ANNUAL REPORT

of the Director of the

METEOROLOGICAL OFFICE

presented by the Meteorological Committee
to the Air Council

For the Year ended
March 31
1934

The Seventy-ninth Year of the Meteorological Office

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The Committee met on July 12 and November 8, 1933.

COMMITTEE OF THE METEOROLOGICAL OFFICE EDINBURGH, 1933–4

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Secretary: Mr. A. H. R. GOLDIE, M.A., F.R.S.E.

The Edinburgh Meteorological Committee met on June 20, 1933. Professor J. R. CURRIE was nominated as representative of the University of Glasgow as from April 1, 1933.

A list of the staff and of the divisions and establishments of the Office will be found on pp. 53 to 57.

ANNUAL REPORT of the Director of the Meteorological Office presented by the Meteorological Committee to the Air Council for the year ending March 31, 1934 (the seventy-ninth year of the Meteorological Office).

For descriptive purposes the work of the Meteorological Office may be divided into two main divisions dealing respectively with weather and climate. Although no absolutely sharp line can be drawn between these two aspects of meteorology and in practice they are frequently intermingled, yet they do depend on two fundamentally different principles. Weather deals with the actual conditions existing at any one time over a greater or less extent of the earth's surface, while climatology deals with the value of any given meteorological element which may be expected, as the result of previous experience, to be present at any time and place. The study of weather and its application depend on knowing at any one time the distribution of the meteorological elements both at the surface and in the upper atmosphere over the area for which information is required and also over large surrounding areas. It involves the rapid collection of observations and the marshalling of the information so transmitted in such a way that a mental picture can be formed of the existing conditions. On the other hand, climatology depends on the accumulation of observations over very long periods, the immediate weather being of little interest beyond an additional fact to be added to the record already accumulated.

The method of dealing with these two aspects of meteorological work is obviously fundamentally different, and for the purposes of this Report it will be convenient to describe the weather work and the climatological work separately, so far as they can be separated, and then to describe those branches of the work in which both of these, as well as other activities of the Office, are concerned. Synoptic meteorology, that is the branch of meteorology dealing with weather, will be dealt with first.

SYNOPTIC METEOROLOGY

Synoptic meteorology is a lineal descendant of the weather wisdom of the shepherd, the seaman and other workers whose activities depend on the weather. The opinions expressed by these early weather forecasters depended on three mental efforts : in the first place the existing weather conditions were minutely observed ; from these observations, based on experience and a certain amount of quasi-science, inferences of the changes likely to occur were drawn, and finally the inferences thus deduced were conveyed to the listener. The same three processes are involved in the most modern synoptic meteorology, the only difference

being that the scope of each is infinitely widened. Instead of observing only the conditions in his immediate neighbourhood, the modern forecaster has set out in front of him a full description of the weather conditions over a whole hemisphere. Instead of knowledge based only on experience and inference he has the whole of physical meteorology at his command, and finally his deductions are conveyed to the whole world by newspaper, telegraphy and broadcasting.

The information required.—The information now received in a forecasting office consists of a complete specification of the atmosphere so far as it is ascertainable at the observing posts and provision is made for the following observations :—

Atmospheric pressure and its change in the last three hours ;
Temperature of the air at the time of observation ;
Maximum temperature and minimum temperature within specified periods ;
Humidity of the air ;
Wind force and direction ;
Amount, type and height of the clouds ;
Rainfall ;
Visibility ;

and a concise statement of such factors as hail, snow, rain, thunder and lightning which collectively go under the name of " weather."

These are all surface observations, but information is required of the conditions in the upper atmosphere, e.g., the wind direction and force and temperature at all levels which can be reached. The collection of information regarding the wind direction and force is relatively easy ; for this purpose pilot balloons, which are small rubber balloons filled with hydrogen, are released and their motion is followed and recorded by means of a specially designed theodolite. In this way the actual track through the atmosphere travelled by the balloon as it rises through each layer of the atmosphere is determined, and from this the direction and velocity of the wind in specified layers is easily calculated. Pilot balloons carry no instruments, and therefore can give no information regarding temperature and humidity. For scientific purposes balloons carrying such instruments are employed and will be described later in this report, but they cannot be used in synoptic work because the records they obtain do not become immediately available, as time is required for the instruments to be found and returned and for the record to be reduced. The only practical way for obtaining rapidly the temperature and humidity of the upper atmosphere is by means of observations taken from aeroplanes, and these are being used for meteorological purposes to an ever-increasing extent.

The stations collecting the information.—There are 63 stations in the British Isles which despatch to the Meteorological Office, London, several times a day messages giving the results of their

observations. These stations are of three different types. There are first 21 stations at which the observations are taken by Meteorological Office staff; these stations are located mainly on aerodromes. At most of these stations pilot balloon observations are made, trained personnel being necessary for this purpose. Secondly, there are 24 stations in charge of observers who are not members of the Meteorological Office staff but take observations under the instructions of the Office, for which they are paid appropriate allowances. These stations are in many cases located at lighthouses and coastguard stations, and the observations are taken by the lighthouse or coastguard staff; other stations are established in suitable localities and private individuals act as observers. These stations are the remnants of the original forecast service established before the introduction of wireless telegraphy and have retained the old name of Telegraphic Reporting Stations. At these stations pilot balloon observations are not made. Thirdly, there are 18 stations which do not take complete sets of observations, but are ready at any time to send information on demand. These are called Auxiliary Stations.

Observations as far west as longitude 40° W. are obtained from British ships in the manner described in detail on p. 26. In addition the information from foreign ships is received in the broadcast reports issued by their own countries. Observations are also made on cross-channel steamers and telegraphed to London on arrival at ports.

Information regarding the upper air is supplied from Duxford, where a small Meteorological Flight, consisting of two aeroplanes with the necessary pilots and ground staff, has been established. One or two flights are made daily, excluding Sundays, and heights between 25,000 ft. and 30,000 ft. are regularly attained. So great is the keenness of the R.A.F. personnel engaged in this work that flights are made almost independently of the weather and cloud is no obstacle, many of the flights penetrating clouds thousands of feet thick. During the year under review over 90 per cent. of the scheduled flights were actually accomplished.

Times of observation.—The times at which observations for synoptic meteorology are taken have been fixed by international agreement. There are four main hours of observation common to the whole world, namely, 0000, 0600, 1200 and 1800 G.M.T., but a latitude of one hour from these standard times is permitted for regional use. From considerations of the hours of opening telegraph offices in the morning and the need for early observations in the evening to meet newspaper requirements, the hours adopted throughout Europe are the following: 0100, 0700, 1300 and 1800 G.M.T., all of which, of course, fall within the limits agreed to internationally. Eighteen British stations observe at all four hours, twenty-seven omit the 0100 observations but report at the other three hours. The observations taken at these standard hours form the framework of the observations for the synoptic work, but the ever-increasing demand of aviation for more detailed

and more recent information has resulted in arrangements being made for a number of the stations to report at intermediate hours, and along the main air lines arrangements are made for hourly observations.

Transmission of information to Headquarters.—As soon as the observations have been taken, a telegram in code is prepared for despatch to the Meteorological Office in London. The stations which are on R.A.F. aerodromes despatch these messages by the R.A.F. wireless service, while other stations transmit their observations either by telegraph or telephone. The wireless messages are received by a wireless station situated at the top of the Air Ministry, and on receipt are transcribed on to forms in triplicate, which are immediately transmitted to the forecasting room by means of a pneumatic tube. The telegrams which arrive at the Central Telegraph Office were originally transmitted by telephone direct to the forecast room of the Meteorological Office, but during the year a teleprinter has been installed. This instrument consists of a pair of special typewriters, one situated in the Central Telegraph Office, and the other in the forecast room, connected by telegraph wires. The messages typed on one instrument are reproduced in type on the other instrument, the operators being in communication with one another by typing on their respective instruments. After preliminary adjustments, the teleprinter is now working satisfactorily and, except during the night, it displaces the telephone link with the Central Telegraph Office.

Within a period of less than half an hour from the time of observation, the messages from all the stations in the British Isles have reached the forecast room at the Air Ministry.

Exchange of Information with Foreign Countries.—One of the first uses made of the information as it is received in London is the preparation of a selection of the observations for distribution to foreign countries. The international exchange of weather data is probably one of the best examples of international co-operation which exists. Every country in Europe has a system of collecting information similar to that described for Great Britain. Europe is divided into three main groups, namely, the Western group, the Central group and the Russian group. As soon as each country has collected the observations from its own stations, those in the Western group communicate their observations, according to a pre-arranged time-table, to the Office National Météorologique in Paris, while all those in the Central group forward theirs to the Deutsche Seewarte in Hamburg, and the countries of the U.S.S.R. forward their observations to Moscow. On receipt of the observations in Paris, Hamburg or Moscow, they are re-issued by powerful wireless stations, generally simultaneously on long and short waves, with sufficient power for the messages to be received in all parts of Europe. All the three messages can be received by any station which has three receiving sets, but by an ingenious use

of time-tables, it is possible for a station with only one receiving set to receive most of the information which is of importance to itself. Arrangements are made in the Air Ministry to receive these wireless messages, and very shortly after the messages have been received from British stations information has already been received from the whole of Europe extending from Spitsbergen in the north to the north African coast in the south, from the Azores in the west to the Levant in the east. This exchange of information with the continent takes place at each of the standard international hours and a great deal of additional information is also exchanged in connexion with the aviation services, to which reference will be made later.

Twice a day the United States of America issue a message containing information from a certain number of stations in the North American continent, including stations in Canada and Central American countries. These messages are issued from a powerful wireless station at Annapolis and can be picked up over practically the whole of Europe. These observations are of great utility for forecasting purposes. The European return messages to America are made from the Rugby wireless station. Two messages are prepared in the London office each day containing a selection of the European observations and despatched to Rugby for issue.

Thus the complete interchange of weather information for the northern hemisphere is carried out by the five main meteorological issues made by :—

(*a*) U.S.A. from Annapolis.
(*b*) Great Britain from Rugby.
(*c*) Germany from Hamburg.
(*d*) France from Paris.
(*e*) U.S.S.R. from Moscow.

The messages issued by these five stations can be picked up practically everywhere in the northern hemisphere. It is therefore, only a matter of erecting a suitable wireless receiving station to have the material available to prepare a complete weather chart of the northern hemisphere twice daily, and of Europe four times daily.

The use made of the data at Headquarters.—While the receipt and exchange of messages described in the previous paragraphs are taking place in one part of the forecast division, copies of the telegrams are supplied to another part of the division for the preparation of synoptic charts. Weather charts are drawn on outline maps on the scale of 1 : 10 million for observations at 0100, 0700, 1300 and 1800 G.M.T. These outline maps extend from Spitsbergen in the north to north Africa in the south and from the Ural Mountains in the east to Newfoundland in the west. They are used for preparing the forecasts for 24–36 hours ahead and for the further outlook beyond that period. The scale of these charts is, however, too small to allow of plotting

all the information and further charts are prepared on outline maps of double the above scale but embracing a smaller area for the hours mentioned above and also for the intermediate hours of 1000 and 1600 G.M.T. On these charts information regarding the height and quantity of low cloud, the dew point and visibility are entered for each station or ship in addition to the meteorological elements entered on the smaller scale charts. These detailed charts are essential for the preparation of the highly detailed forecasts required for aviation. Both sets of charts are, however, necessary, as they supplement one another, the first giving the large scale view and the second the detail necessary for local requirements.

