

Meteorological Office

REPORT FOR THE YEAR
ENDING
MARCH 31, 1960

METEOROLOGICAL OFFICE

A.T.C.C.

29 SEP 1960

R.A.F. NICOSIA

LONDON

HER MAJESTY'S STATIONERY OFFICE

FOUR SHILLINGS NET

ANNUAL REPORT
ON THE
METEOROLOGICAL OFFICE

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

FOR THE YEAR
APRIL 1, 1959 TO MARCH 31, 1960



LONDON
HER MAJESTY'S STATIONERY OFFICE
1960

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The Committee met on December 2, 1959.

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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 June 1, 1959.

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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, 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 £5,500,000. Of the expenditure chargeable to Air Votes, about £3,390,000 represents expenditure associated with staff and £1,700,000 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 twelve months covered by this Report have seen a number of interesting events in the progress of meteorology, both as a public service and as a science, in this country.

On the service side, the increase in non-aviation enquiries noted in my last report has led to the opening in London, Glasgow and Manchester of weather information centres, planned to give the general public, as well as industry, commerce and sport, up-to-date facts and forecasts of the weather in this country and abroad as speedily and as easily as possible. The London Weather Centre, situated in Kingsway, W.C.2, which has an attractive window display and a comfortable, brightly decorated interior, may set the pattern for future urban centres wherever sufficient demand exists and suitable premises can be found. At the same time considerable attention has been given to making increasing use of automation, for example, by the transmission of analyzed charts from the Central Forecasting Office to the outstations by facsimile, and the whole problem of the storage and processing of data in a form adapted to machine analysis is being thoroughly reviewed before the move to the new headquarters at Bracknell.

On the research side, two of the many items described in this Report seem to be especially significant. Meteorology began to make its most rapid advances when, in the early years of this century, it became possible to explore the atmosphere to great heights. The Dines balloon-meteorograph, one of the most beautiful examples of instrument design in meteorology, was the standard equipment for upper-air soundings until it was superseded by the radio-sonde. Radar wind-finding, which came into full operational use after the Second World War, enabled the forecaster to have up-to-date information about the winds at great height irrespective of cloud cover, and the aircraft of the Meteorological Research Flight have for some years provided unique data about the physical properties of the air at heights up to 50,000 feet or more. But balloons and aircraft are necessarily limited in the height attained, and the meteorologist is insatiable in his demands for knowledge of the atmosphere at even greater heights. We are now in the era of the sounding rocket and the artificial satellite, and to exploit these new devices to the full has necessitated the creation within the Office of an assistant directorate to study high-atmosphere problems. One of the first tasks of the new unit will be to study the instrumentation for meteorological observations in satellites.

One of the functions of the Meteorological Office is 'research in geophysics' and for many years continuous observations of high quality have been made in geomagnetism at the Eskdalemuir and Lerwick Observatories and in seismology at Kew Observatory. The pressing demands of meteorology, however, have meant that in the last 20 years it has become increasingly difficult to find staff to undertake research on these subjects from within the Office. The position of geophysics has been considered by the Meteorological Committee, with the result that Lord Hurcomb and his colleagues recommended to the Secretary of State for Air that the problem could best be solved by the creation of two

research fellowships, in geomagnetism and seismology, respectively. These fellowships, known as Gassiot Research Fellowships, are designed primarily to attract candidates from the universities, and the selection will be made in association with the Royal Society. It is hoped that this scheme, by making better use of facilities for observation which the Meteorological Office can offer, will promote vigorous research in these important fields and at the same time encourage a long overdue expansion of interest in the earth sciences in the universities of this country.

The foundation stone of the new headquarters building of the Meteorological Office at Bracknell, Berkshire, was laid by Sir Cyril Hinshelwood, the President of the Royal Society, on 28th October, 1959. According to present plans the transfer of staff will begin early in 1961.

The year under review also saw much activity in the international aspects of meteorology. I attended the Third Congress of the World Meteorological Organization in Geneva in April as leader of the United Kingdom delegation and also the subsequent session of the Executive Committee of W.M.O. The Sixth Conference of Commonwealth Meteorologists was held in London immediately after the meeting in Geneva and was attended by the Directors of the meteorological services of most of the countries concerned.

THE DIRECTORATE OF SERVICES

All sections of the community continue to become more aware of how meteorological information in one form or another can help them in their activities, and it is the business of this directorate to try to meet this increasing demand for its services within the limits of the number of trained staff available. The longer term plans for coping with this situation take three main directions: by mechanising the processes which the weather reports have to go through before they become the working material for the forecaster and for the climatologist; secondly, by centralising the preparation of forecasts for particular kinds of activity, for example, aviation; and thirdly by extending the channels through which the forecasts and the climatological advice are communicated to the customers.

During this year progress has been made in each of these three directions. A grid of landlines has been installed which allows weather charts that have already been analyzed at the Central Forecasting Office to be reproduced by facsimile equipment at a proportion of the outstation forecasting offices. This can now be done within 20 minutes of the completion of the master chart at Dunstable. Again, arrangements are almost complete for introducing a meteorological organization within Bomber Command of the Royal Air Force by which the specialized forecasts required for long-range, high-altitude flights will be prepared at the Command headquarters and disseminated to the operational airfields by the use of facsimile reproduction equipment and direct telephone lines. Meanwhile, on the public sector, and with the co-operation of the B.B.C. and the independent companies, the latest weather forecasts are being broadcast at more frequent intervals throughout the day both by radio and television. Altogether 38 forecasts are now specially prepared each day for radio broadcast by the B.B.C. In addition, offices for dealing solely with inquiries from the public have been opened in London and Glasgow and a third office will be opened in Manchester in April.

These developments are primarily concerned with short-range forecasting which requires for its raw material current weather reports from a wide area. But those paragraphs in the following pages which describe the work of the climatological services division of the directorate show that weather reports are still of great value after they have served their immediate purpose for forecasting. Along with the reports made by the non-professional weather observers up and down the country, they go to form the body of climatological data on which advice is based for answering inquiries from a wide range of interests. For this work speed in extracting the right data at the right time from the vast accumulation that has been made over the years is nearly as necessary as it is in the preparation of forecasts. Since 1945 much of this climatological information has been stored on punched cards. But the cards are bulky and to put even a selection of the pre-war material into this form would be an enormous task: in addition the machinery for handling the cards is, by modern standards, slow and outmoded. Much thought has therefore been given to alternative ways of storing observations so that they are permanently and yet readily available for use with modern high-speed sorting and computing machines.

It is of the nature of the science of weather forecasting in its present state of development that short-range forecasts can be more accurate and more precise than forecasts for a longer period. But it is also realized that in spite of its shortcomings a forecast for two or three days ahead may be useful for some activities. Forecasts of this kind have been prepared regularly at the Central Forecasting Office for many years; they have been used for the 'further outlook' in radio and television weather bulletins, for advice on the likelihood of spells of frost, fog, dry weather and such like. During the present year these extended forecasts have been issued daily to main outstation offices for replies to inquirers who are aware of the reservations associated with this kind of forecast.

The work in the Services directorate is organized as set out in Appendix I. A deputy director is in charge of each of the two broad categories of service, central and outstation: in addition an assistant director controls the Meteorological Office Training School and sees that the technical procedures and practices at meteorological offices are maintained at a high level of efficiency. The Deputy Director for Central Services is responsible for the collection of the weather reports and for using them at the Central Forecasting Office to prepare the primary analyses and forecasts which are issued for the guidance of meteorological offices and for dissemination to the public by radio, television and the Press. The second Deputy Director controls about 110 forecasting offices in this country and 35 oversea. Most of these offices are either on airfields or at aviation control centres, but many are listed in the Post Office Guide and in local telephone directories as offices which the public of neighbouring towns may consult by telephone for forecasts and other meteorological information. In the course of the year 390,000 inquiries have been answered by this means alone. Together with the new public service offices, these aviation stations also keep the automatic telephone weather service in eight cities supplied with the latest forecasts: five million calls were made in this service during the year and plans are nearly ready for extending it to three new areas.

CENTRAL FORECASTING

The Central Forecasting Office (C.F.O.) is primarily a master analysis centre with an output designed to help meteorological offices 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 meteorological offices 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 allotted.

In September a meeting was held with nearly 30 representatives of the Press. The object was to review generally the meteorological services provided through

the Press, and in particular to consider ways of reducing the interval between the issue of a forecast and its appearance in print. A Meteorological Office proposal for an additional forecast to be issued at midnight was welcomed, and some morning newspapers are now able to include a forecast issued only six hours earlier than the one heard by radio at the breakfast table.

There has been no change during the year in the arrangements for providing weather information to shipping. 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 extension of the landline network of the Dunstable facsimile broadcast which is now taking place has led to experiments to determine what material can most profitably be sent to meteorological offices. Charts of analyses can be transmitted more accurately and simply by this means than by any other, and partly for this reason it has been decided to broadcast to outstations forecast charts for two and three days ahead. Dissemination of these charts is regarded as a general forecasting aid rather than a basis for more ambitious forecasting by outstation officers. Nevertheless there is growing evidence of the importance in many walks of life of a knowledge of the weather over the next few days, often more so than for a few hours or even a few weeks. The inevitably lower accuracy of medium-range forecasts, as these are called, favours selective application. The Fine Spell Service for farmers and the weekend temperature forecasts for industrial firms are established forecasts involving a single element. On the other hand forecasts of the amount and intensity of rain or the occurrence of frost, for example, depend so critically on local conditions and the precise forecasting of other factors that they are likely to remain a relatively unsuccessful feature of medium-range forecasting for many years to come. Among the new forecasts which have been given during the year was one required for the suitable timing of an advertising drive. A series of forecasts in the summer was designed to help estimate the consumption of ice cream, and in the month before Christmas forecasts were issued to a firm concerned with the refrigeration and transportation of turkeys.

Changes have been made in the Meteorological Office daily publications, namely the *Daily Weather Report* with its *Overseas Supplement* and *Monthly Summary* and the *Daily Aerological Record*. These included a general revision of layout to meet the requirements of a new printing process introduced by H.M.S.O. The publications are unchanged in size but the new process has enabled the replacement of hand-written entries by typescript and the opportunity has been taken to revise the selection of charts published in the *Daily Aerological Record*.

During the year there have been a number of opportunities to compare the routine 24-hour forecast charts prepared by the Central Forecast Office, with those produced by the numerical computer in the Dynamical Research Division. A substantial improvement in the accuracy of forecast pressure charts would be accompanied by a noticeable, though proportionately smaller, improvement in

the forecasts of weather derived from them. It is probably true to say that although the computed charts have fulfilled expectations, it is likely to be some years before routine forecast charts are prepared by wholly objective methods, and it is expected that the initial stage will be characterized by the old and the new methods being used simultaneously.

PUBLIC SERVICES

In the field of Public Services, in addition to the general expansion mentioned last year and continued this, two notable developments can be recorded—the opening of weather information centres and the direct broadcasting on B.B.C. sound radio of forecasts by Meteorological Office staff.

Weather information centres. The move of the London Forecasting Office from its long established location on an upper floor of Victory House becoming inevitable, advantage was taken of the occasion to plan, and in late summer to open, the first weather centre in a street-level site at Princes House, Kingsway. A window display, incorporating an hourly captioned weather map of the British Isles and adjacent areas, mock television charts of past, present and future weather, dials of distant-reading instruments and a London area forecast, climatological diagrams of topical interest together with small exhibitions illustrating the importance of weather to the community at large, attracts large numbers of passers-by and there is little doubt that it has become one of the more popular windows in London. Behind this window visitors are welcomed into the Centre itself. Although to begin with the public has been a little cautious in making enquiries at the counter it is believed that, in time, greater numbers will utilise the service provided. Out of sight is the main forecasting office where bulletins are prepared and where, in ever increasing figures, telephone calls for weather information are answered. The formal opening of this first weather 'shop', as it was known for a short time, followed a Press Conference addressed by the Parliamentary Under-Secretary of State for Air, Mr. Airey Neave, M.P., on 28th August, 1959. This event was well publicized by the Press, B.B.C., Sound and Television and the Independent Television Companies. There has been a marked increase in requests for meteorological services by industrial and commercial concerns following this opening.

In Glasgow the second weather centre, so far without a window display, was opened in December and immediately succeeded in taking much of the non-aviation load from the shoulders of the Renfrew Airport meteorological staff. This office aroused considerable further interest in Scotland.

In Manchester the third weather centre will have a central and popular position, and will also provide a window display and enquiry counter.

Sound broadcasting. Following a suggestion made to the B.B.C. in 1958, arrangements were made this year for informal weather talks by Meteorological Office staff to be broadcast at 8.55 a.m. daily on the Light Programme and, on Sundays, also on the Home Service. These broadcasts, made from a studio in Bush House, began on Whit Sunday and were continued until the late summer.

The Light Programme, which previously carried only shipping forecasts, is now broadcasting an increasing number of land area forecasts, these being much shorter and less formal than the presentations on the Home Service.

Numerous non-routine broadcasts have been made by members of the staff during the year. Although some of them were planned well in advance others

were given at embarrassingly short notice, it being often difficult to provide a suitably qualified speaker at any particular studio as quickly and as frequently as the radio producers would wish.

Television. In spite of protracted trials at Lime Grove no significant improvement could be made to the presentation of the nightly 'Weatherman' programme on B.B.C. Television. Small changes in timetable took place and, after a long gap, the Sunday evening broadcast was resumed. From B.B.C. Audience Research figures it may be gathered that, in general, viewers are satisfied with the present style.

Three new areas have been covered by the Independent Companies during this year and additional forecasts are now provided for East Anglia (Anglia Television), Northern Ireland (Ulster Television) and South East England (Southern Television operating from Dover as well as Southampton).

As mentioned in connection with sound broadcasting there have been frequent calls from television producers for Meteorological Office staff to broadcast on a variety of weather topics. Wherever possible their requests have been met but many had, through force of circumstances, to be refused.

Publications. A third edition of *Your Weather Service* was produced jointly with the Central Office of Information and published in May.

Automatic telephone weather service. Plans for extending this popular amenity are now well advanced and it is expected that telephone subscribers in several new areas, including Bristol, Southampton and the Lancashire coast will soon be able to dial for forecasts.

