

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

for the period  
August, 1945 to March 31, 1947

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LONDON: HIS MAJESTY'S STATIONERY OFFICE

1947

ONE SHILLING NET

# CONTENTS

	<i>Page</i>
LIST OF MEMBERS OF THE METEOROLOGICAL COMMITTEE ... ..	3
COMMITTEE OF THE METEOROLOGICAL OFFICE, EDINBURGH ... ..	3
LIST OF MEMBERS OF THE GASSIOT COMMITTEE ... ..	4
<b>REPORT</b>	
1. INTRODUCTION ... ..	5
2. ORGANIZATION ... ..	6
3. SYNOPTIC METEOROLOGY	
(1) Central Forecasting Office ... ..	8
(2) Forecasts for the Public, Government Departments, the Press, etc. ... ..	11
(3) Services for the Royal Air Force ... ..	13
(4) Services for Civil Aviation ... ..	15
(5) Services for the Army ... ..	17
(6) Services for the Ministry of Supply ... ..	17
(7) Services for the Navy ... ..	17
(8) Services for the Merchant Navy and Fishing Fleets ... ..	17
(9) Services for the Colonies, etc. ... ..	17
(10) Services in foreign countries ... ..	18
(11) Special investigations and technical memoranda ... ..	21
4. CLIMATOLOGY	
(1) British Climatology ... ..	21
(2) World Climatology ... ..	23
(3) Upper air observations ... ..	24
(4) Marine Climatology ... ..	24
5. WORK OF THE OBSERVATORIES	
(1) Kew ... ..	25
(2) Eskdalemuir ... ..	26
(3) Lerwick ... ..	27
(4) Aberdeen ... ..	27
6. METEOROLOGICAL RESEARCH	
(1) Organization for research ... ..	27
(2) Current research problems ... ..	29
7. STAFF	
(1) War-time grades and strength ... ..	32
(2) Meteorological air observers ... ..	34
(3) Reversion to peace-time grades and strength ... ..	34
(4) Training of staff ... ..	34
(5) Resumption of staff discussions ... ..	35
8. INSTRUMENTS	
(1) Location and accommodation ... ..	36
(2) Provision and production of equipment ... ..	36
(3) Issue of equipment and store accounting ... ..	36
(4) Testing and calibration ... ..	37
(5) Design and development ... ..	37
(6) Specifications and instrument instructions ... ..	39
9. LIBRARY AND PUBLICATIONS	
(1) Library ... ..	39
(2) Publications ... ..	39
10. INTERNATIONAL CO-OPERATION	
(1) International Meteorological Organization ... ..	40
(2) Provisional International Civil Aviation Organization ... ..	41
(3) International Union of Geodesy and Geophysics ... ..	42
<b>APPENDICES</b>	
I. ORGANIZATION OF THE METEOROLOGICAL OFFICE ... ..	43
II. CLASSIFICATION OF BRITISH STATIONS WHICH REPORT TO THE CLIMATOLOGY BRANCH	44
III. DISTRIBUTION OF METEOROLOGICAL FLIGHTS, AUGUST, 1945 ... ..	45
IV. PROVISION IN AIR ESTIMATES FOR METEOROLOGICAL SERVICES... ..	46
V. PUBLICATIONS ... ..	47

## METEOROLOGICAL COMMITTEE

Appointed by the Air Council

Chairman :—The Parliamentary Under Secretary of State for Air

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

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

Sir D'Arcy Thompson, F.R.S. (Royal Society of Edinburgh)

Rear-Admiral A. G. N. Wyatt (Admiralty)

Major General C. G. G. Nicholson, C.B., D.S.O., M.C. (War Office)

Sir Edward Salisbury (Ministry of Agriculture and Fisheries)

Sir Ben Lockspeiser (Ministry of Supply)

Captain J. H. Quick (Ministry of Transport)

Mr. G. M. Macintosh (Ministry of Civil Aviation)

Mr. W. J. Bigg (Colonial Office)

Mr. J. J. W. Handford, C.B. (Scottish Office)

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

Mr. R. C. Chilver (Air Ministry)

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

Secretary :—Mr. R. J. Williams

The Committee met on October 3, 1946.

## COMMITTEE OF THE METEOROLOGICAL OFFICE, EDINBURGH

Chairman :—The Director of the Meteorological Office

Secretary :—Dr. W. A. Harwood

The following bodies are represented on the Committee :—

The Royal Society

The Royal Society of Edinburgh

The Royal Meteorological Society

The Fishery Board for Scotland

The Department of Health for Scotland

The Department of Agriculture for Scotland

The University of Aberdeen

The University of Glasgow

The Committee has not met during the period covered by this report, but steps are being taken for the Committee to be reconstituted and to resume its work.

## THE GASSIOT COMMITTEE

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

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Professor G. M. B. Dobson (Chairman)

Sir Edward Appleton

Professor P. M. S. Blackett

Professor D. Brunt

Professor S. Chapman

Lord Cherwell

Sir Alfred Egerton

Mr. E. Gold

Professor H. W. Massey

Professor E. A. Milne

Sir George Simpson

Sir Geoffrey Taylor

Sir George Thomson

The Astronomer Royal (Sir Harold Spencer Jones)

The President of the Royal Astronomical Society (Professor H. H. Plaskett)

The Director of the Meteorological Office (Sir Nelson Johnson)<sub>A</sub>

The Committee met on September 25, 1945 and March 14, 1946.

## ANNUAL REPORT

of the Director of the Meteorological Office,  
presented by the Meteorological Committee to the Air Council  
for the period August, 1945 to March 31, 1947.

### § 1. INTRODUCTION

Before the outbreak of war in 1939, a report on the work of the Meteorological Office was prepared by the Director each year. During the war years no reports were issued, but a detailed account of the work done during that period is being compiled, and will be included in the "Official history of the war." The present report covers the period of 20 months from the end of hostilities against Japan (August, 1945) to March 31, 1947. In future, reports will be issued annually.

Substantial progress has been made during the period under review in placing the Meteorological Office on a peace-time basis. The transition from a war to a peace organization has been difficult for a variety of reasons, of which the staffing problem has been the most serious. Owing to the demands of the fighting forces, the Meteorological Office expanded about sixfold during the war, and by August, 1945, some 90 per cent. of the total staff were in uniform. Since then the military requirements have fallen progressively, but at the same time there has been a rapid increase in the demands of other interests, particularly civil aviation. The pre-war strength of the Meteorological Office would be quite inadequate to deal efficiently with all its post-war responsibilities, and it has been necessary to recruit new staff to replace the temporary war entrants. The latter have been leaving in accordance with the age and service release scheme, but it is gratifying to record that a number of them have returned to the service of the Meteorological Office after their release leave.

It will be recalled that a Committee on the Scientific Staff of Government Establishments was set up during the war to inquire into the constitution of the Scientific Civil Service. The recommendations of this Committee, under the chairmanship of Sir Alan Barlow, were accepted by the Government and presented to Parliament in a White Paper (Cmd. 6679) in September, 1945. The Meteorological Office, as part of the Government Scientific Service, is being reorganised on the lines recommended in the White Paper (see § 7 (3), p. 34).

The necessity of providing the military forces with an efficient meteorological organization was fully demonstrated during the war. In peace time, the scope of the Meteorological Office, as the State Meteorological Service, is much wider. Its importance to civil aviation is generally recognised, but there are many other concerns—agriculture, various forms of transport and industry generally—in which the impact of meteorology is of great economic importance. In these directions every effort is being made to ensure that the contribution of the Meteorological Office is as effective as possible (see § 4, p. 21 and § 6, p. 27).

The impetus given to research in meteorology by the demands of war led to a number of important advances both in the technique of forecasting and in the development of special and more accurate instruments for measuring atmospheric elements. As examples, mention may be made of the improved technique in 3-dimensional forecasting, the application of radar to the measurement of winds aloft, the routine exploration of the upper atmosphere by radio-sonde and the use of radio direction-finding equipment to locate thunderstorms up to a thousand miles away. There are, however, many fundamental problems

still awaiting solution, and it is essential that the greatest possible emphasis be placed upon research. To this end the Meteorological Research Committee was formed in 1941, to co-ordinate and direct all the research carried out within the Meteorological Office. It works in close liaison with the Royal Society and the Universities, and includes several of the most eminent meteorologists in the country (see § 6 (1), p. 27).

An important development towards improving the network of weather reporting stations is the project to establish stationary meteorological ships in the North Atlantic Ocean. The contributing countries are those with Atlantic seabords. Great Britain is to operate two stations and, with Norway and Sweden, to assist in the operation of a third (see § 3 (1) (c), p. 9).

The Meteorological Office has played an active part in securing an early resumption of the important work of the International Meteorological Organization. The primary function of this Organization, the members of which are the Directors of Meteorological Services, is the standardization of meteorological practice throughout the world. Progress in meteorology depends above all things on efficient international collaboration. Forecasting for aviation and other purposes would be impossible if countries did not conform to uniform methods and times of observation and to agreed codes and wireless frequencies for broadcasting their weather reports to the rest of the world. During the war the activities of the International Meteorological Organization were severely restricted, and with the return of peace it was necessary to set the machinery of the Organization into operation again. At an extraordinary meeting of the Conference of Directors held in London early in 1946, new members of the International Meteorological Committee were elected and the technical Commissions and the six Regional Commissions were reconstituted. The way was thus made clear for a restoration of the international procedures in operation before the war and for the world-wide introduction of improvements in the field of scientific meteorology made by certain countries during the war (see § 10 (1), p. 40).

The cost of the Meteorological Office is borne on Air Ministry votes. Appendix IV shows the provision made in the Air Estimates for expenses and receipts of the Meteorological Office for the financial year 1947-8.

## § 2. ORGANIZATION

The Meteorological Office is the State Meteorological Service, and is responsible for meeting the requirements of the following :—

General Public.  
Royal Air Force.  
Army.  
Civil Aviation.  
Government Departments.

Basic information is also supplied to the Naval Meteorological Service, a Branch of the Hydrographical Department of the Admiralty.

The Meteorological Office is responsible for :—

- (a) The collection, publication and distribution of meteorological information from all parts of the world.
- (b) The organization and distribution of magnetic and seismological information from certain British observatories.
- (c) Research in meteorological and geophysical subjects.

Since 1919, the Meteorological Office has formed part of the Air Ministry, the Director being responsible to the Secretary of State for Air through the Permanent Under Secretary of State. General policy control is exercised by the Meteorological Committee, of which the Under Secretary of State for Air is Chairman. Government departments served by the Meteorological Office, the Royal Society and the Royal Society of Edinburgh are represented on this Committee.

### (1) Headquarters

The present internal organization of the Office is shown in the diagram at Appendix I. The revisions made necessary by the change over from war to peace, as well as by the implementation of the Government White Paper already referred to, are not yet completed. The present chain of responsibility and the distribution of duties are described in the following paragraphs :—

(i) *The Director* is assisted by a Deputy Director and 5 Assistant Directors. Each Assistant Director is in charge of a number of Branches.

(ii) *The Deputy Director* is in charge of those sections of the Office immediately concerned with synoptic meteorology and the supply of forecasts to the Services, Civil Aviation, Government Departments and the public. Under his control are three Assistant Directors : Forecasting, Services and Civil Aviation.

(iii) *The Assistant 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 forecasts, and investigations into the technical problems of weather forecasting. The Central Forecasting Office also supplies the weather forecasts broadcast regularly by the British Broadcasting Corporation, and has a small section located in London to provide information to the Press and general public.

(iv) *The Assistant Director (Services)* is responsible for meeting the requirements, both at home and overseas, of the Royal Air Force, the Army and the Ministry of Supply.

(v) *The Assistant Director (Civil Aviation)* deals with the requirements of Civil Aviation, both at home and overseas.

(vi) *The Assistant Director (Personnel)* is responsible for all personnel and establishment matters and for works, services, finance, etc.

(vii) *The Assistant Director (Research)* is responsible for co-ordinating all research within the Meteorological Office. In general, each Branch carries out investigations into its own special problems and the Assistant Director (Research) deals with those aspects which do not come within the scope of a particular Branch. He attends in addition to all matters connected with the Meteorological Research Committee, and is responsible for liaison with outside bodies on questions relating to research and development. The Assistant Director (Research) controls all the observatories of the Meteorological Office and, as a temporary measure, is also in charge of the Climatology, Marine and Instrument Branches.

### (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 three observatories at Eskdalemuir, Lerwick and Aberdeen. The telegraphic reporting stations and such auxiliary reporting stations as are not attached to airfields are also administered by Edinburgh.

### § 3. SYNOPTIC METEOROLOGY

#### (1) Central Forecasting Office

**(a) Organization and functions.**—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 Office at Dunstable is divided into three Branches under the Assistant Director of Forecasting. These are the Forecast Branch, the Synoptic Services Branch, which is responsible for the collection and distribution of data, and the Upper Air Branch, which is charged with the administration of the Meteorological Flights and the radio-sonde and radar-wind stations, and deals with technical questions arising in these fields. Communications services are at present provided by a unit of 90 Group, Royal Air Force, but arrangements are in hand for a civilian section to take over this work. There is also at Dunstable a printing office, staffed by H.M. Stationery Office, for the production of the *Daily Weather Report*, basic charts and other lithographic printing required for meteorological purposes.

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 smaller airfields where there is no meteorological office (see § 3 (2) (c), p. 12).

**(b) Reporting stations.**—The number of stations in the British Isles making regular weather reports had increased to about 550 by the end of the war, but, largely as a result of the closing of many R.A.F. airfields, the number has fallen steadily, and at the end of March, 1947, was 225.

**(c) Ships' reports.**—(i) *Voluntary ships.*—The wireless transmission of weather reports from merchant ships, which was suppressed during the war, was resumed on November 1, 1945. The number of messages received each month from vessels in the North Atlantic has increased rapidly, as the following table shows :—

November, 1945	April, 1946	July, 1946	January, 1947
601	1,190	1,910	2,374

Ships' observations are made at the main synoptic hours, 0000, 0600, 1200 and 1800 G.M.T. and are transmitted to the appropriate shore station (Portishead, Wick, Malin Head, Humber or Valentia) if the ship is east of 40° W. The shore stations relay reports to the Central Telegraph Office, G.P.O., whence they are sent by teleprinters to Dunstable. Reports from ships west of 40° W. are transmitted to Halifax or Gander and reach Dunstable via the W/T point-to-point channel between Montreal and Prestwick.

The number of merchant ships from which reports are received is approximately 500. They are, however, subject to the disadvantage that the observations are concentrated along the main shipping routes, and the weather over some important areas is not reported.