The charts already mentioned are prepared throughout the year, but the increase of aviation in the summer months and especially the early morning flights connected with the distribution of newspapers to the continent, have rendered extra charts necessary early in the morning during these months. In previous years this need has been met by observations taken at 0500 G.M.T. (6 a.m. summer time), this being the earliest hour at which the meteorological observing stations were opened. This time, however, was too late to serve the purpose, the hour of 0400 G.M.T. being much preferable for many reasons. Not only does it come midway between the observing hours of 0100 and 0700 but it permits of more time for the preparation and issue of the early morning forecasts which are required during the summer months. During the year under review observations at the earlier hour were instituted at most of the observing stations and a chart for 0400 G.M.T. was prepared each day during the period of summer time.

The observations are plotted on the charts by special draughtsmen and are simultaneously studied by the forecasting staff. As soon as the charts are sufficiently completed to allow of the existing meteorological situation to be properly appreciated, the preparation of reports and forecasts is taken in hand. These forecasts are required for many purposes and for many different interests but they may be divided into four main classes :

(*a*) for the general public ;
(*b*) for shipping ;
(*c*) for agriculture, and
(*d*) for aviation.

Forecasts for the General Public.—Forecasts for the general public are issued through the newspapers, through the B.B.C. and through the printed *Daily Weather Reports*. Weather forecasts for the Press are issued three times a day, in time respectively for the earliest editions of London newspapers ; for the town and country evening newspapers ; and for next morning's newspapers. Probably the most useful set of forecasts issued to the general public are those which are broadcast by the B.B.C. Omitting for the moment the forecasts for shipping and farmers referred to later, the B.B.C. issues forecasts as part of their news bulletin at 6 p.m. and 9 p.m. (10.15 p.m. in Regional

programmes). The issues at 9 p.m. (Summer Time) are examples of the rapidity with which it is possible now to make weather forecasts available to the public, for the observations on which these forecasts are based are made at 7 p.m. (Summer Time), that is, observations have been made over the whole of Europe, collected in the London Meteorological Office, charts plotted, and deductions drawn and conveyed to the recipient all within two hours.

Many people who require forecasts in connexion with their business arrange for telegrams to be sent directly from the Meteorological Office immediately before the occasion for which information is required. One of the most interesting examples of this use of forecasts is in connexion with pigeon racing, and several organisations controlling long distance pigeon flights arrange for regular forecasts to be issued to them during the summer months as it is now generally recognised that if long distance flights are to be successful and there is not to be loss of valuable birds, unsuitable weather conditions must be avoided.

Another example of the use now made of forecasts is the arrangement made by several manufacturing companies which have installed air conditioning machinery in their factories to receive warnings of certain definite weather changes. The use made of the Meteorological Office in connexion with industry and sport increases every year. It is becoming an increasing practice for the public to telephone to the Meteorological Office to ask for forecasts. Anyone is entitled to have read out to him over the telephone the latest forecast for any district in which he is interested. As part of his campaign to popularise the telephone, the Postmaster General referred to this facility in an advertisement which appeared widely in the daily press and recommended the use of the telephone for obtaining weather forecasts free of charge. There was immediately a large increase of telephonic inquiries which made it necessary to make special arrangements for dealing with them. As was naturally to be expected, the unusually large increase of inquiries which occurred during the time when the advertisements were appearing fell off to some extent, but the number still remains at a considerably higher level than previously.

In addition to publishing the official forecasts, the Press make frequent reference to the existing weather, especially when—as during the last year—the weather has been abnormal. The matter for these special paragraphs and articles is obtained by reporters through inquiries made at the Meteorological Office, either personally or by telephone, and there was a general increase in such inquiries last year. The following table illustrates the increase in inquiries just referred to :—

	1932–3.	1933–4.
General inquiries	4,228	4,662
Press inquiries	4,477	5,504

The inquiries dealing with aviation will be referred to later.

Supply of information for shipping.—One of the first duties of the forecaster as soon as the first observations are plotted on the charts is to examine the conditions to estimate the probability of high winds which may be dangerous to shipping. If it is estimated that on any part of the British coasts or on the neighbouring seas wind is likely to rise to gale force, a gale warning is immediately issued. These warnings are conveyed to shipping in a number of ways. In the first place, warnings are made by visual signals, so-called "gale warning" signals. At 235 points around the coast there are gale warning stations at which the apparatus exists for hoisting cones on masts so that they may be visible to shipping to indicate the probability of a gale being experienced in the near future. These masts and the arrangements for hoisting the cones are provided at the expense of the local community but the Meteorological Office bears the cost of the cones and also of the telegrams issuing the instructions for hoisting and lowering them. As soon as the forecaster has decided to raise the storm cones on any part of the coast, telegrams are immediately issued to all the gale warning stations affected. These telegrams are distributed by the Post Office on a multiple address system and considerable help in reaching many of the stations is given by the Board of Trade, who arrange for the telegrams when received at certain stations to be distributed locally over their own telephone wires. In this way the messages are much more rapidly distributed and a considerable reduction of cost has been effected. The gale warnings are also issued from a number of Post Office wireless stations situated at ports. These messages are telegraphed in the morse code and are preceded by the warning signal TTT. This is a very efficient means, and one which is appreciated by small craft, for reaching vessels out of sight of the visual signals. In addition notice of the issue of the warnings is sent to the B.B.C. and at the first of certain specified times the B.B.C. announcers include the warning in their broadcast messages. The issue of gale warnings is the first duty of the forecast division whenever their charts indicate the probability of a gale. (See Appendix II).

Shipping is also provided with weather information by the issue twice a day of special wireless messages called "The Weather Shipping Bulletin." These messages are prepared on the observations taken at 0700 and 1800 G.M.T. They contain a general statement of the weather conditions, observations made at 12 coast stations, 10 in the British Isles and 2 in foreign countries (Reykjavik and Thorshavn), and finally forecasts of the weather expected in the next twelve hours in a number of specified sea areas around the British Isles. These messages are issued in morse by the Air Ministry wireless stations on three wave-lengths (4,098 m., 54 m., and 32.29 m.) simultaneously, at 0910 and 2133 G.M.T.; at the same time the messages are issued by the powerful Rugby station on 18,740 m. The weather

shipping bulletins are also issued from three Post Office W/T stations on 600 metres, but as these stations can only be heard for a relatively short distance, they issue only the part of the weather shipping bulletin which refers to their own locality. In this way every ship which has a wireless operator on board is able to receive the messages.

To meet the needs of those vessels which do not carry a wireless operator, the weather shipping bulletin is issued also by wireless telephony by the B.B.C. through their station at Daventry each morning at 10.30 a.m. and each evening at 11 p.m. (clock time). In this way craft fitted with an ordinary wireless receiving apparatus (practically all vessels, including small vessels, are now so fitted) are able to receive the weather shipping bulletin in almost all parts of the seas around the British Isles. This service is particularly welcomed by fishermen and yachtsmen.

In addition to the weather shipping bulletin which is issued throughout the year, special weather messages are issued at certain seasons to meet the needs of the fishing fleets. At the request of the Fishery Board for Scotland a weather forecast for the Scottish Herring Fishing Fleet was issued on week-days between Tuesday and Friday inclusive from the Scottish stations of the B.B.C. from July 24 until September 13. Similar forecasts for the east Anglian Herring Fishery were supplied to the B.B.C. for broadcasting during the months October, November and December.

In addition to these arrangements for the supply of information to shipping, arrangements have been made with the Post Office by means of which any ship can send a wireless message to the nearest coast station and obtain from it a short standardised weather report. This service is much appreciated and frequently used by vessels navigating in coastal waters, especially when making an entrance to a harbour.

Supply of information for Agriculture.—Each morning a message is prepared specially for farmers and is broadcast by the B.B.C. immediately before the Weather Shipping message. It is recognised that the time of issue of this message (10.30 a.m.) is very late for agricultural purposes but this is the earliest hour at which the B.B.C. is able to issue a message from their high-power station at Daventry.

Facilities are also available to farmers for receiving notifications when it is anticipated that there will be spells of settled weather. This information is required chiefly in connexion with harvesting operations but the demand for " Spell notifications " has greatly decreased since the development of broadcasting of weather information by the B.B.C.

Thames Floods.—Following the disastrous flood which occurred in 1928 notifications have been sent to Scotland Yard whenever there has been an onset of strong north-westerly or northerly

gales over the North Sea, experience having shown that these conditions often lead to an abnormal raising of the water level in the River Thames. During the past year the method of issuing these notifications has been altered and since October the notifications have only been sent to Scotland Yard when the normal tides are so high that appreciable abnormal raising of the water level would lead to a dangerous flood. At other times, as no flood could occur even with a large abnormality of water level, no notification is sent to Scotland Yard.

Weather Reports from Health Resorts.—For about 22 years the office has organised a system of collection of weather reports from Health Resorts by telegraph each evening and of their re-issue to the press in a form suitable for printing in the morning daily newspapers. This was undertaken not so much because the office required the information for its own purposes, but to meet the requests of several health resorts who were forwarding separate telegrams to a number of leading newspapers which printed the data as a form of advertisement for the health resort. Another reason why the office undertook the work was to ensure that the reports from different health resorts were comparable with one another. This necessitated an annual inspection of each station in order to ensure that the instruments were in good order and that the site upon which they were exposed conformed to certain conventions which had been found to be necessary for ensuring comparable results. At the end of the year 92 health resorts were taking part in this scheme.

Aviation

The work of the Meteorological Office for aviation is based almost entirely on synoptic meteorology, so a description of the whole aviation service will be given here.

The service given by the Meteorological Office to aviation divides itself into two main parts :—

(*a*) the provision of information regarding existing weather conditions and the changes likely within the next few hours, since pilots are only interested in the weather changes during the periods covered by flights they are about to make ; and

(*b*) the organisation of a number of local stations situated on aerodromes where this information may be obtained and a professional meteorologist consulted.

During recent years the organisation of the work in the Meteorological Office has been based on these two divisions of the work, the former being undertaken by the forecast division and the latter by the aviation services division. There is, however, no sharp demarcation, for forecasts are made at the stations on the aerodromes while the method of taking observations on the aerodromes is largely governed by the requirements of the forecast division at Headquarters.

There are 19 meteorological stations, called Distributive Stations, because their business is to distribute meteorological information to those requiring it, on 16 R.A.F. aerodromes and 3 civil aerodromes.

Royal Air Force.—Meteorological stations are not provided on all R.A.F. aerodromes but only on those which require direct meteorological aid in the work carried on at the station; for example, they are provided at aerodromes where night bomber squadrons are stationed as the work in these squadrons depends very largely on weather changes; at seaplane stations, as aerial navigation over the sea can only be carried out with a complete knowledge of the air currents which are likely to be met with out of sight of land; and at aerodromes where there are R.A.F. flying schools. The meteorological officer on an aerodrome not only issues forecasts but he is constantly consulted by the Commanding Officer in arranging the work of the day and pilots visit the Meteorological Office to examine the charts before taking part in a flight. The work of the meteorological officer in charge of such a station is one of considerable responsibility.

As a general rule a distributive station is manned by a Senior Professional Assistant, assisted by a Grade II Clerk and two Grade III Clerks, who act as observers. At some of the more important stations this staff is increased. The observers at the distributive stations take observations for the general forecast service and transmit their messages as already described at the specified times to London. The meteorologist in charge of a distributive station requires a synoptic chart for his work and therefore requires observations from a large number of stations not only in the British Isles but from surrounding countries and the oceans. To meet this need the forecast division at Headquarters prepares a message containing a suitable selection of observations which is broadcast from the Air Ministry and received by the wireless sections on all the aerodromes at which there are meteorological distributive stations. Charts based on these observations are prepared twice each day at most stations; but where necessary a third chart can be prepared in the evening, and this is generally done at stations attached to night bomber squadrons.

