatory commenced duties at the Meteorological Section, Kai Tak, in May 1947, which had previously been staffed and operated by Air Ministry personnel. From August 1, 1947, the Director, Royal Observatory, Hongkong, undertook responsibility for the provision of all meteorological facilities at Kai Tak.

(d) *Falkland Islands*.—The meteorological organization established in the Falklands in 1946 maintained its functions during the year. In collaboration with the Department of Scientific and Industrial Research an ionospheric station was set up at Port Stanley.

(10) Services in foreign countries

(a) *European area*.—(i) *Germany*.—Consequent on the disbandment of No. 2 Group and No. 84 Group of the Royal Air Force, the Meteorological Service in the British Zone was reorganised, and all subsidiary formations brought under the direct control of the Chief Meteorological Officer, Air Headquarters British Air Forces of Occupation (B.A.F.O.). The meteorological organization in B.A.F.O. continued to meet the requirements of the occupational forces, the Control Commission and civil aviation. The forecast centre at Air Headquarters, B.A.F.O.; is linked by teleprinter to Dunstable, to meteorological centres in France, Belgium, Holland and Denmark (thence to Malmö and Stockholm) as to the Weather Service of the United States Forces in Europe. Weather reports are received from the German network of observing stations, lightships and fishing trawlers. The meteorological radio stations at Quickborn and Pinneburg collect reports broadcast from neighbouring areas.

Policy concerning the German Meteorological Services in the four Zones of Occupation continues to be directed by the Allied Control Authority which is advised by the Quadripartite Meteorological Committee. In August 1947 the airport at Fuhlsbüttel was handed over by the Royal Air Force to the Control Commission, Germany, but the forecast section there has continued in operation for the benefit of civil aircraft.

(ii) *Austria*.—Following on the withdrawal of Royal Air Force units, British meteorological sections have also been withdrawn from Austria except at Schwechat (Vienna). The Committee on Meteorology of the Allied Control Authority was dissolved in May 1947, the work being undertaken by the Policy Sub-Committee of the Air Directorate, but *ad hoc* meetings of meteorological representatives of the Occupying Powers have been held when required.

(iii) *Italy*.—British meteorological staff were withdrawn from Ciampino in May 1947, and from Udine in September 1947.

(iv) *Greece*.—British meteorological staff were withdrawn from Calato (Rhodes) in April 1947. The last British forecaster, attached to the Royal Air Force Delegation to Greece as Meteorological Adviser at Hassani (Athens) was demobilised at the end of November 1947, and was not replaced.

(b) *Mediterranean–Middle East area*.—(i) *Libya*.—A meteorological organization has been maintained in Libya with forecasting sections at Castel Benito and El Adem. The network of reporting stations has been strengthened by new stations at Giarabub, established in September 1947 and at Hon, established in January 1948. All inland meteorological stations in Libya are now manned by locally engaged meteorological assistants who have been given signals training to enable them to operate wireless pack sets for the transmission of their reports to Castel Benito or El Adem.

(ii) *Egypt*.—Close liaison has been maintained with the reconstituted Egyptian Meteorological Department. The Royal Egyptian Air Force Meteorological Flight, equipped with Royal Air Force aircraft, was disbanded at the end of December 1947.

(iii) *Sudan*.—Air Ministry meteorological staff have been withdrawn gradually. Two forecasters and two assistants remain, primarily to meet the needs of the Royal Air Force at Khartoum. One meteorological officer has been seconded to the Sudan Meteorological Service for a period of one year.

(iv) *Syria*.—A memorandum on a meteorological organization for Syria was prepared for a firm which had been commissioned by the Government of Syria to prepare an economic survey of that country. Meteorological equipment for four reporting stations was sold to the Syrian Government.

(v) *Somalia*.—A small network of reporting stations, manned by locally engaged meteorological assistants, has been maintained in Somalia.

(vi) *Eritrea*.—A forecast section at Asmara and a network of 11 meteorological reporting stations, manned by locally engaged assistants, have been maintained in Eritrea to meet the requirements of the British Military Administration, the Royal Air Force and civil aviation.

(vii) *Iraq*.—A Senior Scientific Officer was seconded from the Meteorological Office as Director of the Iraqi Meteorological Service. He arrived at Baghdad in December 1947, and the date of transfer of control of the service from the Air Ministry to the Iraqi Government is under discussion.

(viii) *Persia*.—A request was received from the Persian Government for advice and assistance in the organization of a meteorological service in Persia. The Chief Meteorological Officer, MED./M.E., accordingly visited Persia and drew up a report on the type of organization required. This is now being examined.

(c) *Far East area*.—(i) *Japan*.—Forecasting sections have been maintained at Iwakuni and Miho, but they are expected to be withdrawn shortly. Staff from the Japanese Central Meteorological Service have been employed as assistants with British forecast sections to economise in British personnel.

§ 4. CLIMATOLOGY

(1) British Climatology

The British Climatology Branch is charged with the supervision of all voluntary climatological and rainfall stations in the British Isles, with the collection, summarising and preservation of permanent records of surface observations including autographic records, with the preparation of publications containing summaries of these observations, and with replies to inquiries from

other Branches of the Meteorological Office and Air Ministry, other Government Departments, commercial and industrial firms and the general public.

(a) **Types of stations.**—The stations are of five classes :—

(i) *Observatories* (see § 5, p. 22) where continuous records of all meteorological elements are maintained. These are staffed by Meteorological Office personnel.

(ii) *Synoptic stations.*—The observations from these stations are primarily used in preparing synoptic charts for forecasting but climatological returns for 0300, 0900, 1500 and 2100, and in certain cases for additional hours, are also made. Most of these stations are manned by Meteorological Office personnel, but at some the observers are coast-guards, lighthouse keepers or others whose occupations enable them to make meteorological observations at all hours.

(iii) *Crop-weather stations.*—These are situated at certain agricultural colleges and research institutions for the study of the relations between the weather and growing crops.

(iv) *Climatological and* (v) *Rainfall stations.*—These are maintained by private observers or by municipal or other local authorities without payment by the Air Ministry. Great public spirit is shown by those who participate in the operation of these stations.

The distribution of the stations of the above classes among the 16 regions into which Great Britain and Northern Ireland is divided for climatological purposes is shown in Appendix III.

The British Rainfall Organization, which was taken over by the Air Ministry in 1919, has collected a large amount of data on the duration and intensity of precipitation, on droughts and rain spells, and on percolation and evaporation. In addition, maps of the average annual rainfall on a scale of 16 miles to one inch are available for purchase, and maps of smaller areas on larger scales are prepared for special purposes. A great deal of information is supplied regularly to the Metropolitan Water Board, Thames and Lee Conservancy Boards and to a number of authorities responsible for water supply and land drainage.

(b) **Publications.**—The suspension of several series of publications during the war has led to a heavy accumulation of arrears. For the most part the available material has been analysed and is ready for printing, but it will take some time to clear off the 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.

Monthly Frequency Tables of upper winds, clouds and visibility have been issued up to June 1946. With the issue for July 1945, the format was revised to allow more detailed treatment of upper winds obtained by radio soundings.

The latest published volume of *British Rainfall* is that for 1939. "Copy" of *British Rainfall* 1946, was forwarded for printing during 1947; that of *British Rainfall* 1940–2 in January 1948, and that of *British Rainfall* 1943–5 in March 1948. The data for the six war years are being published in two volumes, each volume being the size of a pre-war volume.

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

(c) **Special work.**—(i) *Agricultural Meteorology.*—Throughout the year an officer has been attached to the headquarters of the South-West Province of the National Agricultural Advisory Service in Bristol. Through this organization it has been possible to give a good deal of help to agriculturists by using existing climatological data. To supplement these data, a number of small stations have been set up in south-west England, mainly in connexion with agricultural

experiments. Advice has been given on special problems, including the drying of hay, and the temperature effect in the testing of milk.

The existing frost data for south-west England were collected and analysed; the results are to be circulated in a memorandum entitled "Frost in south-west England". A meteorological exhibit was arranged for the Hampshire Market Produce Show at Southampton in June 1947.

(ii) *Evaporation*.—An investigation is being carried out into the variation over the country of the average evaporation from a free water surface, use being made of the records from the few evaporation tanks, the duration of bright sunshine, the saturation deficit and the relative intensity of solar radiation. The wind factor has had to be omitted so far, because the records from evaporation tanks are necessarily made in relatively sheltered sites.

(iii) *Night-sky recorders*.—The tabulation of the records of the time during which Polaris and Delta Ursæ Minoris are visible has been carried out for six stations.