(ii) *Ocean weather ships*.—An International Conference to discuss arrangements for providing vessels at “fixed stations” for meteorological reporting purposes in the North Atlantic was held in London in September, 1946 (see § 10 (2), p. 41). It was decided to establish 13 such stations covering the whole of the North Atlantic. It was agreed that Great Britain should undertake responsibility for providing and maintaining two reporting stations at positions 60° N. 20° W. and 53° 50' N. 18° 40' W., whilst a third station at 66° N. 2° E. would be the joint responsibility of Norway, Sweden and Great Britain. It is proposed to use corvettes for the purpose, and the vessels are now being modified. It is hoped that the first will take up position in July, 1947. Each vessel will make full reports in ships' synoptic code eight times daily, whilst radio-sonde and radar-wind observations will be made four times daily at the standard hours. Direct point-to-point working will be established between the British ocean weather vessels and Dunstable to enable the reports to be received without delay and to be disseminated by W/T and teleprinter broadcasts so as to be available to all British forecast stations and to places such as Shannon, Amsterdam, Paris, Stockholm and Lisbon which serve transatlantic air services. It is envisaged that the ocean weather ships will intercept reports from other vessels and from aircraft in flight in their vicinity and transmit small “collective” messages to Dunstable.

(d) *Meteorological flights*.—The meteorological flights undertaken by the Royal Air Force consist of weather reconnaissance sorties, made in medium or long-range aircraft, and vertical flights which are made in fighter aircraft. Routine reconnaissance flights are usually made on triangular tracks, of which the first and third legs are flown at a general level of 950 mb. (1,500 ft.), and the second leg at 500 mb. (about 18,000 ft.). Full weather observations are made every 50 miles along the track and at intermediate points if important changes in conditions are experienced. During ascent or descent at the turning points measurements of temperature and humidity are recorded. Reconnaissance flights are also made when it is desired to obtain detailed information on cloud structure, precipitation or icing conditions over areas where observations from the surface are lacking or where rapid development is expected.

The distribution of meteorological flights in Europe at the end of the war is shown on the map in Appendix III, on which the tracks of the routine reconnaissance flights and the code names by which they were known are also indicated. It has not, however, been possible to maintain this organization, and adjustments have been made to utilize the available effort to best advantage.

By July 1, 1946 the establishment of meteorological aircraft had been reduced to one reconnaissance squadron of three flights, two of which were based in Northern Ireland and the third at Gibraltar, and a special flight in Burma for reconnaissance over the Bay of Bengal. A plan was also devised whereby front-line squadrons undertake meteorological duties as part of their peace-time commitments, but Bomber Command became responsible for routine reconnaissance over the northern North Sea and Coastal Command for reconnaissance over the south-western approaches to the British Isles. In Germany certain R.A.F. fighter squadrons have carried out vertical ascents since the meteorological flights were disbanded, and arrangements have been made for similar ascents to be made each day from two Fighter Command stations in England.

Towards the end of 1945, discussions were opened with the French Meteorological Service which resulted in an agreement that France would be responsible for meteorological reconnaissance flights operating from Bordeaux, using British

aircraft and meteorological equipment. A meteorological air observer officer was sent to Bordeaux to instruct French crews in the technique of weather reporting from aircraft. This training was completed in May, 1946, and occasional reconnaissance flights from Bordeaux began the following November.

**(e) Radio-sonde and radio-wind stations.**—During the war eight stations in Great Britain were equipped for making radio soundings of pressure, temperature, humidity and wind in the upper air. By August, 1945, soundings of the atmosphere were made daily at each of the four main synoptic hours at Larkhill, Lerwick, Downham Market and Fazakerley, while at the remaining stations—Stornoway, Penzance, Nutts Corner and Leuchars—two observations were being made each day. This network was augmented by radio-sonde stations at Valentia and Brussels which were opened during the war by British staff.

In the radio-sonde a transmitter responds to changes in sensitive elements which record the pressure, temperature and humidity. The instrument is carried aloft by a free balloon rising at about 1,000 ft./min., and the continuous transmission of radio signals enables the meteorologist at the ground receiving station to compute instantaneous values of the pressure, temperature and humidity up to a height of about 18 Km. In addition, the signals may be received at each of three satellite stations situated at the corners of a triangle surrounding the central station. By taking synchronised direction bearings on the transmitter during flight, the speed and direction of the wind may be calculated.

A more convenient method of measuring upper winds has recently been brought into general use. In this case the balloon carries a special reflector, and its elevation, azimuth and slant range are recorded on radar equipment at the ground station. The position of the balloon may thus be determined at intervals of time, and hence the wind speed and direction computed.

The great advantage of using radio methods for measuring meteorological variables in the upper air is that the balloon can be followed in practically all weathers.

Since the end of the war, steps have been taken to establish radio-sonde stations overseas. During 1946 equipment was installed and put into routine use at Malta, Gibraltar, Lydda and Habbaniya, and early in 1947 radio-sonde observations were started at Nicosia in Cyprus. About 15 more stations, mainly in Africa and the Far East, are to be supplied with radio-sonde and radio-wind installations in the near future.

**(f) Location of thunderstorms.**—The “sferic” organization for determining the location of thunderstorm activity was developed during the war. Radio direction-finding equipment is employed and lightning flashes can be detected up to distances of 1,500–2,000 Km. In the British Isles there are four observing stations, situated in Bedfordshire, Cornwall, east Scotland and Northern Ireland. Observations are normally made every three hours, but when there is marked thunderstorm activity half-hourly observations are made so that adequate warnings may be given to aircraft. The designing of the equipment and setting up of the stations were carried out by the National Physical Laboratory on behalf of the Meteorological Office.

**(g) Meteorological communications.**—**(i) Teleprinter communications.**—The Meteorological Office has its own teleprinter network centred on Dunstable. From the Central Forecasting Office two direct teleprinter channels go to each Type 1 station situated at a principal service or civilian flying centre. One of these channels, “Channel 1,” extends to the subsidiary meteorological offices of the Type 1 stations and is used for the collection of reports and for general broadcasts to all meteorological stations on the teleprinter network. The other line, “Channel 2,” terminates at the Type 1 station and is used partly for

broadcasts of additional or special information, and partly for urgent administrative messages. In addition to these channels, there are also direct lines to certain Naval Meteorological Offices and to meteorological centres in Europe.

An important development has been the extension of the teleprinter circuits to the continent. Duplex channels to the French Central Forecasting Station in Paris and to the communications centre of the American Air Force at Orly permit the direct reception of information from all stations in France and in the American Occupied Zone of Germany. Similar channels to Bad Eilsen enable reports to be received from the British Occupied Zone. In January, 1946, lines to Brussels and Utrecht were installed and an extension to Copenhagen was made later in the year. At the present time British reports are supplied hourly to places as distant as Marseilles, Berlin and Copenhagen, and plans are in hand to provide links to more distant continental centres such as Rome.

A direct teleprinter circuit to Broadcasting House was provided in 1945 for passing forecasts, gale warnings and other messages, while the circuit to the London Headquarters of the Meteorological Office carries forecasts and other data required for issue to the Press.

The use of radio-teletype for the exchange of weather reports between Montreal and Dunstable was recently begun on an experimental basis.

(ii) *Wireless telegraphy*.—There are three separate programmes of meteorological transmission which are made from Dunstable. The first, GFA, contains basic data, analyses and general inferences, while the second, GFL, contains advance upper air information and may later include hourly and half-hourly reports for aviation purposes. Both these transmissions are general broadcasts on several frequencies to ensure reception over a wide area. The third transmission is part of a duplex point-to-point circuit to Moscow, and is used for passing American data to the U.S.S.R. and for the reception of Siberian data. North American reports are received at Prestwick by point-to-point and are relayed to Dunstable by teleprinter.

Another transmitting station is to be installed for point-to-point communication with the British ocean weather ships which will be operating in the Atlantic.

(iii) *Facsimile transmissions*.—The employment of apparatus for transmitting pictures by land-line or radio has for a long time been considered in relation to the reproduction of synoptic charts, and tests using B.B.C. apparatus were first made some 20 years ago. The idea is an attractive one since it may possibly eliminate the necessity for plotting separate maps at each outstation. In December, 1945, it became possible to arrange further tests when four "transreceivers" were obtained on loan from the United States Army Air Force. The machines were installed at Dunstable, Headquarters Transport Command, Victory House and Gloucester, using existing land-lines. During a period of eight months, some 600 weather maps were transmitted from Dunstable with considerable success, but improvement in definition is required before detailed synoptic charts, containing full observations, can be transmitted satisfactorily. It is intended to pursue the possibilities of facsimile transmissions as soon as equipment of British manufacture is available.

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

A detachment of the Central Forecasting Office functions at the London Headquarters of the Meteorological Office at Victory House, Kingsway to ensure close contact with Government Departments and the Press. This detachment receives basic forecasts from Dunstable by teleprinter.

**(a) British Broadcasting Corporation.**—The B.B.C. resumed broadcasts of weather forecasts as soon as the war in Europe came to an end. Since December, 1945, forecasts have been issued by the B.B.C. at 0655, 0755 and 1755 clock time, and brief general forecasts with an outlook are also added to the news bulletins at 1 o'clock in the afternoon and at 9 o'clock at night. Warnings of gales, snow and frost are broadcast by the B.B.C. on their 1,500 m. transmitter as soon as they are received from Dunstable.

In addition to the routine forecasts for shipping, forecasts for the East Anglian Herring Fishing Fleet are supplied for broadcast when required, and the B.B.C. Scottish programme also provides forecasts for the Scottish Herring Fishing Fleet.

**(b) The Press.**—Routine issues of weather information to the Press are as follows :—

- 10 a.m. General inference, district forecasts for 24 hours commencing at noon, and outlook.
- 10 a.m. London observations.
- 11 a.m. Morning health resort reports.
- 3 p.m. General inference, advance district forecasts for period 6 a.m. to midnight next day, and outlook.
- 9 p.m. Evening health resort reports.
- 9 p.m. General inference, district forecasts for 24 hours commencing at 6 a.m. next day, and outlook.
- 9 p.m. Weather summary for previous 24 hours and London observations.

From February 1, 1947, specially prepared weather maps showing the actual synoptic situation at 1200 G.M.T. and the forecast or "prebaratic" chart for noon the following day have been made available to the Press every evening.

**(c) AIRMET.**—AIRMET broadcasts, which are similar to the Borough Hill weather broadcasts of pre-war days, were begun on January 7, 1946. These broadcasts, which are on a wave-length of 1,225 m., are made from 0600 to 2100 G.M.T. in summer and from 0700 to 1800 G.M.T. in winter. Each hour actual weather reports from 40 airfields in the United Kingdom are broadcast, and, during two 10-minute periods in each hour, a forecast officer gives a detailed account of the weather situation over the British Isles and of the developments expected within the next few hours. A further 10-minute period is allotted each hour to the announcement of navigational warnings and "unservicability" reports provided by the Ministry of Civil Aviation.

**(d) Miscellaneous forecasts.**—Forecasts for the Central Electricity Board are prepared daily at 6 a.m. and 6 p.m. The morning forecast gives the temperature expected in the early evening in the London area and inland south of the Tay, together with the general wind and weather conditions expected during the afternoon. The evening forecast, which also covers the area south of the Tay, gives the conditions of temperature, wind and weather for the following morning.

Week-end temperature forecasts have been supplied during the winter months to Regional Officers of the Ministry of Fuel and Power. Warnings of cold spells are supplied as necessary to Regional Officers to enable gas undertakings to anticipate abrupt variations in the load.

Notifications of spells of fair weather for farmers have been resumed, and special forecasts are also issued to commercial firms for industrial processes. During the winter months reports of fog, snow, heavy rainfall and glazed roads have been supplied to the Royal Automobile Club.

Weather forecasts for broadcasting by the Dublin Broadcast Service have been provided since July 1, 1945. The forecasts are in general terms for Ireland and are broadcast three times each day.

### (3) Services for the Royal Air Force

(a) *General.*—The widespread deployment and operational activities of the Royal Air Force and of the associated land forces during the 1939–45 war entailed the provision not only of greatly increased complements of personnel, but also of adequate systems of communications—both land-line and radio—for meteorological purposes.

In August, 1945, in addition to a greatly expanded meteorological organization for the Royal Air Force in the United Kingdom, there were important and large commitments overseas, viz., in the north-west European, Mediterranean, Middle East and south-east Asian theatres, in Iceland, the Azores, Bermuda, the West Indies, British East Africa and British West Africa. The ensuing transition towards a peace-time footing has resulted in a reduction of the meteorological commitments now to be met in the United Kingdom and in the British Forces of Occupation (in Germany, Austria and Japan), in the Mediterranean, Middle East, India and Far East Commands. The responsibility for the British East African and British West African Meteorological Services, assumed during the recent war to meet the requirements of the Royal Air Force, has continued.

(b) *Organization.*—(i) *At Headquarters.*—Immediately before the outbreak of war, one headquarters branch of the office was directly concerned with the Home Commands, while another dealt with service and civil aviation overseas. By the end of the war the administration of the meteorological services for the Royal Air Force in the United Kingdom (excluding Coastal and Transport Commands) and north-west Europe was shared by three branches, constituting the Home Operations Division. The other overseas Commands, together with Coastal and Transport Commands, were the concern of three other branches, forming the Overseas Operations Division. These arrangements continued until May, 1946, when the work for all Commands, home and overseas, was concentrated in one Services Operations Division comprising three branches.

(ii) *Within Royal Air Force Commands at Home.*—In general, the arrangements were on similar lines to those introduced in the immediate pre-war period. Meteorological units of appropriate types were provided at R.A.F. formations, airfields and flying-boat bases.

A Chief Meteorological Officer, supported by staff to assist in providing forecasts and other technical advice, is maintained at the headquarters of Operational Commands, and acts as adviser to the Air Commander and his staff on meteorological requirements in the Command.

Major forecasting centres—Type 1 offices—at the Group headquarters of Operational Commands provide the information and advice required by the Group headquarters staffs in the planning and control of flying by units in the Groups. These offices administer subsidiary meteorological sections attached to airfields within the same Group, and may perform a similar function towards other stations not part of the Group but located in the same area.

Subsidiary forecasting offices—Types 2 and 3—established at airfields and flying-boat bases maintain observational routine and, in consultation with the parent station at Group headquarters, furnish information to the local R.A.F. authorities. The forecasters provide detailed meteorological briefing, supported by written or pictorial forecasts and synoptic charts, to the members of aircrews before flights.

Type 4 offices, staffed by assistants, are established at airfields where the services of forecasters are not essential. In addition to carrying out observational

routine, the staff display and explain forecasts and other information received from the parent Type 1 office.

The observations made hourly (in many cases throughout the 24 hours) at airfield offices are sent by meteorological teleprinter to the office at Group headquarters and thence to the Central Forecasting Office, Dunstable, for general distribution. All stations receive reports, technical analyses and forecasts broadcast from Dunstable.

(iii) *Within Royal Air Force Commands Overseas.*—The organization was similar in principle to that just outlined. In many areas meteorological communications were necessarily effected by radio instead of by land-line, and meteorological offices at airfields were in less close contact with the parent centre.

