

February
M.O. 525

1 (MIDDELEBURY)
127 OCT 1949
MET. UNIT

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

for the year
April 1, 1948 to March 31, 1949



LONDON : HIS MAJESTY'S STATIONERY OFFICE
1949

NINEPENCE NET

Decimal Index
551.5 (058)

CONTENTS

	<i>Page</i>
METEOROLOGICAL COMMITTEE	3
COMMITTEE OF THE METEOROLOGICAL OFFICE, EDINBURGH	3
METEOROLOGICAL RESEARCH COMMITTEE	4
GASSIOT COMMITTEE	4

REPORT

1. FUNCTIONS OF THE METEOROLOGICAL OFFICE	5
2. FORECASTING SERVICES RENDERED BY THE METEOROLOGICAL OFFICE	
(1) Organization for forecasting	5
(2) Supply of forecasts for the General Public, Government Departments, etc.	10
(3) Services for the Royal Air Force	11
(4) Services for Civil Aviation	12
(5) Services for the Royal Navy	14
(6) Services for the Army	15
(7) Services for the Ministry of Supply	15
(8) Services for the Merchant Navy and Fishing Fleets	15
(9) Services for the Dominions, Colonies, etc.	15
(10) Services in foreign countries	16
3. CLIMATOLOGICAL SERVICES RENDERED BY THE METEOROLOGICAL OFFICE	
(1) British climatology	18
(2) World climatology	20
(3) Marine climatology	22
(4) Upper air statistics	22
4. RESEARCH AND DEVELOPMENT	
(1) Co-ordination of research	23
(2) Instrument development	25
(3) Forecasting research	26
(4) Research in physical meteorology	27
(5) Work of the observatories and geophysical research	29
(6) Special investigations	31
5. ORGANIZATION	
(1) Structure	31
(2) Staff	32
(3) Supply of instruments	35
(4) Library and publications	36
6. INTERNATIONAL CO-OPERATION	
(1) International Meteorological Organization	38
(2) International Civil Aviation Organization	38
(3) International Union of Geodesy and Geophysics	39
(4) International Maritime Consultative Organization	39
(5) International Conference on Safety of Life at Sea	39

APPENDICES

I. ORGANIZATION OF THE METEOROLOGICAL OFFICE	40
II. THE DIRECTORATE OF THE METEOROLOGICAL OFFICE AND HEADS OF BRANCHES	41
III. CLASSIFICATION OF BRITISH STATIONS WHICH REPORT TO THE BRITISH CLIMATOLOGY BRANCH	42
IV. CHART SHOWING AREAS USED IN GALE WARNINGS AND WEATHER BULLETINS FOR SHIPPING	43
V. PROVISION IN AIR ESTIMATES FOR METEOROLOGICAL SERVICES	44
VI. PUBLICATIONS	45

METEOROLOGICAL COMMITTEE

Appointed by the Secretary of State for Air

Chairman:—Mr. Geoffrey de Freitas, M.P. (Parliamentary Under Secretary of State for Air)

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

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

Professor D. Brunt, F.R.S. (British Universities)

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

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

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

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

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

Sir Ben Lockspeiser (Ministry of Supply)

Captain J. H. Quick (Ministry of Transport)

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

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

Mr. H. R. Smith (Scottish Office)

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

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

A representative of the Ministry of Fuel and Power

Secretary:—Mr. R. J. Williams

The Committee met on May 27, 1948.

COMMITTEE OF THE METEOROLOGICAL OFFICE, EDINBURGH

Appointed by the Meteorological Committee

Chairman:—The Director of the Meteorological Office

Secretary:—Mr. R. A. Watson

The following bodies are represented on the Committee:—

The Royal Society

The Royal Society of Edinburgh

The Royal Meteorological Society

The Scottish Home Department

The Department of Health for Scotland

The Department of Agriculture for Scotland

The Scottish Universities (two representatives)

Arrangements have been made for the Committee to resume its activities which have been in abeyance since 1939.

METEOROLOGICAL RESEARCH COMMITTEE

Appointed by the Secretary of State for Air

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

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

Professor D. Brunt, F.R.S.

Professor S. Chapman, F.R.S.

Mr. H. M. Garner (Ministry of Supply)

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

Wing Commander W. G. Macfarlane (Air Ministry)

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

Professor P. A. Sheppard

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

Professor Sir Geoffrey Taylor, F.R.S.

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

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

GASSIOT COMMITTEE

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

Professor D. Brunt (Chairman)

Sir Edward Appleton

Professor P. M. S. Blackett

Lord Cherwell

Professor T. G. Cowling

Professor G. M. B. Dobson

Mr. E. Gold

Professor H. W. Massey

Professor E. A. Milne

Professor F. A. Paneth

Professor P. A. Sheppard

Professor O. G. Sutton

Sir George Thomson

The Astronomer Royal

The President of the Royal Astronomical Society

The Director of the Meteorological Office

There were no meetings of the Committee during the period under review.

ANNUAL REPORT

of the Director of the Meteorological Office
presented by the Meteorological Committee to The Secretary of State for Air
for the year April 1, 1948, to March 31, 1949

§ 1. FUNCTIONS OF THE METEOROLOGICAL OFFICE

The Meteorological Office is the State Meteorological Service. It forms part of the Air Ministry, the Director being responsible to the Secretary of State for Air through the Permanent Under Secretary of State.

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

The general functions of the Meteorological Office are :—

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

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

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

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

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

(vi) Organization and distribution of magnetic and seismological information from certain British observatories.

(vii) Research in meteorology and geophysics.

The Meteorological Office takes a leading part in the important work of the International Meteorological Organization, the present President of which is the Director of the Meteorological Office. Other international organizations which include representatives of the Meteorological Office are the International Civil Aviation Organization and the International Union of Geodesy and Geophysics. The General Secretary of the latter is the Principal Deputy Director of the Meteorological Office.

The cost of the Meteorological Office is borne on Air Ministry Votes. Appendix V shows the provision made in the Air Estimates for expenses and receipts of the Meteorological Office for the financial year 1949-50.

§ 2. FORECASTING SERVICES RENDERED BY THE METEOROLOGICAL OFFICE

(1) Organization for Forecasting

(a) **Central Forecasting Office.**—The headquarters of the forecasting service and the main communications centre of the Meteorological Office are situated at Dunstable. The organization of the Central Forecasting Office, into Divisions and Branches under a Deputy Director, is shown in Appendix I. The functions of the Central Forecasting Office are :—

(i) To collect meteorological data required for forecasting both at Dunstable and at outstations.

(ii) To disseminate the data to meet the needs of outstations and in accordance with international requirements.

(iii) To provide basic analyses and prognostic analyses covering a wide area for the guidance of forecasters at outstations and for the information of foreign meteorological services.

(iv) To provide the forecasts, weather warnings and other information on current weather required by Government Departments, public services and the general public.

(v) To prepare and keep up-to-date the forms, handbooks and other publications required for the dissemination of information relating to the services provided.

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

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

During the year under review much preparatory work was done in connexion with the introduction of the new codes and procedures recommended by the Conference of Directors of the International Meteorological Organization which met at Washington in 1947; a new publication, the "Handbook of Weather Messages, Codes and Specifications", giving full details of the new codes and procedure, was prepared and put on sale to the public; the pamphlet containing instructions for making abbreviated weather reports was completely re-written and issued to observers; and new editions of all the charts and forms used at stations were prepared. The new codes and procedures were introduced on January 1, 1949, simultaneously with their introduction by nearly all meteorological services of the world.

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

Routine issues of upper air bulletins have been increased, and now include forecast contour charts for levels of 700 and 500 mb. for 12 hr. ahead issued every 6 hr., and for levels of 700, 500 and 300 mb. for 24 hr. ahead issued every 12 hr. Some experimental work has been done on the daily construction of contour charts for the level of 200 mb.

(b) Reporting stations.—A further slight reduction in the total number of stations in the British Isles making regular synoptic observations occurred in the past year and the number now stands at 159, of which 54 are classified as full synoptic reporting stations. To supplement the observations received from meteorological offices some 50 auxiliary reporting stations are maintained, particularly in remote districts of the country. At these stations part-time observers undertake to make regular observations according to a programme.

Observations from the auxiliary stations are transmitted in code by telegraph or telephone to the nearest convenient station on the meteorological teleprinter network. Eleven stations report regularly in the full synoptic code and 36 in the shortened AERO form. In addition, 2 stations have the responsibility of only maintaining wind records from Dines anemometers. It is hoped to open a station at Loch Rannoch in the near future.

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

During the year, 4 stations were equipped with searchlights for the accurate determination of cloud height at night. New anemometers, giving a direct reading of wind speed and direction, have been installed at 5 stations and similar equipment is being provided for 8 more stations.

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

(i) "Selected" ships, which make meteorological observations at standard synoptic hours. Meteorological instruments, instructions and logbooks are supplied to these ships. The observations are transmitted by wireless in the international code to meteorological centres. When completed, the logbooks are sent to the Marine Branch for climatological study. Approximately 500 ships co-operate in this manner.

(ii) Supplementary ships, which make and transmit observations in an abbreviated form at the main synoptic hours. Where the ships' own meteorological equipment is considered adequate no instruments are supplied. In other cases thermometers or an aneroid barometer may be lent to the ship.

(iii) About 80 coastal vessels (MARID ships), which are equipped with sea thermometers and canvas buckets. They make and transmit observations of sea temperature in home waters for the benefit of the forecast service.

(iv) Five light vessels, which have been "recruited" to provide observations of wind, visibility, air and sea temperature twice daily, at 0600 and 1500 G.M.T. These observations are passed to the nearest coastguard station and thence by telegram to the Central Forecasting Office.

About 100 ships' reports, three fourths of which are from British ships, are received daily at the Central Forecasting Office. Rapid transmission is ensured by a direct teleprinter line between Dunstable and the Post Office wireless station at Burnham-on-Sea.

The number of supplementary ships fell from 182 to 17 during the year, mainly because pressure of work on the Port Meteorological Officers at London and Liverpool precluded their visiting many of the ships, which, because of changes in crew, were consequently unaware of the meteorological commitment. Port Meteorological Officers have recently been appointed to Southampton and Cardiff, and a new fleet of supplementary ships is being organized.

Ocean weather ships.—Further progress has been made in implementing the international agreement to establish 13 weather stations in the North Atlantic Ocean. The joint Scandinavian and United Kingdom Station M at position 66° 00' N. 2° 00' E. and the United States and Canada Station B at 56° 30' N. 51° 00' W. both became fully operative in mid September 1948. The United States Stations E at 34° 00' N. 52° 00' W., D at 45° 00' N. 45° 00' W., and F at 35° 30' N. 40° 00' W. started to operate on September 29, 1948, January 9, and February 26, 1949, respectively. The total number of ocean weather stations in the North Atlantic from which regular surface and upper air observations are received is now eleven.

The United Kingdom is solely responsible for two stations—Station I at position 60° 00' N. 20° 00' W., and Station J at position 53° 50' N. 18° 40' W. These stations were occupied practically continuously throughout the year. Breaks of some ten days in manning Station I during July and August were occasioned by diversions to co-operate in aircraft-safety arrangements for the outward and return flights to the United States via Iceland of a flight of Royal Air Force Vampire aircraft.

The ships have carried out a full programme of meteorological work, including surface and upper air observations which are transmitted to the Central Forecasting Office by point-to-point W/T communication. Periodic air/sea rescue exercises have been carried out since August 1948 in co-operation with aircraft of Coastal Command with the aim of keeping the ships' companies conversant with air/sea rescue organization and drill.

Merchant ships, especially trawlers, have become increasingly aware of the presence of the weather ships, and the number of requests for meteorological information has risen considerably. The weather ships' navigational aids are also being used with increasing frequency by civil and Royal Air Force aircraft flying over the North Atlantic: 300 contacts were made by one ship during her patrol of 21 days.

The vessels have experienced very severe weather at times, and great credit is due to the crews and meteorological staff who have maintained the observational routine in conditions which often involve extreme discomfort and hardship.

(d) Meteorological flights.—Routine meteorological reconnaissance flights have continued to be made by aircraft of Coastal Command operating from Aldergrove, Gibraltar and St. Eval. Flights on special tracks, carried out when observations are needed from a particular area, have been made by aircraft of Bomber Command operating from Binbrook. The frequency of these flights during the past year has been somewhat below that desired because maintenance difficulties have resulted in a shortage of serviceable aircraft; for the same reason routine flights formerly made over the North Sea had to be discontinued in April 1948.

Plans have been made for operating a meteorological flight in the Indian Ocean based on Negombo, Ceylon. This flight will be equipped with Brigand aircraft specially modified for the meteorological rôle.

Vertical soundings have been carried out by Mosquito aircraft of Fighter Command operating from bases at West Malling (Kent) and Coltishall (Norfolk). At present it is only practicable to make one ascent daily from either one or the other of the two stations.

Similar aircraft ascents are made daily from Wahn, in the British occupied zone of Germany, and from Singapore by a flight of Air Command, Far East.

Frost-point hygrometers are being fitted on the aircraft operating from Aldergrove to give more accurate measurements of humidity in the upper atmosphere. In addition to routine meteorological sorties some flights have undertaken special investigations for which additional equipment has been fitted to the aircraft.

Towards the end of 1948 three reconnaissance flights were established by the United States Air Force operating from bases in this country.

