

Meteorological Office

REPORT FOR THE YEAR
ENDING
MARCH 31, 1959

METEOROLOGICAL OFFICE

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LONDON

HER MAJESTY'S STATIONERY OFFICE

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ANNUAL REPORT
ON THE
METEOROLOGICAL OFFICE

*Presented by the Director-General
to the
Secretary of State for Air*

FOR THE YEAR
APRIL 1, 1958 TO MARCH 31, 1959



LONDON
HER MAJESTY'S STATIONERY OFFICE
1959

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The Committee met on November 4, 1958.

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The President of the Royal Astronomical Society
The President of the Royal Meteorological Society
The Director-General of the Meteorological Office

The Committee met on July 14, 1958.

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FUNCTIONS OF THE METEOROLOGICAL OFFICE

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

The general functions of the Meteorological Office are :

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

The Meteorological Office also takes a leading part in international co-operation in meteorology. The Director-General is the Permanent Representative of the United Kingdom with the World Meteorological Organization.

Except for the common services provided by other Government Departments as part of their normal function (e.g. accommodation by the Ministry of Works; stationery by Her Majesty's Stationery Office; postal services by the Post Office) the cost of the Meteorological Office is borne by Air Votes.

The gross annual expenditure by the Exchequer, including that on the common services, is of the order of £5,000,000. Of the expenditure chargeable to Air Votes, about £3,250,000 represents expenditure associated with staff and £1,500,000 expenditure on stores, communications and miscellaneous services. Of the total expenditure, over £1,000,000 is recovered from other Government Departments and outside bodies in respect of special services rendered, sales of meteorological equipment, etc.

FOREWORD BY THE DIRECTOR-GENERAL

The year under review saw a further rise in the demands made by non-aviation interests on the services provided by the Meteorological Office. There were very large increases in the number of telephone calls, both in the automatic service and in enquiries to meteorological offices, and new requirements for television programmes had to be met as far as possible. Some of this increase can be ascribed, no doubt, to the generally poor weather of 1958, but apart from this there is evidence of a growing appreciation of the benefits to be gained from professional advice on weather and climate in many walks of life. While I welcome this interest most heartily, it cannot be denied that it is difficult, with existing facilities, to meet the growing demands of the public and to maintain aviation services at their present high level of efficiency. Special attention is being given by my staff to the problem of making information about the weather more readily accessible to the man in the street, and it is hoped that the opening of a weather office for the public in the heart of London will go some way to achieving this purpose in the metropolis.

The supply of meteorological information to military and civil aviation, the armed forces and government and municipal departments has continued on normal lines. In research, I am glad to say that the high-speed digital computer is now installed at Dunstable. At present, this machine is used solely for research, but it is hoped that ultimately this, or similar equipment, will be used in routine forecasting. A new post, that of Chief Forecasting Research Officer, has been created by the promotion, on special merit, of Mr. J. S. Sawyer, formerly Assistant Director (Dynamical Research). This is specially welcome as an important strengthening of the effort on those aspects of research which bear directly on the weather service.

The end of 1958 saw also the close of the International Geophysical Year, to which the Office has contributed in full. The I.G.Y. is being followed by a period of International Geophysical Co-operation, with the Meteorological Office again taking its share of the work.

Plans for the new headquarters building at Bracknell have now been finally agreed and it is expected that work on the site will begin this summer. By autumn 1961 it is hoped that the whole of the staff now housed in London (with the exception of the London Forecasting Office), Harrow and Dunstable and the Training School at Stanmore will be settled in their offices. This should greatly increase the efficiency of the Office in all departments.

I attended the meetings of the Special Committee for the International Geophysical Year at Moscow during August 1958 and also the Tenth Session of the Executive Committee of the World Meteorological Organization during April and May 1958.

THE DIRECTORATE OF SERVICES

Services as used in this title mean the application of meteorology in the service of all sections and interests of the community. The directorate deals with the making and collection of its own raw material in the form of weather observations, the wholesale processing of this material at the central forecasting office, Dunstable and, on the climatological side, at the meteorological offices in Harrow and Edinburgh, and the retailing of the final product in the form required by the customer at outstations throughout the country and overseas.

As a broad division of labour within the directorate, the deputy director in charge of central services, D.D.M.O.(C), looks after the raw material and the wholesale side; the deputy director in charge of outstation services, D.D.M.O.(O), is responsible for seeing that the customers get what they need in the form best suited for their purpose. In practice, the division of labour is not quite as clear cut as this. For example, D.D.M.O.(O)'s staff at outstations provide more than half of the observations from this country needed in the central forecasting office. Conversely, D.D.M.O.(C) deals with his customers in some matters without the intermediary of D.D.M.O.(O)'s outstation offices. From the central forecasting office at Dunstable he supplies forecasts to the B.B.C. for broadcasting to the public, and his London forecasting office answers telephone enquiries from individual members of the public in the London area. In marine matters and those relating to climatology and agriculture, D.D.M.O.(C)'s branches also deal direct with their customers. On the opposite side of the balance some of D.D.M.O.(O)'s main offices, for example, that at London Airport, operate in large measure independently of the Dunstable central office because they have to deal with forecasts for air routes which go far outside Dunstable's primary area of interest.

For those services, D.D.M.O.(C) and D.D.M.O.(O) have between them about 2,400 staff of all classes and grades: of these over 1,700 are on D.D.M.O.(O)'s side at outstations in this country and abroad, about 650 are under D.D.M.O.(C) at the central communications and forecasting office, Dunstable; at Harrow for climatology, agriculture and marine meteorology, and at surface, upper air or atmospheric observing stations.

In addition to those two main groups under deputy directors, the Director of Services also has an assistant director in charge of training and techniques, A.D.M.O.(T.T.). He is responsible for the professional training of all members of the assistant, experimental and scientific officer classes on first recruitment to the Office, and for refresher and advancement courses at later stages. On the techniques side his job is to ensure that the technical efficiency of the staff, working for the most part in small groups up and down the country, is maintained. He is a two-way link between them and the research staff, bringing those of the outstation local problems he cannot solve himself to the attention of the research staff and seeing that the outstations apply the new ideas and practices developed in research.

In the sections that follow are set out the main features of the year in each of the branches of the directorate. One dominating theme recurs, the increasing awareness in all sections of the community of the value of meteorological information for a wide variety of activities. This information is supplied either in the

form of weather forecasts based on current weather reports or advice and guidance based on climatological records, or a combination of both. In this connection it should be mentioned that in addition to their primary work for Royal Air Force and civil aviation, many of the outstation offices provide weather information for a great number of other interests including the B.B.C. and Independent Television companies, British Railways, British Electricity Authority, Area Gas Boards, the G.P.O. for the automatic telephone weather services, and members of the general public. In this last category the enquiries to outstations range wide, from agricultural and industrial matters to holiday activities; they increased from 210,000 in the previous year to nearly 294,000 in the year ending March 1959.

At the London forecasting office, soon to be transferred from the top floor of Victory House, Kingsway, to an office at street level with a shop front in the same area, nearly 103,000 enquiries were answered by telephone in 1958-1959 compared with just over 85,000 in 1957-1958, this in spite of the fact that the automatic telephone weather service for the London area provided answers to over 2,900,000 enquiries in the present year (nearly 2,800,000 in 1957-1958). In addition to London, the automatic telephone weather service operates in the areas surrounding Edinburgh, Glasgow, Belfast, Cardiff, Manchester, Liverpool and Birmingham. London subscribers can also get forecasts for the Essex, Kent and Sussex coasts. The total number of calls on those services rose by a million to nearly 6,000,000 in 1958-1959.

CENTRAL FORECASTING

The Central Forecasting Office (C.F.O.) is primarily a master analysis centre with an output designed to help outstations to meet their forecasting commitments. The material for this purpose is broadcast by teleprinter and facsimile and consists mainly of actual and forecast analyses of surface and upper air charts, supplemented by appreciations of atmospheric developments. This work has been carried on without any fundamental change from previous years.

In addition to being a master analysis centre the Central Forecasting Office is responsible for the issue of a number of forecasts and warnings, most of which have a nationwide application. These are in three main categories. First, there are general forecasts prepared for the Press and for broadcasting; concurrently with the latter certain outstations prepare more detailed forecasts of the weather over smaller regions. Secondly, there are forecasts for public utilities such as the Central Electricity Generating Board; again with outstations being responsible for providing a parallel service in the form of forecasts to regional control centres. Thirdly, the Central Forecasting Office provides certain special forecasts for periods up to three or four days ahead, an undertaking for which staff are specially provided.

The continued extension of television coverage has resulted in more forecasts being required, but because of the regionalized plan of television broadcasts, most of these forecasts are prepared by outstations following the general guidance issued by teleprinter from C.F.O. There has been no corresponding decrease in the programme of forecasts on sound radio.

Apart from minor re-arrangements of the broadcasts from G.P.O. stations, the bulletins for shipping have continued as before. Forecasts and gale warnings for shipping covering sea areas from Iceland to the mainland of Europe are broadcast by the B.B.C. on 1,500 m. and by a number of G.P.O. radio stations around the coast of the British Isles. Instructions to operate the gale warning

cones around the coast are also issued by telegram from the Central Forecasting Office. A weather bulletin for the eastern half of the North Atlantic, prepared at C.F.O., is broadcast twice daily from the G.P.O. station at Portishead and storm warnings for this area are broadcast whenever they are considered necessary.

The provision of forecasts and outlooks is generally restricted to a day or two ahead. But the importance of providing forecasts beyond this period has long been recognized. As yet, however, the reliability of forecasts decreases rapidly as the period is extended. On the other hand, there are occasions when some elements can be forecast further ahead than others or when it can be confidently expected that particular conditions will not occur for several days. The long-standing Fine Spell Service is an example of this. Under this scheme a forecast of dry weather for at least three days is sent by telegram from C.F.O. to individual subscribers whenever the necessary conditions can be foreseen. Consideration of developments over the next three or four days has also proved useful in shorter-term forecasts. Warnings of persistent fog in densely populated areas (on occasions when a visibility below 200 yards for at least 24 hours is expected) were issued on several occasions during the winter and involved long-term considerations over a very broad area.

Forecasts supplied by C.F.O. which illustrate the varied applications of meteorology for special purposes are forecasts of ice on the conductor rails of electrified railways, forecasts of periods of dry weather for specialized building construction, forecasts for pigeon races (in which adverse weather may result in the loss of hundreds of valuable birds), warnings of wind likely to result in dangerously high water along the east coast and forecasts of weather for climbing and skiing in the mountains of Scotland.

Among the responsibilities of the C.F.O. outside the sphere of forecasting is the preparation of the *Daily Weather Report* with its *Overseas Supplement* and *Monthly Summary*, and of the *Daily Aerological Record*. Plans have been developed during the year for improving both the processing and the form of presentation of these publications.

PUBLIC SERVICES

During the year, public utilities, industrial concerns, broadcasting authorities, growers, and the general public have all made greater use of the services provided by the Meteorological Office than ever before, notwithstanding the fact that, in many cases, charges for specialized services have had to be increased. (See p. 36.)

Telephone services. Although, apart from the one exception mentioned below, no extension of the automatic telephone weather service was possible, the number of calls on this service increased by 20 per cent. over those of the previous year, while personal telephone enquiries over the country as a whole were over 40 per cent. higher than in 1957-1958 and reached a record level of nearly half a million. At times, especially on the eve of Public Holidays, lines to many offices were so saturated with calls for weather information that some would-be enquirers were unsuccessful in obtaining connections. That four-fifths of these telephone enquiries are addressed to offices established primarily for aviation purposes and that the peaks of these public enquiries often coincide with the times of greatest air traffic is a matter of some concern.

A new use was made of the forecast for the London area available on the automatic telephone weather service. At the request of the British Travel and Holidays Association, translations into French and German, made on its behalf

by the B.B.C. overseas service staff, were used by the G.P.O. during the summer months on their automatic foreign language information services.

Sound broadcasting. Two new items were introduced. At the request of the B.B.C., a short forecast was prepared each evening, Mondays to Fridays, for inclusion in 'Roundabout' at 6.29 p.m. in the Light Programme. Also, a shipping forecast for the use of small-boat fishermen was broadcast nightly on the Scottish Home Service. Informal talks covering expected holiday weather were given by the Assistant Director (Central Forecasting) early on the morning of August Bank Holiday and again just before Christmas. It is hoped that this may become a regular feature. The B.B.C. overseas service twice visited Dunstable and gave foreign language descriptions of the work there and in one case a member of the staff broadcast in German to German listeners.

Television. After much planning, the format of the routine evening 'weatherman's' programme on B.B.C. television was changed to allow of more detailed regional forecasts, prepared by certain outstations and fed into television regional studios for reading by B.B.C. news announcers. This apparently simple modification involved considerable communications problems which were solved jointly by the B.B.C. and the Office. The so-called 'fair copy' chart, in addition to being shown at 6.9 p.m., 7.30 p.m., and at the end of the programme is now also screened during the 10 p.m. television news. The abandonment of the Sunday evening personal presentation on B.B.C. television was regretted, but the omission was partly covered by the transfer from Thursday to Sunday of the weekly 'Farmers' programme, with its weather item.

With the formation of two new commercial television programme companies, Southern Television operating from Southampton and Tyne Tees Television from Newcastle, each requiring three forecasts a day, the work on this side also increased. Several approaches were made by individual companies for the services of Meteorological Office personnel to present routine weather programmes. Unfortunately, staff shortages prevented such participation, but the representative of one company was given some training before appearing in a weekly weather series. Numerous ad hoc broadcasts of topical interest were made by various members of the staff.

Exhibitions. After two or three years of successful display, the itinerant meteorological exhibition was temporarily withdrawn from circuit, its last appearance being on loan to the U.S.A.F. base at Burtonwood, when on one day in May over 60,000 visitors were estimated to have seen it. Several requests were met for small-scale exhibitions for various educational bodies.