The Chief Meteorological Officers at Command headquarters overseas control all the meteorological stations in the Commands, which are usually extensive. The organization includes a central forecasting unit, which is responsible for the collection and distribution of meteorological information and for technical co-ordination in the Command. Liaison has been maintained with other meteorological services located in or near the Command area. In some countries the British service has been the only effective service in operation throughout the period. Considerable assistance has been given in the re-establishment of national meteorological services in countries formerly occupied by the enemy.

(c) *Royal Air Force Meteorological Policy Committee.*—This Committee, constituted in 1937 to formulate the meteorological requirements of the Royal Air Force and to recommend measures for meeting them, met periodically during the period. The Chairman of the Committee is an Assistant Chief of the Air Staff; the meetings are attended by representatives of the Air Staff at Air Ministry and Commands, and by senior members of the Meteorological Office. Among the matters which received attention were—the type and provision of aircraft for meteorological reconnaissance purposes; meteorological sorties by operational squadrons; standard meteorological accommodation at Royal Air Force headquarters and airfields; meteorological communications facilities; attendance by senior meteorological officers at Staff College courses; the implications, for aviation, of the new international meteorological codes to be introduced in the near future.

(d) *Notes on other activities for the Royal Air Force.*—With the cessation of war operations, the main demands for meteorological service have been for transport and communications flights, basic and operational flying and photo-reconnaissance.

In the first part of the period, facilities were provided for transatlantic flights by Transport Command, similar arrangements being continued later for the civil flights across the Atlantic.

The early active period of repatriating troops by Transport and Bomber Commands from Europe, the Mediterranean and Far East and also flights along the Royal Air Force trunk routes to the Far East necessitated close co-ordination of the meteorological advice provided during the successive stages of these flights. This was achieved by the exchange of information between the main area control centres or other main meteorological offices concerned. As an aid to aircrew flying over France and the western Mediterranean, pilots within range of the Royal Air Force staging post at Istres (south of France) could discuss the weather situation with the duty forecaster by radio-telephony. In addition to full meteorological briefing before flight, aircrew during flight received latest weather information and advice from area control centres or airfields at intervals along the routes, either on request or by listening to broadcasts (in U.C.O. code) made half-hourly or hourly. The meteorological organization along the trunk routes, though originated for the Royal Air Force, has been used increasingly by civil aviation.

Weather reports made by aircrew during flight and amplified by them on landing are of great value in supplementing the information received from ground stations (which are deficient in number in many areas over which flights are made). In-flight reports are made at specified points on the route, and are transmitted to the ground-station terminal for general distribution.

At the end of the war plans were drawn up for the participation by the Royal Air Force in a number of meteorological research projects, involving flying by operational and training units. Although a beginning was made with some projects, the contraction of the Royal Air Force prevented completion of the enterprise.

Special arrangements were made to provide meteorological advice for the attempts made on the air speed record at Herne Bay in October-November, 1945, and near Littlehampton in August-September, 1946.

Assistance was given in 1946 and 1947 in trials, in the Singapore and European areas, of radar equipment for the detection of dangerous storm clouds from an aircraft.

**(e) Meteorological instruction for the Royal Air Force.**—Lectures were given in regular courses at the Empire Navigation School, Jurby (until September, 1946) and at the School of General Reconnaissance. Lectures and other less formal instruction were given by Meteorological Officers at many stations in Training and the Operational Commands. A lecture was given at the Air Ministry to each course for Accident Prevention Officers.

To strengthen the instructional and other meteorological services at the Royal Air Force Cadet College and the Empire Central Flying School, an experienced officer was posted to each establishment in January, 1947.

A Meteorological Officer was maintained at the Central Examination Board, Flying Training Command, to supervise the setting and marking of examination papers in meteorology.

A revised edition of the "Meteorological Handbook for Pilots and Navigators", of which two editions were issued during the war, was in preparation. A new publication, a handbook of climatology for aviators, is being written.

In collaboration with the Deputy Directorate of Films, Air Ministry, the film "Meteorological Service" was nearly completed. It deals mainly with the organization and procedure of the Meteorological Office, with emphasis on service for aviation.

#### (4) Services for Civil Aviation

**(a) Organization.**—When the war ended Civil Aviation began to expand rapidly, and it became necessary to form two branches, under an Assistant Director, to plan and administer the meteorological organization required. One branch was made responsible for the needs of Civil Aviation within the United Kingdom and on air routes terminating in Europe, while the other was charged with meeting the requirements of overseas routes with destinations outside Europe.

The routes to be developed included those to the various European capitals, to west Africa, South Africa and the Far East. Numerous conferences were attended to plan the meteorological organization needed for these routes; a senior member of the staff also accompanied Ministry of Civil Aviation missions on a number of surveys of routes and landing grounds. The work was naturally concerned closely with the activities of the Provisional International Civil Aviation Organization, and the Assistant Director or the Head of a Branch has attended Regional Air Navigation meetings at Dublin, Paris, Washington and Melbourne.

**(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 and Hurn. At Prestwick the main commitments were for transatlantic flights, but there was an increasing demand for forecasts to European centres as air routes connecting Prestwick to the continent were opened.

Meteorological staff were posted to London Airport in May, 1946. The work there has developed rapidly, and forecasts are now supplied regularly for flights to Malta, Palestine, Turkey, Foynes and the Azores, as well as to places in south and south-east Europe.

Hurn was the main base in England for British Overseas Airways Corporation landplane services operating on trunk routes until June, 1946, when this traffic was transferred to London Airport, Hurn becoming a diversionary airfield for the London area. A meteorological office manned by assistants has been kept opened at Hurn, whilst at Poole a forecasting office has been maintained to supply forecasts and briefing for B.O.A.C. flying boats engaged on the service to Cairo, and, until it ceased in March, 1946, on the service to Lisbon.

**(c) Services provided in the United Kingdom for internal and European routes.**—Forecasting offices have been maintained at 16 airfields in the United Kingdom to provide meteorological facilities for air lines operating on the routes within the United Kingdom and to European terminals. The normal ground organization for supplying forecasts and briefings has been supplemented by a system of broadcasts which enable the pilot to obtain detailed, up-to-the-minute weather information while in flight. In addition to the AIRMET transmissions (see § 3 (2) (c), p. 12), broadcasts of actual landing conditions are made every half-hour from the main civil airfields both in Great Britain and in Europe.

**(d) Services provided overseas.**—(i) *Bermuda*.—After the withdrawal of the Royal Air Force from Bermuda in 1946, the only Air Ministry meteorological office remaining in Bermuda was that at Hamilton, which provided forecasts for the British flying-boat service to Baltimore and issued synoptic messages for the Royal Navy.

(ii) *Trinidad and Nassau*.—In Trinidad and Nassau the Air Ministry have continued to be responsible for the meteorological service. Meteorological staff were gradually replaced by civilians after the withdrawal of the Royal Air Force.

(iii) *West Africa*.—In continuation of a war-time arrangement, the Air Ministry have remained in control of the British West African Meteorological Service. Forecasting services have been maintained for the supply of information to British Overseas Airways Corporation and British West African Airways, as well as to local government authorities at Accra, Lagos, Freetown, Bathurst and Kano. In March, 1947, Pan American Airways opened a route from Dakar through Accra to Johannesburg, and arrangements were made to supply forecasts for this service.

(iv) *Portugal*.—For most of the war a British forecast section was stationed at Lisbon to supply weather information to British civil aircraft landing there. In December, 1945, arrangements were made for Portuguese staff to be trained to take over the work, and in April, 1946, British assistant staff returned to England. In the following October, the forecast staff was reduced to one.

(v) *Sweden*.—The British forecast section which had been stationed in Stockholm during the war was reduced in September, 1945, to one forecaster who remained for another year.

**(e) Training.**—Two thousand and sixty candidates were examined for the Pilot's "B" licence. Owing to the increased numbers, written papers replaced oral tests in July, 1946. Monthly, instead of quarterly, examinations for the

2nd class Navigator's licence were begun in January, 1946, and a total of 1,606 candidates have presented themselves. Examinations for 1st class Navigator's licences were resumed in July, 1946.

A Forecast Office was opened at Aldermaston, where the British Overseas Airways Corporation established a Training School.

#### (5) Services for the Army

During the war the Royal Air Force and Army formations in areas of active operations shared a joint meteorological organization. Mobile meteorological units, controlled by meteorological centres at the joint Army H.Q., R.A.F. Group H.Q. level, were attached to Army formations. Practically all these Army meteorological units were disbanded early in the period, though a few remained available for exercises.

A meteorological section has been maintained, as in pre-war years, at the School of Artillery on Salisbury Plain for artillery and sound-ranging purposes. The meteorological officer gives instruction to courses at the School. A meteorological section also operated at the Artillery Range, British Forces of Occupation, Germany.

#### (6) Services for the Ministry of Supply

Information for the main experimental establishments (air) of the Ministry of Supply was provided by meteorological offices at these stations.

At the Artillery Ranges, Shoeburyness, specialised information was provided for gunnery trials. In addition to a complete lay-out for the determination of upper wind by pilot-balloon procedure, the station is provided with equipment to measure the upper winds by radar.

At Aberporth and Porton, the meteorological sections have provided meteorological information for the special work of these two establishments.

#### (7) Services for the Navy

By arrangement with the Admiralty, meteorological information required for naval purposes was supplied by stations of the Meteorological Office, both at home and overseas. These included the preparation of collective reports, Fleet synoptic messages, analyses and forecasts for use of H.M. ships, *e.g.*, from Gibraltar, Malta, Aden, Mombasa and Nairobi. Similar facilities were provided in Cyprus, Palestine, Ceylon, Malaya and Hongkong.

#### (8) Services for the Merchant Navy and Fishing Fleets

The Central Forecast Office provides a weather bulletin twice daily for broadcasting to shipping. This is transmitted from the Admiralty at 0900 and 2100 G.M.T. and from Portishead at 0930 and 2130 G.M.T. The message consists of a general inference and forecast, an analysis of the pressure systems and a selection of reports from shore stations and ships. In addition, shipping forecasts are included in the general weather forecasts issued through the B.B.C. three times a day, and special forecasts are broadcast for the Herring Fishing Fleet.

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

(a) Mediterranean-Middle East area.—(i) *South African Forces.*—Close co-operation was maintained with the South African Air Force Meteorological Service in the Mediterranean-Middle East Command until the return of the South African Forces to the Union.

(ii) *Cyprus*.—The forecast centre at Nicosia, established during the war, was maintained. It has commitments for civil aviation in addition to those for the Cyprus Government, the Royal Air Force, Army and Navy. Four observing stations are manned by local staff.

(iii) *British East Africa*.—The British East African Meteorological Service has been under the control of the Meteorological Office since 1943. The main forecasting centre is located at the Royal Air Force station, Nairobi. There has been a considerable reduction in military requirements but an increase in those for civil aviation. The Chief Meteorological Officer has kept close contact with neighbouring meteorological services.

(iv) *British West Africa*.—The British West African Meteorological Service remained under Meteorological Office control exercised through the Chief Meteorological Officer at Accra. The main stations were at or near Accra, Kano, Ikeja, Takoradi, Freetown and Bathurst. In the latter part of the period, services provided for civil aviation exceeded those for the Royal Air Force.

(b) *Indian area*.—(i) *India*.—It was arranged early in 1946 that the India Meteorological Department should be responsible for the provision of meteorological requirements of the Services in India. Co-ordination between the War Department and the India Meteorological Department is effected by means of a Joint Meteorological Committee, which meets at frequent intervals, under the chairmanship of the Director-General of Observatories, and consists of representatives of the India Meteorological Department, Air Headquarters, Army Headquarters, Naval Headquarters and other Departments of Government. The senior British Meteorological Officer, located with Air Headquarters, is a member of the Joint Meteorological Committee.

(ii) *Ceylon*.—A forecasting centre has been maintained at Negombo and a subsidiary meteorological station at Koggala. The Ceylon meteorological authority is responsible for providing reports from other stations in the island.

(c) *Far East area*.—(i) *Burma*.—A forecasting centre has been operated at the main Royal Air Force base, and there are two subsidiary stations at airfields. Liaison has been maintained with the Burmese Meteorological Service, which is in process of re-establishment.

(ii) *Malaya*.—The Meteorological Office at present maintains five stations. The Chief Meteorological Officer, Far East Command, has been responsible for meeting the Service and some civil aviation requirements. The main forecast office at the area control centre is the central collecting and distributing agency in the Command. There has been close co-operation with the Malayan Meteorological Service, now being re-established, which is gradually taking over the commitments for civil aviation.

(iii) *Hongkong*.—The forecasting office provided for the R.A.F. staging post maintained liaison with the Royal Observatory in the issue of typhoon warnings.

(d) *Falkland Islands*.—A meteorological office was established in the Falkland Islands in October, 1946. Its functions are to maintain synoptic observations, to prepare a Falkland Islands collective message for broadcast by wireless, to issue local forecasts for agricultural purposes, to analyse climatological data, to undertake upper air observations, and to collaborate with the Department of Scientific and Industrial Research in carrying out ionospheric observations.

#### (10) Services in foreign countries

As indicated elsewhere in this Report, the British Meteorological Service during the war operated widely in territory which was not British or normally

under British influence. Many of the commitments then undertaken necessarily continued after the cessation of hostilities. In countries liberated from enemy occupation, assistance has been given in the rehabilitation of the national meteorological services by the attachment of liaison officers and the supply of equipment.

(a) **European area.**—(i) *Iceland.*—The British meteorological centre which had been established at Reykjavik in 1940 was discontinued on the withdrawal of the Royal Air Force. Responsibility for meteorological facilities at this airfield then passed to the Icelandic Service, some of whose staff had previously been attached to the British centre.

(ii) *Azores.*—With the closing of the Royal Air Force base in the autumn of 1946, the forecasting centre, which had operated throughout the British tenure of the base, was withdrawn. Following this, Meteorological Office staff were seconded to the Portuguese Government for service at the Civil Aviation base at Santa Maria.

(iii) *Norway.*—The meteorological units which accompanied the British forces to Norway on the collapse of Germany in 1945 were withdrawn towards the end of that year. A British officer remained in Norway until the early part of 1946 for liaison purposes with the Norwegian Meteorological Service.

(iv) *France.*—Meteorological units provided for Royal Air Force staging posts in France were reduced to two. A Meteorological Officer attached to a Royal Air Force formation in Paris maintained close touch with the French Meteorological Service, to which the two British meteorological units are linked.

(v) *Belgium.*—Assistance was given in the rehabilitation of the Belgian Meteorological Organization. The R.A.F.V.R. (Belgian) Meteorological Section, created during the war, played a large part in these activities. Teleprinter communications were arranged between the Belgian centre, the United Kingdom and the British Zone of Germany; equipment and stores were provided and British personnel were attached to Brussels airfield until November, 1946.