(e) Radio-sonde and radio-wind stations.—Measurements of pressure, temperature, humidity and wind in the upper atmosphere are made four times daily at eight stations in the United Kingdom, in the two British ocean weather

ships, and at eight overseas stations under British control. Shortage of staff has prevented the full programme of ascents being maintained at some stations.

Measurements of pressure, temperature and humidity in the upper atmosphere are made by means of the Kew Mark II radio-sonde, and upper winds are determined by radar observations using the GL III type of radar equipment. Routine ascents have been supplemented by special observations required for investigating both the technique of upper air sounding and general meteorological problems of the higher atmosphere. In particular, efforts are being made to improve the value of the results by achieving greater accuracy of measurement and to obtain observations to greater heights. Steps are also being taken, with the co-operation of the Ministry of Supply, to develop new equipment of greater range and accuracy.

The station formerly at Penzance has been transferred to new and specially designed accommodation at Camborne where it has been combined with the thunderstorm location station previously at St. Eval.

A search has been made for a suitable site in East Anglia to which it is intended to transfer the radio-sonde unit at Downham Market and the thunderstorm location unit at Dunstable.

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

(f) Thunderstorm location.—The four stations engaged in the direction-finding of atmospherics ("Sferic") have continued in operation, the station formerly at St. Eval being transferred to Camborne in August 1948. The latest types of Plessey sets have been installed at both Camborne and Leuchars, thus completing the installation, which was started last year, of new equipment at all four stations.

As expected, the new apparatus has given observations of greater accuracy, and has shown that the present limit of observational accuracy is determined by the local characteristics of the site. Investigations into the magnitude and causes of site errors are proceeding.

During the past summer the number of routine periods of observation were increased temporarily to 13 a day. A number of special observations have been undertaken on behalf of scientists at London and Cambridge Universities in connexion with investigations into long-wave propagation and wave forms.

With the co-operation of the National Physical Laboratory, photographic apparatus for recording the bearings of atmospherics has been developed and trials have been made. All four "Sferic" stations have been equipped with moving-film camera and synchronising gear. In addition, a special set has been built, to the design of the National Physical Laboratory, to provide the information required for an investigation into the possibilities of determining the distance of the source of an atmospheric from a single receiving station.

(g) Meteorological communications.—*Land-line communications.*—It has not been found necessary to make any important changes in the contents of the two-channel teleprinter broadcasts issued from Dunstable. The first-channel broadcast, which contains data required by all types of meteorological stations, is now received by 160 stations, and there are 44 recipients of the second-channel broadcast which contains data covering a larger area and additional upper air material required by major airfields and sub-centres. The first channel has for a long time been fully loaded, and with the introduction on January 1, 1949, of the Washington Code (see p. 6) which contains more groups than the code formerly in use, the number of full synoptic reporting stations was reduced from 84 to 54.

Teleprinter links have been provided at certain airfields in the United Kingdom which have been manned by the United States Air Force, and the first-channel service has also been provided at the headquarters of the British Electricity Authority.

The exchange of reports between Dunstable and European centres has continued satisfactorily over the international meteorological teleprinter circuits; lines have been extended to Copenhagen, Stockholm and Oslo for a limited amount of traffic.

Radio communications.—The high-power low-frequency transmission from Rugby was discontinued on August 31, 1948, after inquiries had shown that the high-frequency transmissions alone were sufficient to meet requirements. Since September 1, 1948, the transmitter GFT has been used to re-diffuse North American data for the benefit of European countries which are not connected to the teleprinter network. The radio-teleprinter receiver to which reference was made in the last report has been operating at Dunstable since July 18, 1948; direct reception from New York is successful over about 18-20 hr. of the day on the average, and during bad atmospheric conditions data can usually be received via the relay station in the Azores. Not only is material received at a speed three times that of W/T working, but re-diffusion over land-line circuits is greatly facilitated by using a system of "tape relay".

The point-to-point W/T channels to British ocean weather ships have remained satisfactory; agreement has been reached with the Post Office for merchant ships out of range of coast stations to clear reports through the weather ships.

The AIRMET radio-telephony broadcasts which can be heard on an ordinary domestic wireless receiver on a wave-length of 1,225 m. have continued unchanged, and evidence continues to be received that the broadcasts are used not only by aviators but by many other sections of the community. An interval signal consisting of a musical phrase based on the morse signals for AIRMET has been in use since February 1949. Negotiations are in progress for the allocation of a suitable frequency for the AIRMET broadcast to be adopted when the Copenhagen frequency plan is introduced in 1950.

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

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

(a) British Broadcasting Corporation.—These have been maintained on similar lines to those of the previous year.

(b) Railways.—The Southern Region of British Railways and other electrified lines in the London area have continued to be supplied with special forecasts relating to icing on conductor rails. The system of general warnings to British Railways of fog, snow, frost and gales also continued in operation. Special attention was directed to consultation between the forecasters and the railway control officers; to facilitate this, the forecasting work was divided amongst a number of major forecasting offices situated in the areas into which the country is divided for purposes of railway control.

(c) Road Research Laboratory.—The issue of warnings of drifting snow or ice formation on roads in London and the Home Counties was instituted in October 1948 to assist research in the Department of Scientific and Industrial Research into the effect of snow and ice on the roads.

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

(e) Gas companies.—Warnings of various types of weather change have been issued to gas undertakings to assist in meeting abrupt variations in the demand for gas resulting from such changes.

(f) Film companies.—A special weather forecasting service for film producers has been instituted. Routine forecasts for the Greater London area are issued twice daily, with emphasis on the meteorological factors which are of particular importance in photography and sound recording. Similar forecasts for other areas are provided on request.

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

(h) Water supplies.—Forecasts of conditions liable to result in flooding have been supplied to the Yorkshire Ouse Catchment Board.

(i) Road engineers.—Forecasts of snow and glazed ice have been supplied to various County and City Surveyors and to Divisional road engineers.

(j) Olympic Games.—Special local forecasts were supplied during the Olympic Games.

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

(3) Services for the Royal Air Force

(a) General.—Little change occurred in the number of meteorological offices maintained for the provision of meteorological facilities for the Royal Air Force in Home Commands and along the trunk routes in the Mediterranean and Middle East Command and the Air Command Far East, but there was an increase in commitments for the British Forces of Occupation in Germany due to the air-lift operations to Berlin.

In view of the problems involved in the operation of jet aircraft every effort has been made to provide a forecasting officer at all airfields on which jet aircraft are based.

(b) Organization.—Further progress has been made in the adoption of International Civil Aviation Organization procedures for the provision of meteorological facilities for the R.A.F., aided by the integration of R.A.F. and Ministry of Civil Aviation facilities at joint-user airfields overseas.

Meteorological sub-area broadcasts began at Malta and Hamburg in June 1948, and it is proposed to inaugurate similar facilities by the addition of landing forecasts to the existing broadcasts of weather reports at certain stations in the Mediterranean and Middle East Command shortly.

The provision of TALK TO MET facilities, enabling pilots of overflying aircraft to consult forecasters by radio-telephony, has continued at Istres. Similar facilities have been available at Shaiba and El Adem since July 1948.

Arrangements have been made for the provision of radio receivers for the reception of AIRMET broadcasts at Flying Training Schools in Reserve Command, and for the provision of meteorological equipment, barometers, wind speed and direction indicators and cloud searchlights, for flying units of Reserve Command.

Radio-telephone links between Malta, Ismailia and Habbaniya have been in operation since May 1948, for discussions on the meteorological situation by forecasters.

(c) Royal Air Force Meteorological Policy Committee.—The membership of the Committee was revised, in July 1948, to include senior Air Staff Officers of the Air Ministry, the Directorate of the Meteorological Office, and a senior member of each R.A.F. Command.

(d) Miscellaneous activities.—Meteorological facilities were provided for flying training and for flights on internal and trunk routes. Special arrangements were made for R.A.F. exercises, including joint exercises with the Royal Navy, and for the goodwill flight of a squadron of jet aircraft from the United Kingdom to Canada and the United States during July and August.

Investigations have been made of winds at 40,000 ft. for photographic operations from a high altitude over the British Isles. Other investigations are being made of the motion of the air between the ground and 50 ft. in connexion with parachute landings.

Arrangements were made for reports to be obtained from R.A.F. pilots of bumpiness at high levels, and of precipitation from non-freezing clouds.

Discussions have been held on the requirements of meteorological staff, equipment, telecommunication and accommodation, for the R.A.F. Flying Boat Depot Ship *Adastral*.

(e) Meteorological instruction for the Royal Air Force.—Regular courses of meteorological instruction were given by meteorological officers at the Empire Air Navigation School, the Empire Flying School and the Cadet College, and as far as possible at other schools in Flying Training Command; also at the Operational Conversion Units in Bomber, Coastal, Fighter and Transport Commands; and lectures were given to Squadrons of the Royal Auxiliary Air Force, Royal Air Force Volunteer Reserve Centres and University Air Squadrons. Examinations in meteorology for pupils at the Flying Training Schools and at the Air Navigation Schools were conducted by the meteorological member of the Central Examination Board.

Instruction in making meteorological observations and in tropical weather conditions was given to navigators of the Brigand Meteorological Flight which will operate from Negombo, Ceylon (see p. 8).

(4) Services for Civil Aviation

(a) Organization.—Considerable adjustments to the organization both in the United Kingdom and overseas were made to implement the recommendations of regional Air Navigation Meetings of the International Civil Aviation Organization. In particular, the recommendations of the European-Mediterranean and North Atlantic Regional Meetings necessitated revised schedules of half-hourly weather broadcasts for aviation from London Airport, Preston, Gloucester and Prestwick.

A representative of the Meteorological Office attended a meeting of the Anglo-French Joint Standing Committee in London.

The meteorological office at Aldermaston was closed, but by the end of the period under review arrangements had been made to open a new office at Birmingham (Elmdon). A main meteorological office was established at Preston (Barton Hall) in July when the Air Traffic Control Centre was opened.

(b) Services provided in the United Kingdom for trunk routes.—Civil aircraft operating on the trunk routes, including the North Atlantic, were served by the meteorological offices at London Airport, Prestwick, Bovingdon and Hurn. When the flying-boat operations of British Overseas Airways Corporation were transferred from Poole to Southampton Water the meteorological service at Poole was moved to Eastleigh airfield, Southampton, from which forecasters were detached daily to Southampton harbour to conduct meteorological briefings.

London Airport.—The continued development of civil air operations at London Airport called for increased forecasting and briefing facilities. Forecasts to near and distant European and Mediterranean terminals continued to be issued. In addition, increased operations from London Airport on the North Atlantic routes and the establishment at the airport by certain operating agencies of North Atlantic Flight Control Centres necessitated building up a full North Atlantic forecasting routine.

In order to ensure the rapid dissemination of meteorological information to the offices of a number of operating agencies at the airport a local meteorological teleprinter system was installed.

At the request of the Air Safety Board of the Ministry of Civil Aviation special measurements of visibility were made as an experimental measure during periods of poor visibility from the end of the runway in use.

Prestwick.—The main responsibilities continued to be:—

(i) forecasting and briefing for transatlantic flights and for flights to and from various European centres.

(ii) acting as a main meteorological communications centre for the interchange of meteorological information between Europe and North America.

(iii) providing meteorological information for the Transatlantic Air Control and the Central Scottish Air Traffic Control Centre.

Bovingdon and Hurn.—Small meteorological offices continued to meet requirements at these main diversion airfields for London Airport.

(c) Services provided in the United Kingdom for internal and European routes.—By the end of the year meteorological offices were being maintained at 23 airfields, additional to those enumerated above, for the benefit of air lines operating on routes within the United Kingdom and to European terminals.

To ensure co-ordination of technical opinion on the current weather situations, arrangements were made for telephone conferences to be held three times daily between major meteorological offices in the London area serving civil aviation. An exchange of terminal forecasts and special reports and warnings was also effected between offices at Air Traffic Control Centres.

For purposes of terrain clearance and vertical separation of aircraft operating over the United Kingdom, forecasts have been supplied of hourly values of minimum sea-level pressure for each of the Flight Information Regions.

The text of the meteorological section of the "United Kingdom Air Pilot" was extensively amended on the introduction of the new meteorological codes (see p. 6).

(d) Services provided overseas.—British West Indies.—The United Kingdom continued to be responsible for the meteorological organization in the British West Indies. Forecasting offices were maintained at Piarco (Trinidad), Oakes Field (Nassau) and Palisadoes (Jamaica), and smaller offices were provided at Grenada and Barbados.

The main function of each of these offices is the supply of meteorological information for air-route operations. In addition forecasts and climatological data are provided for other local needs such as agriculture, the press, broadcasting services, etc.

The recommendations of the International Civil Aviation Organization Caribbean Regional Meeting were introduced on April 15, 1948, and were implemented at the British meteorological offices in that region.

Azores.—British staff seconded to the Portuguese Meteorological Service continued to be replaced gradually by Portuguese staff until in September 1948 the last British forecaster was withdrawn.

(e) Examinations.—The number of candidates examined for various licences during 1948 was as follows:—

"B" licence (monthly examination)	223
2nd Class Navigator's licence (monthly examination)	880
1st Class Navigator's licence (bi-monthly examination)	744
Total	1,847

Although the total number of candidates fell to less than half that of the preceding year, the number presenting themselves for the 1st Class Navigator's licence was nearly doubled.

(5) Services for the Royal Navy*

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

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

At the request of the Senior Naval Officer, Persian Gulf, broadcasts of shipping forecasts for the Persian Gulf have been made from Habbaniya.