If meteorological information is required at a R.A.F. aerodrome at which there is no meteorological station, a forecast can be obtained at short notice by sending a wireless message either to the nearest distributive station or to the Meteorological Office in London. Special arrangements have been made for dealing promptly with these requests and during the year no less than 4,583 such inquiries were received at Headquarters from R.A.F. stations.

During the year there has been a considerable development in the meteorological service for the R.A.F. and new distributive stations were opened at Bircham Newton, Manston, Pembroke

Dock and Bicester. The stations at Manston and Pembroke Dock were opened in pursuance of the policy already mentioned by which a meteorological station is attached to each night bomber aerodrome and flying boat base, while the other stations mark a new departure in attaching meteorological stations to day bomber squadrons for cloud flying training.

The organisation just described continues throughout the year, but special arrangements were made to meet seasonal requirements. In July the annual Air Defence Command Exercises took place, and as in previous years special arrangements were made for the supply of meteorological information. Meteorological Office staff were attached to the various Command Headquarters to act as advisers on meteorological questions to the A.O's.C. and temporary meteorological stations were opened at the bases of units operating away from their home stations. A special system of reports was organised to give the extra information required within the zone of operations. Similarly, special arrangements involving transfer of staff were made, for Bombing Exercises on the south coast in August, for the Coast Defence Exercises held in eastern Scotland in September, and for Camera Obscura Exercises in Wessex Bombing Area in April.

In addition to supplying meteorological information and advice to units to which they are attached most distributive stations supply a considerable amount of information to other services and outside bodies ; thus, several stations supply ballistic wind data to artillery units ; South Farnborough is called upon to supply forecasts or data to War Office units in the Aldershot Command ; Mount Batten frequently supplies forecasts and other information to the Royal Navy ; Abbotsinch supplies forecasts to the Clyde shipping companies and to industrial firms. The station at Lympne co-operates regularly with the Air Defence Experimental Establishment.

Regular courses of instruction in meteorology have been continued during the year at the Cadet College at Cranwell, the Flying Training Schools at Grantham and Sealand, the Royal Air Force Base at Calshot, the School of Naval Co-operation at Lee-on-Solent, the Royal Air Force Training Base at Leuchars and the Air Pilotage Course at Andover. Regular lectures have also been arranged in connexion with the Instrument Flying Course and Flying Instructors' Courses at the Central Flying School at Wittering.

In addition to the above courses individual tuition and occasional lectures have been given by the meteorological officers at the various stations. During the Individual Training Season a lecture was given at each Fighting Area Station on the meteorological aspects of cloud flying.

The R.A.F. also frequently applies to the Meteorological Office for advice on meteorological questions not associated with current weather ; for example, in recent years the R.A.F. has been interested in the problem of ice accretion on aircraft in flight and

the Office was asked to advise. Two memoranda on the subject have been prepared and arrangements have been made for certain members of the staff in touch with cloud flying to make special observations on this problem.

Civil Aviation.—Distributive stations are established on three civil aerodromes (Croydon, Lympne and Manchester). The increase of night flying on the civil air routes has necessitated maintaining a day and night service at Croydon, Lympne and Biggin Hill. The rapid growth of flying in and above clouds on the continental air routes and the practice of following a direct compass course between the terminal aerodromes have necessitated the forecasting of much more critical conditions than formerly. Consequently the work at Croydon has become highly specialised and necessitates forecasters of considerable experience of the peculiarities of these air routes, which—in the opinion of pilots of wide experience—are the most difficult from a meteorological point of view of any in the world. In this connexion it may be mentioned that it has now become the practice when visibility is bad to communicate to pilots before landing the barometric pressure at aerodrome level as several of the large air liners are now equipped with special open-scale landing aneroids. The whole tendency is for civil pilots to fly in all weathers, thus necessitating considerable new burdens on the meteorological officers whose duty it is to advise the pilots.

There has been considerable increase in the development of internal air services which has involved a material addition to the work of the Meteorological Office. The distributive stations at Abbotsinch and Aldergrove have been called upon to supply help to a new air service flying between Renfrew and Belfast and another between Renfrew and the Western Isles of Scotland. Similarly the distributive station at Mount Batten has been called upon for information in connexion with the railway air service between Plymouth, Cardiff and Birmingham, and an air service between Plymouth and Croydon *via* Southampton. Flying on these routes, however, is not continuous, but no doubt internal flying will increase and further demands will be made on the Meteorological Office. The new distributive station at Manchester has been established in view of such a development of internal air lines. The establishment of this station marks a change of policy in that the Air Ministry provide wireless and meteorological services on an aerodrome which is not owned by Government. The buildings and necessary works services at Manchester are provided by the Corporation, the Meteorological Office being responsible for the supply of staff and the necessary technical equipment.

The facilities already described as available to the R.A.F. when undertaking cross-country flights are also available for civil pilots and many demands are made by civil pilots for information regarding cross-country flights. During the year 3,236 inquiries were received in the forecast division from civil pilots.

To meet requirements of civil pilots the Automobile Association established a wireless station on the Heston aerodrome for issuing weather reports and forecasts broadcast by radio-telephony. This station has continued in activity, but during the course of the year it was transferred from the Automobile Association to the Air Ministry.

Help is regularly afforded to pilots visiting this country in connexion with long-distance flights, the most important occasion for such help being the visit of the Italian seaplane flight on its journey from Rome to Chicago and back. A special service of reports was concentrated at Leuchars on July 2, 1933, for communication to the aircraft during the flight from Amsterdam to Londonderry. On the arrival of the flight in Londonderry the forecast division in London forwarded a number of forecasts for the next stage of the route between Londonderry and Iceland, also a considerable amount of climatological information was supplied to Professor Eredia, the meteorologist with the flight. The meteorological staff at Aldergrove kept in close touch with the officers of the flight during this period and gave all possible help regarding the provision of information. During the preparation for the return flight from Chicago the station at Valentia provided a large amount of information to Professor Eredia.

In addition to the 3,236 inquiries from civilian pilots dealt with at Headquarters, 43,760 inquiries were dealt with at outstations, this being an increase of over 6,000 on the corresponding figure for last year. In addition, 8,020 weather reports were passed from Croydon or Lympne to aircraft in flight on the civil air route.

CLIMATOLOGY

Climatology is a much older branch of science than synoptic meteorology. The chief object in collecting climatological records is to have information available regarding the type of weather which may be anticipated in any locality, this information being desirable for a number of purposes, the chief of which are in connexion with agriculture and public health, whilst in recent years climatological data are frequently studied before the site of a factory for a new industry is established. In order that this information may be readily available it is necessary to systematise and analyse the actual data received from the observing stations, and to publish the results in such a way that they can be readily used by those requiring the information.

British Climatology

The preparation of climatological data for the British Isles is in charge of the British Climatology Division, South Kensington. This Division receives returns of practically all meteorological observations taken in the British Isles, no matter for what purpose they are originally made. The four chief observatories at Kew (in south-east England), Valentia (in south-west Ireland), Eskdale-

muir (in south Scotland) and Aberdeen (in north-east Scotland), provide the backbone of the climatological work. In addition to numerous observations taken at specified hours, these observatories keep a watch on the weather during the daytime and maintain sets of self-recording instruments from which hourly values of all the meteorological factors which can be recorded are obtained. The observations taken for synoptic meteorology at the distributive and telegraphic reporting stations, as already described, are also sent in monthly registers to the Climatology Division in addition to being telegraphed immediately for the use of the daily weather work. At all these stations the personnel is paid for by the Meteorological Office. These stations, numbering approximately 50, are however not sufficient to give a complete account of the climatology of the British Isles. A much larger number of stations is required. The Office for this purpose depends on voluntary help, and observations are made at 261 small climatological stations maintained by private observers, municipal or other local authorities without payment by the Office. In most cases these climatological stations only take one observation a day, at about 9 a.m., but a number of them take a second observation in the evening at 9 p.m. Typical climatological stations have a rain-gauge and a set of thermometers, and if they observe once a day they take a reading of the rainfall, the wet and dry bulb thermometers, the maximum and minimum thermometers and make remarks regarding the type of the weather. At some stations temperatures are observed by means of a thermometer lying just above the grass, and at some stations also by means of thermometers in the ground at depths of one foot and four feet below the surface; while at an increasing number of stations sunshine recorders are maintained. In all except a very few districts of the British Isles, there are sufficient climatological stations to give accurate information regarding the weather over the whole district.

Meteorological elements such as temperature and type of weather do not vary appreciably over a large district, but rainfall is a much more variable element both in time and space. In consequence, it is necessary to have a much closer network of rainfall stations and the need is met by a large number of stations which maintain only a rain-gauge which is read once a day. There are 5,329 of these rainfall stations maintained by voluntary observers. The returns from these rainfall stations provide the information necessary for all discussions of rainfall and are used in connexion with projects for the water supply in the British Isles.

During recent years there has also been established a new type of station, called Crop-Weather Stations. These are maintained at certain agricultural colleges and research institutions in connexion with the study of the relation between the weather and growing crops. At present there are 31 crop-weather stations in Great Britain which report, partly to the Meteorological Office, and partly to the Ministry of Agriculture and Fisheries

and the Department of Agriculture for Scotland. The arrangements for the observations at these stations are under the general control of a Committee on which the Meteorological Office is represented.

In Appendix I the distribution of these stations in the various districts of the British Isles is shown. The table includes only stations whose autographic records are regularly received at the Office. These records are of great value for many investigations and are frequently consulted when more detailed information is required than can be obtained from the published records.

The observers at all stations submit monthly registers containing the results of their observations but in the case of a large number of the rainfall stations these records are only received at the end of each year. As soon as the registers are received in the Climatology Division they are examined and doubtful observations investigated and then they are summarised and the results published in the various publications of the Office dealing with climatology, the chief of which are the *Weekly Weather Report*, the *Monthly Weather Report*, *British Rainfall* and the *Observatories' Yearbook*.

Weekly Weather Report.—This publication gives values of the chief meteorological elements for 57 stations according to the calendar week. Formerly this report was issued to the public weekly but it has been found that this is not convenient to users, who prefer to have the weekly data for a station collected together for the whole year rather than spread over 52 separate issues. In consequence the form of this publication was changed in 1928 and now the *Weekly Weather Report* is published annually. The volume for 1932–3 was published on January 8, 1934.

Monthly Weather Report contains monthly values for all the stations supplying information. Not only are the actual mean values for the elements given but in most cases the variation from normal is also published. This publication is the chief source of information regarding the seasonal values of the weather of the British Isles. The report is published at the end of the month following that to which it refers.

British Rainfall.—All the rainfall data for the country are collected together and published in an annual volume entitled *British Rainfall*. In addition to the rainfall data this volume also contains a number of articles dealing with interesting features of the rainfall during the year and short discussions on scientific problems connected with rainfall. The volume for 1932 was published on September 23, 1933.

The Observatories' Year Book contains the data from the observatories. It deals not only with the chief climatological factors but also with terrestrial magnetism, atmospheric

electricity, seismology and the investigation of the upper atmosphere. The publication of the volume for 1932 has been delayed owing to a change in the method of printing. The old and expensive method of setting up the volume in ordinary type has been replaced by the use of the Replika process (see p. 47). The volume for 1932 is with the printer and it is expected that publication will be effected shortly.