Instead of once daily, forecasts at 12-hourly intervals are now provided for the French and German Teletourist Service of the British Travel and Holiday Association and the General Post Office.

Automobile Association. Closer co-operation between the Automobile Association and the Meteorological Office has resulted in wider and better circulation of up-to-date weather news to both organisations. In summer the flow of information is largely from this Office to the Automobile Association, but in winter the direction tends to be reversed. In particular, visibility reports from a large number of garages, etc., in the London area are now, for the first time, available in the Kingsway centre, and have been of great help to the forecasters.

Port of London Authority. An exchange of information between the Thames navigation control room at Gravesend and the Office has given the Kingsway forecaster a closer awareness of the weather in London River. More forecasts are now produced for mariners in this area.

Industry. Notwithstanding the abnormally fine weather of much of the year (which tended to reduce the number of weather enquiries from the man-in-the-street) industrialists have come more and more to operate with an eye to probable weather prospects. Accordingly many big concerns in the chemical, electricity, gas and food industries, as well as civil engineers and advertisers, have asked for additional or more regular meteorological services. In particular, requests for forecasts concerning three or four days (or even longer) from time of issue have been on the increase.

For the first time in the history of the Office a staff discussion meeting was entirely devoted to a study of the meteorological needs of industry and of the general public. Many interesting suggestions, which are now being considered at

Headquarters, were made by outstation staff who showed a lively appreciation of our responsibilities.

OBSERVATIONS AND COMMUNICATIONS

Synoptic reporting network. For many years the density of the reporting network has been less over mountainous areas than elsewhere in the British Isles. With the ready co-operation of the North of Scotland Hydro-Electric Board and of the Ministry of Aviation, some improvement of this position has been possible. Six new auxiliary reporting stations have been established in central Scotland, one in southern Scotland and one in Cumberland. The last two are at heights greater than 2,000 feet.

Auxiliary stations not manned by Meteorological Office staff now comprise some 40 per cent. of the total number of reporting stations in the British Isles and of these about a half are manned by members of the Coastguard and Trinity House organizations. The latter have this year agreed to provide a fresh source of observations in Bardsey Island. The co-operation of the Decca Navigation Company and the Atomic Energy Authority is also being sought to provide reports to fill further gaps in the reporting network.

Radio-sonde and radar-wind observations. The network of combined radio-sonde and radar-wind stations, eight in the United Kingdom and eight overseas (see Appendix IV) has been maintained. At the home stations observations of pressure, temperature and humidity in the upper air have been made twice daily and of wind four times daily. At the four Mediterranean stations pressure, temperature and humidity are measured twice daily. The frequency of upper wind measurements has been increased from two to four daily at two of these stations and arrangements are in hand for a similar increase at the other two. At the other overseas stations measurements are made twice daily.

The heights up to which measurements are obtained average about 70,000 feet.

For radio-sonde measurements of pressure, temperature and humidity in the upper air, a new automatic measuring and recording equipment has been introduced and will give improved accuracy.

Meteorological flights. As in previous years, meteorological reconnaissance flights have been made over sea areas around the British Isles by Hastings aircraft of No. 202 Squadron of the Royal Air Force, based on Aldergrove. During a short period, when a Dutch Weather Ship was unable to occupy its station to westward of Portugal, daily flights of the Squadron were routed near this station.

Daily vertical soundings by aircraft, formerly made by a civilian contractor using Mosquito aircraft, terminated during the year.

Thunderstorm location. Trials of the joint operation of equipment in the United Kingdom, Gibraltar and Malta were completed and led to improved accuracy of thunderstorm fixes. To extend the area over which thunderstorm location can be effected, equipment is now installed in Cyprus also, so that the Mediterranean stations can operate either independently, or in conjunction with similarly equipped stations at home.

Teleprinters. Dunstable, with landline and cable links to Paris, Offenbach, De Bilt, Dublin and Montreal, is one of the three main meteorological communication centres in Europe.

Simultaneously with the printing out of weather messages being received or

transmitted, code-punched paper tape has been obtained for selected data to provide a permanent data store for the Office. A portion of the tape output was also used on most days in the electronic computer for numerical forecasting experiments. To simplify the programming of the computer, effective standardisation of message headings is necessary. An attempt to achieve this has been made.

The almost continuous traffic on certain of the circuits terminating at Dunstable makes these ideal for proving new terminal equipment. In co-operation with the G.P.O., early models of a new teleprinter, designed to operate 50 per cent. faster than models now in use, have been tested.

With the agreement of Canada, North American data received in Dunstable from Montreal are transmitted, on request, to Paris during periods when the radio link between Paris and New York is for any reason unserviceable.

Radio communications. The World Meteorological Organization has agreed that radio-teleprinter (RTP) broadcasts should replace the slower wireless telegraphy (W/T) broadcasts hitherto used for the distribution by radio of continental and sub-continental collective messages. The European continental broadcast made from Dunstable by W/T up to November 30, ceased on that date and was replaced by a more comprehensive broadcast covering the same area made by RTP on four frequencies. Plans to convert our second meteorological broadcast, the sub-continental for Northwest Europe, are expected to materialise early next year.

The Royal Air Force, in addition to supplying and maintaining transmitters for the above radio broadcasts, has continued to provide a RTP link between Dunstable and Cyprus and, in addition, has made available an RTP circuit linking Dunstable with the Headquarters of the East African Meteorological Service. This latter link will bring to Dunstable weather data for a great part of Africa and the Indian Ocean. The Office will reciprocate with European and certain West African data which are not easily received by radio in Kenya.

Facsimile. Facsimile transmission by radio broadcast from Dunstable of analysed weather charts and forecast charts continued with little change. Landline facsimile transmission has been extended considerably during the year. Circuits specially engineered by the G.P.O. together with some improvement of recorders have increased effective transmission rates. Landline FAX reception of Dunstable's transmissions is now available night and day at 28 outstations and a further 28 recorders are on order. Experimental transmissions of plotted charts and of weather radar presentations have also been made with gratifying results at the highest available speed of the transmitting equipment.

International Geophysical Co-operation (I.G.C.) 1959. As an extension of the International Geophysical Year (I.G.Y.) special radio-sonde observations continued on only a slightly reduced scale throughout 1959 (I.G.C.) and the onward transmission of messages from the World Warning Agency indicating 'alerts' and 'special world intervals' continued at Dunstable.

CLIMATOLOGICAL SERVICES

The assistant directorate for Climatological Services collects, scrutinises and preserves surface meteorological data for the United Kingdom area to meet the requirements of various users, particularly in the fields of industry, agriculture, horticulture, water engineering and hydrology. It also conducts investigations related to the provision of meteorological services other than forecasting.

At Harrow the work of the assistant directorate is organized under Agricultural Meteorology; British Rainfall and Hydrology; British Climatology. The Meteorological Office, Edinburgh, looks after all these activities in Scotland and arrangements to set up a new office in Belfast to cover this work in Northern Ireland are now almost complete.

This assistant directorate also controls the Cartographic Section which works for the Office as a whole in producing various specialized maps for meteorological work and diagrams, etc., for official publications.

Climatological Services work is greatly aided by those private observers, local authorities, universities and other educational establishments, industrial concerns, trusts and other bodies who maintain co-operating climatological or rainfall stations, usually at their own expense. 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.

Agricultural Meteorology. Staff engaged on the application of meteorology to the problems of agriculture are based at Harrow, Bristol, Cambridge, Leeds and Edinburgh. Contact with research and advisory workers in agriculture is maintained through the National Agricultural Advisory Service, research stations, experimental farms, universities and farm institutes.

Routine work. The supply of weekly weather summaries to agriculturalists continued. Routine estimates of potential-transpiration figures were issued during the summer half-year. Close liaison was maintained with the Plant Pathology Laboratory for the issue of potato blight warnings and with the Veterinary Laboratory on the issue of liver fluke forecasts. The biennial inspection of agro-meteorological stations was continued.

Special work. Experimental work during the year included that carried out on marling, drainage, air pollution, apple scab, downy mildew of hops, shelter in upland areas and for horticultural crops, soil temperatures under plastic mulches, spraying of water over cloches to prevent frost, indoor climate and the mesoclimate of some farms in Devon. The county-by-county survey of suitable horticultural areas continued.

Meteorological displays were arranged for the Bath and West and for the Cambridge County agricultural shows. Assistance was also given for the 'Times Garden of Tomorrow' at the Chelsea Flower Show.

Special investigations were carried out regarding weather and milk production, in which milk yields were again successfully forecast two months ahead, and regarding weather and crop yields, in which reasonably accurate relationships were established for meadow hay and sugar beet. Other investigations involved work regarding spore trajectories, spraying conditions, meteorological conditions affecting agricultural aviation and the incidence of hypomagnesaemia in sheep and cattle.

Basic climatological investigations continued, and memoranda were circulated on the following subjects; the dependence of average sunshine on the distance from the coast and height above sea level, the climate of the harvest period, the persistence of rainfall from month to month, soil temperatures at shallow depths, the calculation of weekly averages, the effect of a growing shelter-belt on wind, the climate of the horticultural areas of the south-west, dates of first and last frost, and radiation on slopes. Contributions were also made to official bulletins on shelter-belts and irrigation.

Enquiries. Subjects dealt with in replies to enquiries included; lying snow and the strength of the roofs of piggeries, herbicide trials, the rate of growth of water weeds, fire blight in pears, the climate of caves, the pollution of well water in floods, pear blossom wilt, winter broccoli in Wales, pink rot in potatoes, the docking disease of sugar beet, shelter for watercress beds and for reclaimed open-cast mining sites, and, as might be expected in a very dry summer, irrigation for a variety of crops.

British Rainfall and Hydrology

The British Rainfall and Hydrology section is responsible for the supply of information and advice on rainfall and evaporation and also on 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. During 1959 observations were received from 255 new stations, but 139 ceased to report. The good record of inspections established in 1958 was maintained, over 750 rain-gauges, including those at climatological stations, having been visited.

The section maintained contact with many organizations and establishments which are active in the field of hydrology or in civil engineering where hydrology is involved. These included the Surface Water Survey of the Ministry of Housing and Local Government, the Road Research Laboratory and the Hydraulics Research Station of the Department of Scientific and Industrial Research, most of the 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 aid of the Metropolitan Water Board, has been continued rather longer than expected because of some curious discrepancies in the results which have not yet been satisfactorily explained. The experiments of the Engineer to the Fylde Water Board at Stocks Reservoir near Slaidburn, Yorkshire, continued to cover a wide field of varied hydrological interest. The post-graduate study of the water-balance of the Ystwyth catchment by the Department of Geography and Anthropology, University College of Wales, Aberystwyth, made good progress, and was fortunate in covering two years of such different rainfall patterns as 1958 and 1959. Discussions of instrumentation and methods have continued with the Imperial Forestry Institute of the University of Oxford, and planning for the proposed investigation on rainfall over hilly terrain in Scotland, in collaboration with the North of Scotland Hydro-Electric Board, was further advanced.

Statistical work. Averages of rainfall over the new standard period 1916-1950 were computed for stations with incomplete observations in 12 river-board areas; this resulted in the addition of about 620 averages to the records. The new techniques referred to in last year's Report for estimating averages for short-period stations have so far proved very satisfactory, and the work is continuing. The experience gained has been summarised in No. 5 of the section's series of *Hydrological Memoranda*: 'Estimation of standard-period averages for stations

with incomplete data'. The comprehensive programme of machine processing of rainfall data has not yet been embarked on, but a study was made of the best method of punching the observations on tape in conjunction with a review of the routine work of the section in order to see how far this work could be carried out automatically on the electronic computer. A selection of data from long-period stations was punched in the course of answering special enquiries using machine methods: this, and the data that had previously been put on to punched cards in the pilot programme, proved their usefulness several times in the course of the year. The systematic renumbering of rainfall stations on the basis of natural drainage areas proceeded well: the basic techniques were established and stations covering over half the area of the United Kingdom were renumbered.

Publications. The volume of *British Rainfall* for 1957 was in the final stage of printing. Estimates of monthly general rainfall were prepared for about 150 areas for which run-off data are available, for inclusion in the *Surface Water Year Book* 1957–1958. The number of areas for which this work is required still continues to increase rapidly, and for the *Surface Water Year Book* 1958–1959, estimates are required for over 190 areas.

Special work. Data for the third full summer season of observations in the rainfall investigation at Cardington were obtained in 1959, but were considerably less in quantity than in 1958 because of the dry summer. A further report was submitted to the Joint Committee on Rainfall and Run-off of the Road Research Board and the Ministry of Housing and Local Government. New and powerful statistical methods of treating the data were developed during the year, and their application, using the electronic computer, is in progress. The scheme for distribution of open-scale rain recorders to local authorities made some progress during 1959, and instruments were sent to about sixty authorities.

Enquiries. The numbers of routine and non-routine enquiries dealt with by the section during 1959 were both somewhat greater than in 1958. They related, for example, to problems of water supply, drainage and flooding, damage to goods, accidents, insurance against rain, rainfall in relation to variation of salt content of Highland lochs, estimation of probable loss of outdoor working time due to rain of certain intensities. In particular, the summer drought brought a number of enquiries concerning the regulation of rapidly diminishing supplies and the statistical chances of speedy and adequate replenishment. The electronic computer proved useful for this work. Information on the frequency and duration of intense falls of rain was again often in demand, by drainage engineers, other government departments, and representatives of the aircraft industry.

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. It supervises and arranges for the periodical inspection of all co-operating climatological stations in Great Britain and Northern Ireland. During the year 28 new stations began making returns but 21 ceased reporting, including those at Barnstaple, Keswick, Croydon Airport and Prestwick where observations began in 1858, 1919, 1921 and 1932 respectively. 155 stations were inspected during the year. The classification of stations which render climatological returns is given in Appendix VI.

Statistical work and machine methods. Preliminary consideration was given to the transfer of data being accumulated on punched cards to punched paper tape in order that some estimate may be made of the relative merits of card-processing machines and of the electronic computer in the preparation of climatological statistics. By harmonic analysis of monthly averages using the electronic computer, ten-day and weekly averages were prepared for certain stations.