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

(6) Services for the Army

The meteorological office at the School of Artillery, Larkhill, has supplied information for artillery and sound-ranging purposes, and has given meteorological instruction to courses held at the School. Other artillery requirements at Practice Camps for calibration shoots, both at home and overseas, were met either by the temporary attachment of meteorological staff to the camps or by a nearby meteorological office.

An officer from Headquarters was attached to the War Office in the Department of the Scientific Adviser to the Army Council.

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

(7) Services for the Ministry of Supply

Meteorological offices have been maintained at the Artillery Ranges, Shoeburyness, and at Aberporth, Pendine and Porton, to provide information for the special work of these establishments. Forecasting offices were maintained also at Boscombe Down, Defford, Felixstowe, South Farnborough and West Freugh.

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

(8) Services for the Merchant Navy and Fishing Fleets

The Central Forecasting Office prepares shipping bulletins and gale warnings for broadcast by the B.B.C., the former at 0655 (except Sundays), 0755, 1255 and 1755 clock times and the latter as soon as possible after issue. The B.B.C. transmissions are repeated by various coastal stations. The bulletins broadcast twice daily from Wick include ice warnings for the Iceland area. During the season a special East Anglian Fishing forecast is appended to shipping forecasts. Changes in the shipping forecast areas and their names were introduced on November 1, 1948 (see Appendix IV).

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

A message giving an analysis of pressure and frontal systems is issued daily at 1145 G.M.T. The message hitherto issued at 2345 G.M.T. has been discontinued since January 1, 1949.

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

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

(a) Mediterranean-Middle East area.—Cyprus.—The Meteorological Office has continued to maintain the forecasting service in Cyprus and a radio-sonde unit at Nicosia, and to provide meteorological facilities for all R.A.F. and civil aviation services operating in and through Cyprus.

British East Africa.—Air Ministry control of the Meteorological Service in British East Africa ceased on April 30, 1948, but the loan of two forecasting officers was extended until the end of 1948. Air Ministry responsibility for reporting stations at Agalega and St. Brandon (dependencies of Mauritius) ceased on May 31, 1948.

British West Africa.—A small number of staff who had been seconded to British West Africa to assist during the transitional period following the transfer of administrative control from the Meteorological Office to the west African Governments were withdrawn in May 1948.

Palestine.—All Meteorological Office staff and equipment were withdrawn from Palestine in April 1948.

(b) *India area.—India and Pakistan.*—Close liaison has been maintained with the Indian and Pakistan Meteorological Services. A meteorological office continues to be maintained at the Royal Air Force Staging Post, Mauripur, pending assumption of the commitment by meteorological personnel of the Royal Pakistan Air Force. Arrangements are being made for officers of the Royal Pakistan Air Force to receive training as forecasters in London in May 1949.

Ceylon.—The Meteorological Office continues to provide all forecasting facilities for the R.A.F. and civil aviation in Ceylon, and maintains meteorological offices at Negombo and Koggala. Cingalese staff are being trained at the Meteorological Office Training School in London. Liaison was maintained with, and assistance given to, the meteorological reporting station in the Maldiv Islands.

(c) *Far East area.—Malaya.*—Little change has occurred in the meteorological organization in Malaya, where the Meteorological Office is responsible mainly for the provision of meteorological facilities for the R.A.F. while the Malayan Meteorological Service is responsible for other commitments. Air Ministry meteorological offices are maintained at Changi, Seletar, Tengah, Sembawang and Butterworth. A reporting station was established at Car Nicobar in June and a forecasting office at Kuala Lumpur in November 1948 to provide meteorological facilities for operations against the insurgents.

(d) *Falkland Islands.*—A small forecast office was maintained at Port Stanley, primarily for local needs. A radio-sonde station has also been maintained.

Weather reports from a number of stations in the Falkland Islands and Dependencies continue to be collected and disseminated three times daily by W/T broadcasts intended mainly for reception in South American countries, by ships in the area, and in South Africa.

The ionospheric station of the Department of Scientific and Industrial Research, which in the initial stages it was found convenient to administer through the Meteorological Office, was administered direct by the Department of Scientific and Industrial Research from December 1, 1948. The meteorological office and the ionospheric station continue to work in close collaboration.

(e) *West Indies.—Bermuda.*—The supply by the Bermuda Meteorological Service of forecasts to the Royal Navy and to British Overseas Airways Corporations was discontinued and arrangements were made to withdraw the small number of Meteorological Office staff on loan to Bermuda.

(10) Services in Foreign Countries

(a) *European area.—Germany.*—The meteorological organization, controlled by the Chief Meteorological Officer, Headquarters, British Air Forces of Occupation, continued to provide meteorological facilities for the occupational forces, the Control Commission and civil aviation. German meteorologists have been employed in briefing civil aviation aircrews and in assistant duties. Consideration is being given to increasing the use of German staff.

The main changes in the organization were occasioned by the air-lift to Berlin (Operation PLAINFARE) which necessitated the provision of additional Meteorological Office staff. Continuous forecasting services were provided at Gatow (Berlin) from October 17 and at Fuhlsbittel (Hamburg) from November 1, and a main forecasting office was opened at Headquarters No. 46 Group Buckeburg, on February 1, 1949, to give continuous services for the air-lift operations.

The Meteorological Section, Air Branch, Combined Services Division, Control Commission Germany (British Element), was withdrawn from Berlin on May 28. The British, American and French Zonal Meteorological Services continue to maintain close liaison.

Austria.—A small meteorological office has been maintained at Schwechat (Vienna). The meteorological officer acts as British representative at meetings of the Occupying Powers.

Greece.—Greek meteorologists visited the United Kingdom for training in forecasting during the period April to September 1948.

(b) Mediterranean-Middle East area.—*Libya.*—The meteorological organization was maintained, including forecasting offices at Castel Benito and El Adem. The reporting network was improved by the opening of a reporting station at Jalo (Cyrenaica) in August. Discussions have been held with Civil Affairs, War Office, regarding the responsibilities of the British Military Administration in occupied territories for the provision of meteorological services.

Egypt.—A meteorological organization continues to be maintained for British Military Forces in the Canal Zone. Close liaison is maintained with the Egyptian Meteorological Department.

Sudan.—Two forecasters and two assistants continue to be provided, primarily to meet the needs of the Royal Air Force at Khartoum.

Somalia.—A small network of meteorological reporting stations manned by locally engaged meteorological assistants has been maintained. An airman-meteorologist was posted to Mogadishu for supervision and liaison duties from May 1948.

Eritrea.—The forecasting Office at Asmara and a network of reporting stations have been maintained to meet the requirements of the British Military Administration, the Royal Air Force, and civil aviation.

Iraq.—Control of the Iraqi Meteorological Service was transferred from the Air Ministry to the Iraqi Government on April 1, 1948, but owing to the shortage of Iraqi meteorological staff all forecasting services for Iraq are still provided from the British Meteorological Office at Habbaniya and Shaiba.

Iran.—Close liaison has been maintained by the Chief Meteorological Officer, MED./M.E. with the Director of Civil Aviation, Tehran, who controls the meteorological service in Iran.

Persian Gulf.—Pakistan meteorological staff were withdrawn from Manoma (Bahrein) and all facilities are now provided by Meteorological Office staff. Similar arrangements are being made at Sharjah.

(c) Far East area.—*Japan.*—All Meteorological Office staff were withdrawn from Japan in October. Meteorological facilities are now provided at Iwakuni by meteorological staff of the Royal Australian Air Force.

§ 3. CLIMATOLOGICAL SERVICES RENDERED BY THE METEOROLOGICAL OFFICE

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

Climatological or rainfall returns from nearly 1,000 stations in Scotland are dealt with at the meteorological office, Edinburgh, and the majority of inquiries for climatological information from Scotland are also answered from that office.

(1) British Climatology

(a) **Organization and functions.**—The British Climatology Branch is charged with the supervision, including periodical inspection, of all voluntary climatological and rainfall stations in Great Britain and Northern Ireland; with collecting, summarising and preserving permanent records of surface observations; with the preparation of publications containing summaries of these observations; and with replying to climatological inquiries from the general public, commercial and industrial firms and Government Departments.

(b) **Types of stations.**—There are five classes of stations contributing climatological observations :—

Observatories (see § 4, p. 29) where continuous records of all meteorological elements are maintained. These are staffed by Meteorological Office personnel.

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 G.M.T. and, in certain cases, for additional hours are also made. Most of these stations are manned by Meteorological Office staff, but at some the observers are coastguards, lighthouse keepers or others whose occupations enable them to make meteorological observations at all hours.

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.

Climatological and Rainfall stations.—These are maintained by private observers, or by municipal or other local authorities almost in every case without payment by the Air Ministry. Great public spirit is shown by those who participate in the operation of these stations. Some of the climatological stations make additional reports for daily publication in the Press under a Health Resorts Scheme.

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

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

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

The *Monthly Weather Report*, which contains full monthly and annual summaries of observations at synoptic and climatological stations, has been issued regularly, but publication of the *Weekly Weather Report* has not yet been resumed, the last issue covering the year ending February, 1939.

Monthly Frequency Tables of upper winds, clouds and visibility have been issued up to September 1946. Arrangements are being made for the format to be revised, and the data for 1948 for certain stations to be issued as an annual volume; for other stations the data will be published quinquennially.

British Rainfall for the year 1946 was published in January, 1949. The data for the six war years are being published in two volumes, each volume being the size of a pre-war volume. *British Rainfall* for the year 1947 was forwarded for printing in December 1948.

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

(e) **Special work.**—*Agricultural meteorology.* This subject has received special attention throughout the year, both at Headquarters and also at the Bristol centre of the South-West Province of the National Agricultural Advisory Service.

Instrumental investigations in collaboration with Agricultural Colleges or Research Institutes have been made into the meteorological aspects of grass conservation, chocolate spot disease in beans, potato blight and cultivation under glass. At Kew Observatory the random errors associated with standard meteorological observations are being investigated as a preliminary to a proposed microclimatic survey of parts of the country (see § 4, p. 29).

Numerous climatological data have been adapted for greater convenience of use by agriculturists, and a series of memoranda on the climate of south-west England has been produced, including those dealing with spells of dry weather, spells of sunshine, and the frequency of ground frost.

Advice has been given on the meteorological suitability of given sites for fruit plantations and to a number of agricultural research workers on the meteorological aspects of their work. Climatological surveys for various areas have been prepared, and reports on the weather during crop trials have been provided. A weekly weather report for the South-West Province has been prepared since July for the use of specialists of the National Agricultural Advisory Service.

A meteorological exhibit was arranged for the Hampshire Market Produce Show in June 1948.

Climatological Atlas of the British Isles.—This is being prepared for publication.

Rainfall maps over Great Britain.—Arrangements have been made for the Ordnance Survey to publish maps showing the average annual rainfall over Great Britain. The maps will be in two sheets, on a scale of ten miles to one inch, in the Ministry of Town and Country Planning series.

Wind speed.—Information on this subject has been supplied for the Wind Power Generation Committee of the British Electrical and Allied Industries Research Association, in connexion with schemes for obtaining power from wind.

Rainfall over the Daer Water.—Under the Water (Scotland) Order, 1948, the Meteorological Office has been authorised to determine the average rainfall over the Daer Water (Lanarkshire) in 1956 for the purposes of fixing the compensation water. Sites were selected for rain-gauges in the area.

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

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

(ii) a committee of the Institution of Water Engineers (Hydrology section) dealing with the preparation of a manual of British water engineering practice ; and

(iii) a technical panel of the Land Drainage Sub-Committee of the Central Advisory Water Committee to consider the effect of land drainage on the flow of rivers.

(f) *Inquiries.*—A great many requests have been received for various kinds of climatological information in connexion with water supply, flooding, town planning, and the work of industrial or research organizations. Rainfall data have been supplied to the Ministry of Health and to the Geological Survey for the purpose of water supply schemes.

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

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

(2) World Climatology

The Branch dealing with World Climatology is charged with collecting and summarising climatological observations at a number of stations overseas and with preparing reports, memoranda and tables on weather conditions in all parts of the world.

(a) *Overseas stations.*—Monthly returns of climatological data have been received from 117 stations, of which seven had not previously sent returns. Returns from 38 stations were discontinued during the year, chiefly owing to the reversion of the services to local control. At the end of the year the stations were distributed as follows :—

6 in Europe, 22 in Asia, 39 in Africa and 12 on islands.

Returns for years before 1948 were also received from a number of stations.

The reprinting of the meteorological summaries from the Colonial Blue Books has been resumed. With the co-operation of the Colonial Services an abbreviated form of "Notes on the observations" was prepared, and was

issued with the reprints for 1938. Typescript copies of the meteorological data have been received from many colonies which had suspended the printing of Blue Books during the war. Copies of reprints have also been received from several services for the years 1945-47.

With the co-operation of the Dominion and Colonial services, the publication in the *Meteorological Magazine* of a table of monthly data for some 35 stations in the British Commonwealth was continued.

(b) Réseau Mondial.—It has not been possible to make much progress with this international work. The volume for 1933 requires final scrutiny before it is passed for printing. The preparation of the volume for 1934 has begun. Data for the volumes 1935-39 have been received from Egypt, India, New Zealand and the United States of America, and for 1935-43 from Sweden. International action has been taken to collect all available data from the other countries necessary for this compilation.