Radar storm warning. A first step in the regular operational use of the radar installation on the roof of Victory House was made when forecasts of heavy rain were supplied experimentally to London Transport, particularly for use where Underground stations are affected by floods or by sudden surges of weather-bound passengers. Extension of the service to assist other local authorities is under consideration.

Public utilities. Close liaison in the provision of forecasts has been maintained with the Gas Council, British Railways, local authorities, the Forestry Commission and the Central Electricity Generating Board. The Office has also co-operated with the Road Research Laboratory of D.S.I.R. and with London Transport Executive Research Division in connection with the forecasting of icing on roads and on electrical conductor rails respectively.

OBSERVATIONS AND COMMUNICATIONS

Synoptic reporting network. Changes in the location of airfields used by the Royal Air Force and the Royal Navy during the year and the closing of associated meteorological offices have caused gaps in the synoptic reporting network. The co-operation of the Coastguard Section of the Ministry of Transport and Civil Aviation in arranging for weather reports from Coastguard stations at the Mumbles and Deal has helped to fill such gaps. Indeed, valuable assistance from the Coastguard organization in establishing auxiliary reporting stations has been given freely over a long period. Co-operation from a new source has become available. Engineers of the Independent Television Authority at their transmitting station on Winter Hill, nearly 1,500 ft. above sea level, agreed to supply weather reports, and these have already proved extremely valuable.

Radio-sonde and radar-wind observations. The network of eight combined radio-sonde and radar-wind stations in the United Kingdom has been maintained. Each station has made observations of pressure, temperature and humidity in the upper air twice daily and of upper winds four times daily. During the International Geophysical Year special efforts were made to increase the height of the observations and the use, to this end, of larger balloons on selected occasions produced a very significant improvement. Selected stations also increased their sounding programme during the World Meteorological Intervals.

Meteorological flights. As in the preceding year, meteorological reconnaissance flights were made by Hastings aircraft of No. 202 Squadron of the Royal Air Force based on Aldergrove and by Mosquito aircraft operated by a civilian contractor from Woodvale. Both types of flights achieved a high degree of regularity.

Thunderstorm location. The network of radio direction-finding stations in the United Kingdom, maintained for locating thunderstorms within 1,500 miles of the British Isles, was operated without change. Equipment was also installed at Malta and Gibraltar. At selected times each day these two stations were operated jointly with the four stations of the United Kingdom network and the results obtained respectively from the four-station and six-station networks are being compared.

Teleprinters. As a result of decisions reached at the joint ICAO/WMO meeting held at Geneva in February-March 1958, new transmission schedules on the International Meteorological Teleprinter Network in Europe were introduced on June 1. The Meteorological Communications Centre at Dunstable is now entirely responsible for disseminating reports from Greenland over this network, while the responsibility, formerly that of this Office, for transmitting reports from Russia-in-Europe, has been transferred to the communications centre at Frankfurt.

Most weather reports originated and received at Dunstable by teleprinter are, with suitable apparatus, simultaneously reproduced as perforated paper tape, which in turn is used for actuating teleprinter transmissions. This year it has been arranged that a selection of reports shall be prepared on a continuous tape for permanent retention to meet the requirements of data processing in the Office. Certain of these continuous tapes are also used with the electronic computer.

Radio communications. In accordance with the recommendations of the World Meteorological Organization and with the aim of replacing wireless telegraphy (W/T) by a radio-teleprinter (RTP) in radio broadcasts of meteorological obser-

vations, transmission on additional frequencies has been introduced for the Dunstable Continental RTP broadcast and the content of this RTP broadcast has been amplified to include the reports for both main and intermediate synoptic hours. By December 1, 1959, this continental broadcast will have been made for 18 months both on W/T and RTP and, on that date, its transmission by W/T will cease as internationally agreed.

To meet the special needs of meteorological services in Cyprus, the bulk of observational data required there has been supplied by radio-teleprinter transmissions keyed from Dunstable.

Facsimile. Facsimile transmissions by radio and landline of analysed weather charts and forecast charts, as well as certain tabulated data, have continued from Dunstable, while a further radio transmission on a frequency in the 18 mc/s band has been added during the year to improve reception of this service. The General Post Office is now engineering special circuits to facilitate and improve the transmission of facsimile weather charts from Dunstable to selected meteorological offices in this country and FAX recorders have been installed during the year at Gibraltar, Malta and Nicosia.

International Geophysical Year (I.G.Y.) and International Geophysical Co-operation, 1959 (I.G.C.). The majority of stations at home and overseas which made special returns of their observations during the International Geophysical Year are continuing to do so during the period of International Geophysical Co-operation, 1959. Facilities will continue to be provided at Dunstable for broadcasting 'alerts' or 'special world intervals' declared by the World Warning Agency.

CLIMATOLOGICAL SERVICES

The functions of the assistant directorate of Climatological Services are the collection and preservation of surface meteorological data for the United Kingdom area, the preparation and publication of meteorological data for general public use and to meet international commitments, the processing and presentation of such data in forms convenient for various users, particularly in the fields of industry, agriculture, horticulture, water engineering and hydrology, and the investigation of various problems related to the provision of meteorological services (other than forecasting). There are three sections of the assistant directorate of Climatological Services, one for British Climatology, one for British Rainfall and Hydrology and one for Agricultural Meteorology. The Meteorological Office, Edinburgh, which looks after these activities in Scotland, is also controlled by the Assistant Director (Climatological Services) and its work is included in the following account.

British Climatology

The British Climatology section is responsible for the supply of meteorological advice and information relating to all aspects of British climate other than rainfall and agricultural matters. The section supervises and arranges for the periodical inspection of all co-operating climatological stations in Great Britain and Northern Ireland; these stations are maintained by private observers, local authorities, universities and other educational establishments, industrial concerns, trusts and government departments. Great public spirit is shown by those who participate in the operation of these stations, often at personal inconvenience occasioned by the requirement for daily readings at fixed times throughout the

year, whatever the weather. During the year, 27 new stations began making returns but 21 ceased reporting, including those at Strelley, Manchester (Whitworth Park) and Leamington Spa where observations began in 1881, 1901 and 1913 respectively. At least one of these closures was due to continual wanton damage of the instruments. One hundred and forty of the stations were inspected during the year. The classification of stations which render climatological returns is given at Appendix V.

Three courses for co-operating observers were held: two of five days each in London and a three-day course in Edinburgh. In all, 87 observers attended.

Statistical work and punched-card methods. The assembly, scrutiny and summarizing of all climatological returns and tabulations were kept up to date.

A new form for monthly climatological returns from co-operating stations was introduced. This form has been designed so that the data on it can be readily transferred to punched cards.

Data from official stations continued to be transferred to punched cards on a routine basis and further progress was made in punching a 'backlog' of ten years data for five stations, those for London and Manchester Airports being completed.

New branch memoranda included "Low temperature related to surface wind and direction at London Airport, December 1948 – February 1958" and "Combined distribution of hourly values of dry bulb and wet bulb temperature, Croydon 1946-1955" plus similar memoranda for Renfrew, Driffeld and Boscombe Down.

Publications. The *Monthly Weather Report*, containing full summaries of observations was published regularly. The *Annual Summary* (for 1957) and the *Introduction* were published in October. Contributions, including climatological statistics, were provided for revised editions of two Admiralty Pilots (the North Sea and West of Scotland); the Ulster Year Book; Digest of Scottish Statistics, etc.

Special work. Special meteorological contributions were prepared for inclusion in the "Guide to Current Practice" of the Institution of Heating and Ventilating Engineers.

Advice was given to the Central Electricity Generating Board on the climatological characteristics of some possible sites for nuclear power stations.

Information on wind structure and extremes was provided in connection with the revision of a British Standard Code of Practice document.

Contributions were made towards the preparation of a draft British Standard Code of Practice on Weather Protection, in collaboration with other bodies concerned.

Enquiries. The number of requests received for meteorological information of all kinds again showed an increase. The variety of enquiries dealt with included the supply of weather data or meteorological advice in connection with fuel consumption and the heating of buildings; the Forth road-bridge; air conditioning plants; a gasification plant; the design of masts (including a 1,000 ft. one in Scotland); shingle deposits; multi-storeyed buildings; swelling of wood block floors; radar installations; road and runway constructions; the heating of a roadway and of a football pitch; a proposed chairlift in the Cairngorms. Investigations for which special information was provided included a study of respiratory diseases; incidence of pyloric stenosis; development of pollution resistant coatings; radio transmission; the breeding of sparrows and fractures in cast-iron

gas mains. Information on the distribution of thunderstorms was again supplied to the Electrical Research Association. Several enquiries related to the wet summer of 1958 in England and Wales. A large number of statements was supplied for legal and insurance purposes. Advice was given to private individuals on such topics as where to live, local climates and weather observing.

British Rainfall and Hydrology

The British Rainfall and Hydrology section is responsible for the supply of information and advice relating to rainfall and evaporation and, increasingly, to more general hydrological problems or investigations in which the rôle of one or both of these elements is important. It also undertakes the supervision and periodical inspection of all co-operating rainfall stations in Great Britain and Northern Ireland. These stations are maintained by private observers and by the engineers or other officers of river boards, water supply undertakings, hydro-electric boards, local government authorities, and so on, without whose help it would not be possible to assess the incidence of rainfall in the detail which is now required in many activities of great economic importance. During 1958, observations were received from 214 new stations, but 186 ceased to report. The number of stations inspected during the year was by far an all-time record, more than 900 rain-gauges, including those at climatological stations, having been visited.

The section maintained contact with many organizations which are active in the field of hydrology, or in civil engineering with hydrological factors involved. These included the Surface Water Survey of the Ministry of Housing and Local Government, both the Road Research Laboratory and the Hydraulics Research Station of the Department of Scientific and Industrial Research, most of the individual river board engineers' departments, the North of Scotland Hydro-Electric Board and many water-supply engineers. There was also liaison with departments in several universities, where engineering, forestry and geography share interests in hydrology. The section continued to co-operate in investigations for which the Meteorological Office has contributed equipment: the evaporation investigation at Kempton Park, controlled by a committee of the Institution of Water Engineers with the valuable aid of the Metropolitan Water Board, approached its concluding stages; the varied and stimulating experiments of the Engineer of the Fylde Water Board at Stocks Reservoir near Slaidburn, Yorkshire, were carried further, covering investigations of evaporation, transpiration, the effects of afforestation on water relationships, and the accuracy of rainfall measurements using rain-gauge shields; a comprehensive hydrological investigation of the Ystwyth Valley, carried out as post-graduate work by the Department of Geography and Anthropology at the University College of Wales, Aberystwyth, made a very promising start, and the installations were visited and inspected during the year; and the Imperial Forestry Institute, Department of Forestry, University of Oxford, initiated investigations concerned with rainfall, interception, evaporation and transpiration in woodland near Oxford. An interesting development took place in Northern Ireland where proposals were discussed for starting investigations in three different reservoir areas into the effects of afforestation on upland water supplies; the fulfilment of the plans prepared would be a major and praiseworthy effort, especially in relation to the size and population of Northern Ireland.

Statistical work. "Averages of rainfall for Great Britain and Northern Ireland 1916-1950", containing information for 719 stations with virtually complete

observations during the period, was published in January 1959. The use of the new standard period, in place of 1881-1915, for rainfall averages, was gradually extended; and good progress was made on a thorough survey of data for the whole country, which will eventually provide estimated averages for several thousand stations with incomplete observations. A new detailed map of average rainfall is to be drawn and the work has already been done for several river basins. The natural hydrological grouping has been introduced for the first time, in place of the old and hydrologically arbitrary system of county divisions. Another new development was the introduction of a sound statistical technique for estimating averages derived from incomplete data, with the object of determining the standard errors of such estimates and eliminating subjective judgments. Efforts were made to extend the use of statistical methods in other directions in preparation for the introduction of machine processing.

The grid references for nearly all rainfall stations were collected and preparations were made to use and publish these references as a regular item of station information. A start was also made on the systematic re-numbering and grouping of all rainfall stations on the basis of natural drainage areas.

Publications. The volume of *British Rainfall* for 1956 was published in February 1959, with serious delay during printing. Material for the 1957 volume was sent to the printers. A report of the Snow Survey of Great Britain for the season 1957-1958 was prepared, eventually to be published in *British Rainfall* 1958, and in the meantime over 150 duplicated copies were distributed to co-operating observers and others. Estimates of monthly general rainfall were prepared for about 120 areas for which run-off data are available, for inclusion in the *Surface Water Year Book* 1956-1957. The number of areas for which this work is required is rapidly increasing and, at the same time, the Surface Water Survey of the Ministry of Housing and Local Government is accelerating the preparation of the data during the period following the end of the water-year to which they refer. Thus, work on the preparation of general rainfall estimates for about 150 areas for the *Surface Water Year Book* 1957-1958 had to be accelerated.

Special work. Data for a second full summer season of observations in the rainfall investigation at Cardington were obtained in 1958. Though improvements in instrumental performance were not as great as had been hoped, the total amount of useful data obtained was about 25 per cent. more than in 1957, attributable in part to the weather! A preliminary report based on the 1957 data was submitted to the Joint Committee on Rainfall and Run-off of the Road Research Board and the Ministry of Housing and Local Government. It was favourably received, with useful comments on the most important results, and on the form of presentation for application to storm-water drainage problems. Material for a further report covering data for both 1957 and 1958 was assembled and brought to an advanced stage.

In a second investigation in which the Joint Committee is interested, which will start with the distribution of open-scale rain recorders to 250 local authorities, developments were very disappointing. After repeated delays the instruments received from the manufacturers were found to be faulty and had to be returned for modification. Distribution did not begin until well into 1959.

Pursuing developments originating during the International Geophysical Year, evaporation pans of the U.S. Weather Bureau Class A type were distributed to a number of co-operating stations where the authorities have undertaken

to maintain daily observations for the Meteorological Office. The total number of stations with this type of equipment is now 16.

Hydrological Memorandum, No. 3: "A compound rain-gauge for assessing some possible errors in point rainfall measurements" was prepared, and on the basis of this paper experiments began at the Road Research Laboratory in October 1958. The compound rain-gauge was made in the workshops of the Laboratory and other instruments for the joint investigation were provided by the Meteorological Office. First results are very promising and should be of special importance in view of the current revival of interest in the accuracy of rainfall measurement.