(vi) *Holland.*—As in Belgium, meteorological teleprinter communications with the United Kingdom and the British Zone of Germany were arranged. British meteorological staff remained at certain airfields in Holland until summer, 1946.

(vii) *Denmark.*—British staff, stationed at Copenhagen Airport to serve the Royal Air Force and maintain co-operation with the Danish Service, were finally withdrawn in July, 1946. Copenhagen was linked by teleprinter to the meteorological network in the British Zone of Germany from early in the period.

(viii) *Germany.*—The meteorological organization created for the operations of 2nd Tactical Air Force and 21st Army Group was stabilised to serve the British Forces of Occupation. The arrangements are on standard lines. The British forecasting headquarters is linked by meteorological teleprinter to Dunstable, to the meteorological centres in Belgium, Denmark and Holland, and to the Weather Service of the United States Forces in Europe. Reports are received from German-manned ground stations, lightships and fishing trawlers. Quickborn radio station intercepts meteorological messages from other areas and transmits collective messages from Germany and selected areas. Four upper air stations using radio-sonde and radar-wind procedure are maintained in the British Zone.

The former State meteorological organization in Germany was practically disintegrated at the end of the war. Policy concerning the re-establishment of the German Meteorological Service is determined by the Allied Control Commission on the advice of the Quadrupartite Meteorological Committee. This Committee, which includes the British Chief Meteorological Officer, co-ordinates the meteorological arrangements which have been set up in the four zones of occupation.

(ix) *Austria*.—A senior British Meteorological Officer has been a member of the Committee of Meteorology of the Allied Control Commission for Austria. The Austrian Meteorological Service (with Professor H. von Ficker as Director) was revived under Allied supervision in 1946.

British meteorological units remain at the Royal Air Force staging post near Vienna and at one other airfield.

(x) *Italy*.—With the progressive withdrawal of British Forces, the British meteorological commitments steadily diminished. A senior British Meteorological Officer has been maintained.

The re-organized Italian Meteorological Service, with assistance and supervision from the Allied Control Commission, has resumed international meteorological responsibilities, and has taken over the provision of services for certain British requirements.

(xi) *Greece*.—The British Service remained almost entirely responsible for meteorological facilities, including radio broadcasts. The Greek Meteorological Service maintains a number of reporting stations, but is unable yet to assume its full responsibilities.

**(b) Mediterranean-Middle East area.**—(i) *French north-west Africa*.—British meteorological staff were withdrawn in June, 1946.

(ii) *Libya*.—Forecasting centres have been retained. Nine reporting stations, staffed largely by locally engaged personnel, are operating. It is planned to establish further reporting stations inland.

(iii) *Egypt*.—The British meteorological organization under the Chief Meteorological Officer, Mediterranean-Middle East Command decreased steadily. Close co-operation has existed with the Meteorological Services of the Egyptian Physical Department and Civil Aviation Department. General responsibility for meteorological arrangements in Egypt is being assumed by the National Service. The British Service will maintain facilities for the British forces in the Canal Zone and elsewhere in the Command.

(iv) *Sudan*.—The Sudan Government Meteorological Service maintains the majority of observing stations, but the forecasting service and the issue of meteorological broadcasts have been operated by British staff serving with Royal Air Force units.

(v) *Palestine*.—The Civil Aviation Department resumed control of the Palestine Meteorological Service in November, 1945. To meet the requirements of the Royal Air Force and other British forces, a British forecasting centre is maintained at Lydda, with subsidiary sections at two other airfields. The Palestine Service collaborates in providing meteorological facilities for Civil Aviation.

(vi) *Lebanon and Syria*.—A British meteorological centre was maintained at Beirut until the summer of 1946. A national meteorological organization exists in the Lebanon, but not in Syria.

(vii) *Somalia*.—Five reporting stations have been operated under the control of the British East African Meteorological Service.

(viii) *Eritrea*.—A forecast section at Asmara, with eleven reporting stations manned by locally engaged assistants is maintained to meet the requirements of Civil Aviation and the British Military Administration.

(ix) *Abyssinia*.—British staff maintained a small reporting station until September, 1946.

(x) *Iraq*.—The Iraq Meteorological Service continued under British control. The main forecast centres at Habbaniya and Shuaiba served the Royal Air Force and Civil Aviation. Meteorological offices were also provided at Basra, Bahrein and Sharja.

(xi) *Persia*.—British meteorological personnel were withdrawn early in 1946. Locally engaged assistants were retained to operate meteorological reporting stations at Tehran, Isfahan, Hamadan and Kermanshah. These stations have now passed to the control of the Persian Government.

(c) *Far East area*.—British sections in French Indo-China, the Netherlands East Indies and Thailand were withdrawn. Assistance was given in the re-establishment of the national meteorological services.

Two meteorological sections are provided with the British Commonwealth Forces in Japan.

### (11) Special Investigations and Technical Memoranda

A separate Branch undertakes the investigations that arise from the current or planned operations of the Air Force, the Army or Civil Aviation. In the case of aviation, the inquiries usually relate to proposed air routes and sites for airfields.

The results of investigations were published in three forms :—

- (i) Synoptic Divisions Technical Memoranda.
- (ii) Aviation Meteorological Reports.
- (iii) Meteorological Office Memoranda.

The first and third series deal with the more scientific and technical problems, whilst the second series is concerned with the more practical and applied type of investigation. Appendix V gives a list of the Memoranda and Reports which have been issued since the war ended.

An interesting investigation, undertaken at the request of the Ministry of Civil Aviation, dealt with the problem of “ pressure-pattern ” flying. A method was devised of laying off the track for shortest time of flight between any two points, taking account of the wind distribution.

The first draft of a book entitled “ The meteorology of airfields ” has been completed. A series of diagrams depicting the lay-out of airfields in the British Isles, together with marginal notes on the manner in which topography and other factors affect the weather conditions, has also been produced. Similar diagrams are being prepared for overseas airfields. At the request of the Royal Air Force, a climatology of the world with particular reference to those features which are of concern to the aviator is in preparation.

## § 4. CLIMATOLOGY

The Climatology Branch at Harrow is concerned with British Climatology (including the British Rainfall Organization), World Climatology and Upper Air Climatology, and is also in charge of the Meteorological Office Library (see § 9 (1), p. 39). Marine Climatology is dealt with by the Marine Branch (see § 4 (4), p. 24).

### (1) British Climatology

In Great Britain and Northern Ireland there are about 400 climatological stations and 5,000 stations reporting rainfall to the Meteorological Office. The records from these stations are used in dealing with inquiries relating to the past weather and climatology of the British Isles, received from Government Depart-

ments, commercial and industrial firms, and from members of the public. Summaries of the records are included in the various climatological publications.

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

(i) *Observatories* (see § 5, p. 25) 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. Weekly summaries of the data obtained are circulated by the Ministry of Agriculture and Fisheries under the crop-weather scheme.

(iv) *Climatological and 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 II.

The British Rainfall Organization, founded by the late G. J. Symons in 1859, was taken over by the Air Ministry in 1919. In the 87 years of its existence a vast amount of data has been collected and averages of rainfall, for the standard period 1881–1915, have been compiled for some 20,000 places. Much of this material, including information on the duration and intensity of precipitation, droughts and rain spells, percolation and evaporation, is published in *British Rainfall*.

**(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, 1945. The preparation of later material, in a form to allow more detailed treatment of upper winds obtained by radio soundings, is in progress.

The latest published volume of *British Rainfall* is that for 1939. It is proposed to issue the data for the war years in two volumes, covering the periods 1940–2 and 1943–5. From 1946 onwards, *British Rainfall* will be published annually.

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

**(c) Special work.**—(i) A “Climatological Atlas of the British Isles” has been completed, and arrangements are being made for its publication by H.M. Stationery Office. The atlas consists of seven sections : pressure and wind ; temperature ; rainfall, snow and thunder ; humidity ; sunshine ; fog and visibility ; cloud. The sections will be published separately and also in a single bound volume which will contain about 260 maps and 28 diagrams with the associated text.

(ii) *Returns for the Registrar-General.*—Weekly summaries of the weather in certain large towns in England and Wales are prepared for the Registrar-General. Quarterly and annual summaries are also supplied, and information of a similar nature is sent to the Government of Northern Ireland.

(iii) *Ministry of Town and Country Planning.*—Maps of average annual rainfall over Great Britain have been prepared for publication on a scale of 10 miles to an inch.

(iv) *Meteorology and Agriculture.*—The Climatology Branch has always been in close touch with the Ministry of Agriculture and Fisheries. In view of the importance of weather to agriculture, a special section for agricultural meteorology was set up in December, 1946, and staff is being provided to work at the provincial establishments of the Agricultural Improvement Council.

A member of the Meteorological Office staff visited the Isle of Man in January, 1947, to arrange a series of lectures on meteorology to be given to the Young Farmers' Clubs, and to discuss other ways in which the Meteorological Office could be of assistance to farmers.

In June, 1946, a meteorological exhibit was arranged for the Hampshire Agricultural Show at Southampton.

(v) *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.

The severe winter of 1946–7 led to many inquiries from Government departments and the Press. At intervals during February statements were prepared comparing this winter with previous severe winters, in respect of low temperature, snowfall and easterly gales.

## (2) World Climatology

(a) *Overseas stations.*—Monthly returns of climatological data were received from 104 stations—10 in Europe, 25 in Asia, 55 in Africa, 2 in Central and South America and 12 situated on islands. In addition, climatological summaries and reports relating to stations in Iceland, Germany, Italy and Palestine have been received from various sources. A member of the staff visited Hamburg to examine the climatological data in the former Deutsche Seewarte.

(b) *Réseau Mondial.*—The annual volume of data known as the *Réseau Mondial* contains summaries of observations of pressure, temperature and precipitation for the whole world. The volume for 1932 was published in 1939. Work on later years was suspended during the war, but the volume for 1933 is now nearly complete.

(c) *Naval handbooks.*—In co-operation with the Naval Meteorological Branch of the Admiralty, the preparation of handbooks dealing with the weather of various Naval stations was continued. The Handbook for the Home Station was completed during the war. Another volume entitled "Weather on the west coast of tropical Africa" is awaiting publication.

(d) *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.

(e) *Special work.*—The drive for the extension of exports has resulted in a large number of inquiries into climatological conditions in all parts of the world, especially in the tropics. Interest was chiefly centred in the effects of great heat or the combined effects of high temperature and high humidity on various pro-

ducts. A study was therefore made of the temperatures likely to be reached within enclosed surfaces of different colours exposed to strong sunshine, and of the factors which lead to deterioration, rusting and moulding. A report on the results obtained was published in the *Quarterly Journal of the Royal Meteorological Society*, 72, 1946, pp. 87-97, and included a world map of the deterioration factor.

Tables of average temperatures and humidity were prepared for about 900 places in all parts of the world. These have been issued to commercial firms and research institutions in response to requests for such data.

Theoretical and statistical investigations are in progress into the diurnal and annual variation of the amount of water vapour in the lowest layers of the atmosphere in different parts of the world. This study has been undertaken to assist exporters in the problem of condensation in packages.

The suitability of various sites for airfields and the world distribution of rainfall and maximum gust velocities have been investigated in connexion with the development of aviation (see § 3 (II), p. 21).

Climatological data giving the average conditions during May in Nigeria and Brazil along the track of the solar eclipse of 1947 have been supplied to the Astronomer Royal.

### (3) Upper air observations

During the war there was a great increase in the number of observations of temperature, humidity and wind in the upper air, including direct observations by meteorological flights, radio-sondes and wind measurements by radar. In order to make these records available for study, a small section, "upper air statistics," was formed in the Climatology Branch.

On a special form, temperature is tabulated against humidity for each month for a variety of pressure levels from the surface to 300 mb. while the temperature summary alone extends to the level of 40 mb. (about 72,000 ft.). Another form is used for analysing wind direction in steps of 10 degrees against wind velocity in steps of 10 knots.

Five-year summaries of all the data available, from stations in the British Isles or elsewhere, are being prepared on each of these forms, and are already proving of great value in answering inquiries.

Useful data concerning the meteorology of the Antarctic are expected to be obtained from a radio-sonde station set up in 1946 in the Falkland Islands and from observations being made on the whaler *Balaena* during the southern summer of 1946-7 by a member of the scientific staff of the Office.

**(a) Inquiries.**—Most of the inquiries received were from Government departments, aircraft corporations and aircraft manufacturers. Information requested consisted of frequencies, means and extremes of temperature and humidity at all heights in many regions, heights of freezing level, frequencies of wind speed and deviation, variation of wind speed with time and place, and the composition of the atmosphere at high levels.

### (4) Marine Climatology

Information regarding the meteorological conditions over the oceans is obtained primarily through the co-operation of the Merchant Navy, although valuable returns are also supplied by the Royal Navy. The Marine Branch of the Meteorological Office is responsible for securing the co-operation of the Commanders and Officers of the Merchant Navy and for their organization in the Voluntary Corps of Marine Observers.

For security reasons the logging of meteorological observations by merchant vessels was discontinued during the war, but close contact was maintained with the observing fleet through the Merchant Navy Agents and the Port Meteoro-

logical Office at Liverpool. The recording of meteorological observations at synoptic hours was resumed on November 1, 1945, and since then every effort has been made to increase the number of ships in the observing fleet, and the scheme has been extended to include Empire shipping. At the start of the war there were about 310 ships available to start observing as "selected" ships and 203 "supplementary" ships. The number of "selected" ships has increased to well over 400, and there are also 79 "MARID" ships which make observations of sea temperatures in Home Waters. Two lighthouses abroad and 6 light vessels or coast stations in Home Waters, which continued to return observations during the war, have maintained this service during the period under review. The observation of surface currents by ships has been resumed, and since July, 1946, a monthly average of 28 report forms has been received by the Branch.

**(a) Analysis of observations.**—The statistical analysis of the data obtained from ships is carried out by the Hollerith process. The observations from the logbooks are transferred to cards of 80 columns by punching holes in positions according to a definite plan. A large increase in the amount of data available for analysis has taken place in consequence of the receipt of copies of all German marine-meteorological and surface-current Hollerith cards from the Deutsche Seewarte, Hamburg. In all there are about 7,000,000 of these cards.

The punching on cards of all data referring to the extreme north of the Atlantic has been completed. Detailed charts of sea temperature in Australian and New Zealand waters have been prepared, and progress is being made on similar charts for the waters adjacent to the southern half of the African continent.

The sections relating to currents and ice in ten Admiralty Pilots have been re-written, and work is proceeding on the computation and charting of currents over a large area comprising the western half of the South Pacific and the extreme eastern part of the South Indian Ocean.