(c) Naval handbooks.—At the request of the Naval Meteorological Branch of the Admiralty, the handbook dealing with the weather of the Mediterranean is being revised. In accordance with modern ideas more emphasis is being laid on synoptic conditions than in previous handbooks.

The proof of the handbook on "Weather on the west coast of tropical Africa" has been corrected and passed for press.

(d) Admiralty Pilots.—As in previous years the Climatology and Marine Branches have co-operated in the revision of the meteorological sections of Admiralty Pilots. Five Pilots have been revised during the year.

Lt.-Cdr. Langworthy has continued to act as the liaison officer of the Naval Meteorological Branch of the Admiralty for the climatic work of the Naval Handbooks and Admiralty Pilots.

(e) Special work.—A detailed study has been made of the distribution of vapour pressure over the world. The work has involved the derivation of a formula for the reduction to sea level of the averages of vapour pressure, and also the investigation of the relationship of the vapour pressure as measured on board ship to the saturation vapour pressure at the temperature of the sea surface.

A provisional map of the world, showing the average vapour pressure at sea level in July over both land and sea, was prepared for the Joint Radio Propagation Sub-Committee (see § 4, p. 24). Work on the maps for January, April and October is continuing.

The Meteorological Office was represented on the Anti-Locust Research Centre Committee of the Colonial Office. Information on climatological conditions was supplied to the Centre and assistance was given on meteorological questions which arose during the course of its researches.

(f) Inquiries.—Numerous requests for information concerning climatic conditions overseas, especially for data on temperature and humidity, have been received from commercial firms in connexion with the export of their products and from engineers for estimating fuel consumption in heating and air-conditioning plants. Other requests from engineers were for information about the maximum intensity of rainfall, water and earth temperatures, evaporation and the temperatures reached by objects exposed to the sun's radiation. Information has also been supplied to Government Departments in connexion with the clothing, housing and comfort of troops, and the supply

and servicing of equipment, and to Universities for various researches. Data were supplied to the Royal Observatory, Greenwich, for use in planning an expedition to observe the solar eclipse in east Africa on November 1, 1948.

Over 2,000 of the manifolded temperature and humidity tables for stations in various parts of the world have been issued.

(3) Marine Climatology

(a) **Collection of observations.**—On the average some 70 ships' logbooks of weather reports have been received each month in the Marine Branch.

The British and German Hollerith cards for the Indian Ocean were lent to the Dutch Meteorological Service for the preparation of an atlas.

Arrangements are in hand for the duplication of a further 700,000 German Hollerith cards recently punched at Hamburg.

British proposals for an international marine meteorological logbook and Hollerith card have been forwarded to Dominion and Colonial services for comment.

(b) **Analysis of observations.**—The sections relating to currents and ice have been rewritten for new editions of five Admiralty Pilots. The section of the Admiralty publication "Ocean Passages" dealing with currents was revised, and a chart of "Currents of the World" was drawn for inclusion in this work.

Charts were drawn to show monthly mean sea temperatures for the North Atlantic, and work was started on the preparation of swell roses for the Atlantic and western Pacific.

A summary of weather at ocean weather ship station J during the first year of operation was prepared.

(c) **Special work.**—An investigation into the characteristics and distribution of waterspouts over the oceans has been completed, and a preliminary investigation has been made into the diurnal variation of pressure in the Mediterranean Sea.

The following studies are being made:—

(i) Comparison of temperatures and humidities measured by different instruments carried on board ocean weather ships.

(ii) Harmonic analysis of mean sea temperatures in the North Atlantic as a means of investigating the annual variation.

(iii) Comparison of surface and geostrophic winds over the ocean.

The "Marine Observer's Handbook" is now in proof and substantial progress has been made with the text-book "Meteorology for Mariners".

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

(4) Upper Air Statistics

(a) **Analysis of observations.**—Since January 1, 1948, upper air observations have been punched on Hollerith cards. It was found, however, that it was desirable to have also a manuscript record of the data for reference; special forms, designed to conform almost exactly to the lay-out of the Hollerith cards, were therefore drawn up and were brought into use on October 1, 1948.

Provision was made on the forms for the entry of discontinuities of temperature and wind. Similar forms were introduced also for use by the ocean weather ships, but as these had to be suitable for microfilming for issue to other meteorological services the design was slightly modified. At the end of the year data were being received as follows: radio-sonde temperatures from 23 stations, radar winds from 24 stations, aircraft observations from 7 stations.

Different methods of sorting the cards on the Hollerith machines have been tried and a satisfactory process evolved. Forms for the computation of the wind data and for the publication of the frequencies have been designed.

(b) Special work.—The work on “Upper winds over the world” was completed during the year.

A table was prepared showing the extreme temperatures at each level recorded during radio-sonde ascents over the British Isles up to the end of 1946.

Upper air data from ocean weather ships were prepared for microfilming for supply to other meteorological services.

(c) Inquiries.—Inquiries have been received for winds and temperatures in the upper air over all parts of the world, including the lowest temperature likely to be recorded. These data were required either for the planning of civil air routes and special service flights or for investigations by the Office and by other Departments.

§ 4. RESEARCH AND DEVELOPMENT

(1) Co-ordination of Research

(a) Meteorological Research Committee.—The general lines along which research should be developed are formulated by the Meteorological Research Committee. The work is mainly carried out within the Meteorological Office but invaluable assistance is given by other bodies such as the Clarendon Laboratory Oxford, the National Physical Laboratory, and Research Establishments of the Ministry of Supply. Within the Office the extended research organization, introduced early in 1948 and mentioned in the previous Report, has applied itself to the majority of the more important problems, but work has been hampered by shortage of staff and, in some sections, improved accommodation and instrumental facilities are necessary.

The constitution and functions of the Meteorological Research Committee are described in the Report for August 1945 to March 1947. Three ordinary meetings of the Committee were held during the year. One joint meeting with the Aeronautical Research Committee was held in October at which were discussed the nature of the further meteorological information required now and in the future for aeronautical purposes, with particular reference to the temperature and wind at high levels over the globe, meteorological conditions associated with gustiness of magnitude to affect the design and flight of aircraft, and meteorological factors in relation to ice accretion on aircraft.

Much of the detailed guidance of the Committee was exercised through Sub-Committees specially appointed in March 1948 to deal with three main sections of research. Each Sub-Committee includes a selection of the members of the main Committee, with co-opted outside experts and certain

members of the Meteorological Office directly concerned. The Chairmen of the Sub-Committees were :—

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

Each Sub-Committee met at least four times during the year to plan work and review progress in the items of the official research programme. In all more than sixty papers were considered. Approved papers were circulated to interested outside institutions and individuals, and selected papers were passed for communication to the appropriate scientific society or journal.

(b) Joint Meteorological Radio-Propagation Sub-Committee.—This Committee, consisting of radio-physicists and meteorologists under the chairmanship of the Director of the Meteorological Office, held one meeting, in November 1948. Resulting from discussion on that occasion arrangements have been made to provide additional information on the frequency of occurrence of inversions of temperature at heights between 1,000 and 10,000 ft. over the British Isles, and to assign a meteorologist to assist in the analysis of the radio and meteorological observational data accumulated in the experiments made near Canterbury, New Zealand, and the preparation of a handbook on the effect of meteorological factors on radio-propagation.

(c) Collaboration with the Royal Society.—The Gassiot Committee of the Royal Society has continued to supervise certain investigations of a long-term nature but of importance in atmospheric physics, which are in progress elsewhere than in the Meteorological Office. Flight trials were made by the Meteorological Research Flight of the infra-red spectrometer devised by Dr. G. B. B. M. Sutherland and Mr. R. M. Goody, Cambridge University, to determine the amount of water vapour in the stratosphere. The work is being continued. A method of obtaining samples of air at great heights is being developed under Prof. F. E. Simon's direction at Oxford University. Arrangements for the standardization of instruments for measuring atmospheric ozone, and for the extension of such measurements, were continued by Sir Charles Normand.

(d) Other activities.—The Meteorological Office has been represented on the British National Committees for Geodesy and Geophysics and for Scientific Radio, on the Atmospheric Pollution Research Committee of the Department of Scientific and Industrial Research and at meetings of other Government Departmental Scientific Committees. Liaison has been maintained, through correspondence or personal contacts with research activities in the Dominions, Colonies and other countries.

During the year the Meteorological Office has collaborated in an extension of the atmospheric-pollution investigation controlled by the Fuel Research Station of the Department of Scientific and Industrial Research. Atmospheric filter apparatus has been installed at the three observatories and several meteorological stations on airfields with the object of obtaining information on the distribution of smoke pollution at various distances from the principal smoke-producing areas.

Towards the end of the year the Meteorological Research and Aeronautical Research Committees decided to establish a permanent joint committee on research in atmospheric gusts in relation to aeronautics.

The Director and other members of the Meteorological Office have given lectures on meteorological problems to staff and students at the Universities of Cambridge, Durham, Nottingham, and Reading.

(e) Research programme.—The following is a summary in generalised form of the main items on which work is to proceed. Most of these items will be necessarily broken down into component and contributory lines of investigation :—

(i) Further development of radio-sonde methods of measuring upper air temperature, pressure and humidity, and the measurement of upper winds by radar, with emphasis on attaining greater heights.

(ii) Development of hygrometers, particularly for use in the upper air.

(iii) Dynamical, statistical and synoptic investigations in relation to the improvement of the technique of forecasting for short, medium and long periods.

(iv) Investigation of the microphysics of water of the atmosphere, particularly in relation to ice accretion on aircraft, together with development of appropriate instruments.

(v) Investigation of the temperature and humidity distribution in the upper troposphere and the stratosphere ; and study of temperature and humidity inhomogeneities at various levels.

(vi) Study of turbulence in convection cloud and also in cloud-free air, in relation to aircraft design and safety.

(vii) Microclimatology near the ground, including heat and water exchange, as affecting agriculture.

(viii) Investigation of the radar detection of cumulonimbus cloud and precipitation.

(ix) Statistical studies of conditions in the upper air.

(x) Study of radiation.

(2) Instrument Development

(a) General instruments.—As a means of measuring visibility at night, several photo-electric visibility meters have been installed at selected stations and preliminary reports have shown satisfactory results. Work was also started on the development of an instrument to measure "oblique" visibility. This is intended primarily for obtaining observations from which it should be possible to advise pilots at what distance they will be able to see airfield landing lights.

Further tests have confirmed the advantages of the Mark III sea-temperature equipment for use on ships. The hand-operated aspiration psychrometer is being redesigned after operational tests on board the ocean weather ships, which showed that the design was sound in principle. The problems associated with the measurement of rainfall at sea are still being investigated ; it has been found that density beads are satisfactory for estimating the extent to which the catch of the rain-gauge is contaminated by sea spray.

In connexion with the proposed Severn Bridge, an instrument has been developed for recording the vertical wind speed. When used in conjunction with a standard horizontal wind speed recorder it will be possible to compute the strength of the vertical component of the wind. Progress has also been made in the development of recorders for use with the cup generator anemometer and remote indicating wind vane, both of which are now in routine use at stations which are not equipped with pressure-tube anemographs.

(b) Aircraft instruments.—Tests of the production models of the manually operated frost-point hygrometer were continued by the Meteorological Research Flight. Certain modifications were made to the instruments to improve

their performance. The laboratory work on the fully automatic photo-electric instruments is proceeding.

In the adaptation of electrical resistance thermometers for use in high-speed aircraft, the suitability of ceramic semi-conductors is being investigated.

The problem of developing equipment for measuring raindrop size from aircraft has raised a number of difficulties, one of which is calibration at aircraft speeds. A whirling arm apparatus capable of speeds up to 200 m.p.h. has now been installed at Harrow and will be used initially for this purpose.

(c) Radio-sonde and radio-wind instruments.—The development of the radio-sonde theodolite continued in collaboration with the Directorate of Communications Development, Ministry of Supply. The Telecommunications Research Establishment has worked out a design for the airborne receiver and transmitter (transponder) and successful flight trials have been made. For the meteorological telemetering link the chronometric method previously under development has been abandoned as it has been proved that the method is not susceptible of the degree of accuracy aimed at.

No changes have been made in the GL III ground equipment used in the radar method of measuring upper winds, but two modified designs of the corner reflector have been evolved with a view to simplifying assembly and reducing costs. These are ready for testing on an operational scale.

Experiments with radio-sonde balloons have continued in the attempt to improve existing types and to produce a new type to reach greater heights. Considerable success is being achieved with balloons specially designed for use in tandem. Also, in connexion with cosmic ray research at Bristol University, several flights of long duration at great heights have been made in which photographic plates were carried.

(3) Forecasting Research

The establishment of the new Forecasting Research Division permitted the introduction of a comprehensive programme of active research although, as would be expected, the stage of important results was barely reached.

Forecasting research has two aspects: first, the study of the properties of the atmosphere and the physical processes which are basic to the problem; secondly, the application of this knowledge to forecasting procedure and technique. Both aspects received attention.

Amongst the basic problems under investigation were the following:—

(i) Temperature changes in the free atmosphere and the relative importance of advection, adiabatic and non-adiabatic changes. It seems now to be established that non-adiabatic changes are significant even in day-to-day problems, and that some method of taking account of them must be developed if the three dimensional pressure-contour patterns are to be forecast satisfactorily.

(ii) The dynamical relationship between vorticity, divergence and vertical motion. Synoptic studies encourage the belief that certain results derived from approximate theory are a legitimate basis for practical forecasting.