Enquiries. The volume of enquiries dealt with by the section again increased during the year. They were mainly related, as usual, to problems of water supply, drainage and flooding, damage to goods, accidents, insurance against bad weather and so on. An unusually large number of enquiries related to summer floods, culminating in the events associated with the thunderstorm in south-east England on the evening of September 5, for which many separate enquiries referring to different localities were received. A comprehensive report on this storm was prepared. Several agencies, both in Government service and in private industry, sought advice on the intensity-duration frequency distributions of heavy rainfall, in relation to the performance of various radar devices under development.

Agricultural Meteorology

The duty of the section for Agricultural Meteorology is the application of meteorology to problems of agriculture, horticulture and forestry. The headquarters of the section is at Harrow and other units are stationed at the National Agricultural Advisory Service Regional Headquarters at Bristol, Cambridge and Leeds. A member of the staff of the Meteorological Office, Edinburgh, carries out similar duties for Scotland. Further contact with associated workers is established by regular inspections of agricultural meteorological stations and by the courses for climatological observers at which special lectures are given.

Routine work. Weekly weather summaries continued to be circulated to agriculturalists, and forecasting centres were kept in touch with current farming operations. Special mention should be made of two important contributions to the weather item in the B.B.C. weekly television programme for farmers (see p. 10)—the forecasting of an outbreak of potato blight and of an epidemic of the liver-fluke disease of sheep. These forecasts were made by Ministry of Agriculture staff of the Plant Pathology Laboratory and the Veterinary Laboratory respectively who had been working in collaboration with meteorologists at Harrow on these disease problems.

Special work. The work on blight forecasting was the subject of a display at the summer Soirées of the Royal Society. Other diseases in which joint work is in progress are apple scab, apple mildew, and cereal rusts. In these researches much use is made of the new surface wetness recorder. This instrument was shown and described at the XVth International Horticultural Conference, at Nice, in April. A paper was also given at this conference on the current work in this country on shelter for horticultural crops.

Other investigations demanding considerable meteorological help dealt with the effect of shelter in upland areas, the climate of poultry houses, the problems

of orchard management on high ground, the trajectories of black rust spores, the extent and distribution of sulphur dioxide pollution, the evaporation of silage effluent and the effect of weather on milk yields. In the last-named problem, it appears likely that the spring weather is the key to the entire summer milk supply and especially to the minimum supplies of early autumn. Further collaboration is proposed with the Nuffield Farm Project in Devonshire, with marling and drainage experiments in the Lancashire mosslands and with an assessment of orchard yields.

In the field of applied climatology work continues on the analysis of soil temperatures, relative humidities, successions of rainy months, run-of-the-wind data and the interpretation of wetness duration charts. County surveys of areas suitable for horticulture continue to be made in collaboration with agronomists and help has been given to the National Institute of Agricultural Botany in the preparation of tentative homoclimate maps for use in the interpretation of the results of seed trials.

Enquiries. Help in a minor way continues to be given in an exceptionally wide variety of subjects. Apart from the perennial problems of frost, irrigation and shelter, the following list gives some idea of the type of work in which meteorological knowledge has been able to help:—potato storage; ecology of heather; gangrene in potatoes; fire-blight of pears; growth of peas; food requirements of sheep; trials of vegetables; potato eelworm; disease of larch trees; yields of grass; petal blight of chrysanthemums; compaction of soil by rain; weed-killer spraying; growing of seed potatoes; condensation in buildings; winter browning of grass; ergot in rye; response to fertilizers; the growth of rhubarb; club root; invasion of diamond-back moths from the Baltic; climate of watercress beds; lodging of cereals; grain drying; epidemics of pea midge; soil moisture measurements; fruit fly infestation; air pollution; the flying habits of beetles and the effect of a new motorway in Kent on the frost incidence in neighbouring orchards.

MARINE BRANCH

Voluntary observing fleet. The constitution of the voluntary observing fleet of the British Merchant Navy was described in the Report for the year ending March 31, 1956. The number of British voluntary observing ships at present is as follows:—

Selected ships	..	..	499
Supplementary ships	..		55
Coasting ships	..	..	90
Trawlers	..	..	33
Light-vessels	..	..	13

a total of 690 out of a world total of approximately 3,100.

During the year a daily average of over 100 weather messages from British ships in the Eastern North Atlantic, and about 15 messages from coasting vessels have been received at Dunstable by radio. The number of weather messages received from trawlers has shown a praiseworthy increase to about 750 a month compared with about 150 a month in 1956. Reports from distant-water trawlers working in high latitudes provided valuable observations which were unobtainable from any other source. A monthly news letter for trawlers, initiated in 1957, has done much to stimulate their interest in this voluntary work.

In an endeavour to obtain more ship reports from the North Sea area, Port Meteorological Officers and Merchant Navy Agents at the various ports made

special efforts to increase the 'recruiting' of ships trading in this area. As a result, the actual number of reports received per day was 11 per cent. higher in 1958 than in 1957.

A study of logbooks received from voluntary observing ships shows that, as a general rule, observations are made throughout their voyages, that the coded weather messages are regularly transmitted to the appropriate radio stations and that the observations are made conscientiously and accurately.

Voluntary observing ships played an important part in the programme of the International Geophysical Year because they provided the only means of obtaining meteorological observations from many oceanic areas. All ship observations made during the course of the I.G.Y., after being extracted from the ships logbooks by machine methods, were tabulated and forwarded direct to the World Meteorological Organization for scientific investigation. Throughout the I.G.Y. these ships also made aurora observations in all oceans on behalf of the Balfour Stewart Auroral Laboratory at Edinburgh.

A new service established by British ships from New Zealand to the west coast of South America will enable meteorological records to be obtained from an area where observations have hitherto been almost non-existent.

In addition to making routine meteorological observations, the observers aboard voluntary observing ships are encouraged to record any special meteorological, astronomical and oceanographical phenomena, sea surface currents, ice, etc. Many of the officers send in ornithological observations. These reports are referred to the appropriate authority in this country and the more interesting of them are published in the *Marine Observer*.

During the year, prizes in the form of books were awarded to 100 merchant ships—including trawlers and coasting vessels—for 'excellent' meteorological work during the year. Barographs were presented to four Masters.

British ocean weather ships. Eleven years of satisfactory service were completed by the Meteorological Office's four ocean weather ships. In May 1958, the "Weather Explorer" was withdrawn and sold after 81 voyages as an ocean weather ship. She was replaced by the former frigate "Oakham Castle" which was converted to an ocean weather ship at a shipyard in the Clyde and was renamed o.w.s. "Weather Reporter" by Lord Hurcomb, Chairman of the Meteorological Committee, at a ceremony in Greenock in May 1958. It is intended that three more "Castle" class vessels shall be converted and commissioned as ocean weather ships within the next two years to replace the other three ships nearing the end of their economic operation as ocean weather ships. The "Castle" class vessels are somewhat larger and better fitted than the earlier ships, making it possible to site the meteorological office in a more convenient position on the upper deck forward of the balloon shelter instead of right aft between decks. More comfortable living accommodation can also be provided. The new ships have a bigger fuel capacity and their radio equipment is more modern and efficient. "Weather Reporter" is proving a successful ship in service.

During the year under review, the British ships, operating in rotation with French and Netherlands ships, at ocean stations 'A' (62°N., 33°W.), 'I' (59°N., 19°W.), 'J' (52° 13'N., 20°W.), 'K' (48°N., 16°W.) in addition to their normal programme of surface and upper air observations, have made special efforts to obtain radar-wind and radio-sonde observations to a height of up to 100,000 ft. with the use of 1,250 gram balloons.

Special observations of the water temperature gradient with the bathy-

thermograph continued aboard all ships on behalf of the Admiralty. Observations of waves by means of an electric wave recorder now installed in "Weather Reporter" were continued.

Special radio investigations were carried out aboard the ocean weather ships on behalf of the Radio Research Establishment; tests were also made with a radio teletype receiver in order to monitor reception of weather messages from aircraft in flight, and with the 'Dectra' long-range navigational aid, on behalf of the Ministry of Transport and Civil Aviation.

Plankton and sea-surface samples were obtained at sea for the Ministry of Agriculture, Fisheries and Food and for the Scottish Home Department.

Microfilmed copies of observations recorded aboard British weather ships were made and distributed in exchange for similar microfilms from other operating countries of the North Atlantic Station Agreement.

Currents and ice. Computational work continued on the analysis of the currents of the eastern parts of the South Pacific. The surface currents and ice sections of eight "Admiralty Pilots" were revised during the year.

Ocean current information was supplied to the Admiralty during the year for inscription on 36 navigational charts.

Special work. A start was made on preparing a ten-year summary of the meteorological observations of the ocean weather ships on stations 'I' and 'J'. These summaries will be in addition to the annual summaries which are prepared each year for stations 'A', 'I' and 'J'.

The radiation instruments originally installed in ocean weather ships for the International Geophysical Year will be retained indefinitely. The data will be punched on cards in the same way as for radiation data for land stations.

Some work was done on the calculation of energy balance terms for selected five-day periods at ocean weather station 'J'.

An investigation was started on the occurrence of sea fog in the western approaches.

The computation of wave height frequencies for 5°-squares of latitude and longitude for each month for all ocean areas was begun.

An investigation into the climatic fluctuation in the tropical Atlantic was completed and a paper written on the subject.

Marine enquiries. The number of enquiries dealt with was slightly greater than in 1957. Requests for information were received from the Royal Air Force, Ministry of Transport and Civil Aviation and other government departments; and from the meteorological services of other countries, scientific institutions, commercial firms and private individuals. The following are examples of the range covered: tables showing the percentage frequency of winds of force three or less, for each month, in the Gulf of Siam, Andaman Sea, Strait of Malacca and the South China Sea; information about the sea areas with the highest air temperature and humidity was provided in connection with the testing of life jackets; percentage frequency tables of wind direction and force and of wave heights were forwarded to the Channel Tunnel Study Group. Special information (including sea temperature data) was worked up for several firms of civil engineers and contractors engaged upon the design of cooling systems for nuclear power stations. The frequency of gale force winds was computed for six areas near the extremity of existing load line zones in different oceans in preparation for the proposed International Load Line Conference in 1960. Information was given to various shipping companies about the state of ice in northern seas. The British

Shipbuilding Research Association was given details of weather conditions in the vicinity of hurricane "Carrie" in September 1957. Long period averages of sea-surface temperatures at 34 light-vessels and other stations around our coasts were requested by the Ministry of Agriculture, Fisheries and Food.

Information was supplied to the Ministry of Transport and Civil Aviation for investigations into several serious shipping casualties.

Punched-card installation. The work required of this Installation, which is administered by the Marine Branch, has continued to increase and new punching and verifying machines as well as a collator were acquired. The punching of cards was increased to include, inter alia, overseas surface land data and radiation data. We are grateful for the co-operation of two other installations which now punch cards for the Meteorological Office during their 'off peak' periods.

Under exchange arrangements with the United States, the Installation received 750,000 cards of daily observations at a network of northern hemisphere land stations and 300,000 cards for upper air data for a network of overseas stations.

A card-to-tape converter was acquired. This machine allows data now held on cards to be converted automatically for direct use by the electronic computer.

MILITARY SERVICES

The Meteorological Office has catered for the meteorological requirements of the Royal Air Force, the Army, the Ministry of Supply and the Home Office, and has maintained collaboration with the Naval Weather Service as hitherto.

The outstation organization serving the Royal Air Force has not changed substantially. Generally, this organisation runs parallel with that of the Royal Air Force, with main meteorological offices at the headquarters of R.A.F. operational Groups, with subsidiary offices at R.A.F. stations within the Groups. Main offices are continuously manned, but at subsidiary offices the hours during which a forecaster is available depend on the local needs of the Royal Air Force. Subsidiary offices are normally connected by teleprinter to a main office which supplies them with technical advice and guidance.

During peace time no meteorological units are deployed with field units of the Army, but a special meteorological section is attached to the School of Artillery, Larkhill, and detachments of staff are made to artillery practice camps as necessary.

Overseas, meteorological sections attached to R.A.F. formations normally provide the special services required by the Army.

Services provided in the United Kingdom. Main forecasting offices continued to operate at certain Air Traffic Control Centres and in Operational and Flying Training Commands. In Bomber Command progress was made towards a modified meteorological organization, as a result of the trial of new procedures for the supply of meteorological information to modern long-range high-altitude aircraft. Special arrangements for the supply of information for transatlantic flights have continued to work satisfactorily. In Fighter Command, amended criteria for the supply of special weather reports to Air Traffic Control have been agreed.

Staff were provided for major R.A.F. and combined N.A.T.O. exercises, and for certain Home Office exercises.

Meteorological offices have been maintained at a few Ministry of Supply

establishments where the meteorological information provided was often of a specialist military nature.

Services provided overseas. Early in the year under review certain changes were made in the meteorological organizations in the Middle East Air Force and British Forces Arabian Peninsula areas, in order to accord with the Royal Air Force reorganizations which were taking place about that time. Staff were withdrawn from six stations overseas; but, on the other hand, additional U.K.-based staff were provided for Cyprus.

In Western Germany, the meteorological requirements of the Royal Air Force and the Army have been met on lines similar to those adopted in the United Kingdom. However, most of the German personnel formerly employed by the Meteorological Office have left to join the German military meteorological service, and have necessarily been replaced by British staff.

In the Middle East, temporary staff difficulties arose in Cyprus from the decision to discharge locally engaged Greek Cypriot staff, but the position rapidly improved following the arrival of British replacements.

At Habbaniya, as a result of events in Iraq, the British meteorological office was unable to function for several months, and most of the U.K.-based staff were gradually withdrawn.

Forecasting and advisory services for British Forces, and on behalf of the local government for civil aviation, continued at the main meteorological offices at Malta, Cyprus and Aden.