(iv) *Infantile paralysis*.—Assistance was given to the Ministry of Health in an investigation into the effect of weather on the incidence of infantile paralysis. Several discussions were held, and data were supplied and analysed.

(v) *Housing investigations*.—Assistance was given to the Ministry of Works in inquiries into the loss of building time through bad weather.

(vi) *Wind pressure on buildings*.—Information regarding wind structure and the maximum winds recorded in the British Isles was supplied to the Codes of Practice Committee of the Ministry of Works in connexion with a revision of the regulations regarding the allowance for wind pressure in building design.

(vii) *Inquiries*.—During the period under review, a large number of requests were received for data in connexion with water supply, county surveys, town planning and the work of industrial or research organizations. Details of past weather were frequently required as evidence in law cases. In addition to average values, frequencies of occurrence of various climatological values are often required.

Monthly reports on the rainfall of the Thames Valley have been supplied to the Metropolitan Water Board. Weekly, quarterly and annual summaries of the weather have been supplied to the Registrar-General for England and Wales and to the Registrar-General for Scotland, and similar information has been supplied each quarter to the Government of Northern Ireland.

The abnormally fine weather during August 1947, followed by shortage in water supplies in many localities, led to many inquiries from Government Departments and the Press.

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.

(2) World Climatology

The Branch of the Climatology Division dealing with World Climatology is charged with the collection and summarising of climatological observations at a number of stations in various Colonies and with the preparation of reports, memoranda and tables concerning weather conditions in all parts of the world. It also deals with a large number of inquiries.

(a) *Overseas stations*.—Monthly returns of climatological data have been received from 131 stations: 9 in Europe, 26 in Asia, 73 in Africa, 2 in South America and 21 on islands.

The reprinting of the meteorological summaries from Colonial Blue Books

was suspended during the war but has now been resumed ; the preparation of the notes and additional tables for the 1938 volume is in hand.

(b) **Climatological table for the British Commonwealth.**—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 been resumed.

(c) **Réseau Mondial.**—The receipt of data for the years 1933–4 from the U.S.S.R. has enabled the volume for 1933 to be completed. The volume for 1934 is in preparation.

(d) **Naval handbooks.**—In co-operation with the Naval Meteorological Branch of the Admiralty, the revision of the handbooks dealing with the weather of the various naval stations has been begun. The part dealing with the Red Sea has been completely revised and awaits publication.

(e) **Admiralty Pilots.**—The Climatology and Marine Branches assist in the revision of the meteorological sections of Admiralty Pilots, which are published for all parts of the world for the use of seamen. Eight Pilots have been revised during the year.

(f) **Special work.**—The chart of the annual frequency of days with thunder over the world, first published in *Geophysical Memoirs* No. 2, has been revised for the area 40° N. to 40° S.

Charts of average vapour pressure over the world have been prepared for the four months January, April, July and October. The diurnal variation of vapour pressure in different climates has been studied and theoretical conclusions have been compared with observations.

Climatological tables for stations in Syria, the Lebanon, Italy, Greece and Egypt have been prepared for publication in aviation meteorological reports.

Data of the diurnal variation of pressure have been tabulated in order that charts of pressure tendencies may be compiled.

The Meteorological Office was represented on the Anti-Locust Research Centre Committee (Colonial Office). Information on climatological conditions, mainly in Africa, was supplied to the Centre from time to time.

(g) **Inquiries.**—Numerous requests from commercial firms for information about meteorological conditions overseas have again been received. Most of these were in connexion with the export of goods, but there have been a number from engineering firms with reference to air-conditioning plant, irrigation and other projects. Requests have also been received from official sources in connexion with service allowances, clothing and housing of troops, claims for pension and the servicing of vehicles. Over 600 temperature and humidity tables have been issued. Information was also supplied to the National Association for the Prevention of Tuberculosis to enable them to give advice to sufferers as to the most favourable areas in the British Commonwealth for their residence.

(3) Upper Air Climatology

(a) **Analysis of observations.**—The tabulation of the observations of upper air temperature and humidity continued for each station. The most important development in upper air climatology during the year was the application of the Hollerith card system to upper air statistics with effect from January 1, 1948. The Hollerith cards were designed by the Meteorological Office and agreed, with some modification, at the meetings of the International Meteorological Organization at Toronto in the summer of 1947.

Three cards cover a sounding of temperature from the surface to a pressure of 40 mb. and include humidity mixing ratio to 200 mb. Two cards cover a sounding of wind to 40 mb. Entries are made primarily according to fixed

pressures. Most of the stations making upper air observations punch their own cards.

(b) **Special work.**—The preparation of the publication “Upper winds over the world”, which is to give as far as is possible with present-day information a picture of the mean distribution and the variability of upper winds, proceeded throughout the year. For the extratropical regions the mean winds are described by charts of the mean contour lines of pressure surfaces from which the mean winds can at once be found in speed and direction by the geostrophic relation. In the tropical regions this relation does not hold, and for these areas charts of mean stream lines with isopleths of mean speeds are being drawn. Charts of the vector standard deviation, a measure of the variability of the wind, are being drawn for the whole world. The charts for the 700-mb. and 500-mb. surfaces have been issued and those for the 300- and 200-mb. levels drafted, while work has begun on the 130-mb. level charts.

(c) **Inquiries.**—Most of the inquiries dealt with have been in connexion with the planning of air routes. Numerous inquiries have also been received from Government Departments, aircraft companies, publishers and private individuals for upper air winds, temperatures and miscellaneous information. Summaries of upper winds between Newhaven and Glasgow were supplied to the Director of the French Meteorological Service.

Work was done for another Department of the Air Ministry on the vector change of wind with time and distance.

(4) Marine Climatology

(a) **Collection of observations.**—On the average about 70 ships' logbooks of weather reports have been received each month in the Marine Branch. In addition, observations have been received from two lighthouses abroad and from eleven light vessels or coast stations in home waters. Miscellaneous reports sent to the Branch have included special reports of sea-surface temperatures.

Copies of Hollerith cards giving marine meteorological data for the Indian Ocean are being sent on loan to the Dutch Meteorological Service. In all about one million cards will be supplied.

(b) **Analysis of observations.**—The sections relating to ice and current have been re-written for new editions of ten Admiralty Pilots. Good progress has been made on the computation and charting of currents in the western half of the South Pacific Ocean and the eastern part of the South Indian Ocean.

Miscellaneous activities included a study of the diurnal variations of certain meteorological factors in some regions of the North Atlantic; a study of the diurnal variation of atmospheric pressure in various regions of the Mediterranean; a comparison of sea temperatures observed by the “bucket” method and those observed from engine intakes; a memorandum on gustiness in connexion with mooring cables for warships; a note on the best time of year for tugs to travel from Hongkong to the Persian Gulf, with comments on the probable weather along the route; a report on gale frequency in an area near Prince Rupert, B.C. in connexion with the “load-line convention”; extraction of data of frequency and direction of winds of gale force in part of the coastal waters of Australia.

Much information, including statistical tables and charts of marine data, was prepared for other branches of the Meteorological Office, for other Government Offices and for shipping companies.

(c) **Special work.**—The publication of the “Marine Observer's Handbook” was postponed because it was expected that the codes for synoptic meteorology would be changed at the International Meteorological Conference at Toronto.

Lectures have been given on several occasions, by members of the Marine Branch, to students at the Meteorological Office Training School. These students included nautical officers of the ocean weather ships.

(d) **Inquiries.**—A large number of inquiries were dealt with by the Branch including 57 major inquiries in connexion with arbitration arising out of shipping casualties.

§ 5. WORK OF THE OBSERVATORIES

(1) Kew Observatory

(a) **Meteorological observations and records.**—The normal meteorological observations for standardization, synoptic and climatological purposes were made. The tabulation of the autographic and other records was kept up to date.

A possible discrepancy, in recent years, between the duration of sunshine recorded at Kew and that recorded elsewhere in the London area is under investigation.

Preliminary work was carried out with a view to replacing the photo-thermograph in the north wall screen by an electrical recording instrument exposed in a ventilated screen on the lawn.

A Shaw-Dines microbarograph working with oil in place of mercury was constructed and has recorded satisfactorily.

A report was made of the performance of a Duvdevani dew gauge during a period of four months.

(b) **Measurement of radiation.**—Records were maintained of direct solar radiation at normal incidence by the Gorczynski pyr heliograph, and of total and diffuse (short-wave) radiation on a horizontal surface by Moll-Gorczynski solarigraphs. Commencing in September 1947 two Moll thermopiles mounted on a heliostat and screened by suitable filters have yielded records of direct radiation of wave-length greater than approximately 6,500 and 5,500 Ångström units respectively. Standardization observations with the Ångström pyr heliometer were made on suitable occasions, while much attention was given to the standardization of the horizontal thermopiles.