Good progress was made in preparing sets of edge-punched cards giving monthly climatological data and synoptic notes for the whole country and for the several districts for the period 1900 to date.

New branch memoranda included 'Combined distribution of hourly values of dry-bulb and wet-bulb temperature, Manchester Airport 1946-1955', and similar memoranda for Stornoway, Lympne, Elmdon, Aldergrove and Bidston; 'Rain and/or low temperatures as factors interrupting external building work in the London area'; and 'The warm dry May to September of 1959'.

Publications. The *Monthly Weather Report* containing full summaries of observations was published regularly, though there were some delays beyond our control. The *Annual Summary* (for 1958) was published in October and the *Introduction* in September. Contributions, including climatological statistics, were provided for revised editions of three Admiralty Pilots (North Sea, Parts I and III and West Coast of England), Registrar General's Quarterly Review (Northern Ireland) and a revised section on climate was supplied for the 1960 Central Office of Information Handbook—'Britain'.

Special work. Further contributions were made towards the preparation of a draft British Standard Code of Practice on Weather Protection, in collaboration with other bodies concerned. Advice was given to the Central Electricity Generating Board on the climatological characteristics of further possible sites for nuclear power stations. Climatological data were provided for use in the new weather information centres.

Enquiries. The large number of requests received for meteorological information of all kinds was maintained. Enquiries dealt with included the supply of data or advice in connection with air conditioning, medical problems, market research, weather effects on manufacturing processes, the design of instruments for use out of doors, an arch dam to be built in Strathfarrar, the design of a large radar installation, the building of nuclear power stations and of a petrol and oil storage depot, protection of vehicles against frost damage, icing on overhead power lines, a passenger ropeway up Ben Nevis and a building on the summit, refrigeration, alternative dates for Bank Holidays, coast protection, smoke control areas, frost damage to a road, wind-driven pumps, design of solar batteries for navigation lights, temperature of a plastic covered swimming pool, dam construction, bird migration, location of a convalescent home, weather on historic occasions, selection of dates for outdoor functions or holidays, erection of marquees, volume of passenger traffic, effect of temperature on trout population, shrinkage of concrete, design of cooling towers, provision of climatic data for holiday resorts to tourists from abroad, the sale of ice cream, the design of buildings, the ageing of rubber, the maintenance of railway tracks, the breeding of chinchillas, the heating effect on rivers of water discharged from power stations, the erection of snow fences, sewage disposal and the design of television masts. Statements for legal and insurance purposes formed a large

proportion of the enquiries dealt with. Advice was also given to private individuals on such topics as where to live, local climate and weather observing.

MARINE BRANCH

Voluntary observing fleet. The constitution of the British observing fleet was described in the Report for the year ending March 31, 1956. The number of British voluntary observing ships is now 705 out of a world total of approximately 3,100. The number in each category is:—

| | | | |
|---------------------|----|----|-----|
| Selected ships | .. | .. | 491 |
| Supplementary ships | .. | .. | 54 |
| Coasting vessels | .. | .. | 88 |
| Trawlers | .. | .. | 38 |
| Light-vessels | .. | .. | 14 |
| Auxiliary ships | .. | .. | 20 |

The voluntary observing fleet includes ships of 113 shipping companies covering all the trade routes of the world.

Scrutiny of the meteorological records from these ships shows that, in general, the observations continue to be made carefully and accurately by the voluntary observers and that the radio weather messages are regularly transmitted to the authorities concerned. The additional observations of special meteorological phenomena and narratives of tropical storms encountered by ships received during the year have been both varied and interesting.

Radio weather messages from the observing ships. Approximately 154 reports were received daily at Dunstable from ships in the Eastern North Atlantic and in coastal waters around the United Kingdom, about five-sixths of them coming from British vessels. Of the reports from British observing ships, 56 per cent. were received within one hour and 78 per cent. within two hours of the time of observation. Considering the heavy radio traffic in this area, this is a very creditable performance. There has been a small increase during the year in the number of observations from the North Sea.

British voluntary observing ships in other areas of the world transmit their weather messages to the weather services of other countries in accordance with the plan approved by the World Meteorological Organization.

The number of messages received from distant water trawlers in the fishing grounds in latitudes above 60°N. has continued to increase and is now about 765 a month, compared with an average of 550 a month last year.

During the year prizes in the form of books were awarded to 100 ships, including trawlers and coastal vessels, belonging to 53 different companies for excellent meteorological work. Barographs were presented to four Masters for long and meritorious voluntary observing.

Ocean weather ships. The Meteorological Office's ocean weather ships completed twelve years of service in the North Atlantic during the year. The Royal Navy anti-submarine frigate H.M.S. 'Amberley Castle' was taken over by the Air Ministry in November, 1959, for conversion to a weather ship at a shipyard in Blyth. Some twenty-five shipyards accepted invitations to tender for this job. She is the second vessel of this class to be converted; the first, formerly H.M.S. 'Oakham Castle', has now completed nearly eighteen months' satisfactory service as ocean weather ship 'Weather Reporter'. 'Amberley Castle' will replace 'Weather Observer' which was the first British weather ship to

enter the service in 1947. The general lay-out of 'Amberley Castle' will benefit from experience gained aboard 'Weather Reporter'; living accommodation, meteorological office, radio and radar offices and chart room will be somewhat more spacious and better arranged; and more modern commercial radio equipment will be installed.

During the year our weather ships operated in rotation with the French and Netherlands ships at ocean station 'A' (62°N., 33°W.), 'I' (59°N., 19°W.), 'J' (52° 30'N., 20°W.), 'K' (45°N., 16°W.). A full programme of surface and upper air observations up to an average height of 60,000 ft. with the 500 gm balloon and 80,000 ft. with the 1250 gm balloon was carried out. Special observations of water-temperature gradient using a bathythermograph were continued aboard all ships and observations of waves, by means of an electric wave recorder in 'Weather Reporter', were also continued.

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

Microfilm copies of observations recorded aboard British weather ships were made and distributed in exchange for similar records from other operating countries.

Special trials were carried out by 'Weather Reporter' during a routine voyage at station 'Kilo' when representatives of the British Shipbuilding Research Association, National Institute of Oceanography and the National Physical Laboratory were embarked with their special equipment to enable comprehensive measurements to be taken of ship motion and sea conditions to be used for comparison with corresponding model tests in the new N.P.L. sea-keeping tank. The data obtained from these trials is expected to prove useful for research into the design of ships.

Currents and ice. Computational work required for the South Pacific Ocean current atlas made good progress during the year, but much still remains to be done to complete this task.

Six 'Admiralty Pilots' were revised and ocean current notes supplied for twenty-six Admiralty navigational charts.

Preliminary work has been carried out with a view to putting ocean current data on to punched cards. It is hoped in this way to transfer to machines most of the laborious computation work at present done by hand. It may also be possible, with improved computing methods, to detect secular change in ocean currents. It is also hoped, with help from the British Shipbuilding Research Association and the Ship Division of the National Physical Laboratory, to improve estimates of ships' drifts in adverse sea and weather conditions. This will, in turn, facilitate a more precise analysis and investigation of ocean currents.

Information relating to field ice and icebergs in areas adjacent to the North Atlantic was received by radio and by post from the Canadian Meteorological Service, the U.S. Coast Guard, the Danish Meteorological Service, the Norwegian Meteorological Service, merchant ships, trawlers and Fishery Research Ships. Baltic Sea ice data were received throughout the ice season from almost every country with a coastline in the Baltic Sea. Facsimile ice maps were received regularly from Canada, giving the distribution of ice over large areas of Canada and adjacent seas. Monthly ice maps were plotted. The detailed changes in the distribution of ice in the Baltic Sea and in the approaches to the St. Lawrence

River have been studied. It is a long time since so many marine ice observations have been available to British scientists and mariners.

Special work. The computation of wave height frequencies for 5° squares of latitude and longitude for each month for all ocean areas was continued and is nearing completion.

An investigation into the seasonal variation of sea surface temperature round the coasts of the British Isles was completed and a paper written on the subject.

An investigation into the downward penetration of snowfall was started, using data from North Atlantic ocean weather ships.

Work continued with the tabulation of radiation records made by our weather ships during the year in a form suitable for punching on to cards.

Marine enquiries. The upward trend in the number of enquiries handled during the year has continued. As in previous years, the great majority were from enquirers seeking information from our records.

There was an increase in the amount of information about wind and wave conditions and about sea temperatures supplied to civil engineers and contractors engaged on the construction of off-shore equipment in connection with nuclear power stations.

Advice was given to the Department of Scientific and Industrial Research in regard to a project known as the Tees Wave Investigation. The National Physical Laboratory was provided with predominant wind data along the route from the U.K. to Australia, Australia to San Francisco and San Francisco to Japan for use in connection with a design of screens for deck spaces aboard passenger vessels. A shipbuilder was supplied with information about the wind speed and direction and sea temperatures experienced over certain measured miles on a large number of specified dates covering the years 1944 to 1959. A request for information about wind speed and direction in connection with bird migration was also dealt with. On a number of occasions weather reports were supplied for Ministry of Transport officials conducting enquiries into shipping casualties.

Punched-card installation. The Branch administers this installation on behalf of the Office. The punching of surface land data was commenced in 1957 and the Office now possesses a sizeable library of these in addition to marine and upper air data. The library of surface land data has been augmented by the receipt of large numbers of cards from overseas.

300,000 cards of daily values at grid points of 500 mb heights and 1,000–500 mb thicknesses for the years 1949 to 1959 were received from the Deutscher Wetterdienst. Observations made during the International Geophysical Year aboard voluntary observing ships of the United Kingdom, Canada, Norway, Australia, Hong Kong and Iceland and weather ship observations made at ocean stations 'A', 'I', 'J', and 'M' in the Atlantic and at the Canadian ocean station 'P' in the Pacific were tabulated mechanically from punched cards and sent to the World Meteorological Organization at Geneva. (The United Kingdom and Australian cards were punched at Harrow, the remainder were received already punched.)

The expansion of the installation is limited by accommodation, but two new machines, one of them a tape editing punch, have been installed during the year. Several other installations have carried out both punching and data-processing for the Meteorological Office and their help is gratefully acknowledged.

MILITARY SERVICES

Meteorological services for the Royal Air Force, the Army, Ministry of Aviation and the Home Office have been provided as hitherto, and close collaboration has been maintained with the Naval Weather Service.

The pattern of the outstation meteorological service for the Royal Air Force largely conforms to the R.A.F. organization. There are three types of station, namely main, subsidiary and observing offices. Main offices function throughout the twenty-four hours and are often located at the headquarters of a R.A.F. Group; at the same time they usually control and advise subsidiary meteorological offices at R.A.F. stations in the Group. At subsidiary offices the hours at which a forecaster is available depend on the needs of the Royal Air Force. At observing offices there is no forecaster and the main duties are the making and issue of weather observations. At R.A.F. Command Headquarters the meteorological unit usually consists of a senior officer of the Meteorological Office who acts as advisor to the Air Officer Commanding-in-Chief and as a liaison officer between him and the Director-General of the Meteorological Office.

No meteorological units are deployed with field units of the Army in peacetime, but a special meteorological section is attached to the School of Artillery, Larkhill, and temporary detachments of meteorological staff are made to artillery practice camps as required. During the summer a meteorological observing station was opened in the Hebrides in connection with missile firings by the Army. The special services required by the Army overseas are normally supplied by the meteorological sections attached to R.A.F. formations.

Services provided in the United Kingdom. At home, main forecasting offices have been maintained at Group Headquarters in Operational and Flying Training Commands of the Royal Air Force, and at certain Air Traffic Control Centres. Many offices, in addition to their work for the Royal Air Force, provide forecasts for radio and television, British Railways, local automatic telephone weather services, electricity and gas undertakings, and the general public.

Plans are well advanced for implementing during 1960 the modified meteorological organization in Bomber Command, which is being introduced to meet the requirements of long-range high altitude aircraft more efficiently.

In Fighter Command the special teleprinter network on which weather reports are exchanged every fifteen minutes has continued to operate satisfactorily.

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 Aviation and War Office establishments, where the information provided was often of a specialist military nature.

A special observing office was opened for a short period in July at Biggin Hill during the Bleriot Anniversary air race between London and Paris.

Services provided overseas. There have been a few minor changes in the British meteorological organization overseas. Meteorological staff were withdrawn from three stations but one station was opened.

In Western Germany meteorological services for the Royal Air Force and Army were provided on similar lines to those adopted in the United Kingdom. All the former German employees of the Meteorological Office have now been replaced by British staff. British meteorological staff have been withdrawn from one observing station (Hohne).

In the Mediterranean and Middle East areas main meteorological offices operated at Gibraltar, Malta, Cyprus and Aden: these offices, as well as serving British forces, supplied forecast and advisory services for civil aviation, and supervised the activities of subsidiary offices attached to them. British meteorological staff at Habbaniya were finally withdrawn on May 8, 1959.

In the Far East, Royal Air Force requirements have been met by a main meteorological office, one observing and one subsidiary office in Malaya. A subsidiary office at Katunayake was handed over to the Ceylon Meteorological Department in February, 1960. The facilities at the meteorological office on Gan in the Maldiv Islands were expanded and a limited forecast service is now available together with observations throughout the twenty-four hours and a programme of upper air observations comprising one temperature sounding and two wind-finding ascents daily. In addition a storm-warning radar set, similar to the one now operating successfully in Malaya, is being installed.

To assist the R.A.F. in Libya, two subsidiary meteorological offices have been maintained in collaboration with the Libyan Government. At Idris the forecast office also serves civil aviation requirements; supervision of the technical work of this office is exercised from the main meteorological office at Malta.

A small subsidiary office was opened at Eastleigh, British East Africa, working in close collaboration with the British East African Meteorological Department, to serve R.A.F. aircrew in that area.