In the Far East, R.A.F. requirements have been met by a main meteorological office and two subsidiary forecasting offices in Malaya. Meteorological Office staff have now been withdrawn from Hong Kong.

A subsidiary forecasting office, working in close collaboration with the Ceylon Meteorological Service, has continued to meet R.A.F. requirements in Ceylon.

To meet similar needs in Libya, meteorological offices have been maintained. The forecast office at Idris also serves civil aviation on behalf of the Libyan Government; supervision of the technical work of this office is provided from the main office at Malta.

A forecasting office and upper air observing stations for the Christmas Island area were maintained as necessary in connection with various atomic tests. Apparatus for the location of atmospherics was provided as an additional forecasting aid.

SERVICES FOR CIVIL AVIATION

Meteorological services are provided for civil aviation both in the United Kingdom and at certain locations overseas in conformity with the standards, recommended practices and procedures of the International Civil Aviation Organization.

Three types of meteorological offices are maintained for civil aviation purposes, namely, main meteorological offices, subsidiary meteorological offices and observing offices. Main offices are provided at Air Traffic Control Centres and major civil aerodromes and give full forecasting service on a continuous 24-hour basis. Subsidiary offices are provided at civil aerodromes of intermediate importance, and at these offices the forecasting service does not normally operate regularly throughout the 24 hours daily. Observing offices are provided at minor civil aerodromes and as their name suggests are mainly concerned with the making and issue of weather reports.

An essential feature of the service is the supply and dissemination of reports of actual weather conditions at aerodromes. To do this, a continuous watch is kept on weather conditions throughout the period of operations. Routine reports are made at hourly intervals, and at half-hourly intervals at many of the principal aerodromes and, in addition, these are kept up to date by special intermediate reports of sudden changes.

Services provided in the United Kingdom. It has been necessary to maintain meteorological services at four main and 13 subsidiary forecasting offices. A new subsidiary office was provided at Gatwick, but this was offset by the simultaneous withdrawal of the forecast facilities from Croydon. The number of observing offices increased from five to seven. The requirements at Croydon Airport necessitated the retention of an observing office after the withdrawal of the forecast service and the aerodrome at Benbecula was transferred from the Air Ministry to the Ministry of Transport and Civil Aviation. The basic functions of these offices have changed very little during the year although there was a progressively increasing demand for meteorological services to meet the expanding scheduled operations. This was particularly noticeable in the case of non-State aerodromes.

The experimental period of new methods of meteorological documentation for flights from London Airport on European and Mediterranean routes has continued. Some modifications were made in the layout of the forms used and appear to have been satisfactory. The extension of these new methods to other meteorological offices is now under consideration.

Meteorological service to aircraft in flight is provided by either (a) an area meteorological watch or (b) a flight meteorological watch. By the former method, applicable to flights in Europe, warnings of certain adverse weather conditions covering particular areas are disseminated by Air Traffic Control Centres. In addition, aerodrome weather reports and forecasts are made available by means of radiotelegraphy and radiotelephony broadcasts from these same centres, and they can also be obtained by pilots by individual request. The supply of this meteorological information to the Air Traffic Control Centres is the responsibility of the main offices at Uxbridge, Preston and Prestwick. Under the flight meteorological watch procedure, which is in use on North Atlantic routes, individual watch is kept on each flight forecast issued, and these are amended or new forecasts supplied as appropriate during the progress of the flight. This work is undertaken by the main offices at London Airport and Prestwick for flights from those aerodromes. In addition, Prestwick provides the necessary service for certain flights from Manchester, Belfast and Glasgow airports.

Arrangements requiring the agreement and co-operation of Commonwealth, colonial and foreign meteorological services were made for a number of flights including those of H.R.H. the Duke of Edinburgh to and from Canada and to India, the Queen Mother to Nairobi, H.R.H. Princess Margaret to and from Canada and the West Indies and H.R.H. the Duke of Gloucester to and from Addis Ababa.

Public inquiries into the accidents to Viscount G-AOJA at Nutts Corner and Bristol Freighter G-AICS at Winter Hill, Lancashire, necessitated a detailed examination of the meteorological aspects, the preparation of briefs for the Treasury Solicitor and the attendance of members of the staff for the purpose of providing meteorological evidence. At the request of the Ministry of Transport and Civil Aviation, a member of the Meteorological Office staff was sent to the

inquiry held at Munich into the Elizabethan G-ALZU accident to act as adviser on icing conditions at take-off.

The Ministry of Transport and Civil Aviation approved many applications made by independent airlines for the operation of new public services. Advice concerning meteorological facilities available for these services was given to the Ministry of Transport and Civil Aviation and to airline operators.

A special forecasting service was provided for the British Gliding Association national championships in July/August. These were held at three sites at Dunstable, Nympsfield (Gloucestershire) and Port Moak (Scotland).

The training of air traffic control officers and flight information service officers from both State and non-State aerodromes in the making and reporting of weather observations continued. This training scheme enables successful candidates to provide aerodrome weather reports when stationed at an aerodrome where there is no meteorological office.

Arrangements were made for appropriate meteorological offices to supply essential data to establishments of the United Kingdom Atomic Energy Authority in the event of accidents.

Special work. Large jet-engined aircraft (e.g. Comet IV) have been introduced on civil routes. This has led to a requirement for forecasts for higher altitudes than previously required for other types of aircraft.

A great deal of work has been done in the preparation of calibration tables to facilitate the assessment of Runway Visual Range at a number of civil aerodromes.

Examinations. All commercial pilots and flight navigators are required to hold licences normally obtained as a result of an examination in various subjects including meteorology. During the year under review 2,000 candidates were examined.

Visitors. Arrangements were made for members of Commonwealth and other meteorological services to visit meteorological offices at civil aerodromes, to enable them to study the procedures in operation for providing meteorological services for civil aviation.

Services provided overseas. Meteorological services for civil aviation were provided at a number of joint-user aerodromes in the Middle East Command, and liaison was maintained with colonial and foreign meteorological services along trunk routes used by British operators.

The Falkland Islands. The Meteorological Office continued to accept responsibility for the provision of services at Port Stanley. In addition, the technical work of the meteorological staff at the bases in the Dependencies is controlled by the Meteorological Office, through the Chief Meteorological Officer at Stanley. With financial support from the Ministry of Transport and Civil Aviation and the Colonial Office, arrangements were made for the temporary radio-sonde unit at Stanley to continue in operation after the end of the International Geophysical Year on a permanent basis.

TECHNIQUES AND TRAINING

Work directed towards providing aids to forecasting at outstations followed several different lines. A survey was made of local forecasting problems stated by the outstations, from which it became apparent that a good many were amenable to statistical treatment by punched card or electronic methods, whilst others needed studying from the synoptic standpoint; two working groups were set up

to study and advise on the handling of the statistical and synoptic problems respectively. Local forecasting rules which have been developed at outstations as the result of experience were co-ordinated and listed, and the lists were distributed for information generally and as a means of indicating to each outstation the parameters and considerations which have been found useful at others. The scope and form of local weather books which are maintained at each outstation for the purpose of assembling local forecasting experience were reviewed, and guidance on their compilation was issued with the aim of increasing the value of these books. A series of diagrams for each outstation, in the form of a map of the locality on which important characteristics of local weather and forecasting rules are entered, was reviewed and proposals were made for the preparation of a revised edition in a larger size so as to provide for the inclusion of more information. Preliminary work was started on two other series of diagrams, viz., charts of typical synoptic situations, and simplified topographical maps high-lighting local geographical features of meteorological importance.

Advances in dynamical research and numerical prediction hold promise of increased accuracy in forecasting the pressure field: but there still remains the problem of forecasting the meteorological elements at a particular place, given the pressure field. Attention is being devoted to this problem with special reference to the forecasting of low cloud. A preliminary examination has failed to disclose an immediate association between low cloud and the data given by a prebaratic, and it has become necessary to study in some detail the temperature and humidity structure in the lowest few thousand feet.

Numerous empirical formulae for predicting temperature, fog, etc., which may be found in various publications have been collected together to form a "Pocketbook for Forecasters" which has been issued to outstations. The second part of "The Handbook of Meteorological Instruments" dealing with upper air instruments, has been completed and the popular "Short course in elementary meteorology", by the late W. H. Pick, has been re-written. Other publications in preparation are a series of diagrammatic aids to instrument maintenance, a booklet on forecasting for gliding, and a new edition of a cloud card for observers.

The Work Study team developed a modern accounting system for use by M.O.4, the branch responsible for the purchase, holding and issue of stores. Substantial savings and greater efficiency are expected to be achieved as a result of this study. The team is currently studying the possibility of reducing the work involved in making climatological returns and in handling the forms.

The programme of training courses has been reorganized and expanded. The introduction of courses in the maintenance of meteorological instruments was mentioned in last year's Report; these now form part of the ordinary courses for forecasters and scientific assistants. Likewise, courses in tropical or Mediterranean meteorology have been incorporated as optional subjects in the initial forecasting course. Arrangements have been made to introduce a new course in climatology, lasting eight weeks, and a short general course for senior forecasters to cover developments in the various fields of meteorology which have taken place since these members of the staff last attended the School.

At its fourth meeting, the Meteorological Committee gave its support to the proposal that the Office should specifically provide for the attendance of oversea students at the Training School and should make the facilities known internationally. A new annual informatory leaflet on professional training courses (*M.O. Leaflet*, No. 4) was issued in October. Copies of the leaflet were sent to

the World Meteorological Organization and to Commonwealth meteorological services.

Details of the number of courses held during the year under review, and the number of Meteorological Office staff and overseas students who attended the various courses, may be found in Appendix IV. It may be noted that the total number of overseas students was 57. Many of the students from eastern countries held fellowships financed under the Colombo Plan.

In addition to receiving training within the Office, staff are encouraged to study for higher examinations; as far as possible they are given financial aid and allowed a certain amount of time off for studying. During the year under review, applications for such concession were received from 89 members of the staff, mostly in the Assistant (Scientific) class; of these, 80 were granted. Staff were also offered the opportunity of taking a 'sandwich course', whereby periods of six months are spent alternately at a technical college and in the Office over a total period of four years; the standard of selection for such courses is high and, in the event, only one member of the staff were selected for a course.

The monthly discussion held in London at the rooms of the Royal Society of Arts during the winter months continued as in recent years. The subjects discussed were as follows:—

October 20	..	..	Clear air turbulence
November 17	..	..	Forecasting cirrus
December 15	..	..	Tropical meteorology
January 19	..	..	Meteorological measurements at aerodromes
February 16	..	..	Hail
March 16	..	..	Objective methods of local forecasting

J. M. STAGG

Director of Services

THE DIRECTORATE OF RESEARCH

Research in the Meteorological Office is now proceeding energetically in many fields. With the advent of electronic computing, forecasting by dynamical calculation has become a realistic prospect upon which there should be enough evidence at the end of another year to base an informed opinion. But not only this; throughout the field of weather forecasting and climatology the handling of formidable quantities of observational data is in a sense the central problem. At times, the meteorologist has, Canute-like, felt his helplessness in face of the flood of data, but modern aids, and here electronic processing enters once more, promise relief with efficient storage and processing. The whole complex problem is therefore being studied and, whether the application is to dynamical calculation, statistically based forecasting or the compilation of climatological summaries, we may look forward to methods which will be revolutionary.

The section of this Report on research in physical meteorology call for a general comment. While the Meteorological Office has traditionally a major interest in weather and climate, as these terms are commonly understood, the science of the atmosphere has a wider connotation and the research meteorologist in recent years has felt himself not only irresistibly attracted by new problems but also goaded on by events. The International Geophysical Year was an unprecedented stimulus to all the earth sciences; atomic energy and nuclear weapons have led to a more than academic interest in atmospheric radioactivity; atmospheric chemistry has come to mean the world-wide study of those invisible substances which, although in minute amounts, trace the circulation of the atmosphere or enter critically into the physics of clouds; new advances in radar technology have provided tools of atmospheric research which demand our skilful application; guided and unguided missiles bring the demand for new data on the higher atmosphere and, feeding back through instrumented rockets and artificial satellites, related technology provides the means of exploration which the atmospheric physicist cannot ignore. Although faced with established commitments, limitations of staff and the persistent difficulty of recruiting able scientists, the Meteorological Office has responded to these new appeals in many directions and will do more as resources permit. More than ever, it can be said that for the young scientist, experimental physicist or theoretician, looking for a career outside the big industries, radio, nuclear energy, chemical engineering and the like where all but the few become obscure units in a large machine—more than ever it can be said that the Meteorological Office offers challenging individual opportunities.