The analysis and discussion of the records of direct solar radiation since 1933 and of the first year's records of total (sun and sky) and diffuse (sky alone) radiation received on a horizontal surface were completed and embodied in a report which it is hoped to publish shortly.

(c) **Atmospheric electricity.**—Autographic recording of potential-gradient and of the current discharged from an artificial point were maintained. The recording of electric charge on rain was suspended at the end of December 1947.

Discussion of atmospheric electric effects in disturbed weather 1942–6 was complete.

(d) **Seismology.**—Records of the three components of earth movement have been maintained with the Galitzin seismographs. Records of the vertical component were also obtained with the short-period instrument constructed at Kew before 1939. Two Wood-Anderson (short-period horizontal component) instruments were set up in April 1947, and, with the short-period vertical component instrument, gave a satisfactory record of the earth vibrations of the Heligoland explosion. Only the normal sound wave of the accidental explosion at Brest, July 1947, was recorded.

Over 300 earthquakes were recorded and analysed. Monthly seismological bulletins were resumed, printing being complete from January 1947. Records of microseisms have been lent to the Admiralty Research Laboratory for correlation with sea-wave data.

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

(e) **Special work.**—The work on radiation has directed attention to wider aspects of the problem of heat exchange at the earth's surface. An investigation involving the simultaneous measurement of radiation, temperature, humidity and wind profiles near the ground was begun.

Installation of an evaporation tank and recording mechanism was nearly complete at the end of the period.

(2) Eskdalemuir Observatory

(a) **Standard meteorological observations.**—Routine weather observations have been made at all synoptic hours, and observations for standardising purposes were made regularly at 0900, 1500 and 2100 G.M.T. A night-sky recorder was brought into operation in August. Hourly values of the various meteorological elements were tabulated for the *Observatories' Year Book*.

(b) **Terrestrial magnetism.**—Absolute observations of declination, horizontal force and vertical force were made three times weekly. All magnetic storms during the period were completely recorded.

Hourly values of declination were contributed to weekly mining journals, prints or tracing of magnetic records were supplied on request and various magnetic inquiries were answered. Notifications of magnetic disturbance, exceeding certain limits, were sent to the National Physical Laboratory, and character figures and magnetic indices representing the magnetic character of each day together with magnetic tabulations of H, D and V were sent monthly to the Meteorological Office, Edinburgh. Notice of sunspot activity, likely to be associated with magnetic disturbance, was received at the Observatory from the Astronomer Royal.

In February the La Cour Vertical Force instrument was dismantled and re-assembled, resulting in an increase in sensitivity.

(c) **Atmospheric electricity.**—Autographic records of potential gradient were maintained throughout the year and absolute determinations were made at regular intervals. The electrometers used in the standardization work were calibrated by means of high-tension batteries, the potentials of which were measured by a potentiometer and standard cell.

The records have been tabulated for publication in the *Observatories' Year Book*.

(3) Lerwick Observatory

(a) **Standard meteorological observations.**—Routine synoptic observations were reported hourly throughout the period and the usual autographic records and climatological reports maintained. Routine upper air soundings for the determination of winds, temperatures and humidities were made daily, at 0000, 0600, 1200 and 1800 G.M.T. to December 31, 1947, and at 0300, 0900, 1500 and 2100 from January 1, 1948.

A detailed trial of the possibilities of improving the accuracy of the radio-sonde results by utilising the radar-height observations as well as, or in place of, the radio-sonde pressure observations was made in October. The use of the radar heights as a routine check of the pressure unit was recommended. It appears probable that such a procedure would significantly improve the present accuracy in approximately 10 per cent. of the soundings.

A night-sky camera was added to the Observatory equipment and recording commenced on August 11, 1947.

(b) **Terrestrial magnetism.**—Character figures and three-hourly range indices representing the magnetic character of each day were sent every month

to the Meteorological Office, Edinburgh, the National Physical Laboratory and the Interservice Ionospheric Bureau.

Anomalies between the various Observatory standard magnetometers for H and V were resolved, and corrections to past standards deduced back to January 1, 1934.

(c) **Aurora.**—The customary watch and log were maintained. Telegraphic reports were made to the Central Forecast Office whenever aurora of intensity 3 or greater was observed.

(d) **Atmospheric electricity.**—The Benndorf electrograph recorded with only a few breaks and the routine of tests and observations were followed.

(4) Aberdeen Observatory

The observatory was established in 1868 in the Cromwell Tower of King's College, University of Aberdeen. Continuous recording of the meteorological elements has been its primary function, but since 1920 changes of site of the pressure-tube anemograph and other outdoor instruments have been necessitated by building developments. In view of further contemplated developments and other local circumstances the work of the observatory was terminated on December 31, 1947. Temporary arrangements have been made to continue certain climatological observations.

§ 6. METEOROLOGICAL RESEARCH

(1) Organization for research

(a) **Meteorological Research Committee.**—During the year under review this Committee has continued to function along the lines described in the last report. Changes in membership have included the addition of Prof. O. G. Sutton, B.Sc. and Asst. Prof. P. A. Sheppard, B.Sc., F.Inst.P. to the Committee, whilst Prof. G. M. B. Dobson has succeeded Prof. S. Chapman as Chairman, the latter remaining a member of the Committee.

Seven meetings of the Committee have been held during the year at which about 50 technical reports and memoranda have been considered.

Towards the end of the year the Committee formed three sub-committees to deal with the three main branches of meteorology.

Within the Meteorological Office the research organization continued on the lines described in the last report for most of the year. In the early part of 1948, however, the research side of the Office was reorganised at the same time as the rest of the Office. There is now a Deputy Directorate of Research with three Assistant Directorates responsible respectively for general research, special investigations and instrument development. The Deputy Director (Forecasting) controls an Assistant Directorate for forecasting research and the Deputy Director (Services) controls the Assistant Directorate for Climatology which supervises research in climatology. The Assistant Director (General Research) controls a Headquarters Branch which is charged with the administration of the observatories and other stations concerned with research, and with the secretarial duties in connexion with the Meteorological Research Committee and its sub-committees and panels.

The general scheme of research is formulated by the Meteorological Research Committee and is carried out by the Meteorological Office organization. The assistance of other research organizations, such as the National Physical Laboratory and the Telecommunications Research Establishment of the Ministry of Supply, is obtained on specialised problems.

(b) **Co-ordination of research.**—Close liaison has been maintained with other Government Departments and with the meteorological services of the Dominions, Colonies and other countries.

Full reports have been received and a careful study made of the rain-making experiments carried out in Australia.

An attempt has also been made to interest the Universities in the fundamental problems of meteorology by drawing the attention of the University staffs to those meteorological problems which seem suitable for attack by independent workers.

The Meteorological Research Committee has also had discussions on international co-operation through the United Nations Educational, Scientific and Cultural Organization.

(c) **Collaboration with the Royal Society.**—Certain long-term investigations continue to be supervised by the Royal Society through the medium of the Gassiot Committee. Some expansion of this work has been made possible by a Treasury grant. One of these investigations is the construction of an infra-red spectrometer to determine the amount of water in the stratosphere by observing the absorption of solar radiation. Design of this apparatus is now nearly complete, and arrangements are in hand to take it up into the stratosphere in one of the aircraft of the Meteorological Research Flight. Another project of the same type is the re-design and standardization of instruments for the measurement of atmospheric ozone, whilst a third project concerns a new method of obtaining samples of the upper atmosphere. These investigations are of vital importance to a full understanding of the radiative equilibrium of the stratosphere.

(d) **Joint Meteorological Radio-Propagation Sub-Committee.**—One meeting of this Sub-Committee has been held during the year. In the field of propagation problems a preliminary report on the temperature and humidity structure of the lower atmosphere has been issued and the first parts of a radio-climatology atlas have been prepared. Work has also continued on the study of radar echoes from cloud and precipitation (see § 6 (2) (e), p. 26).

(e) **Meteorological Research Flight.**—This unit has now become well established at the Royal Aircraft Establishment at Farnborough. The results obtained by the unit have fallen short of expectations due to maintenance difficulties with the aircraft.