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 aviation purposes, namely, main, subsidiary and observing offices. Main offices are provided at Air Traffic Control Centres and major civil aerodromes and give full forecasting service on a continuous twenty-four-hour basis. Subsidiary offices are provided at civil aerodromes of intermediate importance, and at these offices the forecasting service usually does not operate continuously. 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 was necessary to maintain meteorological services at three main and fourteen subsidiary forecasting offices. The number of observing offices decreased from seven to six with the closure of Croydon Airport at the end of September, 1959. The Croydon office had been in existence since March, 1920, and observations had been made without a break except for a few days after August 18, 1940, when the terminal building was bombed and the instruments destroyed. The basic functions of the offices have changed very little during the year, although there was a progressively increasing demand for meteorological services to meet expanding scheduled operations.

This was particularly noticeable in the case of non-State aerodromes which obtain their meteorological service from the nearest appropriate State aerodrome meteorological office. At London Airport there has been an increasing demand for forecasts for higher altitudes as the number of airline operators employing large jet aircraft increased. This is a demand which is now extending to other aerodromes, especially Prestwick.

Meteorological service to aircraft in flight is provided by either 'Area Meteorological Watch' or 'Flight Meteorological Watch'. By the former method warnings of certain adverse weather conditions covering particular areas in Europe are disseminated by Air Traffic Control Centres. In addition, aerodrome weather reports and forecasts are made available by means of radio-telegraphy 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 meteorological 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 this is amended or new forecasts are 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.

In marginal weather conditions an aircraft in flight frequently requires to know not only the current weather conditions at the destination and alternative aerodromes but also to what extent such conditions are likely to change in a short period ahead. To meet this requirement a system of TREND forecasts was introduced on April 1, 1959. These consist of short plain language statements which are added to half-hourly weather reports broadcast to aircraft in flight, and indicate any expected changes in the conditions given in the reports during the ensuing two hours.

It is the policy of the Office to encourage flights by forecasters along the routes for which they have to forecast weather conditions. Such familiarisation flights have until recently been confined to routes in the United Kingdom, Europe and the Mediterranean areas, but have now been extended to North Atlantic routes into New York and Montreal.

Arrangements requiring the agreement of Commonwealth, colonial and foreign meteorological services were made for a number of flights, including those of Her Majesty the Queen and His Royal Highness the Duke of Edinburgh to and from Canada, of His Royal Highness the Duke of Edinburgh from Bermuda and to and from Accra, of Her Royal Highness Princess Margaret to and from Lisbon and the Channel Islands and of His Royal Highness the Duke of Gloucester to and from West Africa.

No public enquiries into civil aircraft accidents were held during the year, but a detailed appreciation of the weather conditions prevailing on the occasion of the accident to the Turkish Airlines Viscount TC-SEV near Gatwick on February 17, 1959, was supplied to Ministry of Aviation Accidents Investigation branch.

There has been a marked increase in the requirement for meteorological evidence in cases where the Director of Public Prosecutions has instituted

proceedings against private aircraft pilots for infringement of the Air Navigation Regulations.

The Ministry of 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 Aviation and to airline operators.

A special forecasting service was provided for the national championships of the British Gliding Association at Lasham, Hants, during May.

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. There has been a considerable increase in the number of trainees availing themselves of the facilities offered by the Meteorological Office and most have come from non-State aerodromes. This is consistent with the increase in the number of scheduled services now operating from these aerodromes. A system of routine six-monthly inspections was instituted whereby a meteorological officer visits each aerodrome, State or non-State, where weather observations are made, and gives advice.

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

The Meteorological Office continued to accept responsibility for the provision of services at Port Stanley in the Falkland Islands. 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 Port Stanley. The radio-sonde station at Port Stanley was established on a permanent basis as an Air Ministry commitment with financial support from the Ministry of Aviation and the Colonial Office.

Special work. Large jet-engined aircraft have been introduced by several more major airline operators on North Atlantic, European and Mediterranean civil routes. The consequential requirement for forecasts at higher altitudes than previously required for other types of aircraft has proved a heavy commitment.

The Ministry of Aviation Study Group on the requirements of supersonic civil aircraft includes a representative of the Office.

A representative is also included in the Ministry of Aviation All-Weather Operations Policy Group, which has particular responsibility for the application of automatic landing facilities to civil aviation.

To enable more precise information to be given to pilots for landing and take-off, a system of measuring Runway Visual Range is in operation at certain civil aerodromes when the visibility falls below a certain limit. Observations are made from the downwind end of the runway on a line of markers, or runway or reference lights. The observations are converted, by the use of a table, to a distance in yards at which a pilot, seated at the controls of an aircraft, would be able to see the runway lights or markers if the aircraft were stationary on the ground at the downwind end of the runway and on the centre line. The conversion tables take into account the difference in light intensity between the reference lights as seen by the ground observer, and the lights as seen by the

pilot. During the year the introduction of a new type of runway light has made it necessary to revise the calibration tables for a number of civil airfields.

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 1,100 candidates were examined in that subject.

TECHNIQUES AND TRAINING

Progress in work designed to assist forecasting at outstations was made along the lines referred to in the Annual Report for 1958-1959. The statistical working group was chiefly concerned with advising on the employment of electronic and punched-card methods for the processing of data, in relation to outstation problems; these methods were used to provide data for studying a particular problem in visibility at Manchester Airport. A pilot programme was devised for providing climatological aids to local forecasting and some progress in its application was made in respect of data for London Airport; in the light of experience this programme will be modified to formulate a standard programme for application to all meteorological offices as data are transferred to punched cards. The synoptic working group gave guidance in local investigations of a number of problems, amongst which were the occurrence of fog and low cloud over the Fens, the influence of topography on local rainfall and snowfall in differing synoptic situations, the movement of fronts over the Welsh mountains as affected by the high ground, delayed clearances behind cold fronts, and the forecasting of fog in hilly terrain.

A considerable amount of important preliminary work was done on the preparation of a revised and enlarged edition of diagrams for each outstation showing important characteristics of local weather, and the project has now been assigned to an officer specially selected to carry it through. Each new diagram will be distributed internally as soon as printed. In the series of simplified topographical maps of the United Kingdom, four maps, of East and Northeast England, the Midlands and North Wales have been distributed to the outstations concerned; the number required to cover the whole area is twenty-one.

On the problem of forecasting the meteorological elements at a particular place given the pressure field, studies were made of variations in the characteristics of anticyclonic inversions and associated stratocumulus cloud. These revealed the recurrent association of well marked temperature and cloud systems in the lower levels of anticyclones, and attempts are being made to derive relationships which can be translated into forecasting aids.

A booklet on forecasting for gliding was completed, as also was a three-dimensional weather map for use in the meteorological training of R.A.F. aircrew. The preparation of diagrammatic aids to instrumental maintenance is continuing, though progress is slow on account of pre-occupation of the compiler's time by his routine work.

Work Study. The Work Study team completed the study of the preparation of climatological returns and the handling of the related forms and a new method of preparing returns was given a trial at four stations during the months of February and March. The following studies were completed:—

- (a) the handling and storage of ships' meteorological log books;

- (b) the accounting systems and handling problems at the Ocean Weather Ship Base, Greenock;
- (c) the utilisation of machines in the Meteorological Office Punched-Card Installation.

Training. At the Training School two new courses (one in climatology, and one for senior forecasters) were introduced. The course in climatology gives a foundation in statistics and statistical methods as applied to meteorology; the solution of practical exercises is emphasized and each student is supplied with a calculating machine for his individual use. A feature of the course for senior forecasters is that specialist staff visit the School to lecture to the classes. Some modifications were also introduced into the course for Assistants (Scientific) which now includes instruction in the operation of facsimile equipment and (except in high summer) instruction in the making of observations at night. A booklet entitled 'Notes for Assistants' containing information about observational practices was compiled; copies of this are given to all assistants upon arrival at the School to help them in understanding their course of training.

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 V. Many of the students from eastern countries held fellowships financed under the Colombo Plan, or by specialized Agencies of the United Nations.

Lectures and demonstrations of equipment were given to a course for school teachers held in July by the Ministry of Education at the College of Aeronautics, Cranfield.

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 concessions were received from 103 members of the staff, mostly in the Assistant (Scientific) class; of these 95 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. Two members of the staff were selected for such courses.

Discussion meetings. The monthly discussion meetings 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 19, 1959 | .. | Icing |
| November 16, 1959 | .. | Mediterranean meteorology |
| December 21, 1959 | .. | Forecasting services to the public |
| January 18, 1960 | .. | Sferics; their accuracy and usefulness |
| February 22, 1960 | .. | Meteorological applications of electronic developments |
| March 21, 1960 | .. | Forecasting high level winds and temperatures. |

J. M. STAGG

Director of Services

THE DIRECTORATE OF RESEARCH

To many people who imagine meteorology to be a synonym for weather forecasting, it must come as some surprise to learn that research in the Meteorological Office is concerned with a diversity of activity in theoretical and experimental physics having contacts with many new developments in that science. To recall a few items, radar was developed as a method of detecting and following enemy aircraft; very soon it was used for following meteorological balloons to determine the winds in the higher atmosphere. A recent advance is pulsed-Doppler radar measuring the speeds of a target from a shift in radar frequency; it is already being used to measure the speed at which raindrops fall to the ground and is providing information on the distribution of drop sizes difficult to obtain otherwise. One of the most famous scientific inventions of post-war years is the electronic computing machine; meteorologists were among the very first scientists to make use of these aids to calculation and the Meteorological Office is proud to own one of the most up-to-date models and, incidentally, to provide opportunities for advanced research in mathematical physics. Automation is another current word; meteorologists are already dreaming of the completely automated weather map with observations from all over the world perhaps made, communicated and plotted without human intervention. There is wide interest and concern about radioactivity and nuclear weapons; the meteorologist is in early demand to study the transport of radioactive pollutants through the atmosphere and is learning new things about the stratosphere from these studies. Rockets and earth satellites are in the news; meteorological rockets designed to study the upper atmosphere and meteorological satellites transmitting cloud pictures back to earth are among the first applications.

The above examples show the remarkable way in which meteorology gets involved in so many innovations of physical science and technology and the Meteorological Office aims to play an active part wherever possible. The section of this Report dealing with physical meteorology indicates the scope provided in the Office for the research physicist and notes, incidentally, new provision for research in related branches of geophysics.

The organization of research is, for the most part, in small teams of three or four scientists, each headed by a Senior Principal Scientific Officer and with supporting assistant staff. These teams fall into two groups, the one dealing with problems of weather and climate (especially forecasting) and calling for theoretical insight and mathematical aptitude. The other is concerned more with the basic processes of atmospheric physics and naturally makes demands on the skills of the laboratory physicist. By the usual media, meetings of learned Societies, international symposia, group discussions and colloquia, and the free publication of results in the scientific press, a lively research atmosphere is maintained and will be further stimulated when, next year, most of the groups come together in our new laboratories at Bracknell.

It is a pleasure at this point to record the indebtedness of the Office to scientific colleagues in the universities and in other government departments, in the first place for their attendance at meetings of the Meteorological Research Committee and its sub-committees but, no less important, also for collaboration in several scientific enterprises. It is also pleasing to think that this help was in part

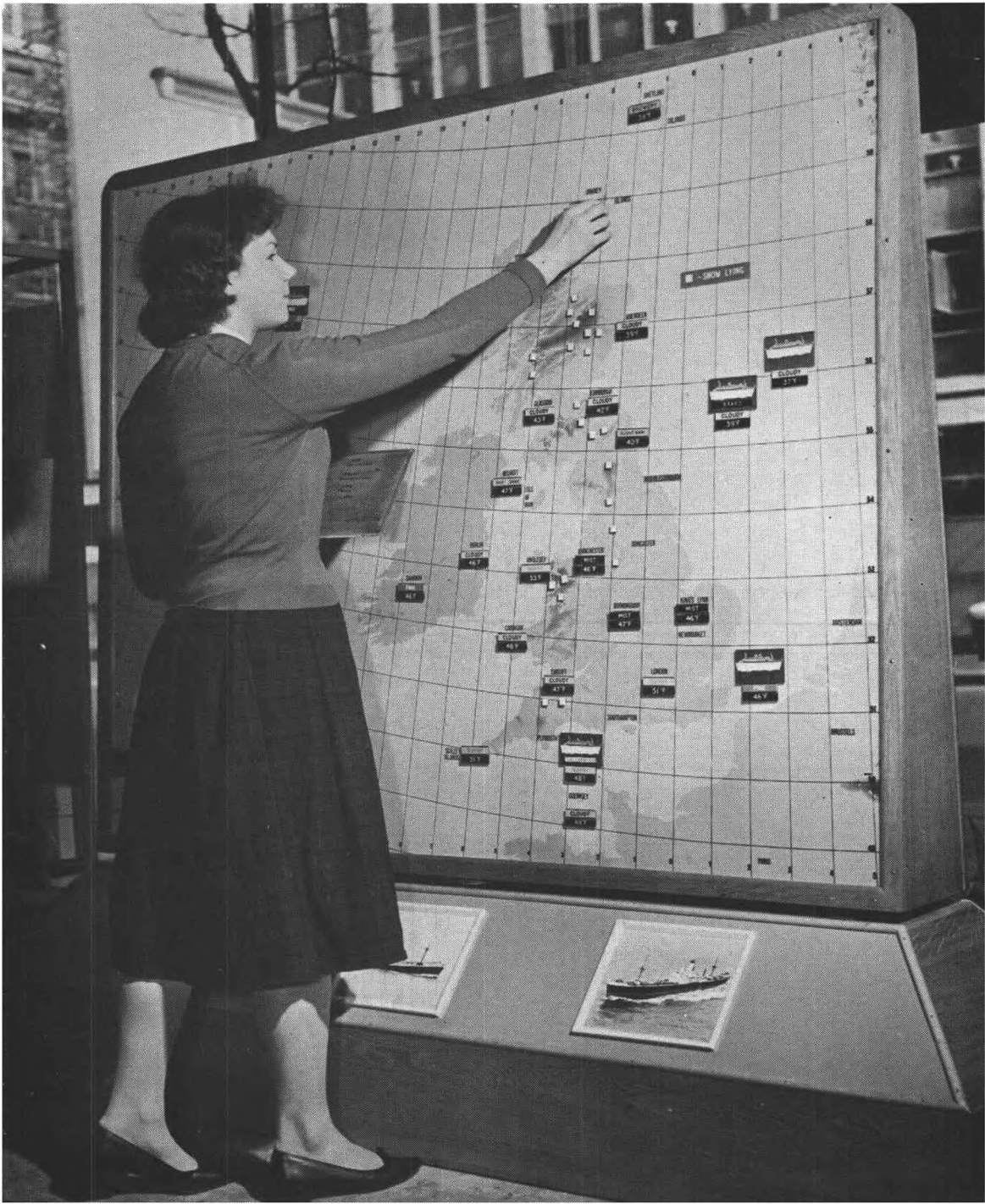
PLATE I



Reproduced by kind permission of the Sport and General Press Agency Ltd.