Fortunately, meteorological science, except in very special contexts, is by tradition and general custom freely published and internationally discussed. Within a very few years it is most exceptional if the new scientific officer has not published papers and become known to colleagues at home and oversea as an individual worker in his chosen field, for the profession is not over large. Attendance at scientific meetings is encouraged freely and visits to scientific conferences in other countries are the normal expectation of a meteorological career. As in other years, many of the scientific staff have found themselves engaged as technical experts in groups set up by the World Meteorological Organization or playing a part in the activities of the International Association of Meteorology and Atmospheric Physics (of the International Union of Geodesy and Geo-

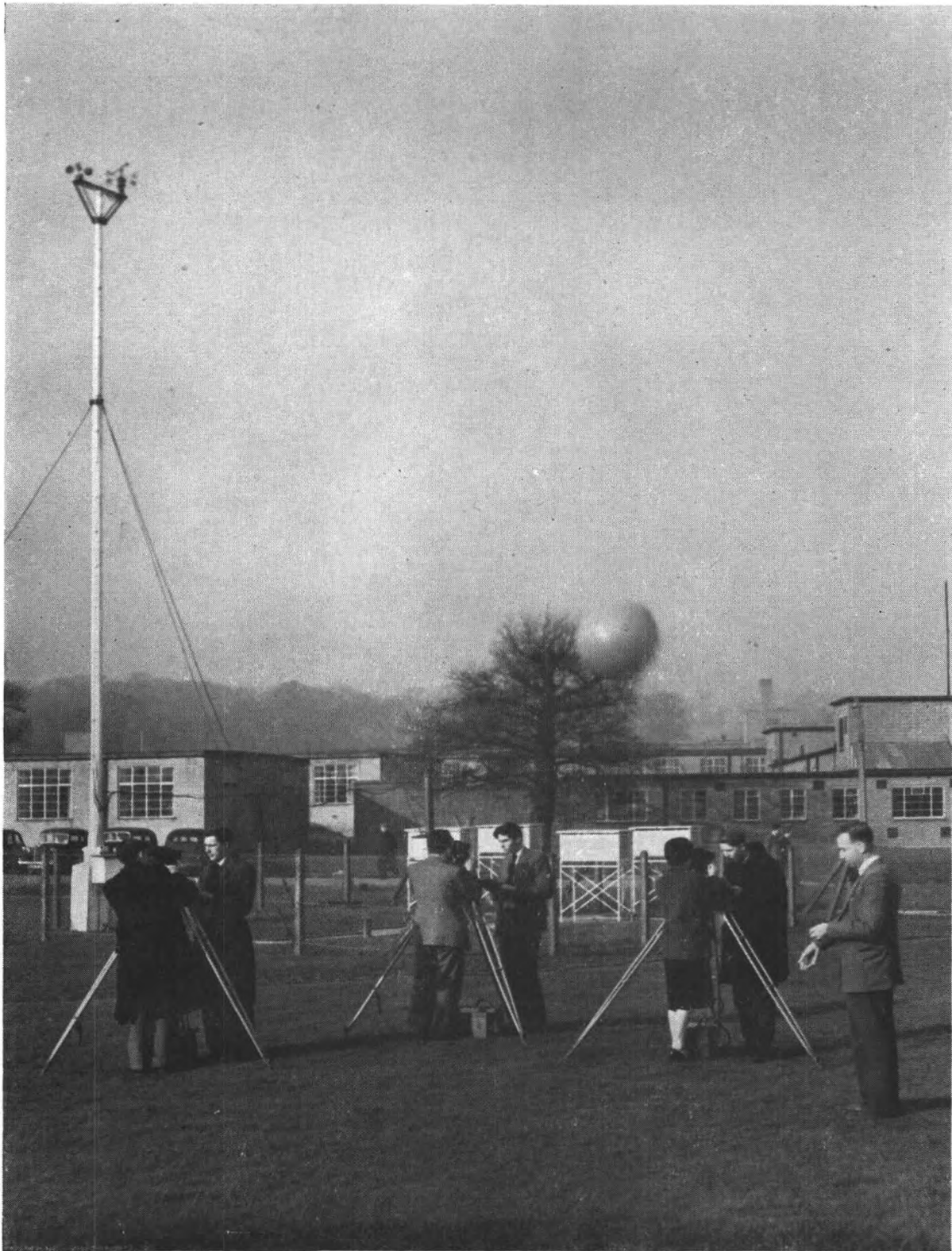
PLATE I



Crown Copyright

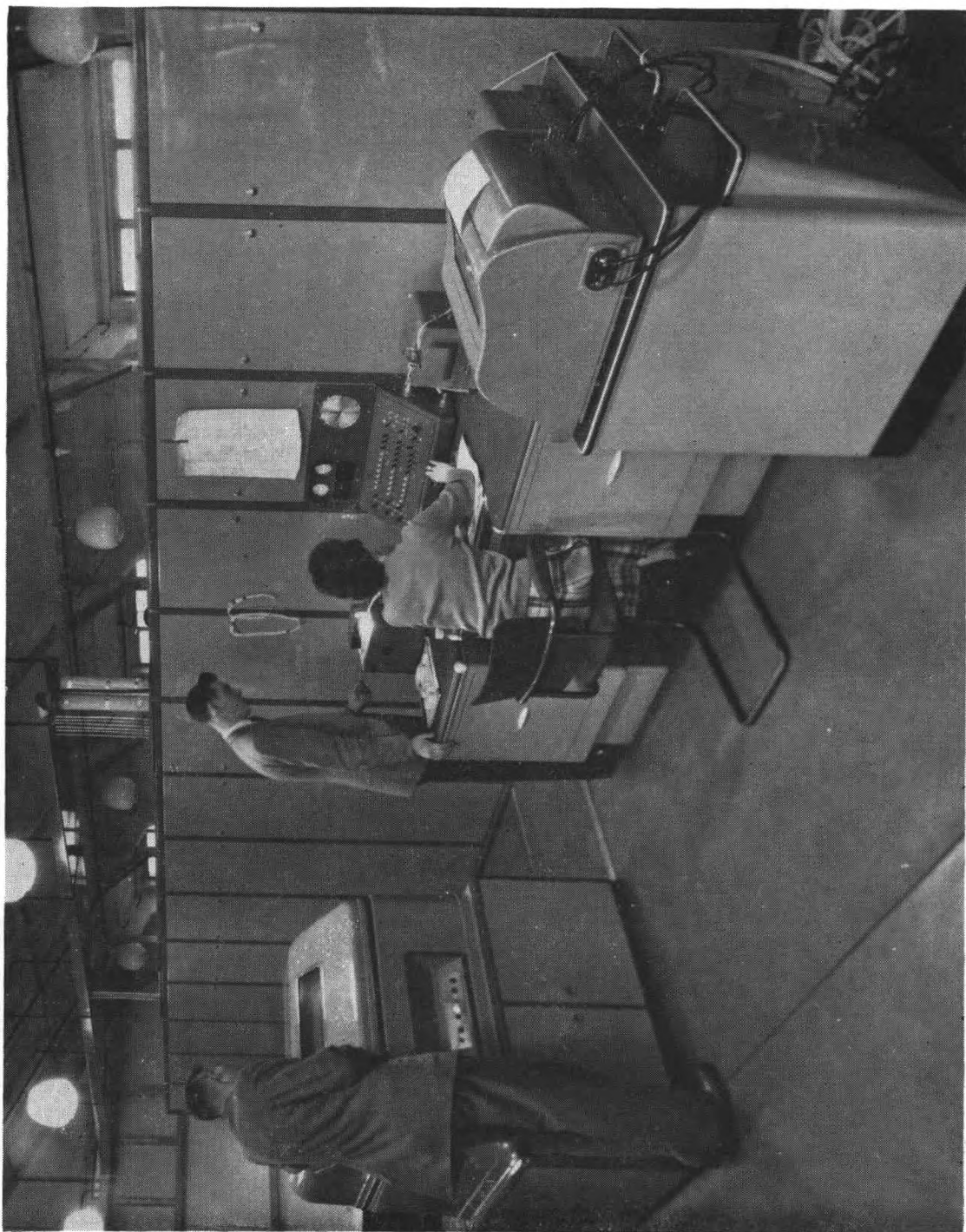
Stern view of Ocean Weather Ship *Weather Reporter* showing balloon filling shelter and balloon, and anemometers and wind vanes on yard arm. (See p. 18.)

PLATE II



Crown Copyright

Pilot balloon instruction at the Training School. (See p. 24.)



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METEOR electronic computer. (See p. 27.)

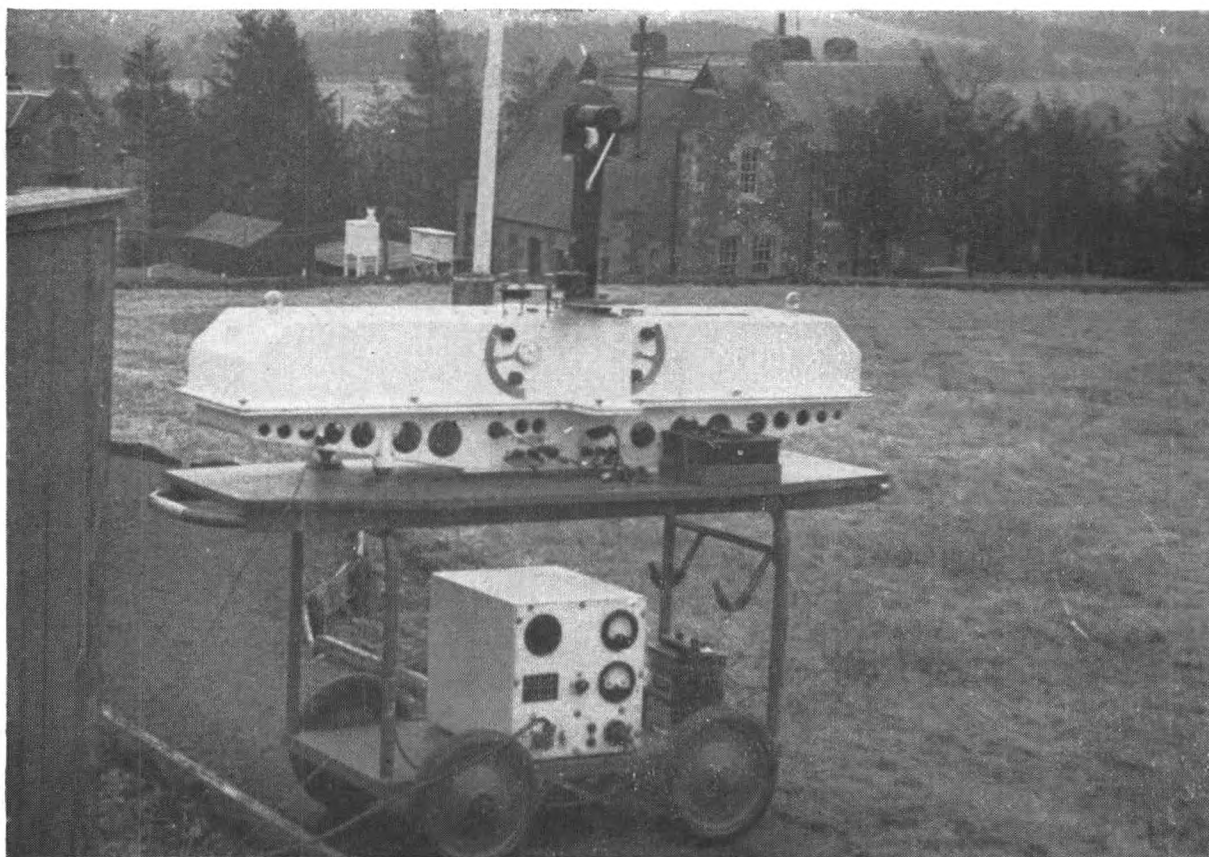
PLATE IV



Crown Copyright

Eskdalemuir Observatory—A view of some of the rain-gauges and experimental snow-gauges, with atmospheric electrical pit further back. (See p. 30.)

PLATE V



Crown Copyright

Eskdalemuir Observatory—Close-up of ozone spectrophotometer, showing Schuster house (hostel) in background. (See p. 30.)

physics). Within the Commonwealth there is a particularly happy relationship, and it is a pleasure to record the special co-operation during the International Geophysical Year of those Services which are directed through the Colonial Office.

No report on research would be complete without acknowledgement, and much more than a formal token, of the assistance and encouragement given by the Meteorological Research Committee and its Sub-Committees. There were 13 meetings in the course of the year, and the regular attendance of members from the universities was particularly gratifying.

Relationship with the Royal Society through its many committees was further extended during this year of expanding interest in geophysics and some tangible help to Royal Society research programmes was again provided, £7,000 for basic research in atmospheric physics and a special grant of £14,000 to support research with rockets.

Helpful co-operation from other Government departments is, happily, something which is taken for granted in scientific work but the support of the Ministry of Supply deserves a special word. During the course of the year our research programme has led to new demands upon the resources of a number of that Ministry's establishments and in each case the request for help has met with an understanding and cordial reception.

FORECASTING RESEARCH

The Ferranti 'Mercury' computer (known as METEOR) was installed in the autumn and early winter of 1958. It was accepted by the Meteorological Office on January 8, 1959, and an experiment in using the hydrodynamical equations of atmospheric motion to calculate the charts of 1,000 mb and 500 mb contours 24 and 36 hours ahead was commenced on a daily basis (five days a week) on January 12. Large-scale vertical motion is also calculated during the course of the experiment. (It is too early to assess results.)

The initial experiment in numerical forecasting is based on data extracted automatically by the machine from the punched tapes which carry a record of teleprinter messages received at Dunstable. The method of calculation uses data from two levels in the atmosphere—100 mb and 600 mb—and makes use of the geostrophic wind approximation.

Alternative methods have been formulated for calculating the future distribution of atmospheric pressure and the programmes to carry out these calculations on METEOR are in course of development. These methods seek to improve upon the geostrophic wind approximation, to take into account the effects of topography, to improve the mathematical procedure and to predict the movement of fronts.

The theoretical study of airflow over ranges of hills continued and programmes are being developed for METEOR which will enable the theoretical wind-flow to be calculated over some simple ground profiles. Observations have been made by the Meteorological Research Flight during the course of several special flights over Wales which will provide a basis for comparison with theoretical results.

Statistical techniques have been applied to the problem of forecasting the visibility at London Airport three and six hours ahead. It seems probable that a degree of success comparable with that of conventional methods can be attained by these techniques, but it is too early to say that the method can be adapted to the stringent needs of airline operations.

Research in the field of long-range forecasting was continued and a comprehensive programme of analysis of the northern hemisphere circulation, by a combination of statistical processing and synoptic study, is in hand. The use of the electronic computer is an important feature of the work and the provision of data by the meteorological services of the U.S.A., U.S.S.R. and the Federal German Republic was a great help.

Pending the outcome of this research, experimental forecasts were made at the end of each calendar month for the succeeding month by a rather simple technique of analogues, that is by searching for similar patterns in all previous years for which records exist. Unfortunately, history in this context seems never to repeat itself, and the degree of success so far obtained does not justify our offering the forecasts as part of a public weather service.

CLIMATOLOGICAL RESEARCH

The charting of mean contours, streamlines and isopleths of wind speed at standard upper levels for the world for the period 1949-1953 was completed and the work is now in preparation for publication. Corresponding charts of the standard vector deviation of wind were nearly completed. This is a major work in world upper air climatology, the results of which are urgently demanded by aviation authorities concerned with the planning of new air routes, using new aircraft flying at ever greater heights.