Other activities have included a study of the diurnal variation of fog in certain regions of the North Atlantic; a preliminary investigation of the relation between the direction of surface winds and that of the pressure gradient in the tropics; a note on the storm of July 3, 1946, in southern England and its connexion with the tidal wave which occurred at approximately the same time in the western part of the English Channel; and an analysis of records of wind and swell in the neighbourhood of the Falkland Islands.

**(b) Special work.**—The "Marine Observer's Handbook" has been revised and a new edition will be published shortly. A textbook of meteorology for sailors is in course of preparation.

A portable cloud searchlight has been tested at sea, and the question of the use of rockets for determining cloud heights at sea is being examined. Some merchant ships are assisting in an investigation into the humidity of cargo holds.

Short courses in meteorology have been given to instructors and members of Nautical Training Schools.

**(c) Inquiries.**—Some 70 inquiries in connexion with arbitration arising out of casualties at sea have been dealt with.

## § 5. WORK OF THE OBSERVATORIES

### (1) Kew Observatory

**(a) Meteorological observations and records.**—The normal meteorological observations made for standardization, synoptic and climatological purposes were carried out. The self-registering instruments provided satisfactory

records. A distant reading mercury-in-steel thermograph has been in operation since November, 1946 ; improved results were obtained from the Dines-Shaw microbarograph after it was rebuilt in July, 1946. Examination of the records from the barographs and seismographs at relevant periods showed no effects of the atomic explosions in Japan and in the Pacific.

The standard records have been reduced and the tabulated material for the *Observatories' Year Book* is up to schedule.

**(b) Measurement of radiation.**—The Gorczynski pyrheliometer record of direct solar radiation was maintained, and standard observations were made with the Ångström pyranometer in cloudless conditions. In June, 1946, recording of the total and diffuse radiation received on a horizontal surface was begun, using two solarigraphs, one of which was shaded from direct radiation. The measurement of direct solar radiation in certain spectral regions is planned and the apparatus for this purpose is being constructed.

The accuracy of the Dines and Linke-Fuessne radiometers, when used for measuring long-wave radiation, has been tested and found satisfactory. Measurements with these instruments have been used to determine revised values for the emissivity of water vapour. There is some evidence that the atmospheric radiation can be considered in two parts, one, which is due to water vapour and carbon dioxide and is computable, and the other, which may amount to 10 per cent. of the total, which is due to other radiation and is not computable.

**(c) Atmospheric electricity.**—Continuous records of potential gradient, charge on rain and discharge from an artificial point have been maintained. Attempts have been made to record the currents flowing in a live tree ; results so far indicate that discharge takes place at about the same time as from the artificial point, but with only one tenth of the amplitude.

**(d) Seismology.**—Over 440 earthquakes have been recorded in the period. The vertical ground movement at the Observatory on November 27, 1945, following an earthquake west of Karachi, was 1·8 mm. This shock caused an exceptional seismic seawave about which a report was submitted to *Nature*.\* The issue of a monthly bulletin of earthquakes has been resumed.

A special investigation was made of the Burton-on-Trent explosion which occurred on November 27, 1944. In addition to the seismic waves, two sound waves, one direct and the other via the stratosphere, were recorded.

The preparation of the *International Seismological Summary* formerly carried out at Oxford, was transferred to Kew on January 1, 1947, pending the finding of suitable accommodation at Cambridge.

## (2) Eskdalemuir Observatory

**(a) Meteorological observations.**—Routine weather reports have been made at all synoptic hours, and observations for standardizing purposes were made regularly at 0900, 1500 and 2100. Until September, 1945, when the instrument ceased to be available, the amount of ozone in the atmosphere was measured three times daily with the Dobson spectrophotometer. 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 a week. All magnetic storms during the period were completely recorded. In one on February 7 and another on April 7, 1946, the range in H exceeded any values previously reported.

\* See *Nature, London*, 158, 1946, p. 63.

Hourly values of declination were contributed to weekly mining journals, and prints or tracings of magnetic records were supplied on request. Notification of magnetic disturbances exceeding certain limits were sent to the National Physical Laboratory, while the Observatory received from the Astronomer Royal notice of sunspot activity likely to be associated with magnetic disturbances.

(c) **Atmospheric electricity.**—Autographic records of potential gradient were maintained throughout the period and absolute determinations were made at regular intervals. The records have been tabulated for the *Observatories' Year Book*.

### (3) Lerwick Observatory

(a) **Meteorological observations.**—Synoptic observations were made every hour and the usual autographic records maintained. Routine upper air soundings for the determination of winds, temperatures and humidity were made daily at 0000, 0600, 1200 and 1800 G.M.T. From October, 1946, there was a considerable improvement in the accuracy of the upper wind observations owing to the substitution of radar technique for the radio direction-finding method.

(b) **Terrestrial magnetism.**—Character figures and 3-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 Inter-Service Ionospheric Bureau.

Suspected anomalies between the various Observatory standards were the subject of an inter-Observatory comparison of H and V standards made at Lerwick, Eskdalemuir and Abinger during August and September, 1946.

### (4) Aberdeen Observatory

Work has proceeded on the customary lines, the routine remaining unchanged.

Long-period monthly averages of temperature in the north wall screen were computed for the years 1906 to 1935. The Jardi rate-of-rainfall recorder has been made more sensitive and rates of fall as low as 2 mm./hr. are consistently observed.

## § 6. METEOROLOGICAL RESEARCH

### (1) Organization for research

(a) **Meteorological Research Committee.**—Shortly before the war steps were taken to form a Meteorological Research Committee, but it was not until 1941 that it actually came into existence. The Committee is a part of the Air Ministry, its members being appointed by the Secretary of State for Air, and the official terms of reference are :—

(i) To advise the Secretary of State for Air as to the general lines along which meteorological research should be developed.

(ii) To advise and assist in the carrying out of investigations and research within the Meteorological Office.

(iii) To receive reports upon meteorological investigations carried out in the Meteorological Office or on behalf of the Air Ministry, and to make recommendations for further action.

(iv) To co-ordinate the investigations performed in the Meteorological Office with related activities carried out elsewhere, both in this country and abroad.

The members of the Meteorological Research Committee are the following :—

Chairman :—Professor S. Chapman, F.R.S.

Members :—Professor G. M. B. Dobson, F.R.S. (Vice-Chairman).

Professor D. Brunt, F.R.S.

Professor Sir Geoffrey Taylor, F.R.S.

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

The Director of the Meteorological Office.

The Director of the Naval Meteorological Service.

The Director of Scientific Research (Air), Ministry of Supply.

A representative of the Air Staff.

A representative of the Ministry of Civil Aviation.

During the period of this Report, 12 meetings of the Committee have been held, and over 80 technical memoranda covering a wide field have been considered.

Within the Meteorological Office the co-ordination of research and the task of liaison with outside bodies are centralised in an Assistant Directorate of Research. The Assistant Director (Research), who also controls the Instruments, Climatology and Marine Meteorology Branches, is assisted at headquarters by a Branch which is charged with the administration of Observatories and other stations concerned with research, and with the secretariat of the Meteorological Research Committee and of the Joint Meteorological Radio-Propagation Committee.

The general scheme of research is formulated by the Meteorological Research Committee and carried out under their guidance. The programme is reviewed annually and priorities are allotted to proposed investigations according to their urgency. There is not yet a general pool of research staff in the Meteorological Office, and items for research are therefore assigned as far as possible to Branches. For some problems assistance is sought from other research organizations, such as the National Physical Laboratory, the Telecommunications Research Establishment of the Ministry of Supply or the Universities.

**(b) Joint Meteorological Radio-Propagation Sub-Committee.**—In February, 1943, a joint Sub-Committee of the Meteorological Research Committee and of the Ultra-Short-Wave Propagation Panel was formed to co-ordinate investigations into the relationship between meteorological factors and the propagation of radio waves. Since the end of the war seven meetings have been held and about 30 separate papers have been considered.

In the early days of its existence, the Sub-Committee was primarily concerned with the phenomenon of super-refraction, which was of great operational importance. The range of ultra-short-waves is dependent upon the meteorological structure of the lower atmosphere, and may greatly exceed the normal under certain conditions. At present the broad outline of the cause of the phenomenon is known, but much remains to be discovered before the range of a particular radio equipment in specified meteorological conditions can be assessed accurately. Experiments to gain this knowledge had been planned to take place on Lough Neagh in Northern Ireland during 1946, but were postponed when an appeal was received from New Zealand for the loan of equipment to carry out similar trials. Only one set of this equipment was available, and it appeared that the New Zealand site would prove more suitable for these experiments than any that could be found in the United Kingdom. The equipment was therefore sent to New Zealand.

The detection of clouds by means of radar is another problem which is being investigated by the Sub-Committee. The importance of this problem arises from the fact that certain clouds (*e.g.*, cumulonimbus) may be dangerous to aircraft, with a risk of icing and of strong vertical currents which may fracture the airframe. In the autumn of 1946 the Royal Air Force radar station at East Hill was acquired for meteorological research. Observations with the radar equipment will be continued with an examination of the size of water drops and other characteristics of individual clouds. As a result, it is hoped to learn what meteorological conditions are necessary to make possible the detection of cloud and precipitation by radar (see § 6 (2) (e), p. 31).

(c) **Co-ordination of research.**—Close liaison has been maintained with other Government Departments and with the meteorological organizations of the Dominions and foreign countries. In Australia and India Meteorological Research Committees have already been formed, whilst Canada, New Zealand and South Africa all have plans under discussion for the prosecution of research in meteorology. Selected reports of the Meteorological Research Committee (Air Ministry) are sent to the United States, Canada, Australia, New Zealand, South Africa, India, Rhodesia, Malaya and Hongkong.

Since the termination of hostilities, special attention has been given to collaboration with the Dominions. A special meeting of the Committee was held in March, 1946, to which were invited the Directors of the Meteorological Services who were attending a Conference of Empire Meteorologists held in London at that time.

(d) **Collaboration with the Royal Society.**—At the time of its formation the Meteorological Research Committee decided to invite the Royal Society to undertake certain investigations of a fundamental character. The Royal Society entrusted the supervision of this work to the Gassiot Committee. The Treasury has recently sanctioned an expenditure of £4,000 per annum for five years on these problems, which include examination of the variability of solar radiation, measurement of the ultra-violet absorption coefficients of oxygen and nitrogen, study of the infra-red absorption of water vapour and carbon dioxide, and a continuation of the work on ozone. The last will comprise an extension of the observations to arctic and equatorial regions, and the correlation of ozone values with the synoptic situation.

(e) **Meteorological Research Flight.**—During the latter part of the war the Meteorological Research Flight operated at the Royal Air Force station, Boscombe Down, with the High Altitude Flight. In August, 1946, it was transferred to the Royal Aircraft Establishment at Farnborough, and the strength of the Flight was increased to 2 Halifax and 2 Mosquito aircraft.

Most of the available effort has been devoted to examining conditions in the stratosphere, especially the distribution of humidity. Special instruments have had to be designed for this work, and a stage has now been reached when a number of instruments are under construction.

## (2) Current research problems

Important progress has been made in connexion with a number of aviation problems and problems related to forecasting and in the development of meteorological instruments. A brief account of the more important developments in each of these fields is given below :—

(a) **Aviation problems.**—A study has been made of the conditions in the atmosphere at heights between 20,000 and 40,000 ft. from the point of view of

their bearing on long-distance flights. In particular, information, both theoretical and observational, has been obtained on the wind speed and direction at these levels.

Attention has also been paid to the problem of computing the navigational route which will enable a long-distance flight to be performed in the minimum of time under a given set of conditions of pressure distribution. The conclusions arrived at are to be tested practically.

A "Meteorological handbook for airfield designers" has been prepared, discussing the factors which affect the siting and design of airfields. It is hoped that the printed version of this report will be available shortly.

Meteorological problems of great practical importance are the degree of gustiness and the rate of ice accretion to be expected under various meteorological conditions. The maximum value of these two quantities are of special importance as affecting aircraft construction and the design of de-icing equipment, but the study of these two meteorological factors presents a number of practical difficulties. Special efforts are being made to obtain the required information as quickly as possible, and a special Panel of the Meteorological Research Committee has been charged with prosecuting this research.

The results of all these investigations are communicated to the Service and Civil Aviation authorities as soon as they become available.

**(b) Forecasting problems.**—Investigations connected with forecasting have included a study of the smoke distribution throughout the United Kingdom in relation to industrial centres and the rate of combustion of coal for domestic purposes. The report is being published.

A physical investigation into the exchange of heat between the air and ground is also in progress, and is of importance as affecting the formation of both fog and low cloud.

Mathematical investigations into the structure and behaviour of cyclones have been carried out, and a long term study of conditions in the stratosphere as affecting the thermal balance and consequent pressure distribution within the atmosphere.

The information and experience acquired during the war of meteorological conditions in the tropics have been made the subject of a critical examination. Whilst this has assisted in clarifying the technique of forecasting in the tropics, it has also brought to light a large number of problems peculiar to the tropics, which still require investigation. Steps have been taken to arrange for the investigation of many of these problems, either by Dominion, Colonial or foreign meteorological services.

Work has commenced on an exploration of the feasibility of making forecasts of the conditions beyond the 24 to 48 hours covered by normal forecasts. The problem is necessarily a complicated one, and rapid progress must not be expected.

**(c) Development of meteorological instruments.**—The problem of determining air temperature accurately from aircraft has now been met by the development of a distant-reading electrical-resistance thermometer employing a balanced Wheatstone bridge. It enables the air temperature to be measured with an accuracy of 1°F.

The Dobson-Brewer frost-point hygrometer for the determination of humidity from an aircraft has been improved in a number of details and has been manufactured by a commercial firm. Two models are available, one for high-flying aircraft with pressure cabins and the other for ordinary aircraft. A number of the latter models have been fitted to meteorological aircraft. Work is

continuing with a view to reducing the time and attention required in making an observation with this type of instrument.

Considerable attention has been devoted to the design of a precision radio-sonde for the purpose of measuring temperature, pressure and humidity at heights above those attainable by aircraft and with a greater accuracy than that of the standard radio-sonde at present available. The design adopted differs fundamentally from that of the present standard instrument and experimental models are now ready for test. This work has been carried out in conjunction with other work designed to improve the accuracy of the measurement of winds at great heights with radar equipment. This has involved the design of a special balloon-borne transmitter. The experimental model of this transmitter is nearing completion.

The measurement of cloud height in daylight by means of a searchlight employing pulsed light is now an accomplished fact. The maximum range (15,000 ft.) to which this searchlight will operate is satisfactory, but further work is necessary in order to meet the requirement of minimum cloud height (4,000 ft.).

Sets of equipment for measuring visibility at night by means of fixed lights and photo-electric cells are in course of production according to designs worked out in earlier investigations.