Window display, London Weather Centre. (See p. 11.)

PLATE II



Crown Copyright

Assistant completing the weather map in the window of the London Weather Centre—
(this map is changed every hour. (See p. 11.)

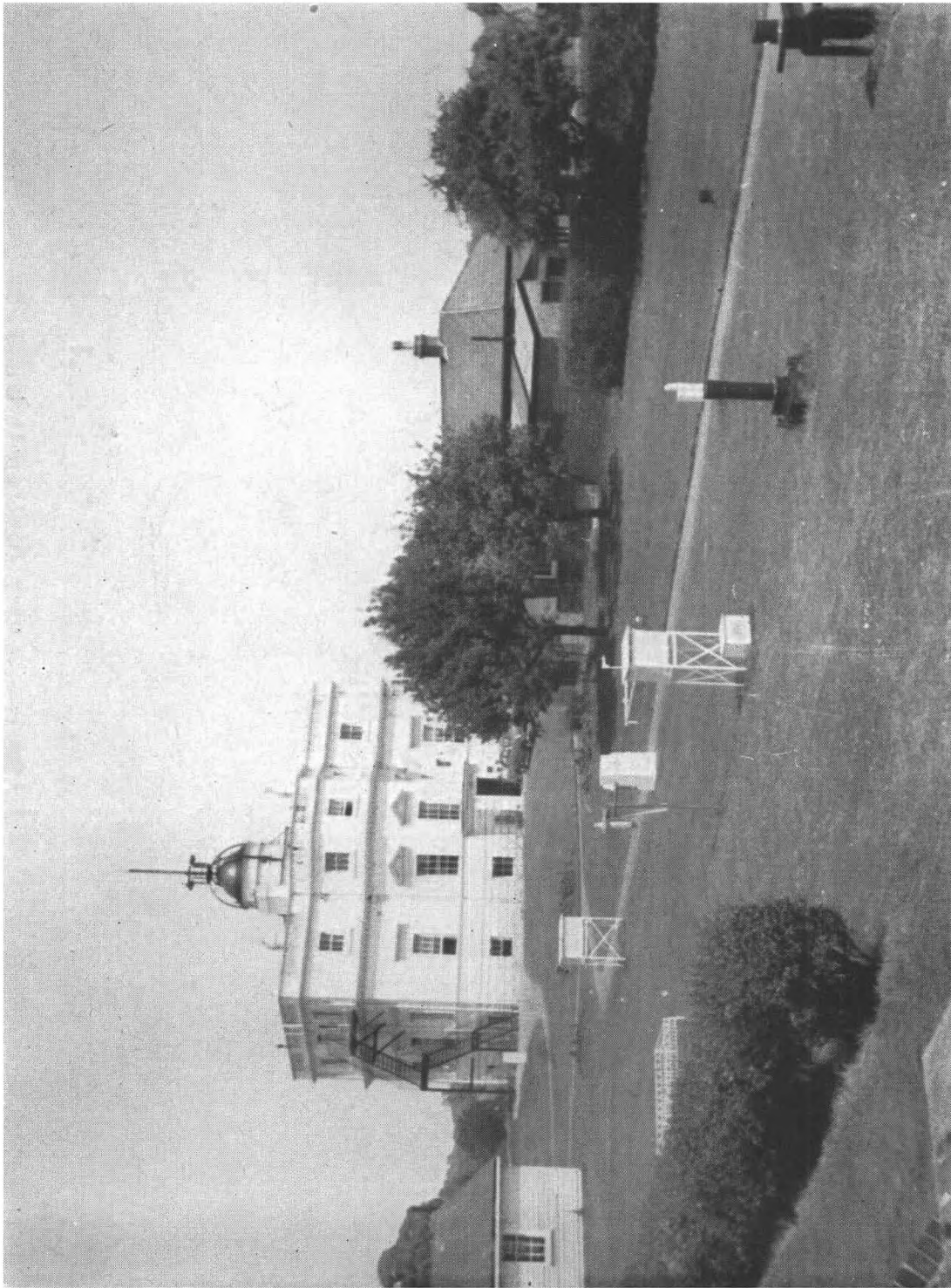
PLATE III



Crown Copyright

Forecast Room, London Weather Centre—the storm warning radar is in the background on the left. (See p. 11.)

PLATE IV



Photograph by Miss R. P. Baxter

Kew Observatory from the SSW. (See p. 33.)

reciprocated through the advice and assistance given by the research staff on a wide variety of scientific committees established, for example, by the Royal Society, the Royal Meteorological Society, the Ministry of Aviation and the Department of Scientific and Industrial Research, and, in more tangible form, by the financial support which it has been possible to provide from Air Ministry funds for research either direct to the universities or through the Royal Society. More than £20,000 was disbursed in this way.

FORECASTING RESEARCH

Forecasting is conveniently divided into short-range forecasting for a period of one to two days ahead which depends on the detailed evolution of the current weather pattern; medium-range forecasting for a period of up to about five days ahead which still depends on the evolution of the current pattern but can take no account of the small-scale features and must give weight to movements over thousands of miles (weather travels commonly some 500–1,000 miles per day); and long-range forecasting for any greater period of time for which there is as yet no established method although statistics, periodicities, analogues, extrapolations and even less reputable procedures have long been studied. In the Meteorological Office no method of long-range forecasting is yet accepted as good enough for the public service although experimental forecasts for a month ahead made by the research staff mainly on the basis of analogues (similar situations in earlier years) continue to show some skill on average. The need is to submit the long-term changes to a systematic analysis, both numerical and geographical, and a comprehensive programme using the electronic computer is now well under way.

Research on the medium-range problem, although rather in abeyance, has not been completely neglected and some useful practical rules have been discovered by empirical methods which assist in predicting spells of dry weather in summer and of cold easterly winds in winter. It is on the short-range problem that research has continued to be concentrated, mainly with the aim of providing forecast weather maps by dynamical calculation programmed on the electronic computer METEOR. This field of research has now led to a distinct branch of meteorological science into which several countries are putting a major effort and there is work for a long time to come in approaching more closely to the true physics of the complex problem, in improving the mathematical formulation and in executing the lengthy calculations with speed and accuracy. Two extended series of forecasts were completed during the year and were regarded as sufficiently promising to call for an early review of the way in which the system might be incorporated with the operational forecasting routine at Dunstable. The United States is the only country as yet using the electronic computer for regular dynamical forecasting but the United Kingdom could now follow at any time, from its present resources, were we satisfied that it would be an improvement. It may be prudent to use both the old and the new methods side by side for a while before deciding to abandon the accumulated skills of expert forecasters since, for a long time to come, the human forecaster will be needed in any case to translate weather charts into probable weather conditions, rainfall, fog, cloudiness and the like. On present knowledge it seems that detailed weather factors of this kind will not be amenable to direct physical calculation and will have to be treated in some objective statistical manner if subjective judgment is

to be eliminated. It is in this context that we may note the outcome of research into predicting the visibility at London Airport for three to six hours ahead—a realistic aviation need. By a purely statistical method, which can be used as a routine without expert knowledge, the results obtained were claimed to be significantly better on average than those hitherto attained by the forecasters. This is of course an outcome of great potential value and is being carefully followed up.

CLIMATOLOGICAL RESEARCH

The work of the research directorate in the field of climatology is restricted to the large-scale problems of the world and should be regarded as supplementary to the detailed work on British climatology more conveniently handled as part of Climatological Services. In broad terms, the aim of the research is to describe the structure and behaviour of the earth's atmosphere on the world scale, to analyse the physical and dynamical mechanisms involved and to arrive at a satisfying theoretical basis. This is an ambitious programme which will continue over many years and be shared by many other countries but the understanding of the general circulation of the atmosphere, with all that it might mean in terms of long-range forecasting and climatic variation, not to mention climatic control, is really the consolidating problem of all meteorology and it is hoped that more effort will be directed towards it in the near future. As a beginning, on more physical lines than hitherto, fluxes and divergences of heat, momentum and moisture were studied for a large geographical area. The processing of daily data from many upper air stations is required and recourse is likely to be had to the electronic computer. It has however seemed worthwhile to bring to completion certain relatively standardized compilations on upper air world climatology, which have proved extremely useful for aviation purposes as well as interesting in themselves. Charts of standard vector deviation of wind at chosen standard upper levels were completed for the world for four mid-season months for the five-year period 1949-53. Mean winds and standard deviations were also mapped for the world for the level of 50 mb (about 70,000 ft.). The structure of the stratosphere is remarkably interesting especially in the higher latitudes and is coming more and more into the sphere of interest of ordinary aviation; the 50 mb world chart, when complete, will therefore meet a real need.

With seasonal forecasting in mind it has been possible to prepare current monthly mean charts of the world for the surface layer and for the 500 mb level (about 20,000 feet) but this is as yet little more than the building up of a coherent body of evidence prior to the formulation of research problems. Empirical work on climatic trends in western Europe and the Atlantic, using pressure charts for January and July each year from 1750-1958, revealed new features which, interpreted in the light of modern synoptic meteorology, led to a paper which received high commendation in a Royal Meteorological Society prize competition.

Tropical meteorology continued to be a particular interest for the Assistant Director of Climatological Research and his survey of the subject was well received by the Sixth Conference of Commonwealth Meteorologists in May, 1959. As an outcome, by agreement with the Colonial Office, there will in the future be a machinery for co-ordinating Commonwealth research in tropical meteorology and there are prospects of much increased activity.

PHYSICAL METEOROLOGY

The year has been notable for an expansion of the Meteorological Office's interest in the field of physical meteorology and in those branches of geophysics—terrestrial magnetism and seismology—in which the Office has for many years carried the responsibility for observations.

The increasing need to study the high atmosphere has been recognised by the establishment of a new assistant directorate and the formulation of plans for the use of instruments carried by artificial earth satellites, rockets and high altitude balloons. Dr. G. D. Robinson, Deputy Director (Physical Research) was a member of the party which accompanied Professor H. S. W. Massey to the U.S.A. in June, 1959, to negotiate the agreement by which British experiments will be mounted on American launched satellites, and following this agreement work was begun at Kew Observatory on the design of an experiment to measure the vertical distribution of ozone in the earth's atmosphere, and the construction of instruments for mounting in a "Scout" satellite vehicle. The first results of the attempt to determine the density of the high atmosphere by observing the beam of a powerful searchlight were obtained during the year. Computed densities fall within the expected range at heights up to 45 to 50 km, but above this there are discrepancies, which may be due to local concentrations of cosmic dust. The equipment is located on the Welsh coast, and the University College of Wales, Aberystwyth, is associated with the observations. As several hours of cloudless and moonless conditions are required for successful completion of an experiment there is some strain on the observers' patience.

In 1946 the Meteorological Office obtained the sole use of a radar station at East Hill, near Dunstable, and the unit established there has over the years taken an internationally acknowledged part in the use of conventional pulsed radar to investigate the structure of thunderstorms and rainclouds, and in the converse application of meteorology to problems of radar propagation. The advance of radar techniques in recent years has opened up new possibilities, some of which were demonstrated by members of the staff of the Royal Radar Establishment when they turned their unique pulsed-Doppler radar on rain and shower clouds. With the co-operation of the Chief Superintendent a new unit has been set up, staffed jointly by the Royal Radar Establishment and the Meteorological Office. East Hill has been closed, activity transferred to the R.R.E. stations at Pershore and Great Malvern, and the first results obtained with the pulsed-Doppler radar have already been submitted for publication. The co-operation in the investigation of hailstorms between the radar unit and the Department of Meteorology, Imperial College, has continued. One interesting aspect of this is the use of single ice spheres carried below small balloons as radar targets in an investigation of the complex effects which occur when the target is comparable in size with the wave-length of the radiation, and which complicate the use of millimetric radar in storm investigations.

The Canberra, Hastings and Varsity aircraft of the Meteorological Research Flight have continued in service. The Canberra has again been used primarily to investigate atmospheric structure in the neighbourhood of jet streams and the large-scale atmospheric circulations, by direct observation of winds, and by measurements of the content of trace gases—ozone and water vapour—which may be used to track the slower circulations. On a month's detachment to El Adem and Nairobi 70 hours were flown at heights between 35,000 ft. and 50,000 ft., on a line from the Mediterranean to Lake Tanganyika. The instru-

ment which automatically records ozone concentration has now been made thoroughly reliable, but the water vapour measurements still depend on manipulations by a skilled observer, in spite of continued efforts to produce a sensitive automatic hygrometer sufficiently robust for use in aircraft.

The Hastings and Varsity aircraft are used in detailed investigation of atmospheric structure near fronts, and in sampling droplets and water content of clouds. The Doppler-radar technique mentioned above allows an estimate of the drop-size distribution in steady rain; it is most effective for the larger drops. The impactor techniques used for the same study on the Meteorological Research Flight aircraft are less effective for the larger drop sizes, because of sampling errors. A combined investigation, with the Hastings aircraft flying in rain in the beam of the radar, has yielded a droplet spectrum over a wider range of sizes than was previously attainable, and the agreement of the two methods in the region where both are sensitive is gratifying. The distribution of drop sizes in rain throws some light on the physical process of rain formation, and the distributions to be expected in certain circumstances have been computed with the aid of the 'Mercury' electronic computer of the Royal Aircraft Establishment.

The Canberra and Hastings aircraft are equipped to measure solar irradiance and illumination on upward and downward facing surfaces, from which the absorption of solar radiation and the diffuse reflectivity of the earth's surface and the atmosphere can be derived. The measurements have been supported by the calculation, using the 'Mercury' computer, of the absorption of solar radiation by the atmosphere for various water contents and solar elevations.