(iii) The relationship between cyclonic and anticyclonic development and vertical stability. There is an indication that more emphasis might have to be placed on vertical stability.

(iv) Hemispherical circulation patterns; the value of long-wave theory and circulation indices. This is basic in medium-range forecasting. So far no positive results can be claimed but work has only recently begun as the collection and charting of data were the first necessities.

(v) The structure of frontal regions. Nature is much more complex than the classical frontal models suggest and it is necessary to establish the facts more thoroughly.

In the field of practical forecasting research the following may be mentioned:—

(i) The relationship between circulation changes and the thickness patterns and contour patterns at 500 mb. Some general rules were formulated and show promise of becoming a useful addition to current practice.

(ii) Classification of anticyclones according to their thermal structure and their associated development and movement.

(iii) Criteria for the formation and movement of special types of depressions. Criteria, having a high percentage of success, were obtained for the case of depressions forming on warm fronts or warm occlusions and breaking away from the primary.

(iv) Timing the formation and clearing of radiation fog. Investigations to test the practical use of upper air data in this problem were begun with the co-operation of volunteers from outstations.

(v) On the basis of hemispherical surface and upper air charts experimental forecasts for four days ahead were begun in October 1948 and more systematically in February 1949. This research experiment represents a very considerable effort. It is too early to say more than that the position is not discouraging. The object is to develop a routine technique for medium-range forecasting suited to our present rather limited knowledge of the problem. Experience with the methods will then be a testing ground for new ideas and will provide an indication of the most promising lines of further research.

The building up of an experimental forecasting laboratory, where new methods can be tested out realistically in current forecasting but without disorganising the routine of the operational forecasting service, is a new departure. It has so far been used only in developing and testing methods of medium-range forecasting, but it might well become a recognised testing ground for new methods or techniques in any branch of forecasting.

(4) Research in Physical Meteorology

A summary of the more important items of research in the field of physical meteorology, which have been carried out during the year at Headquarters and the Research Establishments, is given below.

(i) Additional observational data, obtained in the United Kingdom and elsewhere on the sizes of raindrops, were analysed and two further reports were prepared on the relationship between the size distribution of drops and the rate of rainfall. This work has direct application to questions of the intensity of radar response from precipitation.

From a study of experimental observations of the terminal velocities of water drops falling through air, formulæ were devised to express the relation between terminal velocity drop size and height of drop in the atmosphere.

(ii) A large number of reports from the Meteorological Research Flight, British European Airways and other sources on the bumpiness or gustiness experienced by aircraft flying in clear air at heights of 20,000 ft. or more were examined in relation to the prevailing atmospheric structure. An interesting conclusion of an interim report on the investigation is that horizontal shear of wind is a significant factor in the occurrence of turbulence in the circumstances mentioned.

(iii) The Meteorological Research Flight (located with the Royal Aircraft Establishment), in addition to carrying out flights to test instruments under development and to investigate the variation with height of the speed correction to be applied to readings of air temperature taken in flight, has made further detailed observations of the vertical distribution of temperature and humidity in the upper troposphere and lower stratosphere, together with observations of bumpiness and condensation trails.

Several flights at constant height, made at various levels in cloud-free air, have shown the existence of temperature and humidity patterns in the atmosphere, the individual features of the patterns having dimensions of the order of a few miles. Further simultaneous exploration is to be made by two aircraft at different levels.

Investigation of the constitution of, and the physical processes occurring in clouds is retarded pending the availability of requisite instrumental equipment, but a report was prepared on the size distribution of water droplets in stratocumulus clouds.

Another report from the Flight discusses the frequency of occurrence of high and medium cloud, and the distribution of humidity at fixed temperature levels in the atmosphere in relation to the possibility of the existence of a "critical temperature" effect for the formation of ice crystals.

(iv) Further data were accumulated, by the use of the A.M.E.S. Type 21 radar installation at East Hill, on the detection of clouds and precipitation by radar. Analysis of the data is in progress. A report was submitted on the heights and temperatures of the tops of radar echoes associated with various cloud systems.

Investigation continued, in collaboration with aircraft from the Royal Aircraft Establishment, into turbulence in cumulonimbus and cumulus cloud. A report on this work is almost completed.

(v) The work of the Meteorological Office unit attached to the School of Agriculture at Cambridge has progressed in the direction indicated in the last Report. Observational study of factors involved in the transfer of water vapour and heat over a short grass-covered surface has led to the establishment of a method for evaluating natural evaporation in terms of wind speed and humidity measurements at two or more heights above the surface. The results have been embodied in reports for publication. Future work aims at the further study of the fundamental features of surface roughness and atmospheric stability, and the application of the results so obtained to evaporation and heat-transfer studies over cropped surfaces in various circumstances.

These investigations are directed primarily to application to agriculture, but have other particular and general interest. As mentioned on p. 29, similar studies in the factors controlling the exchanges of heat near the earth's surface are in progress at Kew Observatory.

Other work associated with agricultural problems is described in § 3 p. 19.

(vi) At Rye the recording of humidity, temperature and wind at a series of heights up to 350 ft. was maintained. Progress was made with a comprehensive report dealing with observations for three years.

(vii) The laboratory investigation, under Professor Dobson's direction at the Clarendon Laboratory, Oxford, of the processes of atmospheric nuclei in the formation of ice crystals in air has proceeded. A few flights were made in conjunction with the Meteorological Research Flight, and others with modified apparatus are planned.

(5) Work of the Observatories and Geophysical Research

(a) Kew Observatory.—*Meteorological observations and records.*—The normal observations for standardization, synoptic and climatological purposes were made. From January 1949 full synoptic reports have been made daily at 0600, 0900, 1200, 1500, 1800 and 2100 G.M.T. The autographic records were maintained satisfactorily and they, with other records, were tabulated for publication.

A peculiarity of the standard barometer readings, experienced in the previous year, was resolved. A second Campbell-Stokes sunshine recorder has been in use since June 1948 with the object of investigating a possible discrepancy between the standard instrument's indications and those elsewhere in the London area.

An evaporation tank of standard design with a recording mechanism has been brought into use, and a photo-electric visibility meter has been installed.

At the instance of the Climatology Division, preliminary arrangements were made for an investigation at Kew into random errors of ordinary meteorological observations (see § 3, p. 19).

Measurement of radiation.—Continuous records were obtained of total and diffuse short-wave solar radiation received on a horizontal surface, using Moll-Gorczynski solarigraphs. Further attention was given to the standardization of these instruments.

The records of direct solar radiation at normal incidence were maintained, viz. with transmission through clear glass and through filters cutting off radiation of wave-length less than about 6,500 and 5,500 Ångström units respectively. Standardization of these records by means of an Ångström pyrheliometer was carried out on suitable occasions.

The daylight illumination recorder, brought into use about two years ago, continued in satisfactory operation. An instrument of modified design is under construction at Kew. It is proposed to instal an additional and more sensitive apparatus to give more detail in conditions of low illumination.

Further measurements of atmospheric (long-wave) radiation, using a Linke-Fuessner radiometer, were made.

Experimental work was undertaken to assist in specifying requirements for a recording radiometer of the Robitzsch type.

Atmospheric electricity.—As in the last few years the work was restricted to the recording autographically of potential gradient and of the current discharged by an artificial point, together with standardising observations of potential gradient and observations of air-earth current on suitable occasions.

Seismology.—The Galitzin seismographs were completely overhauled between May and September 1948. Records of the east-west component of earth motion by means of a modified Wood-Anderson seismograph were resumed in April 1948, and a short-period vertical-component instrument was in operation throughout.

About 250 earthquakes were registered and analysed.

The problem of the generation of microseisms was discussed with the staff of the Admiralty Research Laboratory.

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

Special investigations.—The main effort was devoted to the determination of vertical profiles of humidity, temperature and wind in the lowest two

metres of the atmosphere. Some modifications of the special instrumental equipment were made. The results obtained so far give some indication of the relative importance of convection and radiation in the heating and cooling of the air near the earth's surface.

Preliminary consideration was given to the measurement of short-period variations of temperature and wind near the ground.

(b) Eskdalemuir Observatory.—*Meteorological observations.*—The normal meteorological observations for the standardization of autographic records and for synoptic reports and climatological returns were made. Hourly values of the various elements were tabulated for the *Observatories' Year Book*.

Terrestrial magnetism.—Absolute observations of declination, horizontal and vertical force continued to be made three times weekly. Comparison observations between the observatory instruments and a quartz horizontal force magnetometer (QHM) and a vertical force balance (BMZ), travelling standards, were made in April 1948.

Autographic records of the three components were obtained on the normal-run and quick-run La Cour magnetograph sets. All magnetic storms were successfully recorded. The normal-run horizontal force variometer was re-aligned.

Hourly values of the magnetic elements were tabulated as also were daily magnetic character figures and three-hourly range indices (K).

Hourly values of declination were contributed to weekly mining journals, various inquiries were answered, and prints or tracings of records were supplied on request. Information of magnetic disturbance in excess of specified limits was provided to the National Physical Laboratory for application to radio work.

The magnetic survey field party of the Ordnance Survey visited the Observatory on three occasions. During the October visit the party re-determined the co-ordinates of the Observatory and the bearing of the azimuth mark used in measurements of magnetic declination.

A short note on the incidence of "K" indices of magnetic activity was prepared.

Atmospheric electricity.—Autographic records of potential gradient were maintained and tabulated, and control observations of gradient in the open were made at intervals.

(c) Lerwick Observatory.—*Meteorological observations.*—Hourly synoptic observations were transmitted to the Central Forecasting Office, and normal autographic and climatological records were maintained.

Terrestrial magnetism.—Absolute determinations of declination, horizontal force and vertical force were made with the Kew unifilar magnetometer, the Smith Coil and the vertical force balance (BM) respectively, at frequent intervals. Comparison between the Smith Coil and the travelling QHM instrument was made in April 1948. The newly acquired BMZ vertical force balance was compared with the Observatory BM instrument between April and October.

Photographic records of the three magnetic components were obtained by La Cour magnetographs (normal and quick-run) and also by supplementary variometers.

Daily magnetic character figures and K (three-hourly range) indices were allotted. During an ionospheric research period in July 1948, K indices of magnetic activity were transmitted at frequent intervals to the National Physical Laboratory.

The Ordnance Survey field party visited Lerwick in July and checked the bearing of the observatory azimuth mark.

Aurora.—The normal watch for and record of auroral display were maintained.

Atmospheric electricity.—Autographic records of potential gradient were obtained by means of the Benndorf electrograph. The records were standardised by measurements of electric potential in an open position, using a Wulf electrometer.

Upper air observations.—Soundings of pressure, temperature and humidity (radio-sonde) and of wind (radar) were made daily at 0300, 0900, 1500 and 2100 G.M.T. and the results were transmitted by teleprinter to Dunstable. Only one radio-sonde ascent was missed in the course of the year (see also § 2, p. 8).

(6) Special Investigations

Many calls have been made on the Division for Special Investigations which was established primarily for the purpose of investigating the meteorological problems encountered, or anticipated, in connexion with development work of other Government Departments. The majority of the problems concerned aviation.

During the period under review the Division paid considerable attention to conditions in the high atmosphere. In conjunction with the Climatological Division the first draft of the charts of "Upper winds over the world" was produced and manifolded. These charts give information as to the mean winds and wind variability up to 30,000 ft. for most of the world and up to 50,000 ft. for the northern hemisphere. In addition consideration has been given to the statistical variation of wind with time, height and place, and to the magnitude of the variations of temperature at high altitudes. This latter is of great importance in the operation of jet aircraft. The importance to navigation of narrow high-velocity air streams in the upper air has been discussed, and statistics of cloud in the high atmosphere are being collated.

Among other activities may be mentioned the investigation of low visibility and near-ground cloud bases in connexion with the siting of blind-approach systems at important civil airfields in the British Isles; similar investigations were made in connexion with the Berlin air-lift.

In conjunction with the Ministry of Fuel and Power an investigation is being made of the relationship between changes in atmospheric pressure and the efflux of fire damp in coal mines.

§ 5. ORGANIZATION

(1) Structure

(a) *Headquarters.*—No change was made in the internal organization established last year and prescribed in the previous Report. The headquarters structure is shown in Appendix I, and a list of the Directorate and Heads of Branches is given in Appendix II.

(b) *Branch Meteorological Office, Edinburgh.*—The Edinburgh Office, first established by the Scottish Meteorological Society in 1859, has continued to act as a centre for the organization of the climatological and rainfall stations in Scotland, for the administration of the geophysical observatories at Eskdalemuir and Lerwick, the Scottish telegraphic reporting stations and such auxiliary reporting stations as are not attached to airfields.

(2) Staff

(a) Complements.—Recruitment of civilian staff in established officer grades was continued through the “reconstruction” and open competitions conducted by the Civil Service Commission. As a result of these competitions 51 officers accepted established appointments during the year, of whom 41 were candidates already in the Meteorological Office. In addition 12 temporary appointments were made and 22 Poles who accepted temporary appointments in the previous year continued to hold such appointments. The number of additions to officer strength was insufficient to balance resignations, retirements and release from the forces of temporary war-time officers; the net loss in officer grades in the year was 37. During the year 177 assistants were given established appointments, all except 5 of whom were temporary assistants in the Meteorological Office. Recruitment to the temporary grade of assistant continued at the highest possible rate and 263 temporary appointments were made. The additions to strength of assistants were just sufficient to balance the losses by resignation and by the release of airmen and airwomen who did not accept civilian appointments. At the end of the year all but a very small number of war-time airmen meteorologists had been released. Of the 1,480 assistants on the strength at the end of the year, 442 were performing their National Service in the Royal Air Force, employed on meteorological duties. Of the 237 assistants called up for National Service during the year under review all except 9 opted for service with the Royal Air Force for employment on meteorological duties.