**(d) Research work at Rye.**—It has already been mentioned that the propagation of very short radio waves is influenced by the structure of the lower atmosphere. The two most important factors are the vertical gradients of temperature and humidity, and in 1943 it was decided to install apparatus on a lattice tower at the Royal Air Force station at Rye to record these quantities continuously up to a height of 350 ft. Equipment for measuring the vertical gradient of wind velocity at heights up to 360 ft. was added in May, 1945.

The records which have been accumulated on the vertical gradient of humidity are believed to be unique. Temperature gradient records similar to those obtained at Rye have been made elsewhere, but the Rye records provide humidity data for the first time. Sufficient material has now been collected to give statistical means of the elements, and will be embodied in a preliminary report which is being prepared. The results are expected to prove of great value in the application of meteorology to agriculture and other purposes, in addition to assisting in a solution of the problem of short-wave radio propagation.

**(e) Research work at East Hill.**—The A.M.E.S. type 21 radar station at East Hill is the site of investigations into the detection of clouds and precipitation by means of radar. The production of radar echoes by water drops suspended in the atmosphere is understood to a considerable extent, and much theoretical work has been done on the relation between the strength of the echo and the composition of the cloud or precipitation producing the echo. Experimental confirmation of the theory is, however, required before the potentialities of this new method of observation can be exploited to the full.

**(f) Agricultural meteorological research.**—In April, 1945, the Meteorological Research Committee recommended a programme of research on certain meteorological problems affecting agriculture. In June, 1946, after preliminary discussions with Sir Frank Engledow, Professor of Agriculture at Cambridge University, an officer was posted to the School of Agriculture at Cambridge to investigate some of the fundamental problems.

The first investigation takes the form of an experimental study of the exchange of water vapour between the ground and the air. For this work it has been necessary to design and construct special equipment.

Reference has already been made (see § 4 (1) (c), p. 23) to the measures adopted

for maintaining contact with the agricultural community on the more practical and applied problems which arise from their everyday work.

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

(i) Development 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) Improvement in accuracy of weather forecasting beyond 24 hours ahead.

(iv) Investigation of the microphysics of water in the atmosphere, particularly in relation to ice accretion on aircraft.

(v) Investigation of water content of troposphere and lower stratosphere under various conditions.

(vi) Investigation of problems of agricultural meteorology.

(vii) Investigation of conditions governing the radar detection of clouds and precipitation.

(viii) Investigation of problems of tropical meteorology.

**(h) Publications.**—A list of meteorological research papers, the publication of which has been authorised, is shown in Appendix V.

## § 7. STAFF

### (1) War-time grades and strength

From 1935 to 1939 the staff of the Meteorological Office had been composed of the grades approved by the Treasury in accordance with the Report made in 1930 by the Committee on the Staffs of Government Scientific Establishments (the Carpenter Committee). There were two main classes—Technical Officers and Assistants.

The large numbers of staff needed during the war were recruited in two temporary classes known as Meteorologist and Meteorological Assistant. Broadly, a Meteorologist I was equivalent to a Technical Officer or Assistant I, while a Meteorologist II had responsibilities similar to those of an Assistant II. Meteorological Assistants were employed on the same type of work as Assistants III.

Early in 1939, a Meteorological Branch of the Royal Air Force Volunteer Reserve had been formed, recruitment being mainly from outside the Meteorological Office, although a small number of staff also joined the Branch. In 1942 it was found necessary to mobilise into the R.A.F.V.R. permanent and temporary civilian staff posted to units of the fighting forces overseas, and to certain units at home. Considerable numbers of women were also recruited into the Meteorological Service during the war, the majority forming a specialised section of the Women's Auxiliary Air Force.

Establishments were maintained on a civilian basis throughout, and Service ranks were equated with civilian grades according to the following table :—

Civilian Grade				Service Ranks (Meteorological Branch)	
				R.A.F.	W.A.A.F.
Principal Technical Officer	...	...	...	Group Captain	—
Senior Technical Officer	...	...	...	{ Wing Commander Squadron Leader	—
Technical Officer } Assistant I Meteorologist I	...	...	...	Flight Lieutenant	Flight Officer
Assistant II } Meteorologist II	...	...	...	{ Flying Officer Pilot Officer	{ Section Officer Asst. Sect. Off.
Assistant III } Met. Assistant	...	...	...	{ Warrant Officer Flight Sergeant Sergeant Corporal L.A.C. A.C.1 A.C.2	{ Warrant Officer Flight Sergeant Sergeant Corporal L.A.C.W. A.C.W.1 A.C.W.2

By August, 1945, the bulk of the Air Ministry meteorological staff were in uniform, the numbers, excluding industrial employees, being :—

Officers	...	...	...	Civilian	Male	255	
					Female	39	
				Service	Male	1,463	
					Female	165	
							1,922
Assistants	...	...	...	Civilian	Male	63	
					Female	179	
				Service	Male	2,673	
					Female	1,758	
							4,673
Clerical and Minor Grades				Civilian			165
							Total
							6,760

Since the end of the war, Service personnel have been released in accordance with the age and length of service scheme. Civilians who were mobilised after their entry into the Meteorological Office were allowed to count their civilian service during the war in calculating their release groups. It was also arranged that temporary civilians should be released on a similar plan. By the end of March, 1947, the numbers of staff in the various categories were :—

Officers	...	...	...	Civilian	Male	667	
					Female	26	
				Service	Male	154	
					Female	13	
							860
Assistants	...	...	...	Civilian	Male	291	
					Female	191	
				Service	Male	1,124	
					Female	160	
							1,766
Clerical and Minor Grades				Civilian			157

## **(2) Meteorological air observers**

A small section of the General Duties Branch of the Royal Air Force had been formed in September, 1942, to provide personnel to make observations from meteorological reconnaissance aircraft. During the period of this report there was no recruitment to this section, and the strength fell from 38 officers and 137 airmen to 7 officers and 77 airmen.

## **(3) Reversion to peace-time grades and strength**

It was decided that the provisions of the Government White Paper (Cmd. 6679), incorporating the recommendations of the Committee presided over by Sir Alan Barlow, should be applied to the Meteorological Office. The new grades and revised scales of pay were introduced on January 1, 1946, and central recruitment through the Civil Service Commission replaced recruitment by the Department.

Scientific staff are divided into two classes, a Scientific Officer class and an Experimental Officer class, which are roughly equivalent to the former Technical Officer and Assistant classes. It is intended that the number of Scientific Officers shall be restricted, and that they shall concentrate upon purely scientific work, Experimental Officers becoming responsible for much of the routine work formerly done by Technical Officers. The number of higher scientific posts and the salary scales attaching to them, are to be increased. By this means the ultimate prospects for scientific officers should be improved, and it is hoped to attract men of the highest attainments.

Of the established staff 434 members have been assimilated, 104 in the Scientific Officer class and 330 in the Experimental Officer class. Among officers holding temporary posts, 93 were selected for nomination by the Civil Service Commission, and 82 of these have been offered established appointments. Assignments to the Meteorological Office have been made by the Civil Service Commissioners from successful candidates in the Reconstruction Competition. On March 31, 1947, 15 in the Scientific Officer class and 47 in the Experimental Officer class had accepted appointments.

In addition to the reorganization and recruitment of staff made necessary by the White Paper, efforts have had to be made to maintain an adequate number of Meteorological Assistants. Conditions of service for a new Ancillary class to be known as the Assistant (Scientific) class have been agreed. This class will undertake the duties which in the past have been performed by Assistants III and Meteorological Assistants.

## **(4) Training of staff**

**(a) Meteorological Office Training School.**—Experience has shown that all new staff, whether officers or subordinates, require some special training in meteorology. The Meteorological Office accordingly has established a Training School at which suitable courses are given, not only to new entrants but also to specialists, in certain branches of the work.

**(b) Training of forecasters.**—Courses continued after the end of hostilities with no substantial change of syllabus. They continued to aim at producing competent forecasters in the shortest possible time, and theoretical work was limited to the simplest and most direct study of essentials. The 15 weeks' course at the Training School was divided into three parts: about a fortnight spent on the routine work of an assistant; four or five weeks consisting largely

of theoretical work ; and the remainder of the course mainly on chart analysis and forecasting (both written and oral), using current synoptic data most of the time.

The instruction was brought up to a total of six months by further training at outstations since it was necessary to supplement the work at the School by actual experience on stations under the supervision of trained forecasters.

**(c) Courses for assistants.**—Training School courses for assistants lasted for six weeks, followed by an approximately equal period of training at an outstation. The course was an intensive one covering the following subjects : observing, chart plotting, upper air codes and plotting, measurement of upper wind by pilot balloon (single theodolite, with and without tail), and sufficient theory to explain the routine work and provide a basis for later reading.

The first four weeks were largely occupied with learning new material, the real practice in using it coming in the fifth and final weeks. One or both of these weeks were spent on a close approximation to station routine, sometimes in conjunction with a class of forecasters.

**(d) Courses for officers of the Merchant Navy.**—Five courses were held in 1946 for Merchant Navy Officers and Instructors at Merchant Navy Schools, each lasting one week. On the observing side, the aim was to discuss the finer points of observing, and lectures were given to show how greatly the forecaster depends on good observations from ships. The Atlantic weather bulletin was studied to show how the seaman could make the best use of his meteorological knowledge. The course included visits to the Marine Branch and Forecast Branches.

**(e) Courses for upper air observers.**—(i) *Meteorological air observers.*—During the period under review, three courses of training were provided by the Royal Air Force for four officers of the Meteorological Air Observer Section of the General Duties Branch, Royal Air Force, and for 12 N.C.O. Meteorological Air Observers, thus bringing this section up to strength. Subsequent losses by release from the Royal Air Force were offset by a corresponding reduction in flying.

(ii) *Radio-sonde courses.*—Training courses in radio-sonde duties lasting eight weeks were provided at Downham Market for Assistants II, Meteorologists II or Flying Officers. Other courses in junior radio-sonde duties were provided for Assistants III, Meteorological Assistants and airmen, lasting six weeks each. The school was closed last year, and training is now provided by the operational unit at Downham Market.

(iii) *Radar courses.*—Arrangements were made for the training of a number of Meteorological Office personnel in the use of the Army apparatus which had been adapted as a radar theodolite for the measurement of upper winds. The courses were held at War Office Training Schools, and lasted 13 weeks for personnel of officer status, and 14 weeks for Meteorological Assistants and airmen.

## **(5) Resumption of staff discussions**

In 1905 Sir Napier Shaw initiated the custom of holding during the winter months a series of Monday evening discussions, at which members of the staff and others interested in meteorology discussed scientific papers. By this means, staff at outstations were able to keep abreast of developments in meteorological theory and practice, and were brought into contact with important research papers. The first meeting of the post-war series took place at the Air Ministry on February 10, 1947, when Dr. R. C. Sutcliffe opened a discussion on a paper

entitled "Forecasting the weather with the aid of upper air data" by V. J. Oliver and M. B. Oliver of the University of Chicago. Further meetings were held on March 3 and March 31, 1947.

## § 8. INSTRUMENTS

### (1) Location and accommodation

At the end of August, 1945, the Instruments Branch was transferred from its war-time location at Wycliffe College, Stonehouse to Harrow. The space available for stores at Harrow is inadequate, and extra space is to be provided in huts which are now being built.

### (2) Provision and production of equipment

The number of contracts placed, through the Directorate of Contracts (for items expected to cost more than £250) up to the end of January, 1947, was 118. The expenditure during the year 1946-7 was £185,000, and during the same period about £43,000 was received by the sale of equipment to Dominion and foreign governments and to private observers.

The extension of radio-sonde observations necessitated a modification of the arrangement for the manufacture of the radio-sonde Mark IA on a limited scale by three different contractors. Arrangements were made for the mass production of a Mark II model, and contracts were placed in September, 1945, for 50,000 instruments, of which 30,000 were to be made by the Salford Electrical Instrument Co. and 20,000 by Messrs. Whiteley, the former firm to undertake the calibration of the whole. A considerable amount of work was involved in arranging the production, and the first bulk deliveries (of uncalibrated transmitters) were received towards the end of 1946.

Parallel with this production the provision of 48 sets of ground equipment was arranged. Each set included a variable oscillator, an electrically controlled tuning fork, a radio receiver, a cathode-ray oscillograph and a control screen.

For wind-measurement by radar, arrangements were made for the transfer from the War Office of 45 radar sets A.A. No. 3, Mark II (GL.III), together with the necessary sets of spares, and contracts were placed for 15,000 radar "reflectors." The total number of sounding balloons purchased for radio-sonde and radar wind ascents was 57,000.

### (3) Issue of equipment and store accounting

A considerable quantity of used equipment was returned from a large number of meteorological offices at Royal Air Force stations which have closed down. On the other hand, 14 new Civil Aviation stations were issued with standard meteorological equipment.

The largest amount of work, however, resulted from the expansion of the radio-sonde programme, necessitating the supply of complete sets of equipment to 11 stations. Considerable difficulty was experienced in arranging for the shipment of GL.III radar sets, weighing 11 tons, to island stations such as Lerwick and Stornoway.

Regular supplies of stores have been issued to maintain overseas stations manned by Meteorological Office personnel, in particular to the Mediterranean

and Middle East, S.E.A.C., B.A.O.R. and British East Africa. Equipment was also issued in the autumn of 1946 to the British whaling factory ship *Balaena* which proceeded to the antarctic.

Supplies to private observers and to Dominion, Colonial and foreign governments are arranged on repayment terms. The total number of such demands dealt with in 1946 was 8,968, which may be compared with the average of 2,775 for the years 1929–33 and the peak figure 12,470 in 1944.

Inventories of stores in use at outstations and on charge to official observers have been maintained, and over 2,000 inventories relating to land stations and to merchant ships have been checked. Work not covered by the normal accounting routine included the liquidation of loans, made during the war, of large quantities of stores to the French and Belgian Governments.

#### (4) Testing and calibration

**(a) General instruments.**—The test rooms at Harrow form a block on the ground floor. The largest room houses most of the testing apparatus, one small room has been fitted up solely for testing balloons, another is used for visual inspection of instruments, while two rooms are used primarily as offices and card-index store. No fundamental changes in technique have been made. During the year 1946 the number of instruments (excluding balloons) tested was nearly 50,000, compared with the average number of 4,759 for the years 1929–33 and the peak figure of 61,360 reached in 1944.

**(b) Aircraft instruments.**—A Kelvinator “stratosphere” test cabinet was installed in 1945 in the main test room. With a temperature range of  $+100^{\circ}\text{F}$ . to  $-90^{\circ}\text{F}$ . and a pressure range of 1050 mb. to 10 mb., it is used for testing aircraft aneroid barometers and other instruments. The apparatus for calibrating aircraft resistance thermometers, balanced-bridge indicators and thermometer elements for various types of frost-point hygrometers is installed in a separate room and has been in constant use.