Climatic changes and trends for western Europe, the Atlantic and eastern North America since the late 18th Century were studied mainly on the basis of mean pressure charts for the month of January over that period, but also on the basis of depression frequencies by decades in the North Atlantic and Europe. There are indications of a rising trend in the intensity of the atmospheric circulation over the past 150 years, with superposed fluctuations of the order of 40 to 50 years.

It is the intention to introduce the principles of atmospheric physics into these researches as opportunity offers and a beginning was made with studies of the transport of heat, momentum and moisture on the large scale.

A report on research requirements in tropical meteorology, completed by the Assistant Director (Climatological Research) in 1956-1957, was distributed to Commonwealth meteorological services with a view to discussion at the Sixth Conference of Commonwealth Meteorologists in May 1959.

Enquiries and requests for services were, as usual, numerous and varied and of exceptional interest was an urgent request for assistance by a firm of constructional engineers in connection with a proposed scheme of irrigation and dam construction in the Punjab. This request was met by detaching a scientific officer for some months to act as a consultant to the firm in Pakistan.

PHYSICAL METEOROLOGY

The Meteorological Research Flight continued to operate with its Canberra, Hastings and Varsity aircraft. Flights with the Canberra aircraft were chiefly concerned with problems of the large-scale circulation of the upper atmosphere as revealed by the variations of content of the natural tracer gases, water vapour and ozone, and by wind structure in and near the jet streams of temperate latitudes. A flight to Nairobi and ascents to maximum altitude in the region of the equator extended southward the area covered by high-level determinations of water vapour content, though unfortunately, the Canberra's ceiling is below the

equatorial tropopause. More high altitude flights were made to 70°N. Measurements of ozone and water vapour in the neighbourhood of jet streams strengthened the evidence for movement of stratospheric air through the 'tropopause gap' associated with the jet stream. An arrangement was concluded with the United States Air Force which gives the Meteorological Office partial use of a U.2 meteorological research aircraft and its associated equipment. This will supplement the work of the Canberra at high altitudes. A radio-refractometer constructed at the Radio Research Station of the Department of Scientific and Industrial Research has been mounted in the Hastings aircraft, as a part of that establishment's investigation of tropospheric radio propagation; it will, in addition, yield valuable information on the small-scale spatial variation of humidity.

Two developments during the year indicated a growing interest within the Meteorological Office in investigation of the atmosphere at heights above those attainable by aircraft and balloons. A member of the staff collaborated in a study of the radiative balance of the stratosphere at heights up to 90 km., and preliminary observations were made of light scattering from a searchlight beam, from which it is hoped to deduce air densities at heights between 30 km. and 60 km.

Members of the staff of the Meteorological Office Radar Research Station at East Hill, with a portable 3 cm. radar, were invited to join a large-scale investigation at Verona, Italy, in June and July 1958. Their partners were the Department of Meteorology, Imperial College, London and the sponsors, the Italian *Unione Nazionale Antigrandine*. The object was to study the development and movement of destructive hailstorms, and observations were made which indicate the conditions in which hail may be expected to form within the cloud. The sponsors of this project are primarily interested in damage to crops. This is not a major problem in this country, but hail is a considerable hazard in aircraft operation, particularly with high speed machines. By courtesy of the Director of the Royal Radar Establishment, an upward-looking 3 cm. Doppler radar was made available. This plots the vertical velocity of the raindrops and snow crystals within its beam. Interpretation of the records is difficult, but information on vertical air movement in clouds and on the sizes of the falling particles can be extracted. The identification mentioned in last year's Report, of certain radar reflections with flocks of migrating birds has been followed up; and the 'echoes' from soaring birds have been found, in some circumstances, to give a useful indication of convective air motion.

The Meteorological Office unit at Porton continued its studies of atmospheric turbulence and diffusion in the atmosphere over distances of order 100 miles. Equipment was developed for the automatic recording of certain statistics of turbulence which have hitherto been produced by lengthy observation and computation. The same trend for automatic computation was followed in the unit attached to the School of Agriculture, Cambridge, where a prototype system for digital display of the evaporation and convective heat transfer from a growing crop was built and tested. It proved successful in principle, but development is required to make it reliable in unattended operation.

For many years the International Ozone Commission has maintained at Oxford a laboratory at which the spectrophotometers used throughout the world for the determination of the total ozone content of the atmosphere were tested and calibrated. The Ozone Commission being no longer able to carry out this task, the Meteorological Office has now taken responsibility for proper mainten-

ance of the instruments at its own stations, and, at the request of the World Meteorological Organization, has expressed its willingness to assist any neighbouring services in this respect. Ozone observations have been one of the tasks required of the Meteorological Office during the International Geophysical Year and will be continued during the International Geophysical Co-operation. Plate V shows the ozone spectrophotometer at Eskdalemuir Observatory, one of the three geophysical observatories for which the Meteorological Office is responsible, the others being Kew and Lerwick. Eskdalemuir Observatory was built just 50 years ago, primarily for geomagnetic observations. The International Geophysical Year caused an increase in the observing and tabulating programme of the observatories in the fields of geomagnetism, recording of solar radiation and evaporation, observation of ozone amount and of the concentration of certain chemicals in the air and in rain. Much of this increased task will be continued indefinitely, but some special geomagnetic tabulations have been discontinued.

The routine supply of data regarding magnetic disturbances to the International Association of Geomagnetism and Aeronomy was continued. Numerous enquiries were received from workers in geomagnetics and allied subjects in Britain and abroad. The majority contained requests for the loan of magnetograms, e.g. from Jodrell Bank, Sheffield University, Newcastle University, Glasgow University, Edinburgh University, and meteorological institutes in Algeria, Germany, Israel, Roumania and U.S.A. Jodrell Bank and Edinburgh University were also given information regarding the variation of magnetic inclination over Scotland and a region within 500 miles east and west in connection with a radar study of the aurora borealis. Several requests were received for annual values of the magnetic components and for spot values of variation.

SPECIAL INVESTIGATIONS

As in the past, the Service Departments and the Ministry of Transport and Civil Aviation were responsible for most of the problems which were studied in the assistant directorate of Special Investigations. A significant proportion of the work each year consists in the calculation of seasonal equivalent headwinds at various altitudes over air routes anywhere in the world. By normal methods of computation this work is laborious and time consuming, but it has now been programmed for the electronic computer METEOR, and the resulting economy of effort has already been found to be very considerable. Another project begun during the past year concerns the distribution and properties of jet streams over the North Atlantic, Europe and the Mediterranean.

Weather reports made by the crews of aircraft in flight have always had their immediate value in forecasting offices but, hitherto, for a variety of reasons they have not been used extensively in climatology. At the request of the World Meteorological Organization, a pilot investigation of in-flight reports over the North Atlantic covering three years was started, with the aim of assessing the suitability of such reports for use as raw material in the preparation of climatic summaries.

In recent years, detailed information about precipitation has been increasingly sought by airline operators and others. To satisfy this need, an investigation is in progress into the horizontal area likely to be affected when rainfall of a specified intensity and duration occurs.

Examples of other types of problem that were studied include the choice of

the most suitable alternates to London Airport for large jet aircraft, the meteorological requirements at stations of the United Kingdom Atomic Energy Authority, the effects of certain meteorological factors in atmospheric pollution and the frequencies of occurrence of various thicknesses of cloud. Reports on the climatology of a number of countries, written from the aviation aspect, were also produced.

INSTRUMENT DEVELOPMENT

The radio-sonde now in use in this country has developed in slow stages from a basic design which was first put into production 20 years ago. It is now thought that radical improvement is possible, and work was begun on the development of a new sonde. Search was made for suitable methods of measuring pressure and temperature, and the stability and behaviour of small ceramic capacitors, highly sensitive to temperature changes, was investigated. Efforts were also directed towards the construction of aneroid capsules made of Ni-Span-C, a proprietary material of American origin with small temperature coefficient.

The radar used for wind finding within the Meteorological Office is an obsolescent type, and increasing difficulty is expected in obtaining spares. Furthermore, its restricted range makes it unsuitable to meet, in all weather conditions, the current need for winds to heights of more than 100,000 ft. Following a study of performance, enquiries were made of the trade as to the possible provision of a new wind-finding radar, of enhanced accuracy and operating to ranges of 100 miles. Some encouraging replies have been received, and it appears that several manufacturers will be able to offer proprietary radar sets, modified for wind-finding, but based on available transmitting and receiving equipment.

The development of balloons capable of carrying meteorological equipment to greatly increased heights has proceeded, bearing in mind the difficulties of launching such balloons in adverse surface weather conditions. Tests have been made of a composite arrangement of a large but under-inflated high altitude balloon packed within a small balloon providing compactness for handling at the launch. At a relatively low level the small retaining balloon bursts, allowing the full expansion of the inner balloon.

A fully engineered version of the modulated beam cloud base recorder (developed from a laboratory prototype which had been installed at London Airport for some years) was constructed. Tests of the new instrument are proceeding.

The World Meteorological Organization decided to adopt the British 'Snowdon' rain-gauge as the basis of a precipitation gauge for use in international comparisons. Full specifications and working drawings of a suitable adaptation were prepared.

Test and calibration. The volume of work in this section, particularly in the calibrating of radio-sondes, was somewhat higher than usual, and reflected the extra commitments arising from the International Geophysical Year. Tested items included 18,700 radio-sondes, more than 56,500 electrical or radar components, over a quarter of a million balloons (by percentage checks) as well as nearly 40,000 general meteorological instruments. Over 21,000 radio-sondes were calibrated (including nearly 2,000 which had been recovered after use).

A new feature of the electrical testing was the installation of a water load for the testing of magnetrons. Three hundred and forty magnetrons were tested.

There was a marked increase in the use of the wind tunnel owing to larger numbers of anemometers for test. Some 40 anemometers per week were tested, compared with a previous average of 27 per week.

R. C. SUTCLIFFE,
Director of Research

INTERNATIONAL CO-OPERATION

WORLD METEOROLOGICAL ORGANIZATION

The Executive Committee held its final regular session of the present Financial Period (1955-1959) in Geneva from April 29 to May 17, 1958. The session was attended by the Director-General who is a member of the Committee and also Permanent Representative of the United Kingdom with the World Meteorological Organization. The Director-General was accompanied by Mr. C. W. G. Daking, Assistant Director (Defence and International). There was a full attendance of members and a particularly memorable visitor to a special meeting of the Executive Committee was Mr. Dag Hammarskjöld, the Secretary-General of the United Nations. The session was a busy one, as usual, but particularly so on this occasion because of preparations for the Third Congress which was held in Geneva from April 1 to 29, 1959.

In technical matters, the Committee had a long and detailed examination of the meteorological problems which will arise when jet aircraft are introduced for civil aviation on a global basis. It was decided to invite Members who have experience in high-level forecasting to collaborate in the preparation of a Technical Note giving descriptions of the methods used for analysis and forecasting at high levels. The Technical Note will be considered by a Panel of Experts who will attempt to define any special problems related to the improvement of high-level analysis and forecasting with a view to meeting the requirements of the International Civil Aviation Organization in this field.

The Executive Committee also devoted considerable attention to the proposal that the W.M.O. should extend its activities in hydrology. The general feeling was in favour of an initial approach on broad lines, and it was finally agreed to recommend to Third Congress that the future policy of the Organization should be to accept responsibilities in all aspects of hydrology which involve meteorological considerations. There was, however, little enthusiasm for a change in the name of the Organization, and no recommendations for amending its Convention, to include hydrology more specifically, have been made.

Two events of a non-technical nature made this session memorable. One was the laying of the corner stone of the new W.M.O. building by the President. It is hoped that the building will be ready for occupation by the middle of 1960 and that sessions of some of the constituent bodies of the organization will be held there from that time.

The other event which gave great pleasure to meteorologists in many parts of the world, but particularly in the United Kingdom, was the award of the International Meteorological Organization Prize for 1958 to Mr. Ernest Gold, C.B., F.R.S., formerly Deputy Director of the Meteorological Office. The prize consisting of a gold medal, a sum of money, and a certificate giving the citation of the award, was presented by the President in the Meeting Room of the Royal Society on June 30, 1958, in the presence of many members of the Meteorological Office.

A joint U.N.E.S.C.O./W.M.O. Seminar on Mediterranean Synoptic Meteorology took place in Rome in November/December 1958. This was attended by Dr. R. C. Sutcliffe, Director of Research, as an invited lecturer and by Messrs.

T. H. Kirk, Senior Meteorological Officer, Malta, and H. B. Rowles, Meteorological Office Training School.

The second session of the W.M.O. Regional Association IV (North and Central America), was held in Washington, D.C., U.S.A., from December 1 to 6, 1958. The United Kingdom was not directly represented but certain points of interest to this country were put forward on its behalf by Mr. W. A. Grinsted, Director of the West Indies Meteorological Service.

The Director-General (in his capacity as National Correspondent for Meteorology) and the Director of Services (in his capacity as National Correspondent for Geomagnetism) visited Moscow during August 1958 for the meetings of the Special Committee for the International Geophysical Year (C.S.A.G.I.)

INTERNATIONAL CIVIL AVIATION ORGANIZATION

The Meteorological Office, as agent for providing meteorological services on behalf of the Ministry of Transport and Civil Aviation, takes a leading part in international co-operation in all aspects of the requirements of civil aviation for meteorology. Standards, recommended practices and procedures are drawn up by the Meteorological Division of the International Civil Aviation Organization to establish world-wide procedures for meteorological services for civil aviation. The detailed application of these world-wide recommendations in different regions is discussed at Regional Air Navigation meetings. Meteorological matters which concern jointly other Divisions of the International Civil Aviation Organization are also considered at Air Navigation conferences. The Meteorological Office provides advice to the Ministry of Transport and Civil Aviation on the meteorological items on the agenda for these various meetings and on matters arising from them. At the request of the Ministry of Transport and Civil Aviation delegates are provided to attend the meetings which may be held in different parts of the world.