(2) Current research problems

A brief account of the more important developments in the solution of aviation problems, of problems related to forecasting and of instrumental problems is given below :—

(a) **Aviation problems.**—One of the heaviest tasks has been the preparation of data on the frequencies of head winds on various routes. In the calculation of this data charts were prepared of the normal air flow and the variability of wind at high levels. By a special technique it is possible to give an expectation of the frequency with which aircraft would suffer head winds of various strengths on any desired route at any height up to 40,000 ft. In some cases it has been possible to check these computations against the frequencies actually experienced by aircraft regularly operating on the routes. The checks have proved satisfactory. A memorandum is being drawn up on this technique.

Among other special memoranda which have been produced may be mentioned one on the fine structure of wind in the upper air, one on the intertropical front and one on pressure-pattern flying.

A special panel of the Meteorological Research Committee continues to supervise the research on questions relating to ice accretion on aircraft. Efforts

are being made to form a special unit to devise instruments for use on aircraft to assist in these investigations.

(b) Forecasting problems.—The regular preparation and study of circumpolar weather maps for the northern hemisphere, including both surface and upper air data, made a useful contribution to the understanding of the general forecasting problem for 24 hours and beyond. Some new rules and principles have begun to emerge, partly empirical but with a theoretical dynamical basis.

Investigation was made of, the temperature changes in the troposphere due to advection, adiabatic and non-adiabatic processes, a subject which directly enters the forecasting problem in several ways; the modification of air masses; the development of thermal gradients, including frontogenesis and frontolysis; development in the three-dimensional pressure field and the associated development of circulation.

Regular studies were inaugurated of the occasions when routine forecasts were in error. In this way attention is focussed on the inadequacies of current knowledge, thus pointing the way for further research.

(c) Development of meteorological instruments.—Further work on the frost-point hygrometer has been concentrated on the model in which a photo-electric cell replaces the human eye for taking readings. Six of these instruments have been made by a commercial firm and are being tested by the Meteorological Research Flight. Messrs. Elliot Brothers' Research Laboratories are undertaking the development of an automatic frost-point hygrometer.

Work on the chronometric precision radio-sonde has been largely confined to development of ground equipment and calibration technique. Five of these precision instruments have been flown recently and results are being analysed. Work continues on the development of the radio-sonde theodolite and microwave transmitter, and a development contract has been placed with a commercial firm.

Two models of a pulsed-light cloud searchlight for measurement of cloud height in daylight are nearing completion.

Twenty instruments for measuring visibility at night by means of fixed lights and photo-electric cells have been received, and are in course of installation at selected airfields.

Special balloons are under development with a view to carrying radio-sondes to 100,000 ft., a substantially greater height than the present average height.

(d) Research work at Rye.—A preliminary report on the temperature and humidity structure of the lower atmosphere at this station has been prepared, and a more comprehensive report is in hand.

(e) Research work at East Hill.—During the year under review investigation into the detection of clouds and precipitation by means of radar has been continued using the A.M.E.S. Type 21 radar installation. The period has been mainly devoted to the accumulation of data as an essential foundation to the research work in progress. Although the abnormally dry summer and autumn decreased considerably the number of days on which experiments could be made, a considerable volume of data has been obtained. Analysis of these observations is in progress and is expected to indicate the extent to which radar may assist in the investigation of meteorological problems.

In collaboration with aircraft from the Royal Aircraft Establishment and from the Telecommunications Research Establishment of the Ministry of Supply, the investigation of turbulence in cumulonimbus clouds was inaugurated in August with particular emphasis on the detection of dangerous clouds. Some flights have been made, and it is hoped to obtain more comprehensive data

during the more favourable conditions to be expected during the coming spring and summer.

(f) **Agricultural meteorological research.**—Work by the unit posted to the School of Agriculture at Cambridge has been concentrated on the exchange of water vapour between the air and the ground. This has led to a tentative method for computing the rate of evaporation from a grass-covered surface. In an extension of this work it is hoped to examine the effect of water-table level and of crop type on evaporation and on soil temperature.

(g) **Radiation.**—At Kew Observatory the work on radiation has been extended. A discussion of direct solar radiation of normal incidence in the period 1933–46 and of direct and diffuse radiation from sun and sky on a horizontal surface (July 1946 to August 1947) was completed. Investigation of the transfer of heat (and water) near the ground is being initiated at Kew.

(h) **Research programme.**—The following are the items upon which it is proposed to concentrate in the immediate future :—

- (i) Developments of hygrometers, particularly for use in the upper air.
- (ii) Improvement in accuracy of radio-sonde methods of measuring upper air temperature, pressure and humidity, and in accuracy of radar methods of measuring winds.
- (iii) Investigations leading to a better understanding of the dynamics of weather, and means of assessing accuracy of forecasting.
- (iv) Investigation of the microphysics of water in the atmosphere, particularly in relation to ice accretion on aircraft.
- (v) Investigation of turbulence in cumulonimbus clouds as affecting the safety of aircraft.
- (vi) Investigation of the water content of the troposphere and lower stratosphere under various conditions.
- (vii) Study of microclimatology near the ground as affecting agriculture.
- (viii) Investigation of the radar detection of cumulonimbus clouds and heavy precipitation.
- (ix) Investigation of the special problems affecting forecasting in the tropics.

§ 7. STAFF

Civilian staff in established officer grades were recruited through the “ reconstruction competition ” conducted by the Civil Service Commission.

During the year the Civil Service Commissioners assigned to the Meteorological Office 101 from among successful candidates in that competition. Most of these had held temporary civilian appointments in the Meteorological Office during the war. A further acquisition to strength in officer grades was obtained from the temporary appointment of 26 Poles who had served as meteorologists with the Polish Forces during the war. The number of officer grade who resigned or did not return to the Meteorological Office after release from the Forces was 87.

At the beginning of the year the number of civilian assistants was 448 and the number of meteorological airmen and airwomen 1,250. The corresponding figures at the end of the year were 1,238 and 161 respectively. Comparatively few of the meteorological airmen and airwomen accepted civilian appointment as assistants after release from the Forces. Approximately 1,000 new recruits, without any previous experience in meteorological work, had to be enrolled and

trained ; 158 of these assistants have been called up under the National Service Act. The services of 142 of these have been retained by the Meteorological Office, however, since arrangements were made for them to enrol in the Royal Air Force to be employed on meteorological duties after completion of their disciplinary training.

(1) Establishment and strength of staff

In addition to its permanent peace-time requirement of staff, the Meteorological Office has a temporary diminishing requirement resulting primarily from the occupation by British Forces of ex-enemy territory. Establishments of staff which have recently been approved provide for the following number of posts in these two categories :—

	Permanent requirements	Temporary requirements	Total
Scientific Officer Class	190	14	204
Meteorological Officer Class	682	92	774
Nautical Officers	8	—	8
Assistant Class	1,408	168	1,576
Clerical and Typing Staff	122	—	122
Miscellaneous	26	—	26
Total	2,436	274	2,710

The strength on March 31, 1948, was :—

	Staff with permanent appointments	Temporary staff	Total
Scientific Officer Class or equivalent... ..	149	3	152
Meteorological Officer Class or equivalent	550	71	621
Nautical Officers	4	—	4
Assistant Class	4	1,395	1,399
Clerical and Typing Staff	12	80	92
Miscellaneous	—	22	22
Total	719	1,571	2,290

It will be noted that the strength in officer grades remained appreciably below requirements at the end of the year. This has caused considerable difficulty in maintaining an efficient meteorological service and has necessitated an agreed allocation of staff among the various users.

(2) Uniformed personnel

The release of uniformed personnel, in accordance with the age and length of service scheme, continued throughout the year. By the end of March 1948, the numbers on ground meteorological duties had fallen to :—

R.A.F.V.R. Officers	26
Airmen... ..	48
W.A.A.F. Officers	1
Airwomen	5
R.A.F. (National Service) Airmen ..	108
Total	188

The meteorological air observer category of aircrew became obsolete and no further recruitment into this section of the General Duties Branch of the Royal Air Force was undertaken. In November 1947, a scheme was introduced whereby pilots of the Royal Air Force were posted and trained for duty as meteorological air observers. By the end of the year under review, the strength of the Meteorological Air Observer section had fallen to 2 airmen, while the numbers of pilots posted for meteorological air observer duties were 6 officers and 23 airmen.

(3) Training of staff

(a) **Meteorological Office Training School.**—The year under review has been a memorable one in the history of the Training School so far as the number of staff trained is concerned; 14 officers and approximately 1,000 assistants were enrolled for initial training. The number of assistants under training reached a peak of 300 in October. Training at the school is normally followed by further training at a forecasting unit, but in November forecasting units could not absorb all the assistants leaving the school, and additional “further training” schools had to be opened temporarily at Manston and Blackbushe.