(b) Establishment and strength of staff.—In addition to its permanent peace-time requirement of staff, the Meteorological Office has a temporary diminishing requirement resulting primarily from the occupation by British Forces of ex-enemy territory. Establishments of staff provide for the following number of posts in these two categories:—

	Permanent requirements	Temporary requirements	Total
Scientific Officer Class ...	190	6	196
Experimental Officer Class ...	682	43	725
Nautical Officers ...	8	—	8
Assistant Class ...	1,408	104	1,512
Radio (Meteorological) Mechanics	45	17	62
Locally entered Staff (overseas)	239	88	327
Clerical and Typing Staff ...	115	—	115
Miscellaneous ...	27	—	27
Total ...	2,714	258	2,972

The strength on March 31, 1949, was:—

	Staff with permanent appointments	Temporary staff	Total
Scientific Officer Class or equivalent ...	152	6	158
Experimental Officer Class or equivalent ...	515	60	575
Nautical Officers ...	7	—	7
Assistant Class ...	732	748	1,480
Radio (Meteorological) Mechanics	—	61	61
Locally entered Staff (overseas)...	8	265	273
Clerical and Typing Staff ...	12	59	71
Miscellaneous ...	—	25	25
Total ...	1,426	1,224	2,650

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

(c) **Uniformed personnel.**—The release of uniformed personnel, in accordance with the age and length of service scheme, continued throughout the year. By the end of March 1949, the numbers on ground meteorological duties were:

R.A.F.V.R. Officers	...	...	...	2
Airmen	...	...	...	3
R.A.F. (National Service) Airmen	...	...	...	442
				<hr/>
Total				447
				<hr/>

The last members of the war-time aircrew category of Meteorological Air Observers were released during the year.

(d) **Training of staff.**—*Organization for training.*—When the general re-organization of the Meteorological Office took place early in 1948, a separate branch was created to deal with the training of staff. Training has two important aspects: in-service training designed to provide staff with the knowledge and skill required for the efficient performance of their duties and external training which enables staff to improve their academic qualifications and thus increase their general usefulness to the Office.

In-service training is particularly important for the Meteorological Office because meteorology is not widely taught at either schools or universities, and therefore as a general rule the subject is a fresh one to new staff. For the scientific grades in-service training consists of a course of theoretical and practical instruction, which is given at the Meteorological Office Training School, followed by a period of further training at outstations.

During the year consideration has been given to the introduction of modern educational methods in the teaching of meteorology, to the provision of meteorological film strips, and to the design of simple three-dimensional models of the atmosphere.

Courses for Scientific Officers.—The Training School courses for Scientific Officers last four months. During their career Officers in this grade are expected to undertake original research with a view to extending available knowledge in one or more branches of meteorology. Their course is therefore highly theoretical and is intended to cover the general groundwork of the subject, up to the stage from which specialised work could be started. The practical part of the course is concerned entirely with forecasting.

During the year one course was held and was attended by 5 Scientific Officers.

Courses for Forecasters.—Members of the Experimental Officer Class are given a forecasting course which is normally of 12 weeks' duration. In the case of trainees with no previous experience in meteorology, however, 3 weeks' preliminary training is given. The forecasting course entails a study of the thermodynamics and dynamics of the atmosphere and of the application of radiation principles to weather phenomena; on the practical side, which amounts to about 65 per cent. of the time, current weather maps are plotted and analysed, and a detailed study is made of charts of selected sequences of past weather. On completing the course, officers are sent to outstations for 3 months' further training.

During the past year 6 forecasting courses have taken place and the number of staff trained was 36. Of these 28 were previously assistants in the Office. They had been successful in the open competition for assistant experimental officers held by the Civil Service Commission in the summer of 1948.

Courses for Assistants.—An 8-week course of training is normally given to new assistants. The syllabus of the course includes a revision of basic physics, some elementary meteorological theory, instruction and practice in observing (both visual and instrumental), in the plotting of weather maps and in other technical procedures in force at outstations.

Courses have been held during the year and altogether 243 assistants were trained.

Radio-sonde courses.—Training of the staff required for the specialised duties of radio-sonde and radar-wind measurement continues to be undertaken at a special school at Downham Market.

Separate courses are given for the officer grades, meteorological assistants, and radio (meteorological) mechanics, the latter being concerned primarily with the maintenance of the radar equipment. During the past year 15 courses in all were held, the average duration of each being about 6 weeks. The number of staff trained was as follows :—

Officers	...	...	...	...	...	...	...	8
Assistants	...	...	...	...	...	...	...	27
Radio (Meteorological) Mechanics	...	...	...	...	...	...	...	18
Special courses	...	...	...	...	...	...	...	4

Many of the staff trained in radio-sonde work are volunteers for duty in the ocean weather ships, to which they are posted after a period of outstation experience following this initial training.

Special courses have been given to two members of the Eire Meteorological Service and to two meteorologists from Ceylon.

Courses for Air Observers.—Meteorological observations on R.A.F. meteorological flights continue to be made by Royal Air Force pilots who are given a special course in the technique of meteorological observing from aircraft. During the year three courses were given at Aldergrove and 16 pilots were trained. In addition five navigators were given similar training in preparation for their duties when routine meteorological flights start from Ceylon (see § 2, p. 12).

Courses for Officers of the Merchant Navy.—Nautical Officers recruited to the Ocean Weather Service are given a 2-weeks' course at the Meteorological Office Training School. Four such officers attended the School during the period of this report and received instruction on instruments, observational routine and the preparation of weather charts.

Courses for Port Meteorological Officers.—Three officers recruited to the Marine Branch for duty at ports with the Voluntary Observing Fleet were given a course of instruction which began on January 17 and lasted for 4 weeks.

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

Colonial Officers (for Colonial Meteorological Services)	...	7
Ceylon Meteorological Service	...	2
Iraq Meteorological Service	...	2
Greek Meteorological Service	...	5

(e) Technical discussions.—The Monday afternoon meetings for the discussion of scientific papers were continued with considerable success, and attracted large audiences of members of the Office staff and outside research workers.

By the courtesy of the Professor of Physics at the Imperial College, Sir George Thomson, F.R.S., the discussions of the 1948-49 session were held in the physics lecture theatre of the College.

The last meeting of the 1947-48 session held on April 22, 1948 was a most successful symposium on forecasting research in which the staff of the Forecast Research Division described their work on the use of upper air information in general forecasting and the dynamics of warm fronts.

The papers discussed at the three meetings in the autumn of 1948 were on the artificial production of rain, the intensely strong winds found at times near the tropopause ("jet stream"), and high-altitude research with V-2 rockets. The meetings in 1949 were symposia on research work being carried out in the Office on the turbulence of the free atmosphere in cloud and clear air, on forecasting for four-day periods, and on the measurement of atmospheric humidity.

(f) Formation of the Meteorological Reserve.—A meteorological reserve was re-formed during the year as part of the reconstituted Royal Air Force Volunteer Reserve.

Invitations to enrol were extended to war-time meteorological officers, airmen and airwomen now following other occupations as well as to present members of the staff of the Office. In response to these invitations and to Press publicity, a moderate flow of applications for commissions and enlistment has ensued. The strength of the new Meteorological Reserve on March 31, 1949, was 61 officers and 43 airmen and airwomen.

(3) Supply of Instruments

(a) Provision and production of equipment.—Equipment (except for spare parts for radar) has been obtained, as in the past, from existing Royal Air Force stocks and by purchase from manufacturers. During the year 2,249 demands for equipment have been made on Royal Air Force stocks, 79 contracts have been placed, and in addition 1,090 small orders (less than £25 each in value) have been issued. The total expenditure was £286,173. During the same period £60,642 was received by the sale of equipment to Commonwealth, Colonial and foreign governments and to private observers.

Production of equipment has been better than last year but difficulty has still been experienced in obtaining maximum and grass-minimum thermometers and spare parts for radar equipment. On the other hand there has been keen competition from radio manufacturers to secure contracts for radio-sondes, and, as a result, supplies of these instruments are now very good.

At the request of the Inter-Departmental Committee of the Scientific Industry of the Ministry of Supply a report was made on the meteorological instrument industry. Advice has continued to be given to foreign and Commonwealth authorities and to the Crown Agents as to the best sources for obtaining meteorological instruments.

(b) Issue of equipment.—Regular supplies of stores were issued to maintain meteorological offices at home and overseas.

Supplies were also issued to Commonwealth, Colonial and foreign governments and to private observers on repayment terms, and equipment has been sent to other Government Departments and public authorities who

wished to undertake investigations for particular purposes. The total number of demands dealt with in the year was 10,279, an increase of about 120 over the previous year.

At the end of the war the store rooms were congested with large quantities of equipment returned from meteorological offices and from the Army and Navy, and in the ensuing period this has had to be sorted out; this work is nearly finished. Of the equipment concerned some was serviceable and has been placed in stock for re-issue, but most of it was unserviceable. Some of the unserviceable equipment has been repaired and some of it disposed of through the Ministry of Supply, and a small remaining quantity has been set aside for repair and use as necessary.

(c) Store accounting.—Inventories of stores in use at outstations and on charge to official observers were maintained and 2,231 inventories relating to land stations and merchant ships have been checked.

After a lapse of three years it was possible to carry out full stocktaking of all the equipment in store.

(d) Testing and calibrating.—*General instruments and aircraft instruments.*—The total number of instruments tested, excluding balloons, again reached a new record (72,100). The number of balloons of all sizes tested to a 5 per cent. check was 275,500.

Radio-sondes.—Until the end of 1948 it had been necessary to calibrate about 1,500 radio-sondes a month within the Meteorological Office in order to meet requirements. In 1949 the situation changed rapidly, and by March the instrument makers were able to undertake all the calibration necessary. About 10 per cent. of the calibration is checked in the Meteorological Office.

In addition to checking calibration, it is necessary to examine and test large numbers of radio-sondes for general efficiency. During the year 16,700 instruments have been treated in this way.

Instruments which are recovered after use amount to about 300 a month. A good percentage of these are found to be worth reconditioning and re-calibration for further use.

Radar-wind equipment.—Radar Mechanics, based on Harrow, have inspected GL III radar wind-measurement sets at home and in the British Zone of Germany.

(4) Library and Publications

(a) Library.—*Additions.*—The intake of publications increased during the year mainly owing to the resumption of international exchanges. The average intake per month was 800 daily weather reports and 700 books, periodicals and pamphlets. The stock is now about 50,000 books and periodicals and 12,000 pamphlets and many photographs, lantern slides and microfilms.

The physics, mathematics and library methods sections were brought up to date by new purchases. Some publications of data were transferred from the Royal Meteorological Society Library. Many copies of articles were obtained by application to authors. Several microfilms were received from the United States.

International exchange.—The exchange of publications was resumed or commenced during the year with approximately 130 foreign institutions including a few of the more important ones in ex-enemy countries.

Repairing war-time omissions.—The resumption of exchanges filled gaps in many series defective owing to the war. The remaining surplus German publications were offered to the Royal Meteorological Society and the School

of Meteorology at Imperial College, London. A large number of war-time Japanese publications were received through the Chief Meteorological Officer, Air Command Far East.

Co-operation with other British libraries.—Close co-operation was maintained with the Science Library and the National Central Library. A check list of holdings of German periodicals was annotated for a Union Catalogue of these which is being prepared by the National Central Library. A collection of surplus publications was made for ultimate disposal to war-damaged libraries. Members of the staff were elected members of the Circle of State Librarians, and of the Association of Special Libraries and Information Bureaux.

Loans.—The number of loans, excluding daily weather reports, averaged 800 a month. This is five times the average figure in 1938-39.

Bibliographies.—Bibliographies were prepared on a wide variety of subjects including the climate of Saudi Arabia and the physiological effects of atmospheric ions. Bibliographies of books for reading by newly trained Scientific Officers, Assistant Experimental Officers and Scientific Assistants were compiled.

Inquiries.—A large number of inquiries was received from business firms, Air Corporations and students and from other Government Departments.

Maintenance.—Bibliographies and reviews in periodicals received were scrutinised for the purpose of noting suitable books and papers for acquisition by the Library. A microfilm reader was ordered.

(b) Publications.—*Geophysical Memoirs and Professional Notes.*—Three Geophysical Memoirs and five Professional Notes were issued or signed for press (see Appendix VI). All sale copies of Geophysical Memoir No. 81, entitled "The aurora of January 25 to 26, 1938 and associated magnetic storm", by F. E. Dixon, were sold within a week. Several *Geophysical Memoirs* including, "Atmospheric Electricity in Disturbed Weather" by Sir G. C. Simpson are in the press.

Meteorological Magazine.—The *Meteorological Magazine* was published throughout the year. Publication very soon after the first of the month was achieved from the September 1948 number.

Arrangements were made for copies of the February, March and April 1949 numbers to be sent to University Departments of Physics and Mathematics.

Marine publications.—Publication of the *Marine Observer* was continued with the four quarterly numbers for April, July and October, 1948 and January 1949.

A new publication, "International Meteorological Code. Decode for use of shipping", incorporating the Washington (1947) code, was issued. All sale copies were sold within a few days.