During the year, advice and assistance was given by the Meteorological Office on the meteorological aspects of the United Kingdom brief for the following meetings:—

Joint Middle East/South East Asia Regional Air Navigation Meeting held in Rome in January to February 1959.

Rules of the Air, Air Traffic Control Services and Search and Rescue Division Meeting held in Montreal in October 1958.

A Meteorological Office representative was included in the United Kingdom delegation at the first of these meetings.

COMMONWEALTH MEETINGS

Under the auspices of Commonwealth Air Transport Councils, meetings are held periodically between members of Commonwealth territories to discuss the provision of facilities and procedures for civil aviation in Commonwealth territories. The Meteorological Office provides advice to the Ministry of Transport and Civil Aviation on any meteorological aspects of matters under discussion.

Such advice was given during the year for the twelfth meeting of the South Pacific Air Transport Council held in Melbourne, Australia, in November 1958. The South Pacific Air Transport Council includes representatives from the United Kingdom, Australia, New Zealand and Canada and is concerned with the

provision of facilities in the South Pacific. The eleventh meeting of the Council in 1957 recommended the formation of a Study Group to examine meteorological requirements for the South Pacific. The Study Group met in September 1958 in Melbourne and was attended by a representative of the Meteorological Office.

Briefs covering the meteorological aspects were prepared for the meeting of the South African Committee of Air Navigation and Ground Organization in Pretoria.

NORTH ATLANTIC TREATY ORGANIZATION

The fifteenth meeting of the Meteorological Committee of the Standing Group was held in Paris from June 3 to 6, 1958, under the chairmanship of the French member. The United Kingdom was represented by its member Dr. J. M. Stagg, Director of Services, who was assisted by Mr. W. A. L. Marshall (M.O.5a). Policy questions affecting national meteorological services of member nations and the meteorological arrangements for field meteorological services supporting N.A.T.O. military formations were discussed.

Sessions of the working groups of the Standing Group Meteorological Committee were held in Paris from October 21 to 30, 1958, and in Washington, D.C., from March 17 to 26, 1959 to consider problems concerning weather plans and communications. The United Kingdom was represented at both sessions by Mr. L. H. Starr, Assistant Director (Observations and Communications) and Mr. E. Evans (M.O.17).

The seventh meeting of the S.H.A.P.E. Meteorological Committee was held at S.H.A.P.E., Paris, and was attended by Mr. E. Evans (M.O.17).

At the request of the Ministry of Defence, Mr. N. C. Helliwell (M.O.6) attended a Ballistics Conference at Fort Sill, Oklahoma, from November 18 to 20, 1958.

ADMINISTRATION

ORGANIZATION

No change was introduced into the general organization of the Office during the year. A diagrammatic representation covering Headquarters is given at Appendix I. Appendix II records the names of the principal officers.

The total number of outstations remained virtually unchanged; the number of offices closed was offset by the number of those opened. This was mainly due to changing commitments of the Royal Air Force.

CHARGES

A new system of charges for the supply of meteorological services to the public was introduced as from May 1, 1958. The underlying conception is that the Meteorological Office should continue to supply the nation with as much free service as can be generalized; but that when an individual, whether it be person, company or corporation, demands meteorological service 'tailored' for its own needs, it is only being fair to the general taxpayer to make a realistic charge which serves to reduce the nett total cost of the Meteorological Office to the nation. The services and the revised charges are described in *M.O. Leaflets* Nos. 1 and 2. *M.O. Leaflet* No. 3 gives information about weather bulletins and gale warnings to coastwise shipping and fishery vessels.

STAFF

The strengths in the various classes and grades compared with those of a year earlier are given in Appendix III.

The improvement in the staff position reported last year has not been maintained, for although recruitment to the Assistant (Scientific) grade has been satisfactory, a high rate of resignations has resulted in too large a proportion of trainees among the Assistants. There has been a shortage of Assistant Experimental Officers throughout the year in spite of the large number recruited; 41 were appointed, 12 of them coming from outside the Office. Three Experimental Officers were appointed; all being internal candidates. There were four recruits to the Scientific Officer class.

The Vacation Employment Scheme was continued, and 13 students were selected to work in the Office during their long vacation out of a total of 54 applicants.

The Meteorological Office receives many requests for the loan of staff and, despite the pressure of home needs, endeavours to allow a few suitable volunteers to undertake tours of duty with kindred organizations in various parts of the world. During the year under review, they included the Secretary-General of the World Meteorological Organization, the Director of the British East African Meteorological Service and two assistant directors of the British Caribbean Meteorological Service. Others served in Antarctica, the Falkland Islands Dependencies, Ghana, Iceland, Iraq, Iran, Nigeria and Nyasaland.

Dr. D. N. Harrison was appointed an Officer and Miss D. G. Lee and Mr. C. E. Jowitt Members of the Most Excellent Order of the British Empire. The L. G. Groves Memorial Prize for Meteorology was awarded to Dr. R. J. Murgatroyd and the L. G. Groves Memorial Award to Air Meteorological Observers to Flight Lieutenant R. E. Parsons.

Mr. P. J. Meade, Senior Principal Scientific Officer returned to the Office in January after attending a 12 month's course at the Imperial Defence College. Mr. N. E. Rider, Principal Scientific Officer was seconded to a Fellowship with the Commonwealth Scientific and Industrial Research Organization of Australia.

The Director-General records his appreciation of the services of the following members of the staff who retired during the year:—

Mr. S. P. Peters, C.B.E.—Deputy Chief Scientific Officer;
Mr. L. G. Hemens—Senior Scientific Officer;
Mr. J. Wadsworth—Senior Scientific Officer;
Mr. W. L. Andrew—Senior Experimental Officer;
Miss D. G. Lee, M.B.E.—Senior Experimental Officer;
Mr. P. J. Mulholland—Senior Experimental Officer;
Mr. H. L. Pace, M.B.E.—Senior Experimental Officer;
Mr. H. A. Scotney—Senior Experimental Officer;
Mr. J. S. Smith—Senior Experimental Officer;
Mr. E. W. Barlow—Experimental Officer;
Mr. B. G. Brame, M.B.E.—Experimental Officer;
Mr. A. W. Calcott—Senior Assistant (Scientific);
Miss A. J. Clapham—Senior Assistant (Scientific);
Mr. W. J. Hotten—Senior Assistant (Scientific);
Mr. A. D. Mills—Senior Assistant (Scientific);
Mr. W. L. Pepper—Senior Assistant (Scientific);
Mr. W. A. S. Prior—Senior Assistant (Scientific);
Mr. R. M. Rudlin—Senior Assistant (Scientific);
Mr. A. Stevens—Senior Assistant (Scientific);
Mr. F. J. Stevens—Senior Assistant (Scientific);
Mr. W. J. Tomkins—Clerical Officer;
Mr. F. D. Napier, B.E.M.—Technical Grade III.

Six of these officers have accepted disestablished appointments in the Office, two of them finally retired from similar posts.

The Director-General regrets to record the death of the following members of the staff:—

Mr. F. Metcalfe, Experimental Officer;
Mr. M. O'Connor, Senior Assistant (Scientific);
Mr. T. L. Hosker, Assistant (Scientific).

Royal Air Force personnel. Two Scientific Officers and two Assistant Experimental Officers held commissions with the Royal Air Force whilst carrying out their National Service obligations. Two Assistant Experimental Officers and 126 Assistants (Scientific) were serving as airmen meteorologists on March 31, and ten others were with the Royal Air Force acting as Air Meteorological Observers on meteorological reconnaissance flights.

On January 1, 1959, the responsibility for arranging technical training for meteorological reservists was transferred to Headquarters (M.O.10), and Mr. J. Bell was appointed Chief Meteorological Officer, Royal Air Force Reserve. The strength of the Royal Air Force Volunteer Reserve on March 31, 1959, was 74 officers, airmen and airwomen. Of these, 54 officers and airmen undertook full roster duties at meteorological offices at Royal Air Force stations during their period of continuous training this year.

SUPPLY OF INSTRUMENTS

Provision and production of equipment. During the year over thirteen hundred orders and contracts were placed, the more important being for telemetering equipment for the automatic recording of radio-sonde ascents; for a Dobson Ozone Spectrophotometer for use as the national standard; and for a new type of inflatable radar reflector.

Issue of equipment. Regular supplies of instruments and stores were issued for the maintenance of meteorological offices, both at home and abroad. Advice was given to enquirers at home and in the Commonwealth and Colonies, regarding the suitability of equipment and sources of supply.

Large quantities of instruments and equipment were supplied to meet the increased meteorological activity throughout the world during the International Geophysical Year. Demands for stores numbered nearly fourteen hundred, including many from Commonwealth, Colonial and foreign Governments, and from private observers co-operating with the Meteorological Office.

Loans of meteorological equipment were made to various agricultural institutes and schools of agriculture for investigations into a wide variety of subjects including soil erosion, irrigation, apple scab, potato blight and other diseases. Loans were also made to several university exploration clubs and other bodies for expeditions to Greenland, Persia, Labrador and the Belgian Congo.

LIBRARY AND PUBLICATIONS

Library. The Library is the national library of meteorology and the other branches of geophysics for which the Office is responsible. It continued to acquire publications on these subjects published all over the world, to record them in appropriate bibliographies and indexes and to provide an information service based on them to both the staff of the Office and to outside inquirers.

The major part of the publications received in the Library is obtained in exchange for the publications of the Meteorological Office. At the end of the year exchange agreements were in force with 372 institutions in all parts of the world. The Academia Sinica, Peking, and the new Iranian Meteorological Department were among the institutions with which new exchange agreements were made during the year.

The number of publications received during the year was 9,352. Approximately 6,720 separate books, articles and reports were classified by the Universal Decimal System and recorded during the year.

The number of publications lent during the year was 9,721 and many more were consulted in the Library itself or borrowed for the day by the staff at Harrow. Approximately 25 per cent. of loans are made to inquirers (mainly other Government departments, university research workers, airline companies and industrial firms) who are not members of the staff of the Office.

The usual aid to individual units and officers by sending to them new papers of special importance to their work before they became available for general borrowing and also in the reading of foreign languages was maintained.

Inquiries for information were received on a wide variety of subjects ranging from the history of hygrometry and the pressure changes produced by supersonic aircraft to the effect of tunnels through embankments on the 'ponding' of cold air in valleys.

Approval was given for a translator from Russian to be added to the staff of the Library, and the post has been advertized. An Experimental Officer on the

staff of the Library who had learnt Russian at local evening classes attended a fortnight's course in scientific Russian at Birmingham University.

Considerable progress was made during the earlier part of the year with much needed library maintenance such as the binding of periodicals, weeding of over-full shelves in the main library, and bringing the cataloguing of older material into line with that of the newer publications.

Publications. The main research publications of the Office are the *Geophysical Memoirs*, *Professional Notes* and *Meteorological Reports*. A list of those published during the year is given in Appendix VI. Two *Professional Notes* and two *Meteorological Reports* were in the press at the end of the year.

The *Meteorological Magazine* was published each month. Examples of the articles published are: A decade of research (by the Director of Research); Average height of the standard isobaric surfaces over the north polar regions in April and October; Some observations on dew; Extreme wind speeds over Great Britain and Northern Ireland and Air waves from a volcanic explosion. Reports of the monthly discussions (see p. 25), reviews of new books and notes and news of interest to meteorologists were also published in the Magazine.

The *Marine Observer* was published each quarter. Examples of the main articles published included: Ice accumulation on trawlers in the Barents Sea; Some measurements of temperatures and humidity profiles near the sea surface; and Cases of damage to cargoes, and their meteorological significance.

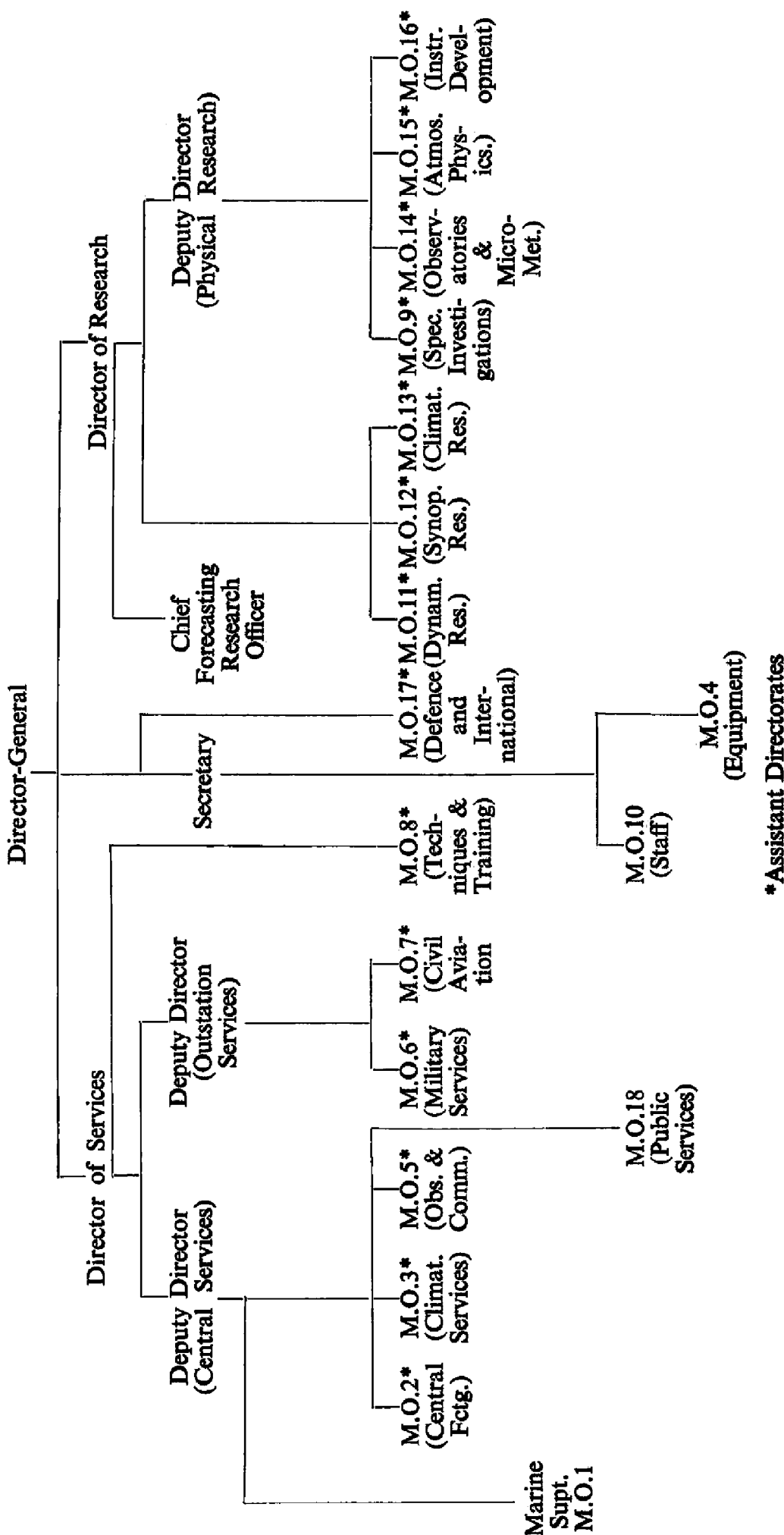
The third edition of the *Marine Observer's Guide* and the second edition of *Monthly meteorological charts and sea surface current chart* were in the press at the end of the year.