Preparation of Averages.—One of the chief objects of climatological work is to obtain the so-called normal values which are the average values of a given element over a long period of years. It is necessary constantly to revise these normals.

During the year the temperature normals were under revision as explained in last year's report. Monthly and annual averages of temperature for all stations having at least 10 years' observations prior to 1930 were prepared for use in the *Monthly Weather Report* and published in a new publication " Averages of Temperature for the British Isles ", M.O. 364. Weekly averages for use in the *Weekly Weather Report* were obtained from the monthly values by graphical methods.

Work is in hand on the preparation of new sunshine averages on similar lines to " Temperature Averages ". Values for the majority of sunshine stations were available for incorporation in the January, 1934 *Monthly Weather Report*, and copy of the complete publication will shortly be ready for despatch to the printer.

Course of Training for Observers.—A course of training for the observers at Health Resorts (see p. 14) was held in the Library at South Kensington on May 9 and 10. Twenty observers attended the course.

Agricultural-Meteorological Conference and Course of Instruction.—A conference of workers in agricultural meteorology was held in the Library at South Kensington on October 6. It was preceded by a short course of instruction which was attended by 22 observers.

Inquiries.—The number of inquiries for information regarding British climatology continues to increase. During the year 2,222 general or scientific inquiries for particulars of past weather, including 162 legal inquiries, were dealt with. A comparison with the year 1923–4 shows that the volume of inquiries has increased nearly six-fold in ten years.

Numerous inquiries for rainfall data from catchment boards set up under the provisions of the Land Drainage Act, 1930, have again been received.

British Association—Inland Water Survey Committee.—During the year the British Association established an Inland Water Survey Committee with which the Meteorological Office is co-operating. The Superintendent of the British Climatology Division has been a member of the Committee and contributed two memoranda dealing with British rainfall.

Climatology of the British Empire

The London Meteorological Office is not responsible for meteorological work in other parts of the Empire except in so far as meteorological sections provided by the Office are attached to the Royal Air Force in Middle East, Iraq and Malta. Each of the Dominions maintains its own meteorological office and efficient meteorological services are maintained in Malaya, East Africa and Bermuda. The London Office is frequently asked for help and advice by these meteorological services. The position is, however, somewhat different for Crown Colonies which do not have a separate meteorological service but in which meteorological observations are taken as an incidental part of the work of some department of the Colonial Government, generally the medical service, but occasionally the Department of Public Works. It is the usual practice for such observations to be summarised and published in the *Annual Reports* of the Colonial Government concerned. According to an arrangement made with the Colonial Office in 1910 reprints of these summaries are forwarded to the Meteorological Office. The separate issues of the reprints are collected together and sets, with an introduction prepared in the Meteorological Office, distributed to meteorological institutes in all parts of the world as part of the international exchange of meteorological information. Thirty-three Colonies and Protectorates supplied reprints for 1932, containing data for 340 stations, a decrease of 250 on the preceding year. This decrease is due to the non-receipt of reports from three Colonies which in 1931 contained reports from 263 stations.

World Climatology

One of the chief functions of the Meteorological Office is to provide information regarding the climate in any part of the world ; for this purpose it is necessary to collect and systematise meteorological information from all parts of the world. The chief source of information is the official publications issued by the meteorological services established in most countries. It has always been a practice of meteorological services to exchange their publications free of charge with all other services. Thus value is received for the cost of publishing the various reports, yearbooks, etc., issued by the Office. In addition to these official publications a certain amount of information is contained in scientific articles published by the Academies and other scientific bodies and also in the reports of travellers. All information of this kind is collected by the General Climatology Division at South Kensington since it has been found desirable to treat world climatology separately from the climatology of the British Isles. This Division not only collects information but is responsible for the publication entitled *The Réseau Mondial*, which is an annual volume containing climatological data from all parts of the world. The scheme on which this publication is prepared divides the world into " ten-degree squares ", that is squares bounded by lines of latitude and longitude at 10° intervals.

The data for two meteorological stations for each square are published; in some squares there are many observatories from which the two most suitably situated and with the best records, are chosen; in many squares, however, it is difficult to find two stations sufficiently reliable for their observations to be published, while many squares containing only sea areas have no representative stations. An attempt has recently been made to provide information for sea areas by using observations taken on ships but this method has not been very successful. The information is generally collected from the published reports of the meteorological services concerned and, therefore, an interval of several years must necessarily elapse between the year dealt with and the year of publication. The volume of the *Réseau Mondial* for the year 1926 was in course of publication at the end of the year under review.

Admiralty Pilots.—These handbooks, issued by the Admiralty for the use of navigators, contain sections on winds, weather and climate and climatological tables supplied by the Meteorological Office. The text of the meteorological portion of 8 Pilots was revised during the year. The tables were revised for 7 Pilots, involving the compilation in the Office of data for 21 stations. In addition, meteorological services abroad were good enough to contribute revised tables for 17 stations.

Special Investigations.—The meteorological records obtained by the British Arctic Air Route Expedition to Greenland have been exhaustively analysed and discussed. A preliminary account of the results was published by the Royal Geographical Society in 1932; the full report is now in course of publication as a *Geophysical Memoir*.

The records of a pressure tube anemometer maintained by Dr. R. S. Taylor at Berbera, British Somaliland, have been analysed for a period of two complete years. The results have been used in conjunction with pilot balloon observations to investigate the circulation of the air in the Gulf of Aden.

In connexion with certain problems of atmospheric electricity, the annual frequency of thunderstorms in different parts of the world was compared with the annual relative sunspot numbers. It was found that in high northern and in tropical latitudes, though not in temperate latitudes, there was a fair measure of agreement, thunderstorms being most frequent in years when sunspots were numerous.

Library.—The Meteorological Office library consists mainly of volumes containing the information collected by official meteorological services, and is the source of information about meteorological conditions in all parts of the world. It is therefore natural that the library should be placed in the charge of the Superintendent of the General Climatology Division. Every effort is made to obtain copies of all papers, no matter where

published, dealing with meteorological matters. In order to further this aim an arrangement has been entered into during the year with the British Dominions and Colonies for them to send twice yearly a list of papers published in their countries which would otherwise not come to the notice of the Meteorological Office. The assistance of the Dominions and Colonies in supplying these lists, and in many cases for presenting copies of the works included in it, is much appreciated.

The library is well catalogued; both author and classified subject catalogues are kept up to date. The library prepares each month a "list of meteorological papers" and copies are circulated throughout the Office, the attention of the staff being called to any paper of special interest. Similarly, a list of papers bearing on agricultural meteorology is forwarded monthly to the Ministry of Agriculture and Fisheries for incorporation in that Ministry's monthly report ("Crop-Weather" scheme).

The library has also provided the titles and short abstracts of works on actinometry published in this country from 1919 onwards for incorporation in a bibliography of actinometry which is being published in France under the auspices of the International Union of Geodesy and Geophysics.

METEOROLOGY FOR THE SERVICES

An account has already been given of the work done by the Office for the Royal Air Force. The demands made on the Office by the Army and the Navy continue to grow steadily.

The Army

The meteorological assistance required by the Army in peace time is chiefly in connexion with ballistics. The range and accuracy tests on large calibre guns, made at Shoeburyness, can only be carried out when the air motion and density of the air along the whole of the track of the projectile—in many cases reaching to great heights in the atmosphere—are known. To provide this information a meteorological station is maintained at Shoeburyness, where a thorough investigation of the upper air currents is made during the trials by means of pilot balloons. Temperatures of the upper air are obtained from Duxford and results of the observations are studied and the necessary corrections to be applied to the trajectory of the projectile on account of meteorological factors are calculated. At Larkhill a small distributive station is maintained for giving similar information in connexion with the artillery practice which takes place at that station. During the summer of 1933 temporary meteorological stations were attached as usual to three artillery practice camps. The Meteorological Section of the Royal Air Force Reserve was called up for a fortnight's training at Cranwell during May, 1933.

The Navy

The services rendered by the Meteorological Office to the Royal Navy may be summarised under three main headings :—

(*a*) the organisation of meteorological work in H.M. ships ;

(*b*) the organisation of the supply of information from land meteorological services to meet the needs of the Fleet in all parts of the world ;

(*c*) the training of Royal Navy personnel in meteorological work.

The meteorological work now carried out in H.M. ships is very much greater than a few years ago. The necessity for full and accurate meteorological information on aircraft carriers needs no stressing. A rapid change in the weather or the encountering of unexpected wind directions at any height may make it very difficult for an aeroplane which is out of sight of the ship to pick up the ship again. The advantages of having a meteorological officer on board flagships is now fully realised. The provision of accommodation and of suitable instruments is not an easy matter on board a modern man-of-war and a large part of the time of the Navy Services Division is taken up in advising the Navy on these matters.

If a ship at sea is to prepare a synoptic chart observations are required from the neighbouring land in addition to any observations which can be collected from surrounding ships. This need can only be met by broadcast synoptic messages sent out from powerful land stations. There are plenty of such messages on both sides of the North Atlantic, but in other parts of the world they are very few. During recent years the Superintendent of the Navy Services Division has visited all parts of the Empire with the object of organising the meteorological work of the Navy, and obtaining from the meteorological services concerned the issue of regular synoptic messages. The arrangements instituted on the Home, Mediterranean and Africa Stations have proved of much value to the Fleet. Considerable progress has been made with the development of an organisation on the America and West Indies Station, particularly as regards co-operation with the Canadian Meteorological Service and it is satisfactory to be able to report that on the China Station the Singapore Fleet synoptic message, which was reduced to one station report in 1933, is now being issued in its original form. It is to be regretted, however, that on the East Indies Station the state of financial stringency which still prevails has prevented local shore meteorological organisations from implementing the recommendations of the local conferences on Fleet meteorology. The Matara Fleet synoptic message is still confined to reports from stations in Ceylon, and the British East African Meteorological Service has not yet found it possible to institute the scheme of co-operation elaborated when the Superintendent visited Nairobi in 1931.

During peace time at least the whole of the meteorological needs of the Royal Air Force and the Army can be met by civilian personnel. This, however, is not the case with the Navy. The meteorological work in H.M. ships at sea must be carried out by naval personnel; this necessitates special training of the officers deputed for this work and a series of courses have been instituted in the Meteorological Office, Kingsway. The courses vary from a full course of twelve weeks to a short refresher course of one week. During the year 28 naval officers took these courses.

Throughout the year Lieut.-Commander T. R. Beatty, R.N., has been attached to the Meteorological Office on special duty connected with single observer forecasting.

Dr. W. A. Harwood, who was for a number of years Superintendent of the Meteorological Office, Malta, has been attached to the Navy Services Division in order that he may take charge of the preparation of a handbook of local meteorology of the Mediterranean Station and action has been initiated on the preparation of a similar handbook for the China Station.

The charting of the upper air currents over the sea is becoming a matter of importance to the Navy. The only method of obtaining this information is by using pilot balloons. It is, however, a difficult matter to observe the flight of a pilot balloon from a moving ship. Considerable attention has been given to this problem and 55 H.M. ships have been supplied with a complete outfit for making pilot balloon observations. During the year 695 pilot balloon ascents were made and the results communicated to the Meteorological Office, where they are being carefully charted. In addition, aircraft attached to H.M. ships took temperature observations in the upper air on 72 occasions.