Several organisations have made use of the flying facilities offered by the Meteorological Research Flight. For example cloud- and rainwater have been collected for analysis at the Atomic Energy Research Establishment, Harwell, spores have been collected in the air for the Rothamsted Experimental Station, and members of the staff of the Radio Research Station have frequently flown with a radio-refractometer. This service is not disinterested, for in each of these examples there is an expectation that the results will have a purely meteorological aspect additional to their primary interest.

The Meteorological Section at the Chemical Defence Experimental Establishment, Porton, has continued its investigations of atmospheric turbulence and diffusion, with the practical aim of relating the spread of atmospheric pollutants to readily measured features of the wind and its fluctuations, and has completed a mathematical investigation of the behaviour of a diffusing cluster. Instruments to record some features of the wind fluctuations were mounted on a kite balloon cable and operated during observations of the spread of fluorescent material dispensed from an aircraft.

An experimental trial of a method suggested for the artificial increase of rainfall was completed. The method, which has in the past been extensively advocated by American commercial interests, involved the release of silver iodide smoke from ground based burners, which were for convenience located along a line in the Salisbury plain area, and operated by the staff of the C.D.E.E. Conditions for release of the seeding material were closely specified before the experiment began in 1955, and statistics of the rainfall over a wide network of stations in south and east England during each release of silver iodide were compared in a predetermined manner with the same statistics for a chosen 'historical' period. A review of the results was carried out late in 1959 and it

was concluded that there was no indication of any increase in rainfall on the occasions of release of seeding material. The experiment was examined and the conclusions endorsed by a sub-committee of the Meteorological Research Committee. The trials have now ceased.

GEOPHYSICS AT THE METEOROLOGICAL OFFICE OBSERVATORIES

For very many years observations of the earth's magnetic field have been made at Eskdalemuir and Lerwick Observatories, and a seismographic record maintained at Kew Observatory, and until the outbreak of the Second World War the rather anomalous position existed that almost the only whole time research staff within the Meteorological Office were working in these subjects. The priority given to meteorological research during and after the war has restricted work in magnetism and seismology to the maintenance of instruments and the publication of their readings. The difficulty of maintaining the standard of measurement in these circumstances, and the growing importance of both subjects, pointed to the need for resumption of research, and towards the end of the year approval was obtained for the appointment of two research fellows, to be known as Gassiot Fellows, to study terrestrial magnetism and seismology within the Meteorological Office, but on terms which will allow full co-operation with a University Department.

Before approval was given to this scheme a start had been made on modernisation of the equipment of the magnetic observatories by the purchase of proton precession magnetometers.

SPECIAL INVESTIGATIONS

The Assistant Directorate for Special Investigations is mainly employed in meeting enquiries from the Service Departments and the Ministry of Aviation, and much of its work is best described as climatology applied to aviation problems. An example is the production during the year, with the aid of METEOR, of equivalent head-winds, for the four seasons, at six different heights, for some 800 air routes distributed throughout the world. It is, however, also concerned with the study of atmospheric pollution, with some of the meteorological aspects of nuclear explosions and nuclear reactors, and with the provision of advice on these matters. In pursuit of this the Assistant Director, Mr. P. J. Meade, presented papers to an International Symposium on the 'Safety and Location of Nuclear Reactors' in Rome and to the International Clean Air Conference in London; attended, as representative of the World Meteorological Organisation, a meeting on 'Measurement of Radioactivity in the Biosphere' called by the International Atomic Energy Agency at its headquarters in Vienna, and was included in the British Delegation to the United Nations Scientific Committee at its meeting on the 'Effects of Atomic Radiation' in New York.

INSTRUMENT DEVELOPMENT

The main effort in the field of instrument development was directed towards eventual production of a new radio-sonde. Laboratory tests continued on materials suitable for use in pressure, temperature and humidity transducers and small-scale contracts were placed with the trade for development of specimen elements. A detailed examination was made of specifications of a wind-finding radar put forward by three contractors to meet the performance requirements which had been drawn up and circulated. The search continued for an inexpen-

sive balloon of convenient size capable of reaching regularly the height of 120,000 ft. on which the range specification of the new radar is based. Field trials and laboratory investigations threw light on the causes of failure of the balloons now available. The height can now be attained by balloons of reasonable size, and there are grounds for expecting that the cost can be considerably reduced.

The first example of a new frequency recorder for use at radio-sonde ground stations was received in January, 1960. This will be installed at all stations, including the ocean weather ships, and preliminary trials indicate that it will improve the accuracy of the results as reported on the synoptic network, and will allow a small saving in man-power.

A contract was placed for the manufacture of six cloud-base recorders from the prototype produced in the Meteorological Office laboratories, and delivery is expected in the first half of 1960.

Test and calibration. The volume of work in the test section maintained the unusually high level reached in 1958, and then attributed to the International Geophysical Year commitments. 20,300 radio-sondes were calibrated, and a percentage check made on 195,000 balloons. Over 55,000 electrical components and 40,000 general meteorological instruments passed through the section. Deliveries of the new radio-sonde frequency recorder, and of direction-finding equipment used in the thunderstorm location network called for an unusual number of tests of the larger types of electronic equipment.

Tests of equipment for outside authorities are occasionally undertaken, though the section is not equipped and staffed with this activity in mind. Such tests realised more than £3,000 in fees during the year.

R. C. SUTCLIFFE

Director of Research

INTERNATIONAL CO-OPERATION

WORLD METEOROLOGICAL ORGANIZATION

There was much activity by the World Meteorological Organization, its constituent bodies, and the Members of the Organization during the year, largely on account of the incidence of a session of the Congress of the Organization and the actions required to be taken in accordance with the resolutions passed by that body.

The Third Congress of the World Meteorological Organization was held in Geneva from April 1-28, 1959. Eighty-eight Member States or Territories were represented. The United Kingdom delegation was led by Sir Graham Sutton, Director-General of the Meteorological Office, who is the Permanent Representative of the United Kingdom with the Organization.

The large agenda was dealt with by three committees which covered general and legal matters, technical matters, and administrative and financial matters respectively. The General and Legal Committee gave considerable attention to the Convention of the Organization and made substantial changes in its General Regulations. One of the decisions taken at Congress on amendments to the Convention was that the Executive Committee should be increased from 15 to 18 members by the election of nine Directors of Meteorological Services instead of six, in addition to the Presidents and Vice-Presidents of the Organization and Regional Associations.

The whole field of technical regulations and activities was examined and a decision was taken to form a new Commission for Hydrological Meteorology. Attention was also paid to the very important subjects of atomic energy and artificial satellites and arrangements for W.M.O. and national participation on the meteorological aspects were agreed by Congress.

Congress authorized an expenditure of \$2,694,484 during the Third Financial Period (1960-63), a sum considerably less than that proposed by the Secretary-General but, nevertheless, some \$900,000 more than the expenditure approved for the Second Financial Period (1956-59). As at Second Congress, there was a protracted and arduous debate on the assessment of proportional contributions. Several delegations pressed for a scale closer to that of the United Nations but, as in 1955, a compromise was ultimately agreed between the existing scale and the current United Nations scale. Since Congress, the United Kingdom has accepted an increase of its contribution from 62 units to 67 units by mutual agreement with five Member Territories who have each had their contributions reduced by one unit. The percentage contribution of the United Kingdom to the General Fund of the Organization for the calendar year 1959 was 5.73 per cent.

Congress decided that the World Meteorological Organization celebration to commemorate its tenth anniversary should take place jointly with the occasion of the opening of the new permanent building of the Organization, which is being erected on a site close to the Palais des Nations, the European Headquarters of the United Nations. It is expected that the new building will be ready for the 12th Session of the Executive Committee which is convened for June 27 to July 15, 1960. Arrangements were made for the United Kingdom to present a gift to the new W.M.O. building which will consist of furniture for a

Conference Room and comprise a set of tables, an armchair and twenty-two hide chairs.

The Director-General attended the 11th Session of the Executive Committee in Geneva from April 29 to May 5, 1959, at which decisions were made on questions concerning the budget and activities of the W.M.O. for 1960 and on matters referred to the Executive Committee by Congress upon which immediate action was required.

A joint symposium on Radiation and Atmospheric Ozone was organized by the International Union of Geodesy and Geophysics and the World Meteorological Organization, and this took place at Oxford in July, 1959. The opportunity was taken to hold sessions of the Working Groups on Atmospheric Ozone of the Commission for Aerology and on Radiation Measurements of the Commission for Instruments and Methods of Observation. The Meteorological Office was represented at these international meetings by Dr. R. C. Sutcliffe and Dr. G. D. Robinson. The Commission for Aeronautical Meteorology met in simultaneous session with the Meteorological Division of the International Civil Aviation Organization in Montreal in September, 1959, to review technical regulations relating to meteorological services for international air navigation, meteorological requirements for high-level operations, and aeronautical requirements for observation networks and climatology. The United Kingdom delegation was composed of Messrs. J. C. Cumming, A. A. Worthington and R. J. Ogden of the Meteorological Office, and Mr. N. V. Lindemere of the Ministry of Aviation.

During the year several members of the staff have attended sessions of working groups of the Executive Committee, the Regional Associations and the Technical Commissions held in various locations in Europe.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

The Meteorological Office, as agent for providing meteorological services on behalf of the Ministry of 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 developed by the Meteorology 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 other Divisions of the International Civil Aviation Organization are also considered at Air Navigation Conferences. The Meteorological Office provides advice to the Ministry of 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 Aviation delegates are provided to attend the meetings which may be held in different parts of the world.

During the year the Meteorological Office was represented at the following meetings:—

I.C.A.O. Panel for Co-ordinating Procedures for the Supply of Information for Air Operations held in Montreal in late May to early June, 1959.

Fifth Session of the Meteorology Division which was held simultaneously with the Second Session of the Commission for Aeronautical Meteorology of the World Meteorological Organization, in Montreal, in September, 1959.

Fourth meeting of the Jet Operation Requirement Panel held in Montreal in late September, early October, 1959.

Third Africa-Indian Ocean Regional Air Navigation Meeting held in Rome in January to February, 1960.

Advice and assistance were given by the Meteorological Office on the meteorological aspects of the United Kingdom brief for the following meetings:—

I.C.A.O. Joint Aeronautical Information Services, Aeronautical Charts Division Meeting held in Montreal in April to May, 1959.

I.C.A.O. Panel on Meteorological Operational Telecommunications Network (Europe) held in Paris in June, 1959.

Limited European-Mediterranean Air Traffic Rules and Services and Communications Regional Air Navigation Meeting held in Paris in February, 1960.

I.C.A.O. Fifth North Atlantic Ocean Stations Conference held in The Hague in March, 1960.

COMMONWEALTH MEETINGS

The Sixth Conference of Commonwealth Meteorologists was held in London from May 7 to 13, 1960, immediately following the sessions of the W.M.O. Congress and the Executive Committee in Geneva. It was attended by delegates from most of the Dominions and Colonial Territories and by an observer from the Republic of Ireland: the Chief Meteorological Officer, Port Stanley, also took part. The Conference was opened by the Secretary of State for Air, the Rt. Hon. George R. Ward, M.P. The items discussed included a review of Commonwealth participation in the International Geophysical Year (I.G.Y.) and International Geophysical Co-operation Year (1959), tropical meteorology, the artificial control of rain and hail, the high atmosphere, numerical weather forecasting and meteorological services for jet aircraft.

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 Aviation on any meteorological aspects of matters under discussion.

Such advice was given during the year for the thirteenth meeting of the South Pacific Air Transport Council held in New Zealand in December, 1959. 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.

Briefs covering the meteorological aspects were prepared for the meeting of the South African Committee of Air Navigation and Ground Organization held in London in June, 1959. The meeting was attended by representatives from the United Kingdom, British East Africa, the Rhodesias and Nyasaland, British West Africa, South Africa.

NORTH ATLANTIC TREATY ORGANIZATION

The sixteenth meeting of the Meteorological Committee of the Standing Group was held in June, 1959, under the chairmanship of the United Kingdom member, Dr. J. M. Stagg. Dr. A. C. Best, Mr. L. H. Starr, and Mr. E. Evans

were also present. Policy questions affecting national meteorological services of the member nations and arrangements for the provision of field meteorological services in support of N.A.T.O. military formations were discussed.

Sessions of the working groups of the Standing Group Meteorological Committee took place in October, 1959, attended by Mr. L. H. Starr and Mr. E. Evans, and in March, 1960, attended by Mr. L. H. Starr and Mr. R. A. Buchanan. Problems concerning the organization and procedures required for the proper functioning of meteorological services to N.A.T.O. were considered.

The eighth meeting of the S.H.A.P.E. Meteorological Committee was held in May, 1959, Mr. L. H. Starr and Mr. E. Evans attending on behalf of the United Kingdom.

A combined meeting of the Meteorological Committees of Allied Forces, Mediterranean, and Allied Forces, Southern Europe, took place in March, 1960, to discuss special problems relating to wartime meteorological arrangements in these areas. Mr. T. H. Kirk, Senior Meteorological Officer, Malta, represented the United Kingdom.

The External Ballistics Group of the N.A.T.O. Armaments Committee met in April and November, 1959. Mr. N. C. Helliwell attended as a member of the United Kingdom delegation.

CENTRAL TREATY ORGANIZATION (formerly Baghdad Pact Organization)

Meetings of the Regional Meteorological Policy Committee were held in June, 1959 and January, 1960. The United Kingdom was represented by Dr. J. Pepper at the first meeting and Mr. R. Murray at the second.

SOUTH EAST ASIA TREATY ORGANIZATION

The Meteorological Committee of the Organization met in March, 1960. Mr. R. Frost, Chief Meteorological Officer, Far East Air Force, attended on behalf of the United Kingdom.

ADMINISTRATION

ORGANIZATION

A new assistant directorate, M.O.19, has been created. The staff will be concerned with the study of the high atmosphere (see also p. 6). An organization diagram showing the structure of Headquarters is given in Appendix I. The names of the principal officers are recorded in Appendix II.

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

STAFF

The strengths of the various grades are shown in Appendix III.