**(c) Radio-sonde, radio- and radar-wind instruments.**—The task of assembling, testing and calibrating Mark IA radio-sondes was transferred from Kew to Harrow between April and July, 1946. At the same time calibration in larger batches in the Kelvinator “stratosphere” cabinet was started. In August, 1946, the first batch of the Mark II radio-sondes was received from the manufacturers, and calibrations reached 1,000 a month by January, 1947.

Several radar mechanics were attached to the Instruments Branch in September, 1946, where they were trained as a squad which could visit GL.III radar-wind stations to carry out periodic overhauls and execute emergency repairs which were beyond the local staff. Some 15 other radar mechanics were given a course in GL.III maintenance.

**(d) Recovery and reconditioning of radio-sonde transmitters.**—This work was entirely undertaken at Larkhill radio-sonde station up to February, 1947, but its transfer to Harrow is expected to be completed by April, 1947. Roughly two thirds of the radio-sondes released in the United Kingdom are returned by finders, and about one half of these are reconditioned for further ascents.

#### (5) Design and development

**(a) General instruments.**—During the war the main effort of the development section was concentrated on meteorological instruments for aircraft, and on the application of radio technique to meteorology. More recently, attention has been given to marine instruments for use on the ocean weather ships, and to ground instruments urgently required at civil airports.

Marine instruments present a number of special problems arising from the motion of the ship, the vibration of the engines and the lack of an adequate base line for cloud searchlights. An anti-vibration mounting has been designed for the open scale barograph, and experiments are being made on a device to eliminate the short-period pressure changes caused by the ship's motion. A new sea-water bucket and thermometer is nearing completion, and a new method of maintaining an adequate supply of pure water to a wet-bulb thermometer is being tried.

For civil airports the two most urgent requirements are an instrument for measuring the height of the cloud base in day-time and a visibility recorder. For the first purpose two types of searchlights are under development ; the first uses a sinusoidally modulated beam of light which, on reflection from the cloud, is detected against the daylight background by a telescope—photo-cell—amplifier system which only amplifies the modulated light. In the second instrument, pulses of light, each of about 1 microsecond duration, are transmitted vertically, and the time taken for the pulse to travel from the lamp to the cloud and back to the detector is measured by a technique widely used in radar instruments. The bulk of the work on the latter instrument has so far been undertaken by the Telecommunications Research Establishment.

An experimental design for a visibility recorder has been developed. It involves the use of a lamp of constant brightness and a photo-cell which operates an indicating instrument. The work has reached an advanced stage, and 20 sets are on order from the trade.

Turning to other general instruments, work has proceeded on the problem of excluding air from the tubes of mercury barometers, on making pilot balloons suitable for tropical stations, on designing a more satisfactory anemograph pen and on developing a simpler remote-recording anemograph. For the last requirement, an impulse recorder invented by a member of the staff has been found satisfactory for recording wind speed in conjunction with a cup contact anemometer. The standard night-sky recorder has been improved prior to resuming the programme, interrupted by the war, of carrying out routine observations at a number of stations.

A sensitive ventilated psychrometer was designed for attaching to a barrage balloon for measuring the temperature and humidity lapse-rates in the lower layers of the atmosphere. Earlier work of this nature had shown that the ventilation in the clockwork Assmann psychrometer was inadequate, and some attempts have been made to overcome this by installing a more powerful spring. A hand-operated fan is also being tried.

**(b) Aircraft instruments.**—The chief emphasis in aircraft instruments has been on the measurement of humidity. The balanced bridge electrical thermometer introduced during the war has been successfully adapted for use as a psychrometer, which gives satisfactory readings of humidity when the air temperature is above  $-10^{\circ}\text{F}$ . For lower temperatures the frost-point hygrometer designed by Dr. Dobson and his colleagues has been put into production in two models, one for use in ordinary aircraft and the other in "pressurised" aircraft. A photo-electric model is now being developed.

An instrument is also being designed for measuring photographically the size distribution of raindrops from an aircraft. This has important bearings on the problems of aircraft icing and radar responses from clouds.

**(c) Radio-sonde and radio-wind instruments.**—This side of the development programme has been carried out in close collaboration with the Directorate of Communications Development, Ministry of Supply. Good progress is being made on the development of a radio-sonde theodolite system for combined radio-sonde and radio-wind measurements. As a result of aircraft

trials it was decided to change from a sinusoidal to a pulse method of determining the range of the airborne transmitter.

The GL.III has been adopted, with one or two modifications, as the standard instrument for routine measurement of upper winds. The metallised-paper "corner reflectors" used with this equipment cause a considerable drag on the ascending balloons, besides being very bulky for storage and transport. A collapsible gauze reflector of either fine knitted wire or metallised nylon is therefore being developed.

With regard to accessories, substantial improvements have been made in the design of the radio-sonde control screen, the launching mast and the radar wind plotting table. Balloons are being developed to reach heights of 100,000 ft. and the use of special dyes to improve their performance in tropical sunshine is being investigated.

#### (6) Specifications and instrument instructions

(a) **Specifications.**—In addition to producing some 21 new specifications, 8 old specifications have been revised and brought up to date. They have been distributed to the Colonies and Dominions.

(b) **Instrument instructions.**—Instructions are prepared for the installation, maintenance and operation of each new instrument, and old instructions are revised to incorporate improvements suggested by experience. A total of 14 instructions was completed during the period.

### § 9. LIBRARY AND PUBLICATIONS

#### (1) Library

In August, 1945, the library was moved from Stonehouse (Glos.) to Harrow.

The international traffic in meteorological literature, which was suspended during the war, developed rapidly when hostilities ceased. The library received vast quantities of publications from Germany and consignments of varying sizes from most other European countries as well as from parts of the British Empire and North and South America. Many important additions have been made to the library and many gaps filled in the records for the years 1939–45. The collection of photographs has increased by some 400 prints, mostly of cloud photographs taken from aircraft of Bomber and Coastal Commands.

Borrowings from the library have been on a scale exceeding five times the figures for pre-war years.

Inquiries from many parts of the world have covered a wide range of subjects. Technical and bibliographical details have been supplied on such subjects as stratosphere ascents in the tropics, the mathematical treatment of air flow above and around heated areas, the scattering of radiation and drop sizes in cloud.

#### (2) Publications

During the war, accounts of researches and similar papers were not published but were reproduced for internal circulation within the Office in the form of Meteorological Office memoranda. There is a considerable amount of material, much of it original research, awaiting publication. Although authority has been received for the resumption of publication of some of the pre-war series, it will be some time before arrears are overtaken.

The *Meteorological Magazine* is to re-appear shortly with the number for January, 1947. It is intended that the magazine shall eventually be issued on the first day of each month. Publication of the *Marine Observer* will be resumed with the edition for July, 1947.

Appendix V gives a list of the Meteorological Office papers which are to be issued as official publications by His Majesty's Stationery Office and a list of papers by members of the staff which have been approved for communication to a scientific society with a view to publication.

## § 10. INTERNATIONAL CO-OPERATION

### (1) International Meteorological Organization

The International Meteorological Organization was formed in 1872, and, apart from interruptions caused by wars, has functioned continuously since then. The organization aims at developing and co-ordinating the meteorological activities of the world, including the standardization of meteorological observations, the rapid exchange of weather information, the publication of meteorological statistics and the application of meteorology to aviation, agriculture, marine navigation and other economic purposes.

The International Meteorological Organization functions through a Conference of Directors, composed of Directors of Meteorological Services of practically all nations and the Directors of certain meteorological institutes. The International Meteorological Committee consists of 25 members elected by the Conference of Directors, together with the Presidents of the Technical Commissions, whilst there are six Regional Commissions which correspond broadly with the continents, and ten Technical Commissions.

Hitherto, the status of the International Meteorological Organization has been little more than that of a voluntary association, but steps are being taken to place the Organization on a more official footing by means of an International Convention. The Organization collaborates with other international bodies whose work is related to meteorology, such as the Provisional International Civil Aviation Organization (P.I.C.A.O.), the International Union of Telecommunications and the International Ice Patrol Service.

At the end of the war several urgent tasks faced the International Meteorological Organization. The advances made by the intensive meteorological activity during the war and the development of long-range flying made it necessary to establish new international procedures and to regain the uniformity that had been lost in the war. An extraordinary Conference of Directors was therefore called, and this took place in London from February 25 to March 2, 1946. The following members of the Meteorological Office staff were elected officers of the Organization :—

*President of the International Meteorological Committee*  
Sir Nelson Johnson

*President of the Commission for Synoptic Weather Information*  
Mr. E. Gold

*President of the Commission for Maritime Meteorology*  
Cdr. C. E. N. Frankcom, R.N.R.

*Aerological Commission*

Members : Dr. R. C. Sutcliffe  
Mr. C. H. B. Priestley

*Commission for Bibliography and Publications*

Members : Dr. A. H. R. Goldie  
Dr. C. E. P. Brooks

*Climatological Commission*

Members : Dr. A. H. R. Goldie  
Dr. C. E. P. Brooks

*Hydrological Commission*

Members : Dr. C. E. P. Brooks  
Dr. J. Glasspoole

*Commission for Instruments and Methods of Observation*

Members : Mr. C. K. M. Douglas  
Dr. F. J. Scrase  
Dr. J. M. Stagg

*Commission for Agricultural Meteorology*

Member : Mr. C. S. Durst

*Commission for Projection of Meteorological Charts*

Member : Mr. H. W. L. Absalom

*Commission for Synoptic Weather Information*

Members : Mr. E. G. Bilham  
Mr. S. P. Peters

*Commission for Aeronautical Meteorology*

Members : Mr. H. W. L. Absalom  
Mr. J. Durward

Meetings of the Commission for Aeronautical Meteorology, the Commission for Synoptic Weather Information and of the European Regional Commission were held in Paris during June and July, 1946, and were followed by a meeting of the International Meteorological Committee. At these meetings resolutions have been framed covering a wide field of applied meteorology and aiming at standardising procedures and securing efficient exchange of data. Meetings of all the Technical Commissions are to be held in Toronto during August and September, 1947, and a further Conference of Directors in Washington immediately afterwards.

## (2) Provisional International Civil Aviation Organization

The Provisional International Civil Aviation Organization (P.I.C.A.O.) was formed at the conference of 52 nations held in Chicago in November, 1944, to establish a world-wide convention for regulating international flying. The organization has a meteorological division whose function is to study, interpret and advise on the meteorological protection of international aeronautics. To avoid duplication, steps have been taken to co-ordinate the meteorological activities of P.I.C.A.O. with those of the International Meteorological Organization. It has been agreed that on questions of general meteorology, P.I.C.A.O. will accept the recommendations of the International Meteorological Organization, and both authorities will combine in the production of general regulations, applicable to all nations, specifying the meteorological arrangements for international aviation.

Representatives of the Meteorological Office have attended the meetings of the Meteorological Division of P.I.C.A.O., and regional meetings of P.I.C.A.O. held in Dublin, Paris, Washington, Cairo and Melbourne. At the Dublin meeting in March, 1946, the Meteorological Committee recommended the establishment of 13 ocean weather stations in the North Atlantic. In the following September a conference was held in London to discuss the arrangements for

these stations, and delegates from Belgium, Canada, Denmark, France, Iceland, Ireland, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom and U.S.A. took part. The United Kingdom undertook to finance and operate two stations, and to assist Norway and Sweden in operating a third.

A British organization closely concerned with the work of P.I.C.A.O. is the Commonwealth Air Transport Council which was formed in 1944 "to keep under review the progress and development of Commonwealth civil air communications." The Meteorological Office was represented at the meetings of this body in London in July, 1945, and at meetings of the South African Air Transport Conference and of the South Pacific Air Transport Council in Capetown and Melbourne respectively.

### **(3) International Union of Geodesy and Geophysics**

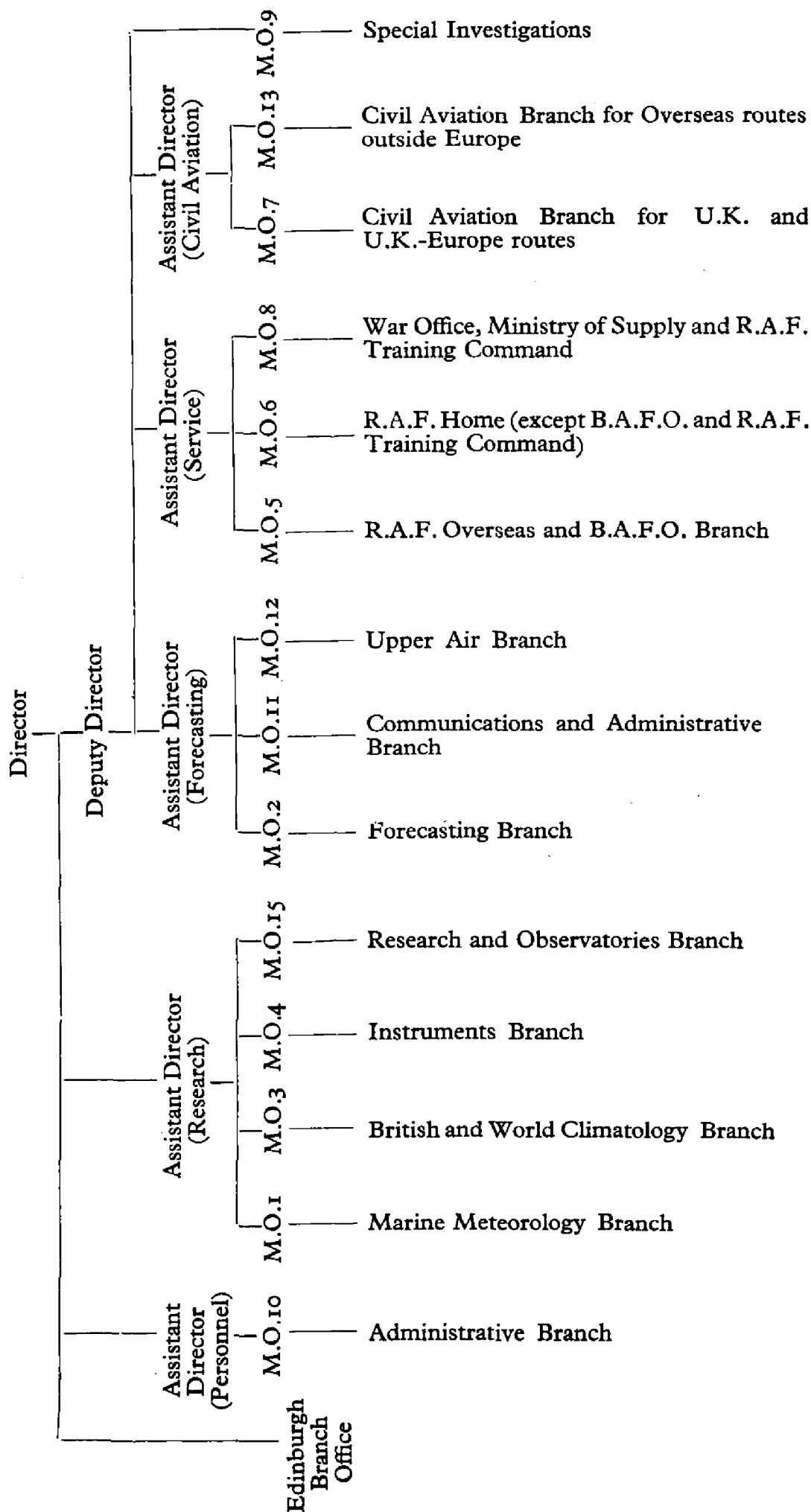
In 1919 an International Council of Scientific Unions was formed with the object of facilitating international co-operation in scientific research and of promoting the formation of international unions in different branches of science. Under the auspices of this Council, the International Union of Geodesy and Geophysics was created and, since meteorology is one of the principal branches of geophysics, the Meteorological Office has always played a prominent part in its activities.