Considerable progress was made with the overtaking of the arrears of publication of the *Observatories' Year Book* which is typed on Varitype machines in the Office for subsequent photo-lithographic printing by H.M. Stationery Office. The volumes for 1940, 1941, 1942 and 1943 were printed during the year.

A comprehensive guide to the editing of Meteorological Office publications was prepared during the year. It is hoped it will reduce substantially the time needed for staff new to editing work to become fully efficient.

APPENDIX I

METEOROLOGICAL OFFICE HEADQUARTERS ORGANIZATION



APPENDIX II

PRINCIPAL OFFICERS OF THE METEOROLOGICAL OFFICE (on March 31, 1959)

DIRECTOR-GENERAL

Sir Graham Sutton, C.B.E., D.Sc., F.R.S., J.P.

ASSISTANT DIRECTOR (DEFENCE AND
INTERNATIONAL) C. W. G. Daking, B.Sc.

DIRECTOR OF SERVICES

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

DEPUTY DIRECTOR (CENTRAL SERVICES) R. G. Veryard, B.Sc.

DEPUTY DIRECTOR (OUTSTATION
SERVICES) A. C. Best, O.B.E., D.Sc.

ASSISTANT DIRECTOR (CENTRAL
FORECASTING) C. J. Boyden, B.A.

ASSISTANT DIRECTOR (CLIMATOLOGICAL
SERVICES) R. H. Clements, M.A.

ASSISTANT DIRECTOR (OBSERVATIONS
AND COMMUNICATIONS) L. H. Starr, M.B.E., M.Sc.

ASSISTANT DIRECTOR (MILITARY
SERVICES) T. W. V. Jones, B.Sc.

ASSISTANT DIRECTOR (CIVIL AVIATION) W. H. Bigg, O.B.E., B.Sc.

ASSISTANT DIRECTOR (TECHNIQUES AND
TRAINING) H. L. Wright, M.A.

MARINE SUPERINTENDENT C. E. N. Frankcom, O.B.E., R.D., Com-
mander, R.N.R.(retd.).

DIRECTOR OF RESEARCH

R. C. Sutcliffe, O.B.E., B.Sc., Ph.D., F.R.S.

DEPUTY DIRECTOR (PHYSICAL RESEARCH) G. D. Robinson, B.Sc., Ph.D.

CHIEF FORECASTING RESEARCH OFFICER J. S. Sawyer, M.A.

ASSISTANT DIRECTOR (SPECIAL
INVESTIGATIONS) P. J. Meade, O.B.E., B.Sc., A.R.C.S.

ASSISTANT DIRECTOR (DYNAMICAL
RESEARCH) E. Knighting, B.Sc.

ASSISTANT DIRECTOR (SYNOPTIC
RESEARCH) V. R. Coles, M.Sc.

ASSISTANT DIRECTOR (CLIMATOLOGICAL
RESEARCH) A. G. Forsdyke, B.Sc., Ph.D., A.R.C.S.,
D.I.C.

ASSISTANT DIRECTOR (OBSERVATORIES
AND MICROMETEOROLOGY) L. Jacobs, M.A., M.Sc.

ASSISTANT DIRECTOR (ATMOSPHERIC
PHYSICS) B. C. V. Oddie, B.Sc.

ASSISTANT DIRECTOR (INSTRUMENT
DEVELOPMENT) A. L. Maidens, B.Sc.

SECRETARY, METEOROLOGICAL OFFICE

W. J. B. Crotch, M.A., A.K.C.

APPENDIX III

STRENGTH OF THE STAFF OF THE METEOROLOGICAL OFFICE

							March 31, 1959
Scientific Officer grades	..	..	..	..	..	..	143
Experimental Officer grades	..	..	..	..	..	..	695
Scientific Assistant grades	..	..	..	..	..	..	1,537*
Technical and Signals grades	..	..	..	..	..	..	283
Assistant Secretary grade..	..	..	..	..	..	..	1
Executive and Clerical grades	..	..	..	..	..	..	123
Typing and Miscellaneous non-industrial grades	..	..	..	..	..	..	77
Nautical Officers	..	..	..	..	..	..	8
Marine staff (Ocean Weather Ships and Base):					..	..
Officers	..	..	..	..	..	..	38
Crew	..	..	..	..	..	..	123
Industrial employees	..	..	..	..	..	..	71
Locally entered staff and employees overseas	..	..	..	..	..	..	179
Total							<u>3,278</u>

*Includes 126 airmen meteorologists and 10 meteorological air observers.

APPENDIX IV

METEOROLOGICAL OFFICE TRAINING SCHOOLS

Courses which ended between April 1, 1958, and March 31, 1959

	Length of Course Weeks	No. of Courses	No. of Students
Scientific Officers	23	1	8
Forecasters, Initial Course ..	16	3	49
Forecasters, Advanced Course ..	6	7	40
Introductory Course for New Officers	3	1	7
Assistants	9	15	212
R.A.F.V.R. Officers	2	2	2
Voluntary Observers	1	3*	87*
Radio-sonde, Initial Course ..	8	7	60
Radio-sonde, Advanced Course	4	5	6
Part-course attendance:—			
Elementary instrument main- tenance	1	—	12
Advanced instrument mainten- ance	2	—	8
Tropical meteorology ..	2	—	4
Total		<u>44</u>	<u>495</u>

*Including one held at Edinburgh.

Students from the following meteorological services attended courses:—

Country	No. of Students
Belgium	10
Burma	1
Ceylon	3
Channel Islands	2
East Africa	7
Falkland Islands	3
Ghana	2
Hong Kong	3
India	1
Iraq	1
Jordan	1
Malaya	1
Mauritius	1
Nigeria	12
Philippines	2
Sierra Leone	1
Switzerland	2
Uruguay	1
Venezuela	2
West Indies	1
Total	<u>57</u>

APPENDIX V CLASSIFICATION OF STATIONS WHICH RENDER CLIMATOLOGICAL RETURNS

	Stations					Autographic Records		
	Observatories	Synoptic	Agro-meteorological	Climatological	*Rainfall	Sunshine	Rainfall	Wind
Scotland, North	1	10	0	19	263	16	7	5
Scotland, East	0	8	7	50	476	41	20	4
Scotland, West	1	5	3	38	460	24	16	6
England, North-east	0	9	4	25	377	27	16	4
England, East	0	10	12	24	535	33	33	10
England, Midlands	0	12	20	45	1,138	56	36	5
England, South-east (including London)	1	19	15	61	816	68	68	15
England, South-west	0	8	10	26	487	33	12	3
England, North-west	0	4	4	22	484	23	34	7
Wales, North	0	2	3	15	205	10	4	1
Wales, South	0	4	8	15	294	21	9	4
Isle of Man	0	2	0	1	15	3	1	1
Scilly and Channel Isles	0	2	0	4	24	6	1	2
Northern Ireland	0	4	1	10	98	7	4	3
Total	3	99	87	355	5,672†	368	261	70

*Includes stations in earlier columns.

†Figures for rainfall stations and autographic rainfall records refer to data for the year 1957 received during 1958. All other figures show the position on January 1, 1959. Some rainfall data are not published. In previous years the rainfall stations column has included only those stations for which data were published.

APPENDIX VI

PUBLICATIONS

The publications prepared by the Meteorological Office are generally issued by Her Majesty's Stationery Office as official publications. A complete list, with the prices at which they can be purchased through any of the Sale Offices or usual agents of Her Majesty's Stationery Office, is sent free to any applicant.

The following official publications were issued during the period of this Report:—

PERIODICAL

Daily Aerological Record, containing information respecting meteorological conditions in the upper air over the British Isles (to March 31, 1959).

Daily Weather Report, containing weather maps for the northern hemisphere, British Isles, etc., and data (to March 31, 1959).

Daily Weather Report, Overseas supplement, containing surface and upper air data (to February 9, 1959).

Meteorological Magazine (to March 1959).

Monthly Weather Report, with a summary for the year (to December, 1958).

Seismological Bulletin. A diary of seismological disturbances recorded on the Galitzin aperiodic seismographs at Kew Observatory, Richmond (to January, 1959).

Marine Observer (quarterly) (to January, 1959).

British Rainfall, 1956. A report on the distribution of rain in space and time over Great Britain and Northern Ireland as recorded by about 5,000 observers.

Meteorological and current summary for Ocean Weather Stations—India ($59^{\circ}00'N.$, $19^{\circ}00'W.$), *Juliett* ($52^{\circ}30'N.$, $20^{\circ}00'W.$) and *Alpha* ($62^{\circ}00'N.$, $33^{\circ}00'W.$) for January to December, 1957.

The Observatories' Year Book comprising the meteorological and geophysical results obtained from autographic records and eye observations at the Lerwick, Aberdeen, Eskdalemuir, Valentia, and Kew observatories. 1940.

The Observatories' Year Book comprising the meteorological and geophysical results obtained from autographic records and eye observations at the Lerwick, Aberdeen, Eskdalemuir, and Kew observatories. 1941, 1942 and 1943.

SERIAL

Geophysical Memoirs: Vol. XII:

100. World distribution of atmospheric water vapour pressure. By G. A. Tunnell, B.Sc.

Vol. XIII:

101. Upper air temperature over the world. By N. Goldie, B.Sc., J. G. Moore, B.Sc. and E. E. Austin, M.A.

Meteorological Reports: Vol. III:

19. The summer sea-breeze at Ismailia. By D. E. Pedgley, B.Sc.

20. Equivalent headwinds at heights of 30,000 ft. and 40,000 ft. along air routes. Supplemented and revised. By P. Graystone, B.A.

Professional Notes: Vol. VIII:

126. A synoptic study of anomalies of surface air temperature over the Atlantic half of the northern hemisphere. By J. M. Craddock, M.A., and C. A. S. Lowndes.

OCCASIONAL

Averages of rainfall for Great Britain and Northern Ireland, 1916-1950.

Elementary meteorology for aircrew.

Tables of temperature, relative humidity and precipitation for the world.

Part I. North America, Greenland and the North Pacific Ocean.

Part IV. Africa, the Atlantic Ocean south of 35°N. and the Indian Ocean.

Part V. Asia.

Part VI. Australasia and the South Pacific Ocean, including the corresponding sectors of Antarctica.

Upper Air Data for stations maintained by the Meteorological Office.—Summaries of radio-sonde observations of temperature and humidity and of radar-wind measurements at standard pressure levels.

1951-1955. Part 2 Larkhill/Crawley.

APPENDIX VII

BOOKS OR PAPERS BY MEMBERS OF THE STAFF

The following books or papers by members of the staff were published during the year ended March 31, 1959.

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- SIR GRAHAM SUTTON, D.Sc., F.R.S. Atomic explosions and the weather. *World Science Review, London*, 71, 1958, p. 3.
- SIR GRAHAM SUTTON, D.Sc., F.R.S. Tornadoes. *New Scientist, London*, 5, 1959, p. 400.
- SIR GRAHAM SUTTON, D.Sc., F.R.S. with D. S. MEYLER. A compendium of mathematics and physics. Pt. I. Pure mathematics. By D. S. Meyler. Pt. II. Physics. By Sir Graham Sutton. London (English Univ. Press), 1958, 8vo, Pp. x+384.
- R. C. SUTCLIFFE, B.Sc., Ph.D., F.R.S. A decade of research. *Met. Mag., London*, 87, 1958, p. 321.
- G. D. ROBINSON, B.Sc., Ph.D. Some observations from aircraft of surface albedo and the albedo and absorption of cloud. *Arch. Met. Geoph. Bioklim., Wien*, 9b, 1958, p. 28.
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- R. J. MURGATROYD, B.Sc., Ph.D. Meteorological measurements in jet aircraft. *Shell Aviation News, London*, No. 244, 1958, p. 7.
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- R. J. MURGATROYD, B.Sc., Ph.D. and N. C. HELLIWELL. The measurement of wind from aircraft using a doppler navigation system. *J. Inst. Navig., London*, 12, 1959, p. 84.
- E. KNIGHTING, B.Sc., D. E. JONES, M.Sc., A.R.C.S. and M. K. HINDS, B.Sc. Numerical experiments in the integration of the meteorological equations of motion. *Quart. J.R. met. Soc., London*, 84, 1958, p. 91.
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- F. A. SHARP, B.Sc. Cloud over the open sea. *Met. Mag., London*, **87**, 1958, p. 202.
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- P. REILLY. Weather charts plotted at sea-oceanic areas. *Mar. Obs., London*, **28**, 1958, p. 95.
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- D. J. GEORGE. Weather stations of the Falkland Islands Dependencies Survey. *Weather, London*, **14**, 1959, p. 3.

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