A high resignation rate among Assistants, though offset by good recruitment, has perpetuated the inflated proportion of trainees in this class which was reported last year. For the first time a similar effect was just discernible in the Assistant Experimental Officer grade because the resignation rate, although still small compared with that of Assistants, increased quite sharply late in the year. The resignations also added to the general manning difficulties in the Experimental Officer class already brought into focus by a steady increase of establishment throughout the year. Forty Assistant Experimental Officers and two Experimental Officers were appointed, twenty-six of the former and both of the latter coming from within the Office which also supplied two Scientific Officer class recruits. Another came from outside.

Thirteen vacation students were selected to work in the Office out of a total of fifty-six applicants.

Her Majesty the Queen graciously appointed Mr. R. F. Zobel and Mr. J. MacDowall Officers of the Most Excellent Order of the British Empire, and Mr. G. E. Court, B.E.M., was awarded the Imperial Service Medal. The L. G. Groves Memorial Prize for Meteorology was awarded to Mr. R. A. Hamilton, O.B.E., and the L. G. Groves Memorial Award to Air Meteorological Observers to Flight Sergeant B. Hunt.

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

Mr. R. G. Veryard—Deputy Chief Scientific Officer;
Mr. M. J. Thomas, O.B.E.—Principal Scientific Officer;
Mr. H. W. L. Absalom, O.B.E.—Senior Scientific Officer;
Mr. W. A. L. Marshall, M.B.E.—Chief Experimental Officer;
Mr. A. E. Mayers—Senior Experimental Officer;
Mr. E. L. Clinch—Senior Experimental Officer;
Mr. H. E. Forster, M.B.E.—Senior Experimental Officer;
Mr. F. W. Jude, M.B.E.—Senior Experimental Officer;
Mr. G. T. Smith—Senior Experimental Officer;
Mr. F. B. Swain—Senior Experimental Officer;
Mr. A. H. Lupton, B.E.M.—Senior Experimental Officer;
Mr. A. A. V. Buchanan—Senior Experimental Officer;
Mr. G. A. Livett—Senior Experimental Officer;

Mr. W. L. Lineham—Senior Experimental Officer;
Miss H. G. Chivers—Experimental Officer;
Mr. C. H. Wood—Experimental Officer;
Mr. G. B. K. James—Experimental Officer;
Mr. F. D. Caine—Experimental Officer;
Mr. C. V. Ockenden, O.B.E.—Experimental Officer;
Mr. W. C. Peters—Senior Assistant (Scientific);
Mr. T. R. S. Starkey-Smith—Senior Assistant (Scientific);
Mr. H. Forster—Senior Assistant (Scientific);
Mr. P. Zealley—Assistant (Scientific);
Mr. G. E. Court, B.E.M., I.S.M.—Principal Foreman of Stores.

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

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

Mr. W. R. Hanson, M.B.E.—Senior Experimental Officer;
Mr. T. H. Parry—Senior Experimental Officer;
Mr. E. T. Young-Evans—Senior Assistant (Scientific);
Mr. J. H. Winstone—Assistant (Scientific).

Royal Air Force personnel. Four Scientific Officers and two Assistant Experimental Officers held commissions in the Royal Air Force whilst carrying out their National Service obligation. One Assistant Experimental Officer and thirty-two Assistants (Scientific) were serving as airmen meteorologists on March 31 and thirteen other Assistants (Scientific) were serving in the Royal Air Force as Air Meteorological Observers on meteorological reconnaissance flights.

The strength of the Meteorological Branch of the Royal Air Force Volunteer Reserve at March 31, 1960, was 61 officers, airmen and airwomen. Of these, 42 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 fifteen hundred orders and contracts were placed. The provision and delivery of new equipment was generally satisfactory in respect of the replacement of standard items but some difficulty was experienced in finding manufacturers willing to undertake the production of new types. The more important contracts placed were for a variety of radio and radar equipments for use on the ocean weather ships; a search radar apparatus for use on aircraft of the Meteorological Research Flight; telemetering equipment which will enable the signals transmitted by radio-sondes to be recorded automatically; and an improved type of leaf wetness recorder for use in research into foliage diseases of crops.

Issue of equipment. Regular supplies of instruments and stores were issued for the maintenance of meteorological offices both at home and overseas. Advice was given to enquirers at home and in the Commonwealth and Colonies regarding the suitability of equipment and its source of supply. Demands for stores exceeded seventeen thousand, 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 other government departments and outside bodies engaged in research. Among the more interesting may be mentioned some to the Department of Scientific and Industrial Research for investigation of high voltage problems and also for research into the horizontal propagation of noise; to various Agricultural Institutes and Schools of Agriculture for investigations into a wide variety of subjects including studies of poultry and other animal diseases; and to the Royal Navy and other bodies for expeditions to the Arctic, Sweden and Arctic Norway.

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 every article of interest to the Office in its author index, subject index and geographical indexes.

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 385 institutions in all parts of the world. Institutions with which exchange agreements were made during the year included the Geophysical Observatory of the University College of Addis Ababa, and the Scripps Institute of Oceanography, La Jolla, California.

The number of publications received during the year was 10,109. Approximately 6,682 separate books, articles and reports were classified by the Universal Decimal System and recorded during the year. The monthly bibliography for July, 1959, reported the accession during that month of 680 items. A scheme for collecting colour transparencies of clouds and other meteorological subjects from the Office staff has proved very successful. During the year 437 such transparencies were received.

The number of publications lent during the year to Meteorological Office staff and others was 10,869 and many more were consulted in the Library or borrowed for the day by the staff at Harrow.

A major development during the year was the appointment of a whole-time translator, mainly for translating Russian articles. Her appointment has greatly increased the number of translations which can be made.

The usual aid to individual units and officers by sending them new papers of special importance to their work before they were made available for general loan and in the reading of foreign languages was continued.

Inquiries for information were received on a wide variety of subjects such as climatic information for the principal maize growing areas, the variation of the semi-diurnal pressure oscillation with altitude and season, and the ozone content of the lower atmosphere.

Much attention was devoted to the detailed design of the library at Bracknell and good progress made in much-needed rearrangements of the Library stock. With a view to saving work by eliminating multiple typing and checking a study was made of the possibility of using the Flexowriter automatic typewriter as a result of which H.M. Stationery Office agreed to supply one for two months' trial.

Publications. The main research publications of the Office remained the *Geophysical Memoirs*, *Professional Notes* and *Meteorological Reports*. A list of those published during the year is given in Appendix VII. It was decided during

the year to replace the *Professional Notes* and *Meteorological Reports* by a new series entitled *Scientific Papers* which will be printed on paper about an inch wider than that of the older series in order to allow more space for diagrams. The final numbers of *Meteorological Reports* and *Professional Notes* were published during the year. Three *Geophysical Memoirs* and four *Scientific Papers* were in the press at the end of the year.

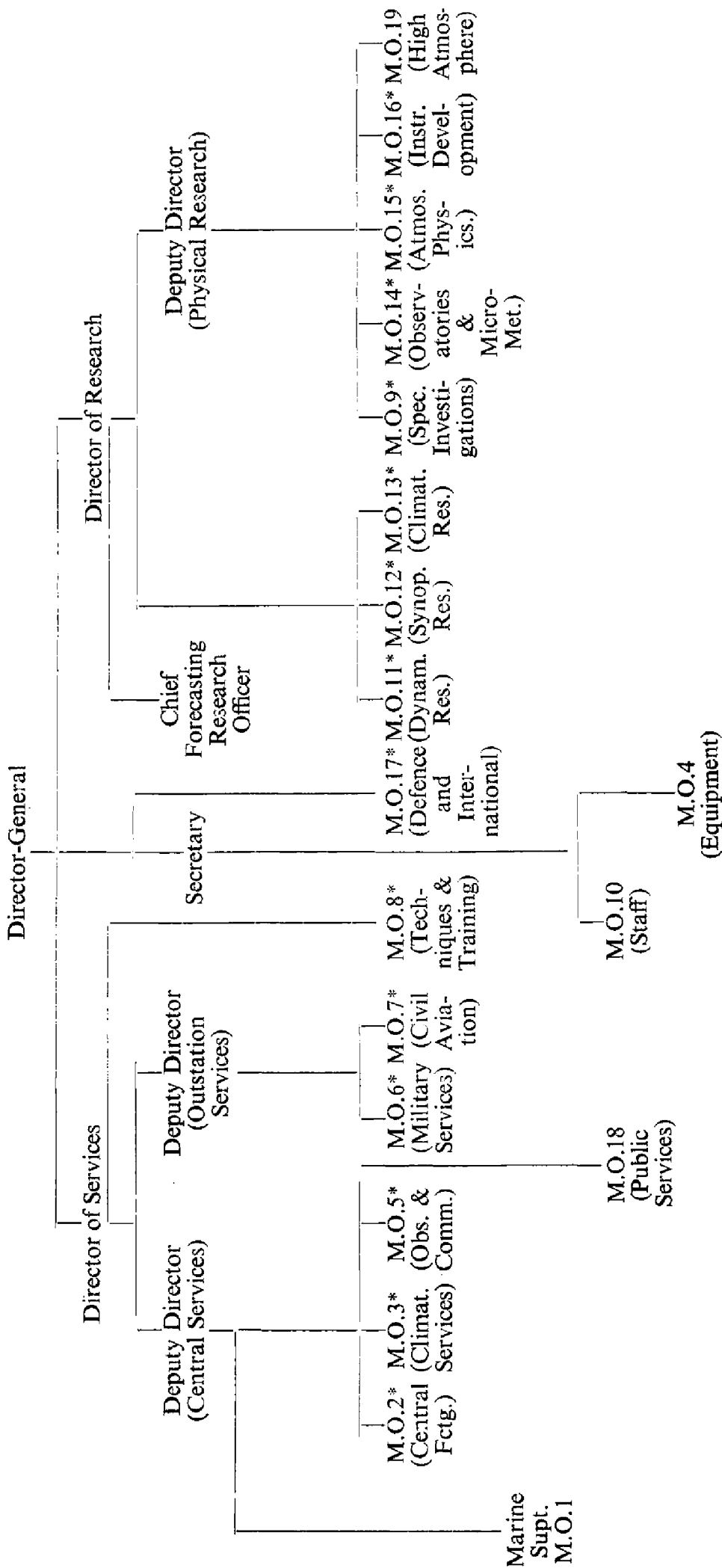
The *Meteorological Magazine* was published each month except that, because of the printing strike of July, a single August/September number had to be issued. Examples of the articles published are: First results of the Meteorological Office experiments on the artificial stimulation of rainfall; Frequency of fog in the London area as compared with that in rural areas of East Anglia and south-east England; and Recent seasonal climatic trends of pressure and temperature variability over Great Britain. Reports of the Third Congress of the W.M.O. and of the Sixth Conference of Commonwealth Meteorologists and reviews of new books and notes and news of interest to meteorologists were also published in the Magazine. In order to provide more space for scientific articles, it was decided to cancel the accounts of weather of the month and the rainfall table and to abbreviate the reports of the Meteorological Office monthly discussions. (See p. 27.)

The *Marine Observer* was published each quarter. Examples of the main articles published are: The use of upper air charts in forecasting two Atlantic storms of March, 1959; and Weather and the fishing industry.

A new edition of the *Handbook of Weather Messages* was published during the year, as also were the third edition of the *Marine Observer's Guide* and the second edition of *Monthly meteorological charts and sea-surface current charts of the Greenland and Barents Sea*.

The 1944, 1945, 1947 and 1948 volumes of the *Observatories' Year Book* were published during the year. In order to produce the volumes for the International Geophysical Year as soon as possible the varityping of the 1957 and 1958 volumes was begun and the preparation of earlier volumes postponed.

APPENDIX I METEOROLOGICAL OFFICE HEADQUARTERS ORGANIZATION



* Assistant Directorates.

APPENDIX II

PRINCIPAL OFFICERS OF THE METEOROLOGICAL OFFICE (on March 31, 1960)

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) A. C. Best, O.B.E., D.Sc.

DEPUTY DIRECTOR (OUTSTATION
SERVICES) B. C. V. Oddie, B.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) (Temporarily as for High Atmosphere).

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

ASSISTANT DIRECTOR (HIGH
ATMOSPHERE) R. Frith, O.B.E., M.A., Ph.D.

SECRETARY, METEOROLOGICAL OFFICE

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

APPENDIX III

STRENGTH OF THE STAFF OF THE METEOROLOGICAL OFFICE

| | | | | | | | March 31, 1960 |
|--|----|----|----|----|----|----|-------------------|
| Scientific Officer grades | .. | .. | .. | .. | .. | .. | 152 |
| Experimental Officer grades | .. | .. | .. | .. | .. | .. | 711 |
| Scientific Assistant grades | .. | .. | .. | .. | .. | .. | 1,611* |
| Technical and Signal grades | .. | .. | .. | .. | .. | .. | 286 |
| Assistant Secretary grade | .. | .. | .. | .. | .. | .. | 1 |
| Executive and Clerical grades | .. | .. | .. | .. | .. | .. | 118 |
| Typing and Miscellaneous non-industrial grades | .. | .. | .. | .. | .. | .. | 77 |
| Nautical Officers | .. | .. | .. | .. | .. | .. | 8 |
| Marine staff (Ocean Weather Ships and Base): | | | | | | | |
| Officers | .. | .. | .. | .. | .. | .. | 44 |
| Crew | .. | .. | .. | .. | .. | .. | 123 |
| Industrial employees | .. | .. | .. | .. | .. | .. | 74 |
| Locally entered staff and employees overseas | .. | .. | .. | .. | .. | .. | 170 |
| Total | | | | | | | <hr/> 3,375 <hr/> |

* Includes 143 airmen meteorologists and 13 meteorological air observers.

APPENDIX IV

RADIO-SONDE AND RADAR-WIND STATIONS

| United Kingdom | Overseas |
|-----------------------|------------------|
| Aldergrove | Aden |
| Aughton (Liverpool) | Bahrain |
| Camborne (Cornwall) | Cyprus |
| Crawley | Falkland Islands |
| Hemsby (Yarmouth) | Gan |
| Lerwick | Gibraltar |
| Shanwell (Nr. Dundee) | Malta |
| Stornoway | Tobruk |

A complete schedule of radio-sonde and radar-wind observations is also maintained by the Ocean Weather Ships on stations 'I' (59° N., 19° W.) and 'J' (52° 30' N., 20° W.)