Other publications.—Arising from the introduction of the new Washington codes, the following new publications were issued :—

Handbook of Weather Messages, Codes and Specifications

Part I. Transmission schedules and station index numbers.

Part II. Codes and specifications.

Part III. Coding, decoding and plotting.

Cloud Forms. 6th edition.

Instructions for the preparation of weather maps.

A new edition of the "Meteorological Observer's Handbook" is in draft form and the draft of a "Manual of meteorological statistics" is nearing completion.

§ 6. INTERNATIONAL CO-OPERATION

(1) The International Meteorological Organization

(a) **Meeting of "Panel" in De Bilt.**—The Marine Superintendent, in his capacity as President of the Maritime Commission of the International Meteorological Organization, attended meetings at De Bilt of Dr. Bleeker's "Panel" which examined in detail the numerous resolutions concerning the Washington (1947) code. A report was submitted to the President of the Commission for Synoptic Weather Information, and the recommendations were later approved by the President of the International Meteorological Committee. The work of this "Panel" was instrumental in solving many difficulties concerned with the implementation of these entirely new codes.

(b) **Regional Commission for Europe—Meeting in Paris.**—The Deputy Director of Forecasting attended the third meeting of the European Regional Commission at Paris in April 1948. Agreement was reached on the symbolic forms of the groups in the Washington code which are subject to regional variation, and the Commission adopted a code for special phenomena based upon a British draft. Pending further examination of the question by the Telecommunications Sub-Commission, it was agreed to continue the existing arrangements for the transmission of European data required by North America by W/T from Dunstable and by radio-teletype from Paris.

(c) **Regional Commission for Europe.—Sub-Commission for Transmission of Weather Information.**—The first meeting of this newly-formed sub-commission was held in London in July 1948 and was attended by the Assistant Director (Observations and Communications) as British representative. The sub-commission's recommendations dealt with the extension of the exchange of meteorological information which is now effected between several countries of north-west Europe by land-line teleprinter, the exchange of data between Europe and North America, the grouping of W/T broadcasts from certain smaller countries and the standardization of messages and procedures on teleprinter circuits. About a dozen countries were represented; an immediate result has been the connexion of Eire to the international teleprinter network and it seems probable that Denmark, Norway, Sweden, Poland, Czechoslovakia and Italy may apply for connexions to suitable centres as soon as their internal circuits are sufficiently developed.

(d) **Regional Commissions for South America and Asia.**—Representatives of the Meteorological Office attended the Regional Commission III (South America) Meeting in Buenos Aires in September 1948, and the Regional Commission II (Asia) Meeting in Delhi in November 1948. Both these meetings were the first to be held in the respective Regions since the war, and many important decisions were taken on matters of regional concern.

(2) International Civil Aviation Organization

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

Europe-Mediterranean Regional Air Navigation Meeting, Paris, May 1948.

North Atlantic Regional Air Navigation Meeting, Paris, May 1948.

South-East Asia Regional Air Navigation Meeting, Delhi, November 1948.

Africa-Indian Ocean Regional Air Navigation Meeting, London, March 1949.

A brief was also prepared for the United Kingdom representative at the North Pacific Regional Air Navigation Meeting, Seattle, July 1948.

Specifications for meteorological services to international air navigation, which set out the general procedure for aviation, were issued both by the International Civil Aviation Organization and the International Meteorological Organization for use from January 1, 1949. The first Meteorological Annex to the International Civil Aviation Organization Convention (No. 3—Meteorological Codes) also came into effect from January 1, 1949.

The Africa-Indian Ocean meeting was the last of the initial regional meetings, and supplementary procedures for international aviation have now been prepared for all the ten regions of the International Civil Aviation Organization.

(3) International Union of Geodesy and Geophysics

At the Eighth General Assembly of the International Union of Geodesy and Geophysics, held in Oslo, August 17-29, 1948, the Meteorological Office was represented by Sir Nelson Johnson, Dr. J. M. Stagg and Mr. C. S. Durst.

To the International Association of Meteorology, one of the seven constituent Associations of the Union, Sir Nelson Johnson contributed papers on the need for more observations of water vapour and helium in the high atmosphere, and on antarctic meteorology. The Radiation Commission of the same Association was reconstituted, and Dr. G. D. Robinson, Superintendent of Kew Observatory, was appointed a member.

The next General Assembly will be held in Brussels in 1951; Dr. Stagg was re-elected General Secretary of the Union.

(4) Intergovernmental Maritime Consultative Organization

The Marine Superintendent, in his capacity as President of the Maritime Commission, represented the International Meteorological Organization at the International Conference in Geneva, at which the Intergovernmental Maritime Consultative Organization was formed. The Conference lasted from February 19 until March 4, 1948.

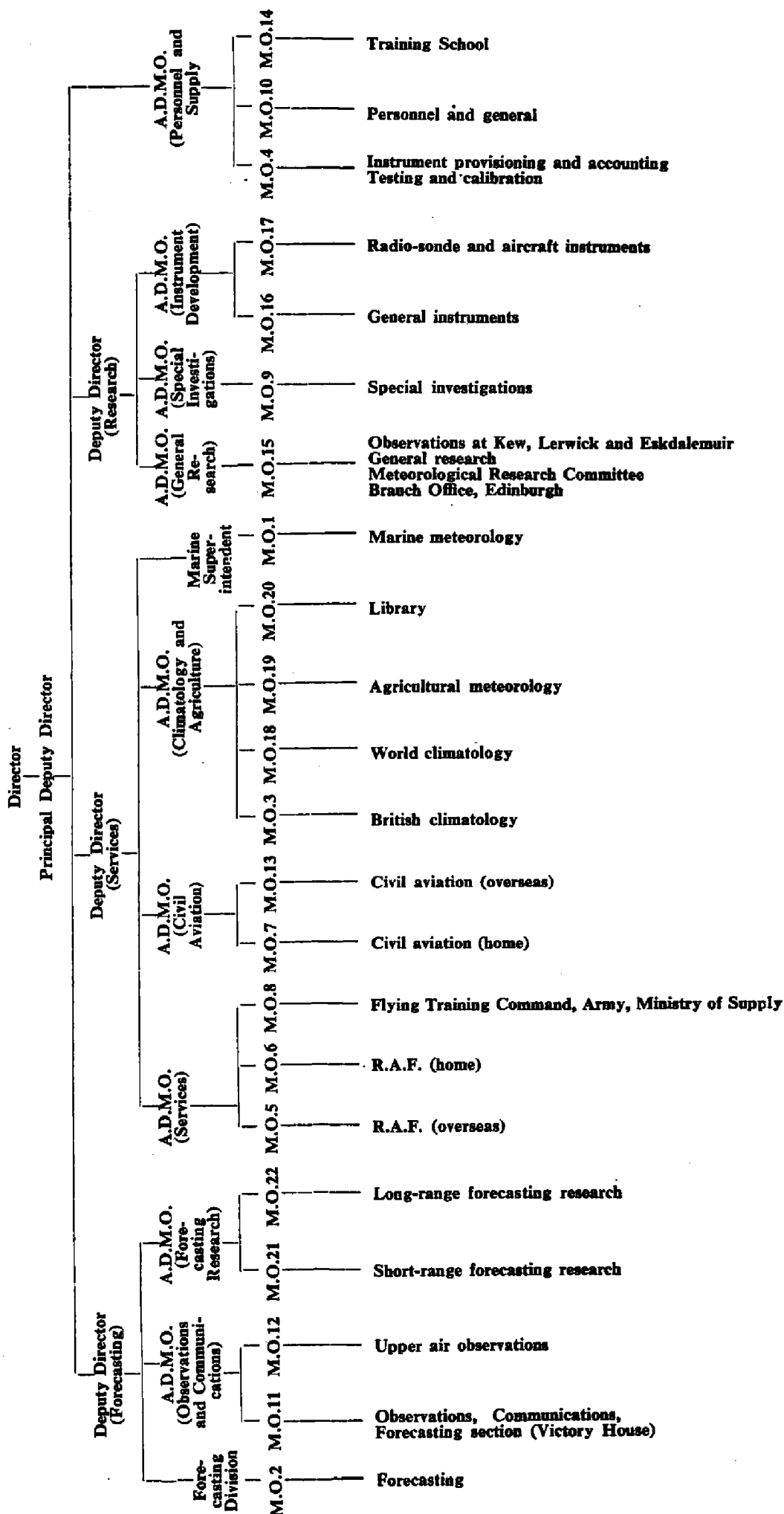
(5) International Conference on Safety of Life at Sea

The International Conference on Safety of Life at Sea was held in London from April 23 until June 10, 1948, following meetings of the "Preparatory Committee of Experts", which had been held also in London to study the co-ordination in the field of aviation, meteorology and shipping of matters concerning safety of life at sea.

The Marine Superintendent, as a member of the British delegation, represented the Meteorological Office. As President of the Maritime Commission, he represented the International Meteorological Organization. The meteorological provisions of the old Convention were entirely revised and were incorporated in the new Convention.

APPENDIX I

ORGANIZATION OF THE METEOROLOGICAL OFFICE



APPENDIX II

DIRECTORATE OF THE METEOROLOGICAL OFFICE AND HEADS OF BRANCHES

Director

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

Principal Deputy Director

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

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

APPENDIX III

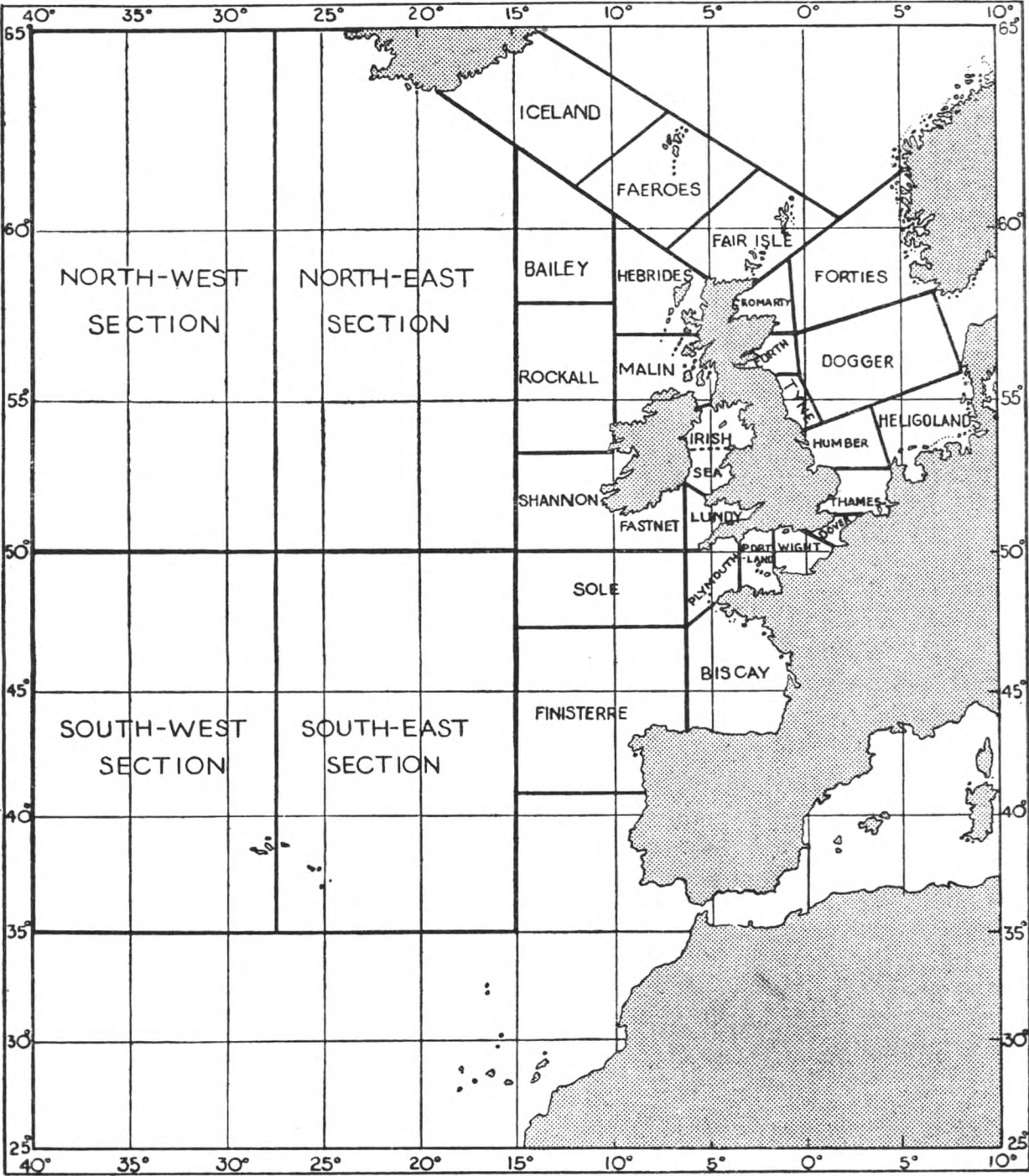
CLASSIFICATION OF BRITISH STATIONS WHICH REPORT TO THE BRITISH CLIMATOLOGICAL BRANCH

			Stations					Autograph records					
			Observatories	Synoptic	Crop-Weather	Climatological	Rainfall	Sunshine	Rainfall	Wind	Pressure	Temperature	Humidity
Scotland, N.	...	...	1	5	0	9	154	13	6	2	5	0	0
Scotland, E.	...	...	0	6	2	35	348	30	11	2	1	3	2
Scotland, W.	...	...	1	4	1	22	372	20	9	5	3	3	2
England, N.E.	...	...	0	6	2	19	297	21	9	5	5	2	1
England, E.	...	...	0	6	8	18	452	25	19	6	6	5	3
England, Midlands	...	...	0	9	5	34	1,017	43	32	2	5	4	2
England, S.E.	...	...	0	11	5	51	736	45	47	11	7	10	7
London District	...	...	2	2	0	9	41	7	4	2	2	1	1
England, S.W.	...	...	0	7	6	27	493	31	8	3	7	4	2
England, N.W.	...	...	0	5	1	19	456	22	24	5	5	4	4
Wales, N.	...	...	0	2	1	9	175	8	5	1	2	2	1
Wales, S.	...	...	0	4	3	10	263	15	8	2	2	1	0
Isle of Man	...	...	0	2	0	1	11	3	0	1	1	1	1
Scilly and Channel Isles	...	...	0	1	0	2	13	1	0	1	1	1	0
Northern Ireland	...	...	0	3	0	5	74	5	4	1	2	1	2
TOTAL	...	...	4	73	34	278	4,902*	289	186	49	54	42	28

* Includes stations in earlier columns.