(b) **Courses for forecasters.**—Courses are of three months’ duration at the Training School, followed by a further period of three months’ training at a forecasting office. During the year, two courses were commenced at the Training School and 13 pupils passed out successfully. Two pupils held colonial appointments and proceeded to west Africa for their advanced practical training.

(c) **Courses for upper air observers.**—(i) *Meteorological air observers.*—Owing to the release of almost all personnel in the Meteorological Air Observer Section of the General Duties Branch, Royal Air Force, a school was opened at R.A.F. Station, Aldergrove, to co-operate with the meteorological reconnaissance squadron in training Royal Air Force pilots in the technique of making meteorological observations from aircraft. The first course commenced in November and, by March, 29 pilots were trained.

(ii) *Radio-sonde courses.*—The school at Downham Market was re-opened to provide training in radio-sonde duties for meteorological officers, assistants and airmen. In addition to the personnel trained for duty at radio-sonde stations at home and overseas, staff were also trained for similar duties aboard the ocean weather ships. Courses lasted from six to eight weeks. A subsidiary school was opened at Fazakerley in September for training meteorological assistants for whom accommodation at Downham Market could not be found.

Familiarization courses in the maintenance of radar wind-finding equipment were also held at Downham Market for radio meteorological mechanics.

(d) **Courses for assistants.**—Courses cover six weeks at the Training School followed by an approximately equal period of training at a forecasting unit. Approximately 1,000 were trained in the year. The quality of the recruits was on the whole good, as shown by the fact that 75 per cent. passed out with average or better than average markings. Wastage was low, being of the order of 4 per cent.

(e) **Courses for officers of the Merchant Navy.**—The inauguration of the ocean weather ship service necessitated a special course of training for nautical officers of the weather ships. The course was of a fortnight’s duration, and covered instruments, observational routine and preparation of weather charts. Lectures were given illustrating modern methods of weather forecasting, and stressing the importance of observations from ships at sea. Four courses in all were held during the year.

(4) Staff discussions

The Monday evening meetings for the discussion of scientific papers were continued with considerable success, over 100 persons being present at some of them.

By the courtesy of the Director of the Science Museum, the discussions of the 1947-8 session were held in the lecture theatre of the Museum at South Kensington.

The subjects discussed cover a very wide range of interests from the theory of cyclones to the accuracy of meteorological instruments and the temperature distribution in the ionosphere.

Discussions were held on April 21, November 17, 1947, and January 19, February 23 and March 22, 1948.

§ 8. INSTRUMENTS

(1) Provision and production of equipment

Up to the end of January 1948 the number of contracts placed (for items expected to cost more than £250) was 56, and the expenditure was £221,000. During the same period £50,000 was received by the sale of equipment to Dominion and foreign governments and to private observers. Among the more unusual types of equipment ordered may be mentioned four atmospheric direction finders, three ozone spectrophotometers, a wide range of spare parts for maintaining the radar equipment used for measuring upper winds, and a large variety of stores needed for the ocean weather ships.

Production of equipment by manufacturers was slow and difficult throughout the year. In the main this was due to general causes affecting the whole country, such as the fuel crisis at the beginning of the year and the shortage of materials and labour. In particular the production of thermometers is causing considerable concern. The large-scale production of radio-sondes, however, continued very satisfactorily, the main difficulty here being calibration.

The maintenance of equipment in use has caused little difficulty except in the case of radar equipment. The difficulties arose from lack of trained maintenance staff and from delays in obtaining spare parts.

(2) Issue of equipment and stores accounting

Regular supplies of stores were issued to maintain Meteorological Office stations at home and overseas, in particular to the radio-sonde stations in this country and to stations in the Mediterranean and Middle East, the British Army of Occupation of the Rhine, British East Africa, British West Africa and the Falkland Islands.

Supplies were issued to Dominion, Colonial, foreign governments and to private observers on repayment terms. The total number of demands dealt with in 1947 was 9,559 which may be compared with 8,968 in 1946 and a peak figure of 12,470 in 1944. Among the stores issued in 1947 may be noted radio-sonde equipment for the Netherlands; theodolites, cloud searchlights and other stores to the Argentine Government; and equipment for two expeditions to Iceland organised by Oxford University and Cambridge University respectively. Equipment was also issued to 15 new stations on Royal Air Force and Ministry of Civil Aviation airfields, and to new radio-sonde stations at Aden and Benina (Libya). Inventories of stores in use at outstations and on charge to official observers were maintained, and 1,848 inventories relating to land stations and the merchant ships have been checked.

In connexion with the supplies needed for the ocean weather ships the base at Greenock was constituted a self-accounting unit with the necessary stocks of equipment.

(3) Testing and calibration

(a) **General instruments.**—The total number of instruments (excluding balloons) tested in the year reached a new record (70,000) partly because of the large numbers of radio spares which are now handled. Some improvements were made in the test procedure for radio-sonde batteries which have resulted in better quality output by the manufacturers.

(b) **Aircraft instruments.**—The calibrating apparatus for electrical resistance thermometers was improved, and adapted for the thermometer elements of the photo-electric frost-point hygrometers. The quality of aircraft aneroid barometers is now much better than during the war.

(c) **Radio-sonde, radio and radar-wind instruments.**—The transfer of the radio-sonde calibrating section from Larkhill was completed in April. The total output of calibrated radio-sondes at Harrow has increased by 50 per cent. to about 1,800 a month. Factory calibration was started by Salford Electrical Instruments Ltd., under Meteorological Office technical supervision, and the output now exceeds 1,000 a month. Assistance was also given to Messrs. Whiteley in setting up a calibration section. Several improvements were introduced in the Kelvinator "stratosphere" cabinets used for calibration.

Radar mechanics, based on Harrow, have carried out inspections of GL III radar wind-finding sets at home and in British Air Forces of Occupation. A mechanic has also been detached for maintenance work on the ocean weather ships' radar equipment at the base in Greenock.

(4) Design and development

(a) **General instruments.**—The most rapid developments were in meteorological instruments for the ocean weather ships. An oil-damped barograph proved very successful, and gives a fine trace under all conditions. Experimental work on the improved sea-water bucket and thermometer was completed, and a small number are being made by the trade for service trials. Admiralty designs of instruments for measuring visibility and swell are being tried out, the former after modification to extend the range. A hand-operated fan psychrometer was designed, and three different types of rain-gauges are being tested. Preliminary results with a new precision aneroid barometer were promising.

Twenty production models of the new photo-electric visibility meter were received, and are being sent to principal airports and other outstations for field trials. Two models of the pulsed-light day-time cloud searchlight are nearing completion at the Telecommunications Research Establishment. A new instrument was designed for recording accurately rate of rainfall, primarily for use in connexion with investigations of radar echoes from storm clouds. Work continued on the simpler remote-recording anemographs and wind vanes. Several special instruments have been made for research purposes.

(b) **Aircraft instruments.**—Samples of the photo-electric model of the frost-point hygrometer were made commercially and are being tested by the Meteorological Research Flight. A specification of requirements for an automatic frost-point hygrometer has been prepared with a view to development in collaboration with a suitable firm of instrument makers.

(c) **Radio-sonde and radio-wind instruments.**—Development of the radio-sonde theodolite continued, in collaboration with the Directorate of Communications Development, Ministry of Supply. Trials of the radio theodolite

with a transmitter over a ground-to-ground path showed that adequate signal strength can be obtained in flight. Plans for the construction of a complete ground station are under discussion. A few trial flights were made to test the meteorological telemetering link, and promising records obtained.

With a view to reducing the cost of calibration of radio-sonde transmitters a plant is being developed which will deal with much larger numbers than the present type. The radio-sonde control screen was redesigned.

No important changes have been made in the GL III radar equipment. A range trebler and a simple direction-finder to aid in picking up the target are in course of construction. An improved corner reflector of metallized nylon mesh has reached the production stage.

Trials of large balloons, intended to reach heights of 100,000 ft. have so far been disappointing. Tests are in progress of balloons made of various rubber mixtures, for use in the tropics.

(5) Specifications

(a) **Specifications.**—Ten new specifications of instrument designs were prepared and 14 were amended. Copies were distributed to the Meteorological Services of the Commonwealth.

(b) **Instrument instructions.**—Instructions for installation, operation and maintenance are sent out with all instruments. Eleven new or revised instructions were issued. Work was started on the preparation of a manual of meteorological instruments.

§ 9. LIBRARY AND PUBLICATIONS

(1) Library

The exchange of publications was resumed with most of the main national services and with the principal independent geophysical institutions. Large numbers of war-time publications have been received, thus partly filling the gaps in our records created by the war years. Surplus German publications were distributed to the Observatory libraries to complete their series. The intake of publications approached the pre-war acquisitions numerically but lacked the variety. Many institutions have not yet resumed issue of their publications.