MARITIME METEOROLOGY

Until the introduction of wireless telegraphy into the Mercantile Marine the chief work of the Marine Division of the Meteorological Office was the collection of statistics of the actual conditions experienced by British ships in all oceans. The work of making the observations and sending them to the Meteorological Office was purely voluntary; the Office only provided the meteorological logs into which the observations were entered, and to some ships supplied the few instruments necessary. The ships' officers took their observations six times a day at the end of each watch, and as these watches were arranged according to local time of the ship the results were equivalent to observations at midnight, 4 a.m., 8 a.m., noon, 4 p.m. and 8 p.m. in local time. For world climatology, observations in local time are much more useful than observations at stated Greenwich times. On the receipt of the logs in the Marine Division they were examined and the observations required for any investigation in hand extracted, after which they were put into store. With the introduction of wireless telegraphy a great change took place in meteorological work at sea. The forecast services in all parts of the world had

long felt the need for observations at sea ; particularly in Europe, since weather systems move from the west to the east and until the introduction of wireless telegraphy the first intimation that the meteorologist had of a depression approaching was obtained from the observations at the most westerly land stations. This, for practical purposes, meant observations on the west coast of Ireland. One of the first uses of wireless on ships was the transmission of meteorological observations from the North Atlantic. The charts on which these observations were to be plotted contained simultaneous observations from the land areas at specified Greenwich times. It was, therefore, natural that these special observations from the sea should also be taken at or near these times. The long period which transmission took in the early days made this consideration of less importance, but the tendency was to ask for ships' observations to be taken at specified Greenwich times instead of at local times. During recent years there has been further development of meteorology at sea. As soon as ships were connected with one another by wireless, the preparation of a synoptic chart in ships at sea, based on the information received from other ships, became a possibility. At the same time the development of the broadcasting of land observations by high-power wireless stations made it possible also for ships to obtain information from land stations to complete the charts they were able to prepare from ships' observations. This development was fostered by the Meteorological Office and pamphlets have been published explaining to seamen how to prepare synoptic charts and the uses which can be made of them in navigation. The development of synoptic meteorology at sea has altered the organisation of the work of the Marine Division and the work is now directed to two main ends :—

(*a*) collection of data along the old lines, i.e., from logs received from the ships ;

(*b*) organisation of wireless messages for the use of land stations and ships at sea.

The first part of the work is carried out by so-called log-keeping ships. These ships are provided with fully tested instruments and blank meteorological logs, the observations are taken as formerly at the end of the watch and the logs are submitted on the return of the ship to port. Fifty ships were engaged in this work during the year under review, and they submitted during the year 122 logs. The ships chosen for this work were selected according to their routes as climatological observations are required from some areas much more than from others. As it is possible only to deal with a certain number of logs it is desirable that these should refer to the regions from which little information is already available.

In arranging for ships to issue wireless meteorological messages, a number of considerations have to be taken into account. In the first place, simultaneous observations are highly desirable ; therefore the observations should not be taken at local time as in the case of meteorological log-keeping ships. In the second place,

it is undesirable that too many ships should issue meteorological messages because this would only lead to difficulties with the normal wireless traffic and result in redundant observations. In the third place, meteorological messages should be issued in code, in order to reduce the length of the individual messages. It is clear that international co-operation is necessary in such a matter, and the International Meteorological Organisation has devoted a great deal of time to organising meteorological observations at sea. It has been decided that ships should be selected to make regular observations and issue them by wireless. Ships chosen for this purpose are now referred to as "Selected Ships." The hours of observation for all oceans are 0000, 0600, 1200 and 1800 G.M.T. The observations to be taken have been laid down and an elaborate code developed which gives a large amount of flexibility to meet the observational powers of different classes of ships. The International Meteorological Organisation decided that there should be 1,000 selected ships of all nations, and that these should be maintained by the various maritime nations in the proportion of their tonnage to the total tonnage of the world. The London Meteorological Office has carried out this scheme with great fidelity. In accordance with the British tonnage the average number of British selected ships throughout the year was 298. A few of the log-keeping ships are also selected ships, but on the whole the selected ships do not keep meteorological logs. They enter the observations they have taken at the synoptic hours on special forms which are usually referred to as meteorological records to distinguish them from the meteorological logs. The observations entered in these meteorological records are coded and a copy of the coded message is entered in a meteorological wireless register. Records and registers are forwarded to the Meteorological Office from the ships. During the year 2,352 records were received in the Meteorological Office.

It is the normal procedure for a selected ship to issue its observations by wireless, at times fixed by a schedule, either to coast stations or broadcast for general information. This method, however, is not feasible in the immediate neighbourhood of the British Isles owing to the proximity of selected ships to one another, which would lead to redundant messages, and also on account of the large amount of wireless traffic in this region. A special scheme, therefore, has had to be adopted for British selected ships in the North Atlantic. The position of all selected ships in the North Atlantic is recorded each day on a special chart in the Marine Division. From this a certain number of ships are selected and a message is broadcast through Portishead Wireless Station asking these ships to send their meteorological messages. In this way a selection of ships well distributed over the ocean is attained and there is little or no overlapping of observations from ships very near to one another. The method works extremely smoothly and an average of 15 messages a day are obtained from the North Atlantic in this way.

The work in the Marine Division is directed to organising the work at sea and to making use of the data collected. Every meteorological log as soon as it is received is now completely "extracted"; that means that the observations contained in the log are punched on to Hollerith cards. These cards are then stored and are available to be used by mechanical sorting in any investigation in which the data contained on them are required. This is a great improvement on the old method of only extracting a few of the entries contained in each log, but it was not possible before the introduction of the Hollerith machine. Not only are all the new marine logs fully extracted but a serious endeavour is being made to extract the large accumulation of old logs in the same way and to punch their observations also on Hollerith cards. During the year 131 new logs and 441 old logs were "extracted"—the largest number of logs the Marine Division has been able to deal with in any one year.

Many requests are received in the Meteorological Office for copies of ships' observations and it is the endeavour of the Marine Division to meet all these needs. The Meteorological Offices of South Africa, Australia and New Zealand are interested in ships' observations in their vicinity. As already explained the wireless registers are copies in code of the observations in the records, and arrangements have been made for sending these registers, after they have been examined in the Meteorological Office, to South Africa, Australia and New Zealand.

In connexion with the International Polar Year the Deutsche Seewarte has undertaken to prepare a daily map of the whole of the northern hemisphere. For this all available ships' observations are necessary. To meet this need 23,937 sets of observations recorded at 1200 G.M.T. in British ships during the Polar Year in the northern hemisphere have been sent to the Seewarte. The Netherlands Meteorological Office has also been supplied with 17,469 sets of observations made in the China Seas in the months January to June 1921–30. In this case Hollerith cards were lent and a great amount of copying obviated.

Considerable progress was made during the year in a study in the Marine Division of ocean currents along the main trade routes. During the year the currents in the Arabian Sea and Bay of Bengal have been the chief subject of study.

The Office continues to receive a large number of inquiries for information of the state of the weather and of the drift of currents where and when there have been maritime casualties.

INSTRUMENTS

The supply of carefully tested and standardised instruments is an important part of the work of the Meteorological Office. The Instruments Division at South Kensington is responsible for the purchase of all new instruments and accessories and in

addition spends much time on improving their design. The Instruments Division also gives help on request to the agents of British Dominions and Colonies in their purchase of meteorological instruments in this country. A few of the problems which have occupied the attention of the Division during the year may be mentioned.

All minimum thermometers are filled with a spirit instead of mercury. There is a tendency, however, for the spirit to evaporate from the bulb and recondense at the upper end of the tube. In this way the reading of the instrument is falsified. A large number of experiments were made during the year to find a suitable spirit to replace the alcohol which is frequently used. So far as the experiments have gone it would appear that glycol-ether is the most satisfactory liquid for the purpose.

All self-recording instruments necessitate the use of a drum driven by clock-work, on which the record is made. Owing to the fact that meteorological instruments have been designed at different times and made by different instrument-makers, a large number of different types of clock-driven drums are in use and it is impossible to interchange the drums between different instruments. Attempts are now being made to design a standard clock mechanism which can be used in all the chief meteorological instruments.

The design of self-recording rain-gauges is far from satisfactory, the chief source of difficulty being the necessity to empty the water after the recording mechanism has reached the limit of its motion in order that the trace may be recommenced. This is generally done by means of a syphon but syphons frequently fail to work and are very irregular in action. An entirely new instrument has been designed and an old pattern instrument, originally designed by the late W. H. Dines, in which the vessel which receives the rainwater tilts when a certain quantity of rain has been received, has been under investigation and it is hoped that one or other of these two instruments can be modified to give satisfactory results.

Pilot balloons, of which a large number are used by the Office, are made of rubber and it is found that there is considerable deterioration of the rubber if the balloons are stored for any considerable length of time. This is particularly so in tropical regions. Throughout the year, this problem has been investigated and balloons of several types and from different makers have been sent out to the Middle East for careful test after various periods of storage.

The Division has also been in co-operation with H.M. Stationery Office in an attempt to improve the material of which the sunshine cards are made as it is found that not infrequently the card commences to smoulder round about the burn, so falsifying the record. H.M. Stationery Office have supplied some fire-proofed cards for trial.

OBSERVATORIES

Kew

Kew Observatory, in the Old Deer Park, Richmond, is the chief observatory of the Meteorological Office. It performs a number of functions of the utmost importance. In the first place, a complete set of self-recording instruments is maintained, eye-observations of standard instruments are taken and phenomena are recorded for which no self-recording instruments are available. The meteorological record obtained at Kew serves two purposes : it is the standard observatory for London for present weather and it is also the observatory from the observations of which questions of secular change in the meteorological conditions of the London area will be determined For the latter purpose every endeavour is made not to alter the method of observing or the nature of the surroundings of the various instruments At the same time new methods of observing are constantly being devised and these are generally tested at Kew and in several cases the same element, for example temperature, is measured in a number of ways. The purpose of the hourly values which are deduced from the self-recording instruments is to determine the normal change of meteorological conditions during a day. Similarly hourly observations are taken at the observatories at Valentia, Eskdalemuir and Aberdeen. As the general change of weather throughout the day is constant over large areas, the change determined at any one station may be applied to the basic observations taken at another station. For example, the daily variation of rainfall is likely to be the same over the whole of south-east England. If therefore, at a station within reasonable distance of Kew the average rainfall is determined by one observation a day, the daily variation at Kew may be applied to this observation and so the probable rainfall at any hour of the day on the average may be determined for the second station.

In addition to the standard meteorological instruments Kew also carries out special investigations on atmospheric electricity, while a complete set of Galitzin seismographs is in constant use.

Meteorology.—During the year under review the meteorological work has been carried on with no major changes. The two thermometers graduated on the absolute scale in use in the north wall screen have been replaced by the two thermometers graduated in Fahrenheit degrees (No. 666 and 788) which had been in use before it was decided to employ the absolute thermometric scale at Kew. The opportunity was taken to have these two thermometers retested at the National Physical Laboratory with the result that they were found to be correct to 0.1° F. These tests indicate not only the consistency of the scales but also that these thermometers with large bulbs have kept their zeros well.

The calendar year 1933 was remarkable for the amount of sunshine. At Kew the total bright sunshine for the year amounted to 1758 hours, which is very near to the highest total on record, namely 1765 hours in the year 1899. Another effect of the unusual drought is seen in the change of water level in the grounds of the Observatory. Since July, 1914 a record has been kept of the level of the underground water at the Observatory, the level being determined by means of a float in a well made for the purpose in the basement. Except for two very short periods the float had never rested on the bottom of the well, 154 cm. above Mean Sea Level, but this happened on August 19, 1933, and a few days later the well was quite dry. Subsequently measurements were made down the borehole of an old pump in the garden, in the first instance by float and line and then by finding the pressure needed to force air through a brass tube terminating under water in the borehole. By the end of February the water was only 91 cm. above M.S.L. That the water was low was due to the continuous drought but the drop to 60 cm. below the previous lowest may have been due to engineering works in the neighbourhood. The construction at Isleworth of great sewage works to deal with the whole of the sewage of south and west Middlesex has necessitated much pumping, but it is not clear how the pumping on the other side of the river can affect the level in the Old Deer Park.