APPENDIX V

METEOROLOGICAL OFFICE TRAINING SCHOOLS

Courses which ended during the period April 1, 1959 to March 31, 1960

| | Length of Course Weeks | No. of Courses | No. of Students |
|--|---------------------------|----------------|-----------------|
| Scientific Officers | 23 | 2 | 5 |
| Forecasters (Initial Course) .. | 16 | 3 | 53 |
| Forecasters (Advanced Course) | 6 | 6 | 26 |
| Senior Forecasters | 3 | 3 | 22 |
| Assistants | 9 | 19 | 288 |
| Climatology | 8 | 2 | 9 |
| Radio-sonde, Initial Course .. | 8 | 5 | 58 |
| Radio-sonde, Advanced Course | 4 | 5 | 13 |
| Voluntary observers | 1 | 2 | 34 |
| <i>Part-course attendance:—</i> | | | |
| Tropical meteorology .. | 2 | — | 2 |
| Mediterranean meteorology | 2 | — | 3 |
| Elementary instrument main- tenance | 1 | — | 1 |
| Advanced instrument main- tenance | 2 | — | 2 |
| Total | | | 516 |

Students from the following meteorological services attended courses:

| Country | No. of Students |
|--------------------------------------|-----------------|
| Belgium | 2 |
| Burma | 2 |
| Ceylon | 4 |
| Channel Islands | 2 |
| Egypt | 2 |
| Falkland Islands Dependencies Survey | 24 |
| Ghana | 2 |
| Hong Kong | 2 |
| Iran | 3 |
| Japan | 1 |
| Mauritius | 1 |
| Nigeria | 9 |
| Pakistan | 2 |
| Philippines | 1 |
| Sierra Leone | 1 |
| U.S.A. | 1 |
| West Indies | 3 |
| Total | 62 |

APPENDIX VI

CLASSIFICATION OF STATIONS WHICH RENDER CLIMATOLOGICAL RETURNS

| | Stations | | | | | Autographic Records | | |
|--|---------------|----------|---------------------|----------------|-----------|------------------------|----------|------|
| | Observatories | Synoptic | Agro-meteorological | Climatological | *Rainfall | Sunshine | Rainfall | Wind |
| Scotland, North | 1 | 8 | 0 | 22 | 294 | 17 | 7 | 7 |
| Scotland, East | 0 | 7 | 8 | 54 | 508 | 43 | 20 | 5 |
| Scotland, West | 1 | 5 | 3 | 42 | 495 | 24 | 16 | 6 |
| England, North-east | 0 | 9 | 4 | 23 | 394 | 30 | 17 | 4 |
| England, East | 0 | 12 | 13 | 19 | 485 | 28 | 20 | 10 |
| England, Midlands | 0 | 12 | 21 | 47 | 1,193 | 61 | 36 | 4 |
| England, South-east (including London) | 1 | 18 | 16 | 61 | 872 | 68 | 81 | 18 |
| England, South-west | 0 | 7 | 8 | 23 | 501 | 33 | 12 | 3 |
| England, North-west | 0 | 4 | 4 | 24 | 479 | 23 | 34 | 8 |
| Wales, North | 0 | 1 | 3 | 16 | 206 | 9 | 3 | 1 |
| Wales, South | 0 | 4 | 8 | 15 | 302 | 22 | 9 | 5 |
| Isle of Man | 0 | 2 | 0 | 1 | 16 | 3 | 1 | 1 |
| Scilly and Channel Isles | 0 | 2 | 0 | 4 | 20 | 6 | 1 | 2 |
| Northern Ireland | 0 | 4 | 2 | 12 | 103 | 8 | 4 | 3 |
| Total | 3 | 95 | 90 | 363 | 5,868† | 375 | 261 | 77 |

* Includes stations in earlier columns.

† Figures for rainfall stations and autographic rainfall records refer to data for the year 1958 received during 1959. All other figures show the position on January 1, 1960. Some rainfall data are not published.

APPENDIX VII

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, 1960).

Daily Weather Report, containing weather maps for the northern hemisphere, British Isles, etc. and data (to March 31, 1960).

Daily Weather Report, Overseas supplement, containing surface and upper air data (to December 10, 1959).

Meteorological Magazine, (to February, 1960).

Monthly Weather Report, with a summary for the year (to September, 1959).

Seismological Bulletin. A diary of seismological disturbances recorded on the Galitzin aperiodic seismographs at Kew Observatory, Richmond (to January, 1960).

Marine Observer (quarterly) (to January, 1960).

Meteorological and current summary for Ocean Weather Stations—India (59° 00' N., 19° 00' W.), *Juliett* (52° 30' N., 20° 00' W.) and *Alpha* (62° 00' N., 33° 00' W.) for January to December, 1958.

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, 1944, 1945 and 1947. (See also p. 42).

The Observatories' Year Book, comprising the meteorological and geophysical results obtained from autographic records and eye observations at the Lerwick, Eskdalemuir, and Kew observatories, 1948.

SERIAL

Meteorological Reports: Vol. III:

21. Synoptic evolution of 500 millibar flow patterns. A medium range forecasting aid. By C. V. Smith, M.A., B.Sc.

22. Aviation Meteorology of the West Indies.

Professional Notes: Vol. VIII:

124. The preparation of statistical wind forecasts and an assessment of their accuracy in comparison with forecasts made by synoptic techniques. By C. S. Durst, B.A. and D. H. Johnson, M.Sc.

125. Averages of accumulated temperature and standard deviation of monthly mean temperature over Britain, 1921–50. By H. C. Shellard, B.Sc.

OCCASIONAL

Handbook of Weather Messages. 3rd Edition, 1959.

Part I. Transmission schedules and station index numbers.

Part II. Codes and specifications.

Part III. Coding, decoding and plotting.

Instructions for the preparation of weather maps with tables of the specifications and symbols. 3rd Edition, 1959.

Marine Observers Guide. 3rd Edition, 1959.

Monthly meteorological charts of Greenland and Barents Sea.

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

Part II. Central and South America, the West Indies and Bermuda.

Part III. Europe and the Atlantic Ocean North of 35° N.

Upper Air Data for stations maintained by the Meteorological Office—Summaries of radio-sonde observations of temperatures and humidity of radar-wind measurements at standard pressure levels.
1951–1955. Part 3, Lerwick.
1951–1955. Part 4, Khartoum.
1951–1955. Part 5, Benina.

APPENDIX VIII

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, 1960 :

- SIR GRAHAM SUTTON, D.Sc., F.R.S. Address to the Conference. [The International Clean Air Conference, London, October, 1959.] *Smokeless Air, London*, 30, 1959, p. 100.
- R. C. SUTCLIFFE, B.Sc., Ph.D., F.R.S. The future of weather forecasting. *Weather, London*, 14, 1959, p. 163.
- R. C. SUTCLIFFE, B.Sc., Ph.D., F.R.S. Basic problems of weather forecasting with special reference to the Mediterranean. *Met. Abh. Inst. Met. Geoph., Freie Univ., Berlin*, 9, H. 1, 1960, p. 119.
- R. C. SUTCLIFFE, B.Sc., Ph.D., F.R.S. Depressions, fronts and air mass modification in the Mediterranean. *Met. Abh. Inst. Met. Geoph., Freie Univ., Berlin*, 9, H. 1, 1960, p. 135.
- R. C. SUTCLIFFE, B.Sc., Ph.D., F.R.S. The Mediterranean in relation to the general circulation. *Met. Abh. Inst. Met. Geoph., Freie Univ., Berlin*, 9, H. 1, 1960, p. 125.
- A. C. BEST, D.Sc. Runway light range as a subjective measurement. *Met. Mag., London*, 88, 1959, p. 161.
- A. C. BEST, D.Sc. and E. C. FIELDER. Short-period variations in visibility. *Met. Mag., London*, 89, 1960, p. 42.
- G. D. ROBINSON, B.Sc., Ph.D. Vertical motion and the transfer of heat and momentum near the ground. *Adv. Geoph., New York*, 6, 1960, p. 259.
- J. S. SAWYER, M.A. The jet stream. *New Scientist, London*, 6, 1959, p. 947.
- B. C. V. ODDIE, B.Sc. Atmospheric chemistry. *Int. J. Air Pollution, London*, 1, 1958, p. 114.
- B. C. V. ODDIE, B.Sc. The composition of precipitation at Lerwick, Shetland. *Quart. J. R. met. Soc., London*, 85, 1959, p. 163.
- B. C. V. ODDIE, B.Sc. First results of the Meteorological Office experiments on the artificial stimulation of rain. *Met. Mag., London*, 88, 1959, p. 129.
- B. C. V. ODDIE, B.Sc. Some cirrus cloud observations made by the Westminster Shiant Isles Expedition, 1958. *Weather, London*, 14, 1959, p. 204.
- C. J. BOYDEN, B.A. The use of upper air charts in forecasting. *Mar. Obs., London*, 30, 1960, p. 27.
- C. J. BOYDEN, B.A. A method of fitting isobaric contours to the gradient wind. *Met. Mag., London*, 89, 1960, p. 68.
- P. J. MEADE, B.Sc., A.R.C.S. Smogs in Britain and the associated weather. *Int. J. Air Pollution, London*, 2, 1959, p. 87.
- P. J. MEADE, B.Sc., A.R.C.S. The effects of meteorological factors on the dispersion of airborne material. *6th Rassegna Int. Elett. e Nucleare, Sez. Nucleare, Roma*, 16-20 Giugno, 1959, p. 107.
- P. J. MEADE, B.Sc., A.R.C.S. and F. PASQUILL, D.Sc. A study of the average distribution of pollution around Staythorpe. *Int. J. Air Pollution, London*, 1, 1958, p. 60.
- C. W. G. DAKING, B.Sc. Conference of Commonwealth Meteorologists, May, 1959. *Met. Mag., London*, 88, 1959, p. 240.
- C. W. G. DAKING, B.Sc. Third Congress of the World Meteorological Organization. *Met. Mag., London*, 88, 1959, p. 203.
- E. KNIGHTING, B.Sc. 'Meteor'. *Met. Mag., London*, 88, 1959, p. 266.

- E. KNIGHTING, B.Sc. and A. GILCHRIST, M.A. The effect of stability on computed tendencies and vertical velocities. *Quart. J. R. met. Soc., London*, **85**, 1959, p. 412.
- R. FRITH, M.A., Ph.D. A note on the effect of radiation errors on the measurements of temperature inversions by radio-sonde. *Met. Mag., London*, **88**, 1959, p. 328.
- R. FRITH, M.A., Ph.D. Thermo-nuclear explosions and the weather. *Weather, London*, **14**, 1959, p. 140.
- C. E. N. FRANKCOM. Meteorology and the sea. *Sea Frontiers, Coral Gables*, **5**, 1959, p. 148.
- A. F. CROSSLEY, M.A., C. S. DURST, B.A. and N. E. DAVIS, B.A. Horizontal diffusion in the atmosphere as determined by geostrophic turbulence. *J. Fluid Mech. London*, **6**, 1959, p. 401.
- T. N. S. HARROWER, M.A., B.Sc. and D. C. EVANS. Similarities of the meteorological situations in which aircraft were damaged by heavy hail. *Met. Mag., London*, **89**, 1960, p. 80.
- F. E. LUMB, M.Sc. Cotswold snowfall of 1 November, 1942. *Met. Mag., London*, **89**, 1960, p. 11.
- F. E. LUMB, M.Sc. A quick method of allowing for trajectory curvature when estimating the gradient wind from forecast contour charts for westbound North Atlantic flights. *Met. Mag., London*, **88**, 1959, p. 262.
- F. E. LUMB, M.Sc. Two Atlantic storms of March, 1959. *Mar. Obs., London*, **30**, 1960, p. 21.
- A. H. GORDON, M.Sc. Twenty years after. The story of the Meteorological Office Training School. *Met. Mag., London*, **88**, 1959, p. 257.
- L. P. SMITH, B.A. A real summer. Little disease but plenty of pests. *Grower, London*, **52**, 1959, p. 102.
- L. P. SMITH, B.A. The year's weather. *Agriculture, London*, **66**, 1959, p. 413.
- R. A. HAMILTON, B.A. The diurnal variation of pressure on the Greenland ice sheet. *Quart. J. R. met. Soc., London*, **85**, 1959, p. 168.
- R. A. HAMILTON, B.A. Meteorological research in the polar regions. *Weather, London*, **14**, 1959, p. 243.
- R. A. HAMILTON, B.A. The pressure gradient at the edge of an ice sheet. *Quart. J. R. met. Soc., London*, **85**, 1959, p. 166.
- H. H. LAMB, M.A. The changing climate. *New Scientist, London*, **6**, 1959, p. 740.
- H. H. LAMB, M.A. Our changing climate, past and present. *Weather, London*, **14**, 1959, p. 299.
- H. H. LAMB, M.A. and A. I. JOHNSON, B.Sc., A.R.C.S. The use of monthly mean 'CLIMAT' charts for the study of large scale weather patterns and their seasonal development. *Weather, London*, **15**, 1960, p. 83.
- G. W. HURST, B.Sc., A.R.C.S., D.I.C. Collection of water from cloud at Gibraltar. *J. Instn. Wat. Engrs., London*, **13**, 1959, p. 341.
- R. F. JONES, B.A. Water and ice in the atmosphere. *J. R. aero. Soc., London*, **63**, 1959, p. 465.
- R. F. JONES, B.A. and others. Use of ground-based radar in meteorology (excluding upper-wind measurements). *World Met. Org., Tech. Note No. 27, W.M.O. No. 84, Geneva*, 1959, Pp. xvi + 81.
- J. BRIGGS, B.A. and J. JOHNS. Variation in shower activity in Acklington. *Met. Mag., London*, **89**, 1960, p. 48.
- R. MURRAY, M.A. Snow in relation to certain synoptic parameters. *Met. Mag., London*, **88**, 1959, p. 324.
- R. MURRAY, M.A. and G. A. COULTHARD. A thunderstorm at Sharjah, Persian Gulf, on 23 November, 1957. *Met. Mag., London*, **88**, 1959, p. 176.
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