As a first step towards the post-war resumption of international collaboration, the Executive Committee of the Union of Geodesy and Geophysics met at Oxford in December, 1945. Dr. J. M. Stagg was appointed General Secretary.

Among the specialised branches of this Union, the Director of the Meteorological Office is Chairman of the British National Sub-Committee for Hydrology, and Dr. A. H. R. Goldie is the Secretary of the Association of Terrestrial Magnetism.

# APPENDIX I

## ORGANIZATION OF THE METEOROLOGICAL OFFICE



## APPENDIX II

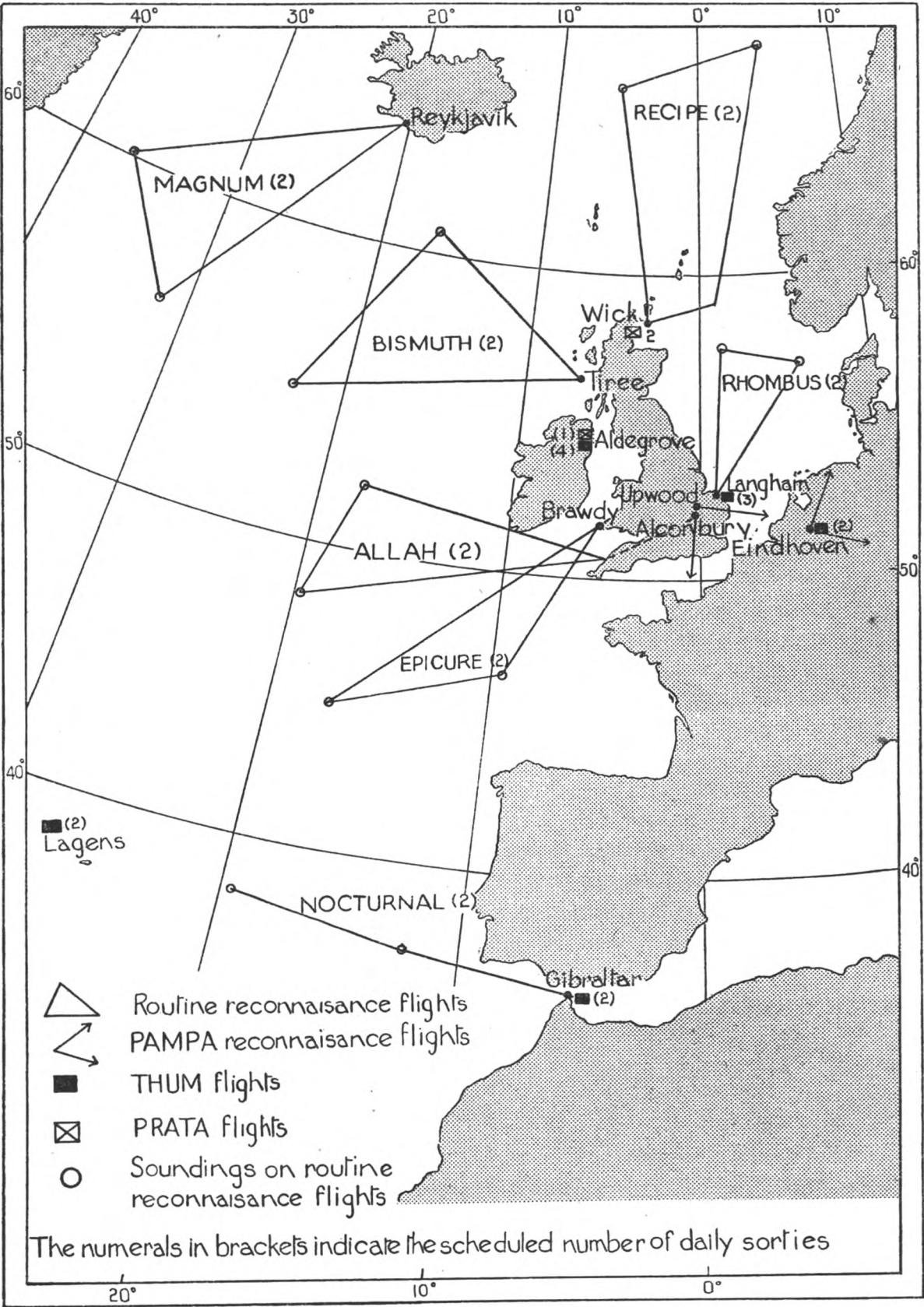
### CLASSIFICATION OF BRITISH STATIONS WHICH REPORT TO THE CLIMATOLOGICAL BRANCH

	Stations					Autographic records					
	Observatories	Synoptic	Crop-Weather	Climatological	Rainfall	Sunshine	Rainfall	Wind	Pressure	Temperature	Humidity
Scotland, N. .. ..	1	5	0	12	134	12	3	3	4	3	0
Scotland, E. .. ..	1	6	2	35	353	25	11	3	4	3	2
Scotland, W. .. ..	1	5	1	27	392	19	8	5	4	4	1
England, N.E. .. ..	0	8	2	16	297	18	4	6	7	7	1
England, E. .. ..	0	6	5	23	449	19	14	6	5	4	5
England, Midlands ..	0	9	7	44	1,038	36	20	2	6	6	4
England, S.E... ..	0	10	5	43	763	35	35	10	13	13	6
London District ..	2	0	0	10	39	5	4	2	2	2	2
England, S.W. .. ..	0	9	5	35	504	31	4	3	5	2	3
England, N.W. .. ..	0	2	1	22	462	17	17	4	2	2	2
Wales, N. .. ..	0	4	1	10	180	7	6	2	2	2	2
Wales, S. .. ..	0	4	2	10	257	12	6	2	3	1	0
Isle of Man .. ..	0	2	0	1	9	2	0	1	1	1	1
Scilly and Channel Isles	0	1	0	0	3	1	0	1	1	1	0
Northern Ireland ..	0	3	0	5	75	2	3	1	3	3	2
TOTAL .. ..	5	74	31	293	4,955*	241	135	51	62	54	31

\* Includes stations in earlier columns

# APPENDIX III

DISTRIBUTION OF METEOROLOGICAL FLIGHTS, AUGUST, 1945



# APPENDIX IV

## PROVISION IN AIR ESTIMATES FOR METEOROLOGICAL SERVICES

The approximate cash provision in Air Estimates, 1947-8, for meteorological services, is as follows :—

Vote	Service	Provision
		£
1	Pay, etc., of officers of the meteorological branch and airmen and airwomen of the trade of meteorologist .. .. .	154,000
	Contributions under national insurance schemes in respect of service meteorological personnel .. .. .	2,000
3	Staff at headquarters of the Meteorological Office .. .. .	240,000
4	Staff at meteorological observatories and outstation offices .. .. .	935,300
5	Conveyance of personnel ; travelling allowances and expenses .. .. .	42,500
	Conveyance of meteorological equipment .. .. .	9,000
6	Provisions and ration allowances for service meteorological personnel .. .. .	19,700
	Clothing, clothing allowances and laundry services for service meteorological personnel .. .. .	7,500
	Fuel and light, general stores, water and sanitary services for meteorological observatories and outstation offices .. .. .	23,000
7	Meteorological equipment .. .. .	343,000
	Technical supplies and services for ocean weather ships :—	
	Non-recurrent expenditure (conversion of corvettes) .. .. .	309,000
	Recurrent expenditure .. .. .	10,000
8	Works services for meteorological observatories and outstation offices :—	
	Capital expenditure .. .. .	20,000
	Maintenance expenditure .. .. .	15,000
9	Telecommunication services .. .. .	30,000
	Other miscellaneous effective services .. .. .	17,000
10	Superannuation allowances and gratuities .. .. .	5,000
	GROSS TOTAL .. .. .	£2,182,000
	Deduct—Appropriations in aid :—	
4	Receipts in respect of salaries, wages, etc., of meteorological staff .. .. .	£182,000
5	Receipts in respect of movement expenses of meteorological staff .. .. .	18,000
7	Receipts in respect of meteorological equipment .. .. .	90,000
9	Receipts for meteorological services .. .. .	10,000
	NET TOTAL .. .. .	£1,882,000

## APPENDIX V

### 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.

*Monthly Weather Report*, with a summary for the year (to December, 1946).

*Meteorological Magazine*. (Issue resumed from January, 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 June, 1945).

#### Occasional

Atlantic weather bulletin for shipping, Notes for use with.

Facsimile weather charts for permanent retention. 1945 and 1946.

Flying in cumulonimbus cloud in west Africa.

Marine observers' guide. Information for the use of the voluntary observing fleet of the British Commonwealth of Nations co-operating with meteorological services.

Measurement of upper winds by radar methods. 2nd edition, 1945.

Meteorological observers' handbook. Supplement No. 4. Instructions to observers at climatological stations at health resorts. 3rd edition, 1945.

Meteorological Office radio-sonde. Appendix IX to Measurement of upper wind (radio-wind).

Monthly meteorological charts of the western Pacific.

Monthly sea surface temperatures of Australian and New Zealand Waters.

Notes on the occurrence of airframe icing, particularly at low temperatures.

Percentage frequencies of observations of the height of base of low cloud at certain places in the British Isles between the years 1927 and 1937.

Quarterly surface current charts of the Atlantic Ocean.

Quarterly surface current charts of western North Pacific Ocean.

Weather in the Mediterranean, Vol. III, 2nd edition, 1945.

Weather of the Sierra Leone Peninsula.

#### Aviation Meteorological Reports :—

7. Meteorological report on northern Germany, 2nd edition.
26. Meteorological report on northern England (including the Isle of Man).
27. Meteorological report on the main islands of Japan.
28. Meteorological report on the Ryu yu Islands.
29. Meteorological report on south China south of a line Shanghai-Tsinling Shan.
30. Meteorological report on north China, Manchuria and Korea, with adjacent parts of Mongolia.

31. Meteorological report on the Bermuda area.
32. Meteorological report on Ceylon-west Australia air route.
33. Meteorological report on west Persia.

#### Professional Notes :—

Vol. VI :—

90. The exposure of the anemometers at Aberdeen. By G. A. Clarke.

#### Synoptic Divisions Technical Memoranda :—

107. Characteristics of the tropopause over southern England, 1944. By C. H. B. Priestley.
111. Visibility in central London. By W. A. L. Marshall.
113. Frequencies of equivalent head winds on route London to New York. By A. F. Crossley.
114. First draft of charts of upper winds over the world at 10,000, 20,000, 30,000 and 40,000 ft. in January and July. By G. H. Gilbert.
115. Frequency of various fitness numbers observed at airfields in the British Isles. By C. S. Durst.
116. Effect of wind on diving aircraft. By C. S. Durst.
117. Flying conditions in the SW. monsoon in India and neighbouring areas. By various authors.
119. Statistics of errors in wind measurements and forecasts. By C. H. B. Priestley
120. Winter circulation over Burma, Thailand and Indo-China. By I. A. John and F. K. Hare.
121. Some meteorological characteristics of 123 United Kingdom airfields.
122. Practical applications of the condensation or Normand curve plotted on the tephigram. By R. M. Murray.
123. Notes on forecasting in north-east India and neighbouring areas.
124. Preliminary investigation of belts of rain and showers affecting the Lesser Antilles during the winter season. By F. H. Marsden and W. J. Fairley.

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The following papers have been approved for communication to a Scientific Society with a view to publication. The Initials M.R.P. after the title indicate that the paper was originally written as a Meteorological Research Paper.

- Atmospheric opacity at certain coastal stations in the British Isles. By H. L. Wright.
- Atmospherics in relation to fronts and air masses. (M.R.P.). By S. Petterssen and A. Berson.
- The application of the Richardson criterion to large scale turbulence. (M.R.P.). By S. Petterssen and W. C. Swinbank.
- A distant-reading electrical air temperature thermometer for use on aircraft. (M.R.P.). By A. W. Brewer.
- Note on errors of cup anemometers in fluctuating winds. (M.R.P.). By F. J. Scrase and P. A. Sheppard.
- The design of a photoelectric deposit indicator for use with a frost-point hygrometer. (M.R.P.). By G. M. B. Dobson and B. Cwilong.
- A theoretical explanation of the latitude characteristics of the stratosphere. (M.R.P.). By A. H. R. Goldie.
- The momentum and density distribution in cyclones. (M.R.P.). By A. H. R. Goldie.
- Vertical transport of heat by turbulence in the atmosphere. (M.R.P.). By C. H. B. Priestley and W. C. Swinbank.
- Frictional influence of horizontal wind shear on vertical motion. By C. H. B. Priestley.

Atlas lee depressions and their significance for scirocco. By F. K. Hare.  
 Ravine winds. By F. K. Hare.  
 Upper air movement above Lerwick and Larkhill. (M.R.P.). By F. M. Jones.  
 A new conception of "balanced flow" in the atmosphere. By T. H. Kirk.  
 Derivation of an equation expressing normal flow through an isobaric surface. By T. H. Kirk.  
 Physical properties of liquid drops obtained by spraying. (M.R.P.). By W. C. Swinbank and J. Mazur.  
 Discussion of the pressure tendencies associated with gradient and longitudinal geostrophic flow. By A. G. Matthewman.  
 Quantitative theory of depressions and anticyclones. By W. A. Harwood.  
 Upper winds over the Globe. By C. E. P. Brooks, C. S. Durst and N. Carruthers.  
 Climate and the deterioration of materials. By C. E. P. Brooks.  
 The atmospheric vortex. By R. W. James.  
 Orographic rain in the British Isles. By C. K. M. Douglas and J. Glasspoole.  
 An approach to upper wind forecasting. By C. J. Boyden.  
 Note on errors in the measurement of refractive index. By G. A. Bull.  
 Sea breeze structure with particular reference to temperature. By R. W. Hatcher and J. S. Sawyer.  
 Two types of sensitive recording cup anemometer. By E. L. Deacon.

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