Atmospheric Electricity.—In addition to the normal routine of the measurement of potential gradient and air-earth current several investigations dealing with different aspects of atmospheric electricity have been in hand during the year.

A new system had been adopted in 1932 for the standardization of potential gradient records. To make the data for earlier years comparable some revision was necessary and it proved convenient to carry the comparison back to the beginning of electrical work at the observatory. Mr. Scrase has incorporated the revised figures in a memoir which is being published under the title "Observations of Atmospheric Electricity at Kew Observatory. A survey of the results obtained from 1843 to 1931." (*Geophysical Memoirs* No. 60.)

The observations of potential gradient at heights up to 10 metres above the ground were continued. It is well known that under normal conditions the gradient at considerable heights is much less than that near the ground, the decrease being a measure of the total space-charge in the intervening space. To ascertain whether the decrease of gradient within a comparatively short distance from the ground is appreciable has been the object of the experiments. It has been established that in the absence of foggy conditions the gradient is not affected by height so that in general there is no appreciable space-charge at Kew. In winter there is great difficulty in maintaining good insulation in the apparatus, not only on account of moisture but also because high voltages are involved, and the observations mainly in that season have not led to any definite result.

A long series of observations of the numbers of charged and uncharged Aitken nuclei has been carried out. The analysis of the observations indicates that the ratio of the numbers depends on the relative humidity of the air, the proportion of uncharged nuclei being decreased when the humidity is high. The effect, which begins to occur when humidity surpasses 80 per cent., is presumably due to an increase of size of the nuclei and is associated with the falling off of visibility when the air is damp.

During the whole of the year 1933 apparatus for recording continuously the conductivity of the air and the number of small ions was in operation.

The point-discharge recorder has been kept in continuous operation since the middle of 1932. This is a simple piece of apparatus ; a sharp point or lightning conductor is connected to earth through a galvanometer and the fluctuations of the current passing through the galvanometer are recorded on an open time-scale. The measurements made during 12 months up to July, 1933, served to demonstrate anew that point discharge with the electric current flowing from point to air exceeds in frequency and in amount the discharge in the reverse direction. Further, it was demonstrated that there is a well marked diurnal variation in the phenomenon, the maximum discharge taking place both in summer and in winter in the afternoon. Another result of the examination of the records is that during the year there were 240 lightning flashes near enough to produce discontinuities in the trace ; it is estimated that these occurred within a radius of about three miles.

It is satisfactory to note that point-discharge apparatus is being installed by the Radio Research Department of the National Physical Laboratory at Slough and Teddington and by the Astronomer Royal at Greenwich, so that before long it will be possible to trace the history of electrical disturbances passing near London.

Seismology.—The Galitzin seismographs have been maintained in operation during the year. An additional seismograph has been made locally, a reproduction of the instrument designed by two American seismologists, Messrs. H. O. Wood, of the Carnegie Institution, and J. A. Anderson, of the Bureau of Standards. The special feature of the Wood-Anderson instrument is the minute moving system, which weighs less than 1 gramme. At Kew 2 seconds has been adopted as the natural period of this seismograph ; the Galitzin horizontal components have the long period of 25 seconds, so that there are striking differences in the records. The short period of the Wood-Anderson instrument favours the registration of near earthquakes.

During the calendar year 1933 the number of earthquakes recorded was 264 ; of these 7 were large enough to gives waves with an amplitude exceeding 0·1 mm. Details of 17 of the records were broadcast in the International Seismological Code. In 8 cases the azimuth of the epicentre could be determined.

Mr. Lee has completed his memoir on the world survey of microseismic disturbance as recorded during the month of January, 1930. The most definite result of the investigation is that there is a close relation between the nature of the geological strata underlying a station and the amplitude of the microseisms recorded there. Large microseisms are recorded when there is a great thickness of weak material overlying the stronger rock. Allowance can be made for this phenomenon and then the amplitudes reduced to the granite standard can be mapped. Comparison of meteorological and microseismic maps indicates clearly that the microseismic disturbances originate near the centres of cyclones, and not, as is thought by many, at places where breakers are beating on the coast. Just how the energy is conveyed from wind to water, from water to ocean floor, and from ocean floor to continental observatory has not yet been discovered.

Airwaves from Gunfire.—The investigation of the propagation of airwaves to great distances was continued. In this investigation the War Office co-operates by the provision of apparatus and by allowing the broadcasting of signals to mark the firing of guns at Woolwich. The B.B.C. kindly arranges for the signals to be broadcast from Daventry. The hot wire microphones used to detect the airwaves are installed at Birmingham, Cardiff (Cefn Mably), Bristol, Exeter, Nottingham and at North Walsham. During the spring and summer of 1933 there were seven trials, in five of which the waves from Woolwich were received at one or more stations. The season of reception at the well-placed stations Bristol, Birmingham, Cefn Mably and Nottingham had terminated by September 1st. It has been noticed previously that reception after the middle of August is exceptional.

There were also trials on February 8, March 15 and 16, 1934. It was hoped that in the winter months the waves might be received at the station at North Walsham, but no definite evidence was obtained there. It was in accordance with earlier experience that no receptions were obtained at the other stations in the winter half of the year.

Additional interest was given to this investigation by an announcement by M. Jaumotte, of the Belgian Meteorological Institute, that abnormally high temperatures were occurring during the summer in the stratosphere at heights between 20 and 30 Km. above ground. The observations of the time of passage of the airwaves across England were not anomalous, and it was found eventually that when due allowance was made for the high temperatures recorded by M. Jaumotte the calculations of the heights reached by the airwaves were not much affected. These heights are always 40 Km. or more ; the highest of the Belgian balloon soundings reached approximately 33 Km.

Visibility.—In accordance with the arrangements made by the Interdepartmental Committee on Visibility in 1930, Mr. M. G. Bennett has continued to act as adviser on all matters connected with visibility and to carry out researches on the fundamental

properties of the transparency of the atmosphere with special reference to the absorption of light by fogs, mists and atmospheric pollution. During the year Mr. Bennett has co-operated with the following Government Departments :—

(*a*) Research and Development (Armament), Air Ministry, in connexion with reconnaissance flares, navigation flares and distress signals ;

(*b*) Chemical Defence Research Department, War Office, in connexion with the obscuring powers of smoke ;

(*c*) Royal Engineer Board, War Office, in connexion with the penetrating powers of searchlights ;

(*d*) Fleet Meteorological Committee, in connexion with visibility at sea.

He has also co-operated with the National Illumination Committee in an investigation on the advantage to be gained from the use of coloured headlight beams for motor driving in fog.

Research work has continued at Kew Observatory on the apparent brightness of a series of black targets at different distances with the object of determining the transmission and scattering factors of the atmosphere in different conditions of visibility, while observations on the visibility of lights of different intensity in daylight during fogs and mists has been continued at South Farnborough in co-operation with the scientific staff of the Royal Aircraft Establishment.

Investigation of the Upper Atmosphere.—The Upper Air Section of Kew Observatory has continued its series of soundings of the upper atmosphere by means of balloons carrying instruments. During the year soundings were made on 57 occasions, mostly on days arranged by the International Commission for the Exploration of the Upper Atmosphere. In eight cases out of the total, the meteorographs were not found but, with two exceptions, good records were obtained from the remaining 49 ascents. The year's work has on the whole been good, the percentage of meteorographs found and returned was high, the mean height reached was 17·4 Km., while two of the soundings reached the unusual heights of 24·7 and 24·9 Km. The maximum effective heights reached were distributed as follows :—

Above 20 Km.	13
Between 15 and 20 Km.	25
Between 10 and 15 Km.	8
Below 10 Km.	3

Work has also continued on the attempt to obtain information regarding the magnitude of vertical air currents in the centre of a thunderstorm. Balloons are sent up carrying special instruments whenever a thunderstorm is observed to be approaching the station in the hope that a balloon will be drawn into the centre of the storm and a record of the vertical currents obtained. Balloons were released in this way on eleven occasions, but only one appears to have entered the active part of the thunderstorm.

The instrument attached to this balloon registered an ascending current of 8½ metres per second ; this value, however, is much below the ascending currents which are known to occur in thunderstorms, in fact it is only slightly above the value of 8 metres per second, which is the minimum ascending current, according to the breaking-drop theory of the origin of the electricity in thunderstorms, capable of producing appreciable electrical separation.

Workshop.—The workshop attached to the Upper Air Section at Kew, in addition to providing the instruments for the sounding balloons, has carried out a considerable amount of constructional work, both for the scientific investigations being carried out at the Observatory and for the Instruments Division at South Kensington. Among the instruments made was a Wood-Anderson seismograph, which has been taken into regular use at the Observatory. In conjunction with this instrument an improved recording drum was designed to remove the irregularities of motion due to the gearing of the cog wheels. Considerable success was attained, the drive being almost completely regular, only slight irregularities being due to the escapement of the half-second pendulum.

Eskdalemuir

The Observatory at Eskdalemuir was established in 1908, when the increasing electrification of the London tramways made it necessary to remove the magnetic work carried on up till then at Kew Observatory to a position as far removed as possible from electrical disturbance. The site chosen was in a sparsely populated part of Scotland 16 miles from the nearest railway at Lockerbie, Dumfriesshire. The chief work of the Observatory is the study of terrestrial magnetism, but meteorological and atmospheric electricity observations are also made.

Terrestrial Magnetism.—Three complete sets of magnetographs, which are instruments for giving a continuous record of the earth's magnetic field, have been in operation throughout the year. The standard magnetograph records declination, D, the horizontal component, H, and the vertical component, V. The scale used is that which has been found best for recording the normal magnetic changes. The second set of magnetographs records the same elements, but the scale value is only half that of the standard instrument. The record from this instrument is used whenever the variations of the magnetic field have been so great that the record on the standard magnetograph has passed the limits of the recording paper. It can also be used to fill in any breaks in the record of the standard instrument which are unavoidable owing to mechanical breakdowns, readjustments or failure of the light. The third magnetograph is one designed by Dr. la Cour with the object of being able to determine with very great accuracy the time at which various changes in the magnetic field took place. By a most ingenious arrangement, although the time scale is twelve times as large as that of the ordinary instrument, the amount of photographic paper used is no greater. This

instrument has worked well, and the record gives very valuable information. At the request of Professor Maurain, of the Institut de Physique du Globe, Paris, copies of the record of this instrument embracing three "sudden commencements" were supplied to him in connexion with an investigation on which he is engaged.

The records of the magnetographs only show variations in the magnetic elements with time. In order that the records may be interpreted it is necessary to have absolute observations made with standard instruments. In previous years the standard instrument for obtaining absolute values of the horizontal force has been the Kew magnetometer. In 1932 a Schuster-Smith coil magnetometer was supplied to Eskdalemuir. For nearly 18 months this instrument has been in constant use along with the Kew magnetometer, and as the result of the comparison it has been decided to use the Schuster-Smith coil as the standard instrument from January 1, 1934. The Schuster-Smith coil has the advantage over the Kew magnetometer in that the time taken over an observation is very much shorter and the actual force at a given moment is measured, while the Kew magnetometer only gives an approximation of the average force over about half-an-hour. The coil also has the advantage that it depends on measurements of electrical quantities which can be determined with very great accuracy. Absolute observations of horizontal force, declination and dip are made regularly twice a week and additional observations of declination are made on the remaining days of the week, except Sundays.