The large photographic collection held by the library continued to be augmented from various sources and more detailed classification became essential. This was done by segregating the prints according to the Universal Decimal Classification system, and by creating further subdivisions for cloud types. Sets of photographs pertaining to a particular subject were retained as sets wherever possible.

Considerable progress has been made in the reduction of arrears in the *Monthly Bibliography*, subject and author catalogues.

Loan facilities were extended to staff serving overseas. The number of publications issued on loan showed a 25 per cent. increase on the previous year's total. Lantern slides and photographs were issued on loan to publishers, film companies and schools.

Bibliographies were prepared on a large number of subjects, including the Polar Year, structure of dust and sand devils, and the size and rate of fall of water drops. Details of all meteorological and associated scientific papers and articles published in this country were supplied to the Director of the French Meteorological Service.

Personal inquiries from business firms and students have returned to pre-war levels.

(2) Publications

A start was made on the publication of war-time research papers and papers whose publication was postponed by the war. A number of *Geophysical Memoirs* and *Professional Notes* (see Appendix V) are in the press.

A new series of publications entitled *Meteorological Reports* has been formed. Papers in this series will be concerned with applied meteorology as distinct from pure research.

The *Meteorological Magazine* reappeared at the end of March 1947 with the number for January 1947 and subsequent numbers up to February 1948 have since appeared. It is hoped soon to achieve publication on the first day of the current month.

The *Marine Observer* resumed publication with the edition for July 1947, and the quarterly issues for October 1947 and January 1948 have subsequently appeared.

Considerable progress was made with the preparation of a new edition of the "Meteorological Observer's Handbook", and a "Manual of Meteorological Statistics" was begun.

§ 10. • INTERNATIONAL CO-OPERATION

(1) International Meteorological Organization

The past year has been one of great activity in international meteorology. A meeting of the Regional Commission for Africa was held at Salisbury, Southern Rhodesia, in April and was attended by the Head of the Overseas Civil Aviation Branch and by the Chief Meteorological Officer, Mediterranean and Middle East.

The main event of the year was the series of meetings held in Toronto and Washington from the beginning of August to mid October. These meetings were arranged, to review the progress made since the Extraordinary Conference of Directors held in London early in 1946, to agree on future plans and to consider the structure of the organization and its relationship to other international organizations.

At Toronto all ten of the Technical Commissions assembled and reviewed the whole field of international collaboration in applied meteorology. Among the important results of the meetings, the following may be mentioned :—

(a) The Commission for Aeronautical Meteorology undertook the preparation of a common text for regulations to be adopted by both the International Meteorological Organization and the International Civil Aviation Organization for the provision of meteorological facilities to aviation. Codes for the transmission of weather reports to and from aircraft, and for the transmission of terminal and route forecasts between ground stations were drawn up.

(b) The Commission for Maritime Meteorology dealt with the operation of ocean weather ships and the measures necessary to increase the frequency and accuracy of weather reports received from ships.

(c) The Commission for Synoptic Weather Information reached agreement on a universal code for basic weather observations, and the specifications for the various elements to be reported were revised.

(d) The Commission for Instruments and Methods of Observation discussed the degree of standardization desirable for different meteorological instruments, and arranged for comparisons to be made between the various

types of radio-sonde instruments in current use. Six permanent Sub-Commissions were formed.

(e) **Climatological Commission.**—The work of this Commission reflected the increased attention which economic concerns are devoting to meteorology.

(f) **The Aerological Commission** was mainly concerned with the scientific and technical use of upper air data, but also found time to discuss dynamical theories of atmospheric motion.

The remaining Commissions—those for Hydrology, Agricultural Meteorology, Bibliography and Publications, and for the Projection of Charts—also held successful meetings and made important recommendations.

The Twelfth Conference of Directors opened in Washington on September 22, a week after the Technical Commissions had completed their work in Toronto. The Conference examined the Resolutions submitted by the Technical Commissions and approved 220 of them. Decisions were taken to transform the International Meteorological Organization into a World Meteorological Organization by means of an International Convention and to seek affiliation to the United Nations.

With regard to the Convention, the International Meteorological Organization has hitherto been a semi-official association of Directors of Meteorological Services, but the increased importance of meteorology has led to a wide-spread belief that the I.M.O. should be replaced by an intergovernmental organization which would be in a more favourable position to enlist official support. The proposal to effect such a fundamental change in the character of the organization gave rise to protracted discussion, but eventually, after proper safeguards to ensure the equality of meteorological services on technical matters had been provided, a World Meteorological Convention was drafted and signed by 33 countries. Nine more countries subsequently signed. When it is brought into force, the World Meteorological Organization, will take over the assets and obligations of the International Meteorological Organization, which will then cease to exist.

A decision to seek affiliation to the United Nations was soon reached once the question of the Convention had been settled. With the assistance of delegates from the United Nations who attended the Conference, a draft agreement was drawn up which, after it has been approved by a majority of members of the International Meteorological Organization, will be submitted to the United Nations. If this is accepted, the World Meteorological Organization will be linked with the United Nations as a Specialised Agency.

At the meetings both in Toronto and in Washington, the Meteorological Office was well represented. The Director was elected President of the Conference of Directors, and was re-elected President of the International Meteorological Committee for a further term. Mr. E. Gold, President of the Commission for Synoptic Weather Information, and Cdr. C. E. N. Frankcom, R.N.R., President of the Maritime Commission, attended the meetings in Toronto and Washington, and Mr. E. G. Bilham, Mr. J. Durward, Dr. C. E. P. Brooks, Dr. F. J. Scrase, and Dr. R. C. Sutcliffe were present at Toronto for meetings of the Technical Commissions. Prof. P. A. Sheppard of the Imperial College of Science also formed one of the British delegation to Toronto.

(2) International Civil Aviation Organization

Close touch has been maintained with the International Civil Aviation Organization through the Ministry of Civil Aviation; representatives of the Meteorological Office attended Regional Air Navigation meetings at Lima and Rio de Janeiro.

Immediately after the meetings of the Technical Commissions of the

International Meteorological Organization at Toronto, the Meteorological Division of International Civil Aviation Organization met at Montreal and adopted for aeronautical use a number of codes recommended by the International Meteorological Organization.

(3) International Union of Geodesy and Geophysics

The Office has always played a prominent part in the activities of the International Union of Geodesy and Geophysics since its formation in 1919 under the International Council of Scientific Unions.

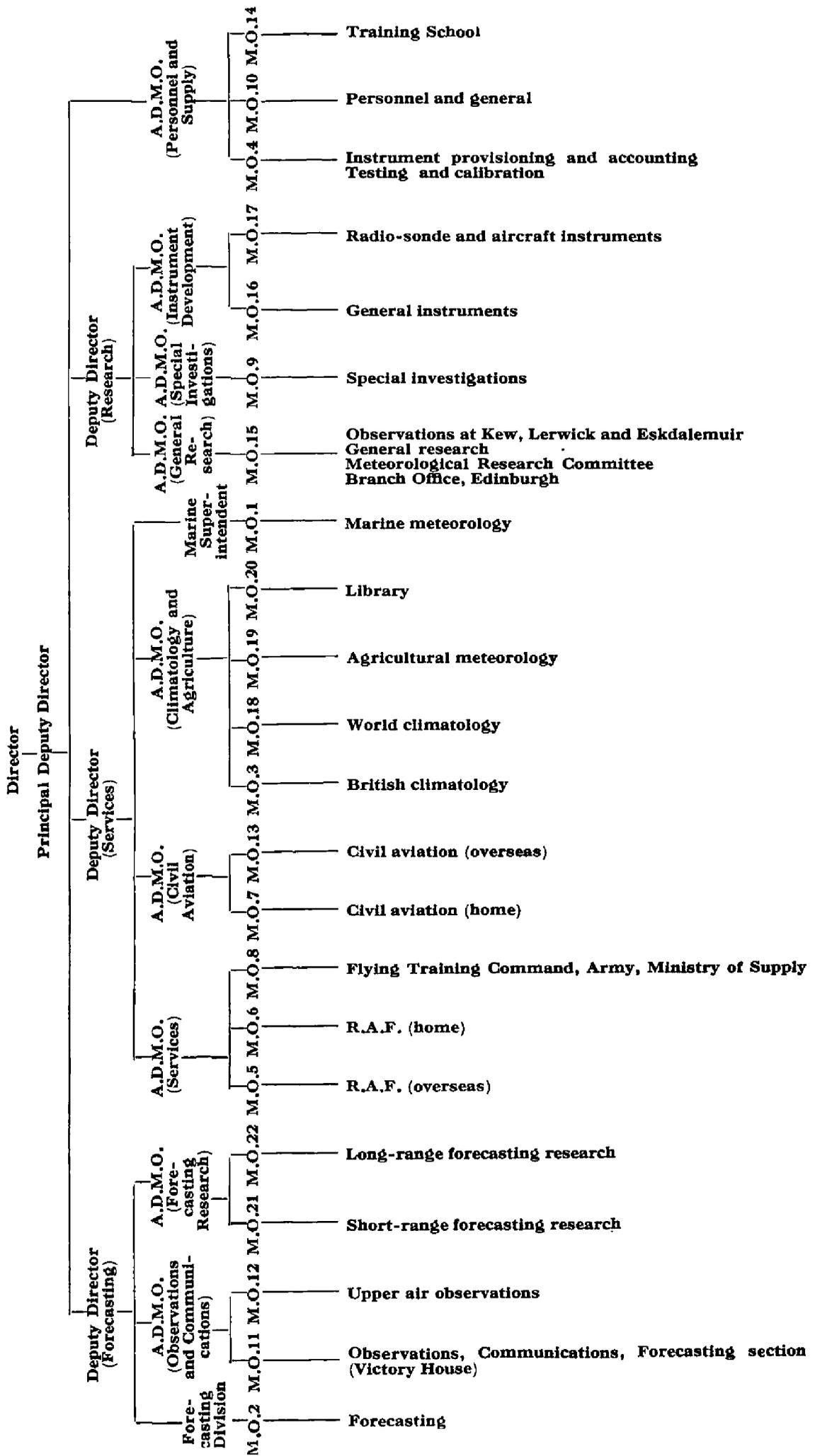
Dr. J. M. Stagg, who became General Secretary of the Union in 1946, has been engaged preparing for the next General Assembly which will be held at Oslo—August 17 to 29, 1948.