APPENDIX IV

CHART SHOWING THE AREAS USED IN GALE WARNINGS AND
WEATHER BULLETINS FOR SHIPPING
effective from November 1, 1948



APPENDIX V

PROVISION IN AIR ESTIMATES FOR METEOROLOGICAL SERVICES

The approximate cash provision in Air Estimates, 1949-50, for meteorological services is as follows:—

Vote	Service	Provision
		£
1	Pay, etc., of airmen employed as meteorologists	52,300
	National insurance contributions	3,400
3	Salaries, wages, etc., of staff at headquarters of the Meteorological Office	249,000
4	Salaries, wages, etc., of civilians at meteorological observatories and outstation offices and in ocean weather ships	993,000
5	Conveyance of personnel; travelling allowances and expenses	48,800
	Conveyance of meteorological equipment	17,700
6	Provisions and ration allowances for airmen; provisions for crews of ocean weather ships	23,000
	Fuel, light, water and sanitary services for meteorological observatories and outstation offices	3,000
	Petrol, oil and lubricants for vehicles required for meteorological services	3,000
	Fuel oil for ocean weather ships	28,000
7	Meteorological equipment	330,000
	Radio, radar and electrical equipment for meteorological services	50,000
	Mechanical transport vehicles for meteorological services	16,000
	Miscellaneous equipment and services for ocean weather ships	35,000
	General stores for meteorological services	800
	Clothing, clothing allowances and laundry services for airmen; clothing for crews of ocean weather ships	6,000
8	Works services for meteorological observatories and outstation offices:—	
	Capital expenditure	35,000
	Maintenance expenditure	16,000
9	Telecommunication services for meteorological purposes	61,000
	Other miscellaneous effective services	12,000
10	Superannuation allowances and gratuities	10,000
	GROSS TOTAL	£1,993,000
	Deduct—Appropriations in aid:—	
4	Receipts in respect of salaries, wages, etc., of meteorological staff	£ 197,000
5	Receipts in respect of movement expenses of meteorological staff	12,000
7	Receipts relating to meteorological equipment	70,000
	Payments by airmen for issues of clothing and footwear	1,500
9	Receipts for meteorological services	4,000
10	Receipts in respect of non-effective benefits of meteorological staff lent to other governments	500
		285,000
	NET TOTAL	£1,708,000

APPENDIX VI

PUBLICATIONS

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

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

Periodical

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

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

Marine Observer (to January 1949).

Meteorological Magazine (to March 1949).

Monthly Weather Report, with a summary for the year (to December 1948).

Monthly Frequency Tables, being summaries of observations of horizontal visibility, height of base of low cloud, and speed and direction of surface and upper winds in the form approved by the International Commission for Air Navigation (to August 1946).

Seismological Bulletin. A dairy of seismological disturbances recorded on the Galitzin aperiodic seismographs at Kew Observatory, Richmond (to February 1949).

British Rainfall, 1946. A report on the distribution of rain in space and time over Great Britain and Northern Ireland as recorded by about 5,000 observers.

Facsimile Weather Charts for permanent retention. November 14 to 15, 1947.

Notes on the meteorological observations made in British Colonies and Protectorates, etc. in 1938 and summarised in the annual reports of Colonial Governments.

Annual Report and results of meteorological observations 1946. Southport Auxiliary Observatory. By George A. Lidster.

Occasional

Cloud Forms according to the international classification. Definitions and descriptions, with photographs of clouds. 6th edition, 1949.

Handbook of Weather Messages, Codes and Specifications.

Part I. Transmission schedules and station index numbers.

Part II. Codes and specifications.

Part III. Coding, decoding and plotting.

Instructions for the preparation of weather maps with tables of the specifications and symbols.

International Meteorological Code adopted by the International Meteorological Organisation, Washington, 1947. Decode for the use of shipping, incorporating the code for weather reports from and to ships and the analysis code for use of shipping.

Meteorology of airfields. By C. S. Durst, B.A.

Marine Observer's Guide. Information for the use of the voluntary observing fleet of the British Commonwealth of Nations co-operating with meteorological services. Special replacement, Washington Code, 1947.

Quarterly surface current charts of the western North Pacific Ocean westward of longitude 160° W., with monthly chartlets of the China Seas. 2nd edition, 1949.

Weather on the west coast of tropical Africa, from 20° N. to 20° S. including the Atlantic Ocean to 25° W.

Geophysical Memoirs :—

Vol. IX :—

80. Hourly ranges of the magnetic elements during the Polar Year 1932-3 at the observatories of Lerwick and Eskdalemuir. With a discussion by F. E. Dixon, B.A.

Vol. X :—

81. The aurora of January 25 to 26, 1938 and associated magnetic storm. By F. E. Dixon, B.A.
82. Weather forecasting in tropical regions. By A. G. Forsdyke, Ph.D., D.I.C.

Meteorological Reports :—

Vol. I :—

1. Aviation meteorology of South America.
2. Aviation meteorology of the Azores.

Professional Notes :—

Vol. VI :—

93. Preliminary note on errors in forecast frontal positions on 18-hour prebaratics. By C. K. M. Douglas, B.A.
94. Visibility and the optical properties of the atmosphere. By G. C. Simpson, K.C.B., F.R.S.
95. Calculation of night minimum temperatures. By R. Frost, B.A.
96. Cooling of air by rain as a factor in convection. By J. S. Sawyer, M.A.
97. Some correlation coefficients between certain upper air data. By Sir Gilbert T. Walker, C.S.I., F.R.S.

The publication of the following books or papers by members of the staff during the period up to December 1948 may also be mentioned.

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

Report on potamology. *Résumés Rapp. sci. Ass. Hydrol. Un. géod. géophys. int. Oslo*, 1948, Paris 1948, p. 39.

By SIR NELSON K. JOHNSON, K.C.B., D.Sc., A. J. LANDER and W. A. TOMS :—

Night-sky recorder. *Met. Mag., London*, 77, 1948, p. 193.

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

Research in the Meteorological Office, 1939-48. *Résumé Mém. Ass. Mét. Un. géod. géophys. int. Oslo* 1948. Los Angeles, Calif. 1948, p. 57.

By C. E. P. BROOKS, I.S.O., D.Sc. :—

Atmospheric pollution in Great Britain. *Proc. Conf. nat. Smoke Abatement Soc. Edinburgh*, London, 1947.

The variability of means of a series of observations. *Met. Mag., London*, 77, 1948, p. 283.

By C. K. M. DOUGLAS, B.A. :—

An unusual vertical temperature distribution over Brussels and Paris. *Met. Mag., London*, 77, 1948, p. 169.

By F. J. SCRASE, M.A., Sc.D. :—

The application of radar to the measurement of upper winds. *Weather, London*, 3, 1948, p. 151.

By R. C. SUTCLIFFE, B.Sc., Ph.D.:—

A contribution to the problem of development. *Quart. J. R. met. Soc., London*, 73, 1947, p. 370.

Physical processes. *Résumé Mém. Ass. Mét. Un. géod. géophys. int. Oslo* 1948, Los Angeles, Calif. 1948, p. 85.

The use of upper air thickness patterns in general forecasting. *Met. Mag., London*, 77, 1948, p. 145.

By O. M. ASHFORD, B.Sc.:—

A new bucket for measurement of sea surface temperature. *Quart. J. R. met. Soc., London*, 74, 1948, p. 99.

The application of radiosondes to meteorology. *Weather, London*, 3, 1948, p. 103.

By A. C. BEST, M.Sc., H. G. BOOKER, M.A., Ph.D., and P. A. SHEPPARD, B.Sc.:—

Radio meteorology in the United Kingdom, 1939–1947. *Résumé Mém. Ass. Mét. Un. géod. géophys. int. Oslo* 1948, Los Angeles, Calif., 1948, p. 66.

By A. G. FORSDYKE, Ph.D., A.R.C.S., D.I.C.:—

Cloud forecasting by means of the tephigram with particular reference to turbulence cloud. *Mem. E. African Met. Dep., Nairobi*, 2, No. 4, 1948.

Synoptic analysis in the Western Indian Ocean. Note on the movement and alignment of fronts during the winter months of the southern hemisphere. *Mem. E. African Met. Dep., Nairobi*, 2, No. 3, 1948.

By J. GLASSPOOLE, M.Sc., Ph.D.:—

The present state of work on evaporation in Great Britain and Northern Ireland. *J. Inst. Water Engrs., London*, 2, 1948, p. 255.

By J. S. SAWYER, M.A.:—

The structure of the intertropical front over N.W. India during the S.W. monsoon. *Quart. J. R. met. Soc., London*, 73, 1947, p. 346.

Pressure pattern flying. III. The meteorological limitations on pressure pattern flying. *J. Inst. Nav., London*, 1, 1948, p. 55.

Pressure-pattern flying. *Met. Mag., London*, 77, 1948, p. 73.

By J. K. BANNON B.A.:—

The estimation of large-scale vertical currents from the rate of rainfall. *Quart. J. R. met. Soc., London*, 74, 1948, p. 57.

A note on the adiabatic lapse rate for saturated air at temperatures below 0°C. *Quart. J. R. met. Soc., London*, 74, 1948, p. 161.

Rainmaking. *Weather, London*, 3, 1948, p. 261.

By J. E. BELASCO, M.Sc., Ph. D.:—

The incidence of anticyclonic days and spells over the British Isles. *Weather, London*, 3, 1948, p. 233.

By J. R. BIBBY, B.A.:—

The use of barographs in ships. *Met. Mag., London*, 77, 1948, p. 176.

By K. L. CALDER, B.Sc., A.R.C.S.:—

Progress in the problems of atmospheric turbulence. 1939–1947. *Résumé Mém. Ass. Mét. Un. géod. géophys. int. Oslo* 1948, Los Angeles, Calif., 1948, p. 71.

By H. T. CARDIS, B.A. and W. H. HOGG, M.Sc.:—

The frequency of snow-cover in Sweden and Finland and its relation to temperature. *Quart. J. R. met. Soc., London*, 74, 1948, p. 83.

By N. CARRUTHERS, B.Sc.:—

Use in agricultural meteorology of tables for great-circle sailing. *Met. Mag., London*, 77, 1948, p. 273.

By R. FRITH Ph.D.:—

Meteorological research flight. *Met. Mag., London*, 77, 1948, p. 241.

By W. H. HOGG, M.Sc.:—

The diurnal variation of rainfall at Rio de Janeiro. *Quart. J. R. met. Soc., London*, 73, 1947, p. 467.

Rainfall dispersion diagrams: a discussion of their advantages and disadvantages. *Geography, Manchester*, 32, 1947, p. 31.

By H. H. LAMB, M.A.:—

On the general circulation of the atmosphere in middle latitudes: southern and northern hemispheres compared. *Bull. Amer. met. Soc., Boston*, 29, 1948, p. 391.

By A. W. LEE, D.Sc.:—

Anomalies of barometric pressure at coastal stations. *Met. Mag., London*, 77, 1948, p. 201.

By F. H. LUDLAM:—

The forms of ice-clouds. *Quart. J. R. met. Soc., London*, 74, 1948, p. 39.

By G. D. ROBINSON, Ph.D.:—

The temperature of the highest layers of the atmosphere. *Weather, London*, 3, 1948, p. 78.

By E. J. SUMNER, B.A.:—

Some aspects of the theory of turbulence. *Met. Mag., London*, 77, 1948, pp. 77, 101 and 121.

By J. WADSWORTH, M.A.:—

Evaporation from tanks in the British Isles. *Weather, London*, 3, 1948, p. 322.

Crown Copyright Reserved

LONDON

PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

To be purchased directly from H.M. Stationery Office at the following addresses :

York House, Kingsway, London, W.C.2; 13a Castle Street, Edinburgh, 2;

39 King Street, Manchester, 2; 2 Edmund Street, Birmingham, 3;

1 St. Andrew's Crescent, Cardiff; Tower Lane, Bristol, 1;

80 Chichester Street, Belfast

OR THROUGH ANY BOOKSELLER

1949

Price 9d. net

(63086) Wt. 2178—M 212 9/49 D.L.

PRINTED IN GREAT BRITAIN
S.O. Code No. 40-41-0-49