One important practical use made of records of terrestrial magnetism is in connexion with surveying in mines. As a large number of surveys in mines are still carried on by means of magnetic compasses, it is necessary that the surveyor should know the exact direction in which his compass is pointing each time he makes an observation. The natural variations of the earth's field are sufficiently large to be of importance in such work. As these natural movements are recorded at magnetic observatories arrangements have been made for the hourly values of the direction in which the compass points (declination) as recorded at Eskdalemuir and Abinger, to be supplied weekly for publication in the Colliery Guardian and the Iron and Coal Trades Review. In connexion with this side of the work, copies of the original records and other information have been supplied in reply to requests from mining engineers. Magnetic data have also been supplied to the Radio Research Board and the National Physical Laboratory in connexion with their investigations.

Meteorology.—Eskdalemuir Observatory is also a first order meteorological station, and in addition it supplies telegraphic reports daily to Headquarters of observations taken at 0700, 1300 and 1800 G.M.T. Hourly values of the main meteorological elements are obtained from self-registering instruments. Pilot balloon ascents are made whenever possible on international days. In August the old Dines pressure tube anemometer was replaced

by an instrument of the latest type. Observations of solar radiation have been carried out with an Ångström pyrheliometer whenever conditions were favourable.

Atmospheric Electricity.—As in recent years the work has been confined to maintaining autographic records and making absolute observations of atmospheric electrical potential gradient. The electrometers in use were standardised by means of a high-tension battery, calibrated by means of a standard cell and potentiometer.

Aberdeen

The meteorological observatory at Aberdeen was established at the King's College in Old Aberdeen in 1867 by the Meteorological Council as one of the six standard observatories, all equipped on the model of the Kew Observatory with self-recording instruments, which were then being inaugurated in various parts of the British Isles. The Observatory has provided a complete record of the meteorological elements since that date and is now, in addition, one of the chief stations providing information for synoptic meteorology. Unfortunately, it has not been possible to maintain the outdoor instruments in the same site throughout the whole period. Building operations at the College necessitated moving the instruments in 1929 to a site some distance away, between the College and the sea. The expansion of the town again necessitated a move, and last year a new site about 300 yards to the north-west of the College was provided by the University. During the year under review the new site was laid out and the instruments installed. The exposure is excellent for observations of temperature and rainfall, but unfortunately the first set of observations has indicated that the exposure is far from satisfactory as regards wind. Compared with the values shown by the cup anemometer on top of the College tower those of the pressure tube instrument at the new site show that winds from nearly all sectors except the western are badly affected, the interference being serious in the north-east sector. The cause of the discrepancy is under investigation.

The ordinary work of the observatory has been carried out satisfactorily throughout the year.

Lerwick

The Lerwick Observatory was established in 1921 mainly for observations of terrestrial magnetism, atmospheric electricity and the aurora. Meteorological observations are taken only in so far as they are necessary for the main purpose of the Observatory, but self-recording instruments for wind, pressure and sunshine are maintained.

The records of the Lerwick observatory are of particular value in connecting up the scientific work, especially that of terrestrial magnetism, in the British Isles with similar work being done at polar stations. During the International Polar Year, August 1932 to August 1933, special observations were taken at Lerwick

as part of this international undertaking. In particular, arrangements were made for taking simultaneous photographs of the aurora at Lerwick and at Urafirth about 26 miles north of the Observatory. This work has been somewhat disappointing owing to the absence of really good displays of the aurora. This, however, was expected as the Polar Year coincided with a minimum of sunspot activity.

It was decided that the special magnetic instruments provided for the British Polar Year party which worked at Fort Rae should, on their return, replace the old instruments which have been in use at Lerwick. These instruments safely arrived at the Observatory in February and arrangements for effecting the change were put in hand, but not completed before the end of the year under review.

A new departure so far as Lerwick is concerned, and one which may be indicative of important future developments, occurred during the year. On two occasions the Observatory was asked to give local weather reports in connexion with aeroplane flights organised by the Highland Airways Ltd., while on August 25 Colonel and Mrs. Lindbergh visited the Observatory and discussed with the staff the meteorological position from the point of view of aviation.

Valentia

Valentia Observatory is also one of the original six observatories established by the Meteorological Council in the period about 1867, to which reference has already been made under Aberdeen. Like Kew and Aberdeen, Valentia Observatory has continued to provide a complete hourly record of the chief meteorological observations since it was established, while during recent years it has taken a leading part in synoptic meteorology. The geographical position of Valentia makes it the most important reporting station in Europe and all meteorological services depend on the accuracy of its observations for the success of their forecasts. In addition to the meteorological work absolute observations of magnetic declination, horizontal force and dip are made weekly. No change has been made during the course of the year in the work of the Observatory, but during July and August the Observatory afforded help to Professor Eredia, the meteorologist who was in charge of the meteorological arrangements for the flight of Italian seaplanes from Italy to America and back.

BRANCH METEOROLOGICAL OFFICES

Edinburgh

A branch of the London Meteorological Office was established in Edinburgh in 1920, taking over the meteorological work which had been carried out in Scotland up to that date by the Scottish Meteorological Society. The Edinburgh Meteorological Office acts as a local centre for the organisation of climatological

and rainfall stations in Scotland, and for the administration of the three observatories at Eskdalemuir, Lerwick and Aberdeen. The number of climatological stations in Scotland is now 83 and the number of rainfall stations about 900.

New climatological stations have been started during the year at Duntulm (Isle of Skye), Colonsay and Craigston (Isle of Barra). The stations at Strathpeffer and Bothwell came to an end during the year. One of the two stations at Helensburgh, namely Ferniegair, was closed and the other station (Valve House) will in future maintain a complete climatological record. Changes of site have occurred at Oban, Stornoway, North Berwick and Kirkcaldy.

A monthly summary of the weather in Scotland, together with statistics for certain large towns has been prepared, as well as an annual report, as usual, for the Registrar-General. A year ago some changes were made in the tabular matter included in this annual report, the effect of these changes being to bring the general form of the report more closely into accord with that followed by the Registrar-General for England and Wales; the same arrangement has been continued. As from February, 1934, with the concurrence of the Registrar-General, the new averages of temperature were brought into use in the reports to the Registrar-General for Scotland.

The total number of inquiries received was 214, of which 89 were dealt with by correspondence and 125 by interview or by telephone. The Superintendent was called to give expert evidence in the Court of Session on three occasions; the cases into which expert meteorological evidence entered covered the somewhat wide range of divorce, collision at sea, and deposit from factory chimneys.

As in the previous year meteorological data were supplied on several occasions in connexion with investigations of the incidence of crop or animal diseases, also in connexion with flooding. The majority of the inquiries of a smaller nature were in connexion with losses or damage sustained by fishing vessels. Special composite reports regarding weather conditions at Scottish stations were supplied occasionally to the Automobile Association and the Royal Automobile Club.

In connexion with the Highland and Agricultural Society's Show at Dundee from June 20 to 23, a meteorological exhibit and demonstration were given. The number of visitors to the exhibit was unusually large, and included T.R.H. the Duke and Duchess of York, and the Secretary of State for Scotland.

Malta

The Meteorological Office in Malta was established in 1922 to provide a meteorological service for British interests in the Mediterranean, especially in connexion with the Navy, the Royal Air Force and civil aviation. Full synoptic and pilot balloon observations are made and synoptic charts are prepared twice daily.

The Navy.—Synoptic messages for the Mediterranean Fleet are issued twice daily, with routine forecasts for the Malta vicinity, and forecasts for units during cruises and for ships on passage in the Mediterranean. Local forecasts are also supplied for ships in harbour. The demands for special forecasts increased during the year from 41 to 83.

Synoptic reports from H.M. ships on cruise or on passage in the Mediterranean continued to be very reliable and were found most useful for general and local forecasting. A remarkable increase in the number of these reports occurred, 2,075 having been received as against 1,349 a year ago. Meteorological officers and navigating officers of aircraft carriers and other ships work in close liaison with the office, and opportunity was taken after each cruise to discuss the charts and weather experienced. Ships' barometers were tested as required.

The Royal Air Force.—Routine reports and forecasts were supplied as usual to R.A.F. Headquarters and to the units established at Calafrana and Halfar. Special forecasts were supplied on frequent occasions and climatological data as required. Route reports and forecasts were supplied to squadrons on trans-Mediterranean flights or on extended cruises from Malta.

Observations of upper air temperatures were continued by the units at Calafrana and Halfar, helped by the Fleet Air Arm Flights from aircraft carriers when the Fleet was in harbour. The number of observations increased from 127 to 140. Special observations were made, when possible, on " international days ".

Civil Aviation.—In addition to work in connexion with R.A.F. flights, reports and forecasts were frequently required by British civil aircraft. Trans-Mediterranean flights under this head numbered 15 and included flights by Imperial Airways on the London-Egypt route and flights by private owners; 165 reports and forecasts were issued for these flights.

As in the past year a good deal of time was spent in supplying reports for the Italian company " Navigazione Aerea S.A." operating the Syracuse—Malta—Tripoli air route. The number of reports transmitted to Syracuse or Tripoli, 624, showed a slight increase over last year. In addition, frequent reports were transmitted to aircraft in flight. In connexion with this service 4,415 signals were handled.

The Army.—There was little change in the nature or volume of work for the Army. Sixty " meteor " reports were supplied to artillery units. Climatological data were provided in connexion with health and works services and forecasts supplied on demand for special occasions.

Local Authorities.—Close touch was maintained with the University Observatory, and the Rector was most helpful in supplying any data required. The Office continued to work in close liaison with the Captain of the Ports, particularly in regard to reports for shipping and general warnings.

Communications.—The arrangement whereby the Naval W/T station, Rinella, broadcasts synoptic messages continued satisfactory. Reception of broadcast synoptic reports continued to improve and the collective reports for western and central Europe were particularly useful. Reports from the eastern Mediterranean and from the Sahara showed an improvement but they cannot yet be described as satisfactory.

Middle East and Iraq

At the end of the war the Royal Air Force in the Middle East and Iraq had its own meteorological service manned entirely by R.A.F. personnel. It was found, however, that the meteorological requirements of the Royal Air Force, even in these outlying places, could be better provided by the personnel of the Meteorological Office than by R.A.F. personnel and in 1928 a branch of the London Meteorological Office was established in Heliopolis to provide a meteorological service for the Royal Air Force in Egypt and Palestine. For some years longer the Royal Air Force maintained its own meteorological service in Iraq but in 1932 this service was also taken over by civilian personnel and a branch office established in Hinaidi was placed, for administrative purposes, under the Superintendent of the Meteorological Office, Heliopolis. The Middle East and Iraq meteorological services were established primarily for Royal Air Force requirements, but they are also called upon to provide meteorological help required by civil aviation, and although the Egyptian Government maintains a meteorological service in Cairo, the British Meteorological Office provides all the information required by the civil air lines passing through Egypt. In Iraq there is no meteorological service other than the British service, and therefore the branch office in Hinaidi is called upon to supply the information required for the whole of civil aviation in Iraq.