Dr. A. H. R. Goldie, who had been Secretary of the International Association of Terrestrial Magnetism since 1936, resigned this office in June 1947. Dr. Goldie was then appointed a member of the Joint Commission on Radiometeorology and of the Mixed Commission on the Ionosphere.

Members of the Office serving on the British National Committee for Geodesy and Geophysics are Sir Nelson Johnson, Dr. J. M. Stagg, Dr. A. H. R. Goldie and Mr. C. K. M. Douglas. Sir Nelson Johnson was Chairman of the Subcommittee on Hydrology from May 1946 until February 1948.

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.

<i>Deputy Director (Research)</i>	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 Observations 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)</i>	F. J. Scrase, O.B.E., M.A., Sc.D.
General Instruments Branch (M.O.16)	O. M. Ashford, B.Sc.
Radio-sonde and Aircraft Instruments Branch (M.O.17)	D. N. Harrison, D.Phil.
<i>Deputy Director (Forecasting)</i>	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 Com- munications)</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.
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Training Branch (M.O.14)	P. J. Meade, O.B.E., B.Sc., A.R.C.S.

APPENDIX III

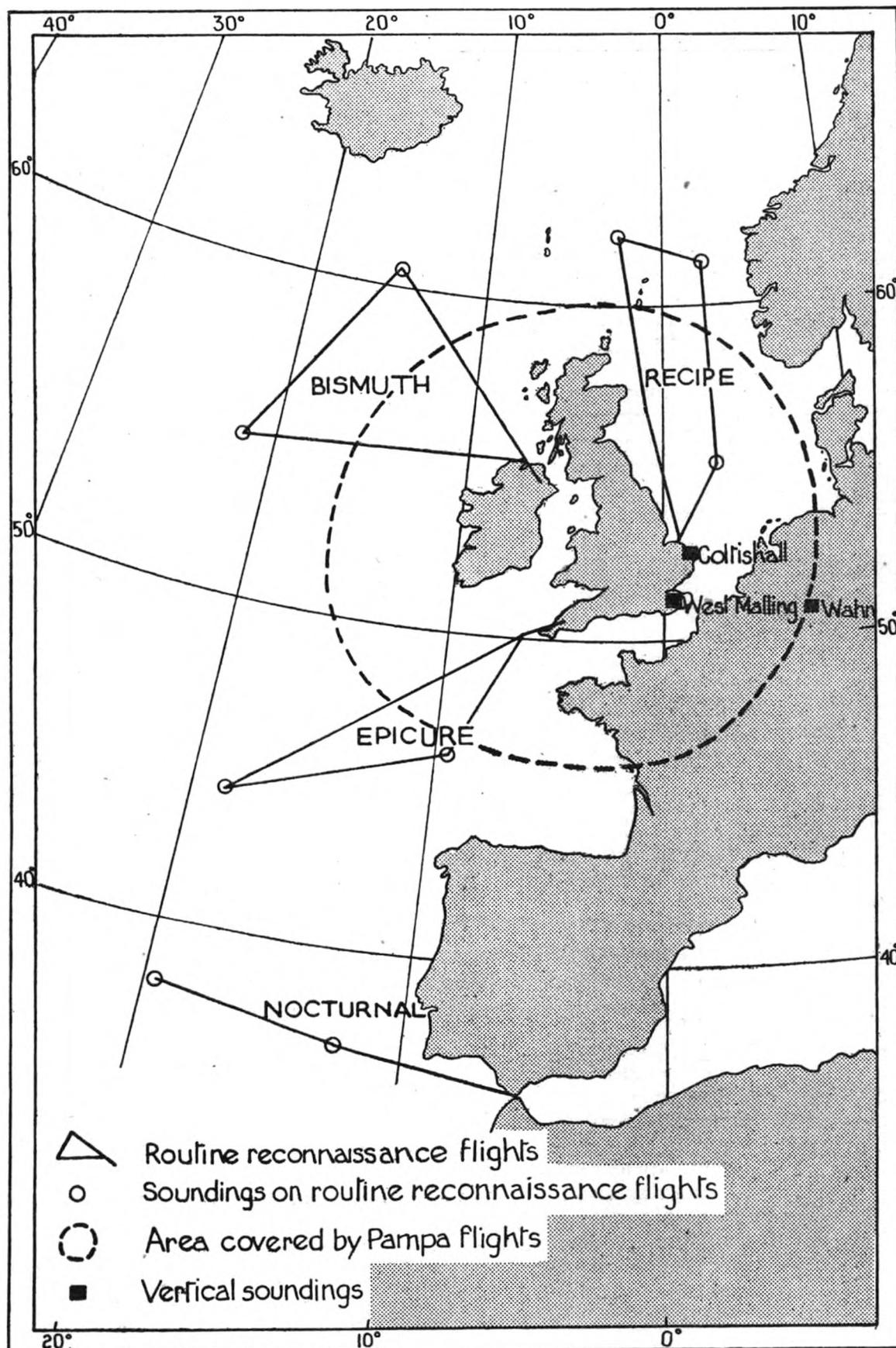
CLASSIFICATION OF BRITISH STATIONS WHICH REPORT TO THE CLIMATOLOGICAL BRANCH

	Stations					Autograph records					
	Observatories	Synoptic	Crop-Weather	Climatological	Rainfall	Sunshine	Rainfall	Wind	Pressure	Temperature	Humidity
Scotland, N... ..	1	6	0	10	139	12	4	2	4	0	0
Scotland, E.	0	6	2	33	353	28	11	2	2	3	2
Scotland, W.	1	3	1	29	374	20	9	5	3	3	2
England, N.E.	0	6	2	17	284	19	10	5	5	2	1
England, E.	0	7	5	17	446	25	16	6	6	5	3
England, Midlands ..	0	9	7	34	1,034	38	30	3	6	5	3
England, S.E.	0	11	4	45	756	41	42	10	7	10	7
London District ...	2	1	0	11	41	8	4	2	2	1	1
England, S.W.	0	7	5	26	495	32	8	3	7	4	2
England, N.W.	0	4	1	16	460	18	23	4	6	5	5
Wales, N.	0	2	1	9	185	8	6	1	2	2	1
Wales, S.	0	4	2	12	263	14	7	2	2	1	0
Isle of Man	0	2	0	1	8	2	0	1	1	1	1
Scilly and Channel Isles	0	1	0	1	10	1	0	1	0	0	0
Northern Ireland ...	0	3	0	5	76	5	5	1	2	1	2
TOTAL	4	72	30	266	4,924*	271	175	48	55	43	30

* Includes stations in earlier columns.

APPENDIX IV

LOCATION OF METEOROLOGICAL FLIGHTS OF HOME COMMANDS



APPENDIX V

PROVISION IN AIR ESTIMATES FOR METEOROLOGICAL SERVICES

The approximate cash provision in Air Estimates, 1948-9, for meteorological services is as follows :—

Vote	Service	Provision
		£
1	Pay, etc., of airmen employed as meteorologists	22,000
	Contributions under national insurance schemes in respect of airmen	1,000
3	Salaries, wages, etc., of staff at headquarters of the Meteorological Office	226,000
4	Salaries, wages, etc., of civilians at meteorological observatories and outstation offices and in ocean weather ships	963,000
5	Conveyance of personnel ; travelling allowances and expenses	38,000
	Conveyance of meteorological equipment	50,000
6	Provisions and ration allowances for airmen ; provisions for crews of ocean weather ships	14,000
	Fuel, light, water and sanitary services for meteorological observatories and outstation offices	12,000
	Petrol, oil and lubricants for vehicles required for meteorological services	3,500
	Fuel oil for ocean weather ships	36,500
7	Meteorological equipment	310,000
	Radio, radar and electrical equipment for meteorological services	50,000
	Mechanical transport vehicles for meteorological services	5,000
	Miscellaneous equipment and services for ocean weather ships	14,000
	General stores for meteorological services	1,300
	Clothing, clothing allowances and laundry services for airmen ; clothing for crews of ocean weather ships	3,200
	Conversion of corvettes for service as ocean weather ships	130,000
8	Works services for meteorological observatories and outstation offices :—	
	Capital expenditure	20,000
	Maintenance expenditure	12,000
9	Telecommunication services for meteorological purposes	85,000
	Other miscellaneous effective services	17,000
10	Superannuation allowances and gratuities	5,000
	GROSS TOTAL	£2,018,500
	Deduct—Appropriations in aid :—	
4	Receipts in respect of salaries, wages, etc., of meteorological staff	£258,000
5	Receipts in respect of movement expenses of meteorological staff	5,000
7	Receipts relating to meteorological equipment	54,000
	Payments by airmen for issues of, and repairs to, clothing and footwear	1,000
9	Receipts for meteorological services	20,000
10	Receipts in respect of non-effective benefits of meteorological staff lent to other governments	500
		338,500
	NET TOTAL	£1,680,000

APPENDIX VI

PUBLICATIONS

The publications prepared by the Office are generally issued by His Majesty's Stationery Office as official publications.

The following official publications were issued or signed for press during the period of this report :—

Periodical

Daily Weather Report, issued in three sections (to March 31) :—

1. British Section.
2. International Section.
3. Upper Air Section.

Marine Observer (to January 1948).

Meteorological Magazine (to February 1948).

Monthly Weather Report, with a summary for the year (to December 1947).

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 March 1946)

Seismological Bulletin. A diary of seismological disturbances recorded on the Galitzin aperiodic seismographs at Kew Observatory, Richmond (to February 1948).

Occasional

Facsimile weather charts for permanent retention. May 1 to 3, 1947.

Report of the Conference of Empire Meteorologists, London, March 4–9, 1946.

Part 2—Resolutions.

Professional Notes :—

Vol. VI :—

91. The vertical gradient of wind velocity in the lowest layers of the atmosphere; By N. K. Johnson, K.C.B., D.Sc.
92. Persistence of weather. By E. G. Bilham, B.Sc., D.I.C.

The publication of the following books or papers by members of the Staff may also be mentioned :—

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

Meteorological investigations in connection with radio propagation. In "Meteorological factors in radio-wave propagation." Report of a Conference held by the Physical Society and Royal Meteorological Society, London, 1947.

By E. GOLD, D.S.O., F.R.S. :—

Weather forecasts (Symons Memorial Lecture). *Quart. J. R. met. Soc.*, London, 73, 1947, p. 151.

By E. G. BILHAM, B.Sc., D.I.C. :—

An azimuthal method of measuring cloud height with a searchlight. *Nature*, London, 159, 1947, p. 677, and *Met. Mag.*, London, 76, 1947, p. 102.
"Here is the weather forecast". London, 1947.

By C. E. P. BROOKS, D.Sc. :—

The numerical basis of climate. *Met. Mag.*, London, 76, 1947, p. 9, p. 36 and p. 56.

Unsolved problem of climatic change. *Met. Mag.*, London, 76, 1947, p. 126 and p. 147.

By C. K. M. DOUGLAS, B.A. :—

Cold pools. *Met. Mag.*, London, 76, 1947, p. 225.

By C. K. M. DOUGLAS, B.A. and J. GLASSPOOLE, M.Sc., Ph.D. :—

Meteorological conditions in heavy orographic rainfall in the British Isles. *Quart. J. R. met Soc.*, London, 73, 1947, p. 11.

- By C. K. M. DOUGLAS, B.A. and J. HARDING, B.A., B.Sc. :—
The thunderstorm of the night of July 14-15, 1945. *Quart. J. R. met. Soc., London, 72, 1946, p. 3.*
- By A. C. BEST, M.Sc. :—
A standard radio atmosphere for microwave propagation. In "Meteorological factors in radio-wave propagation." Report of a Conference held by the Physical Society and Royal Meteorological Society, London, 1947.
- By G. A. BULL, B.Sc. :—
Note on errors in measurement of the refractive index of the air for high-frequency radio waves consequent upon errors in meteorological measurements. In "Meteorological factors in a radio-wave propagation." Report of a Conference held by the Physical Society and Royal Meteorological Society, London, 1947.
Specification of water vapour in the atmosphere. *Met. Mag., London, 76, 1947, p. 195.*
Notes on the I.C.A.N. altimeter and height and airspeed computer. *Met. Mag., London, 77, 1948, p. 6 and p. 29.*
- By C. S. DURST, B.A. :—
Radio climatology. In "Meteorological factors in radio-wave propagation." Report of a Conference held by the Physical Society and Royal Meteorological Society, London, 1947.
- By J. GLASSPOOLE, PH.D. and H. ROWSELL, B.Sc. :—
Absolute droughts and partial droughts over the British Isles, 1906-40. *Met. Mag., London, 76, p. 201.*
- By W. A. HARWOOD, D.Sc., F.R.S.E. :—
Tree rings and climate through the centuries. *Weather, London, 2, 1947, p. 112.*
- By J. S. SAWYER, B.A. :—
Notes on the theory of tropical cyclones. *Quart. J. R. met. Soc., London, 73, 1947, p. 101.*
- By J. K. BANNON, B.A. :—
Artificial stimulation of rain formation. *Met. Mag., London, 76, 1947, p. 169.*
- By R. FROST, B.A. :—
The velocity profile in the lowest 400 ft. *Met. Mag., London, 76, 1947, p. 14.*
- By H. H. LAMB, M.A. :—
A meteorologist's experiences on a floating whaling factory in the Antarctic. *Mar. Obs., London, 17, 1947, p. 75.*
- By MISS L. F. LEWIS, M.Sc. :—
Variations of temperature in London, 1764-1939. *Met. Mag., London, 76, 1947, p. 135.*
- By A. G. MATTHEWMAN, M.A. :—
A discussion of the pressure tendencies associated with gradient and horizontal geostrophic flow. A formula for the variation with height of the vertical velocity. *Phil. Mag., London, 37, 1946, p. 706.*
- By C. H. B. PRIESTLEY, M.A. :—
Dynamical control of atmospheric pressure. *Quart. J. R. met. Soc., London, 73, 1947, p. 65.*
On the frictional influence of horizontal wind shear on vertical motion. *Quart. J. R. met. Soc., London, 72, 1946, p. 284.*
- By C. H. B. PRIESTLEY, M.A. and W. C. SWINBANK, B.Sc. :—
Vertical transport of heat by turbulence in the atmosphere. *Proc. roy. Soc., London, 189, 1947, p. 543.*
- By C. H. B. PRIESTLEY, M.A., S. PETERSSSEN, P. A. SHEPPARD, B.Sc. and K. R. JOHANESSEN :—
An investigation of subsidence in the free atmosphere. *Quart. J. R. met. Soc., London, 73, 1947, p. 43.*
- By G. D. ROBINSON, PH.D. :—
Notes on the measurement and estimation of atmospheric radiation. *Quart. J. R. met. Soc., London, 73, 1947, p. 127.*
- By E. J. SUMNER, B.A. :—
Diurnal variation of evaporation from natural surfaces. *Met. Mag., London, 76, 1947, p. 151 and p. 175.*
- By W. C. SWINBANK, B.Sc. :—
Collisions of cloud droplets. *Nature, London, 159, 1947, p. 849.*

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