Middle East.—In the Middle East the headquarters of the meteorological service are at Heliopolis and reporting stations manned by British personnel are maintained at Aboukir, Ismailia, Ramleh and Amman. At all these stations regular observations of surface conditions are taken, and pilot balloon ascents are made twice daily. During the year Imperial Airways established two stations manned by their own staff at Mirabello (Crete) and Gaza (Palestine) to take ordinary surface observations.

In order to obtain regular observations from the country between Amman and Rutbah Wells, a distance of 250 miles, two stations were established one at Landing Ground H.4, equipped with instruments for normal surface observations, and the other at Mafrak for eye observations only. The Iraq Petroleum Company have kindly permitted their wireless operators to undertake the meteorological work at these stations. The observations are made daily at 0600, 1200 and 1500 G.M.T. and sent by W/T to Heliopolis and Hinaidi.

Observations by Royal Air Force personnel at Limassol, Cyprus, ceased but an upper wind observation station has been established by the Government of Cyprus at Nicosia. An official nominated by that Government received training in pilot balloon work at the Meteorological Office, Heliopolis, and observations are being received once daily through the British Army W/T station in Cairo.

Arrangements have been made for the reception of meteorological reports by wireless from ships in the Mediterranean and Red Sea. The reports have proved very valuable for forecasting the conditions in the east of the Mediterranean.

The Superintendent visited Beirut and discussed with the Chief of the Meteorological Service, Syria, the general meteorological organisation in that country. As a result the co-operation between the Meteorological Service in Syria and the Meteorological Office, Heliopolis, has been considerably improved.

In July, 1933, the Meteorological Office was transferred to a new building in a more convenient position on the Heliopolis aerodrome. In consequence it has been possible to transfer all spare meteorological stores, with the exception of hydrogen, from Aboukir to Heliopolis.

The Royal Air Force.—The issue of special forecasts for the Royal Air Force have continued, and a number of memoranda dealing with meteorological and climatological conditions have been supplied to the Air Staff. Meteorological lectures were given regularly to the pupils of No. 4 Flying Training School, Abu Sueir and a number of candidates examined in meteorology for Class " B " Licences.

The Army.—" Meteor " reports were supplied to the Royal Artillery during the annual training period and help was given in connexion with an investigation into " atmospherics " which was completed in September, 1933.

Civil Aviation.—Regular reports and coded forecasts have been issued to meet the requirements of Imperial Airways Services en route from England to India and England to Cape Town. Reports and coded forecasts are issued on request to the K.L.M. Dutch Air Mail Service. Routine reports and forecasts are issued to Misr Airworks (Egypt) and private owners on request.

Egyptian Army Air Force.—Copies of the routine forecasts issued from Heliopolis together with the latest weather and upper wind reports from all Middle East stations are supplied daily and additional reports and forecasts are issued on request.

Physical Department, Cairo.—Upper wind observations from two western Desert coast stations, Mersa Matruh and Sollum, and surface observations from the Physical Department stations in Egypt, Palestine and the Sudan are received daily by telephone. In return, observations from Iraq and certain European stations are supplied on request.

Iraq.—The growth of the work of the Iraq Meteorological Service has necessitated an increase of staff. The Headquarters are situated at Hinaidi and stations staffed by British personnel are maintained at Mosul and Shaibah. Two stations at Ramadi and Diwaniyah are each manned by one native clerk and auxiliary reporting stations send abbreviated reports from Rutbah and Kirkuk. At all stations routine observations have been made at 0200, 0600 and 1300 G.M.T. daily and pilot balloon ascents are made at all stations except Kirkuk.

As already stated, the Iraq meteorological service supplies all the needs for meteorological information of the Royal Air Force and for civil aviation in Iraq. In addition, information is frequently given to various departments of the Iraq Government.

THE INTERNATIONAL POLAR YEAR, 1932–3

The Second International Polar Year came to an end on August 31, 1933, and since that date news has been received of the safe return of all the parties which occupied stations in polar regions during the thirteen months August, 1932–August, 1933 (see *Annual Report*, 1932–3, p. 33). The National Committees which have organised the expeditions from the various countries are now concentrating on the preparation for publication of the data obtained.

Synoptic charts of the Northern Hemisphere for the period of the Polar Year are being prepared by the Deutsche Seewarte, Hamburg, and similar charts for the Southern Hemisphere by the Norwegian Meteorological Service, Oslo. Although it will be months before the first volumes of data appear, it is not too early to say that, in spite of world-wide financial depression, this international undertaking has been an unqualified success and the ambitions of the International Meteorological Organisation fully realised.

Fort Rae.—The British party—consisting of Messrs. J. M. Stagg (Leader), W. R. Morgans, P. A. Sheppard, W. A. Grinsted (members of the staff of the Meteorological Office), A. Stephenson and J. L. Kennedy—continued their observations until August 31, 1933, and, after packing the instruments to be brought out by the last Hudson's Bay boat of the season, themselves travelled the first stage of the journey by air, arriving in England in early October. Messrs. Morgans, Sheppard and Grinsted returned to their posts in the Meteorological Office on November 1, 1933, but Mr. Stagg will remain seconded to the Royal Society until the end of October, 1934, to carry out the publication of the results.

Complete records in all branches of the work were brought back from Fort Rae and these, with the 4,700 double auroral photographs, have been sent to Edinburgh, where they are being worked up by Mr. Stagg. Messrs. Morgans and Sheppard are

devoting as much time as their official duties will allow to the reduction of the meteorological and atmospheric electrical observations, respectively.

Tromsö.—Professor Appleton's party continued their investigation into ionospheric conditions at Tromsö until the close of the Polar Year. Throughout the period corresponding observations were made, in south-east England for comparison. The reduction of the data is being carried on at the Radio Research Station, Slough, and the results will be published according to the international plan.

Auroral Work in Scotland.—Throughout the Polar Year visual auroral observations were made at Kirkwall, Lerwick and a number of climatological stations in Scotland, and double photographs were obtained on the base line Lerwick–Urafirth. These observations were organised by the Royal Society of Edinburgh, and the results will be published as part of the British contribution to the general scheme.

INTERNATIONAL CO-OPERATION

International Commission for the Polar Year, 1932–3.—A meeting of this Commission under the Presidency of Dr. D. la Cour, Director of the Danish Meteorological Service, was held in Copenhagen from May 15–20, 1933. The Director attended. The Commission passed a number of Resolutions directed to ensuring the early publication of the data obtained by the various expeditions during the Polar Year. The Commission will remain in being to organise and direct the discussion of the data. Resolutions were also passed regarding the continuance of certain observing stations set up for the Polar Year, and decisions were taken as to the ultimate disposal of the magnetic instruments provided out of the funds placed at the disposal of the Commission by the Rockefeller Foundation.

Executive Council of the International Meteorological Committee.—The annual meeting was held on May 23, 1933, at De Bilt ; the Director attended.

International Meteorological Committee.—The Committee met in De Bilt (Utrecht) from October 4–7, 1933, under the Presidency of Professor E. van Everdingen, Director of the Netherlands Meteorological Service. Reports from the following Commissions were received by the Committee :—

Maritime Meteorology.
Synoptic Weather Information.
Agricultural Meteorology.
Solar Radiation.
Polar Year, 1932–3.
Réseau Mondial.
Terrestrial Magnetism and Atmospheric Electricity.
Climatology.
Exploration of the Upper Atmosphere.
Study of Clouds.

The Director attended as a member of the Committee and Colonel Gold presented the report of the Commission for Synoptic Weather Information, of which he is President.

International Commission for Synoptic Weather Information.—There has been no meeting of the International Commission for Synoptic Weather Information during the year.

A report on the work which had been done by the Commission and its Sub-Commissions in the four years following the International Meteorological Conference at Copenhagen was presented by the President, Col. Gold, to the International Meteorological Committee at its meeting at Utrecht in October. In the report, the success of the system of international collective transmissions from Paris, Hamburg, Moscow, Rugby and Annapolis, instituted after the Conference at Copenhagen, was emphasized, and the International Meteorological Committee adopted a resolution urging that steps should be taken to introduce a similar collective issue for the countries of south-east Europe.

A meeting of the Sub-Commission appointed to examine the question of the symbols to be used in the representation of synoptic weather information on charts was held at Utrecht at the same time as the meeting of the International Meteorological Committee. After considering the views which had been expressed —particularly by the Meteorological Offices of London, Hamburg, and Lisbon—the Sub-Commission came to agreement on proposals for submission to the full meeting of the Commission to be held in May, 1934. These proposals were circulated to the different Meteorological Services so that they might give them consideration and trial before the meeting of the Commission.

International Commission for Air Navigation.—There has been no meeting of the Meteorological Sub-Commission of this Commission during the year.

The text of the Meteorological Annex to the Convention, Annex G, which is in three languages (English, French, and Italian), has been revised during the year to bring it into accord with the Regulations concerning the international employment of symbols and terms used in aeronautical technology.

Further index numbers for air routes—more particularly in the eastern Mediterranean, Palestine, and Iraq—have been submitted for the approval of the Commission.

International Union of Geodesy and Geophysics.—The General Assembly of the Union was held at Lisbon from September 17–25, 1933. The Director and Dr. F. J. W. Whipple attended. Apart from the scientific work discussed by the various Associations of the Union, important matters of policy and finance were discussed in the General Assembly, and a new set of Statutes was prepared.

The Director, who had acted as Chairman of the British National Committee for Geodesy and Geophysics since January, 1928, retired from that office at the end of 1933.

PUBLICATIONS

It has been decided to use the Replika process in those statistical publications of the Office for which it is suitable. This process, in which typescript is reproduced by photolithography, is being used increasingly in scientific publications in which large blocks of figures have to be set out, as the cost of production is very much less than in the case of printing from type. The new process has been used in *Averages of Temperature for the British Isles* and also in the *Weekly Weather Report*, 1933. It will also be used in the future in the *Réseau Mondial* and in the *Observatories' Year Book*. The change over from printing from type has involved slight delay as a result of which the volumes of the last two publications which would normally have appeared during the year have not yet been issued, but it is anticipated that these arrears will be overtaken at an early date.

A list of the publications issued by the Office or contributed by members of the staff to outside publications is given on pages 58–60. The most important of the official publications is the *Geophysical Memoir*, by J. H. Field and R. Warden, entitled "A Survey of the Air Currents in the Bay of Gibraltar." This memoir sets out the results of a special investigation, which Mr. Field undertook at the request of the Office, of the wind eddies set up by the Rock, which often reach sufficient intensity to be a source of danger to aircraft. The investigation was carried out by means of intensive observations with pilot balloons and with kites used for raising recording instruments of special type. Valuable observations were also made by Dr. Warden with a model of the Rock on the scale 1/5000, in a wind tunnel at the National Physical Laboratory. The vertical and horizontal extent of the eddies set up by the Rock, and the magnitude of the vertical currents experienced in them have been determined under different wind conditions, and the investigation has achieved results which are of great interest and importance to those engaged in flying near the Rock.

In due course the results will also find their application in other directions, for example, in the investigation of the irregularities introduced into the wind circulation by large-scale obstacles and their bearing on the problems of soaring flight.

The list of papers and articles contributed by the staff to outside publications is again a long one. Mr. D. Brunt has continued to act as honorary editor of the *Quarterly Journal of the Royal Meteorological Society*, and in that capacity has been responsible for securing for that publication a number of interesting problem articles. Mr. A. H. R. Goldie has prepared for Messrs. Kegan, Paul, Trench, Trubner & Co. a new edition of that well-known classic "Abercromby's Weather." The new edition, though it still bears the name of the original author on its title page, is to all intents and purposes a new book, in which the principles of modern synoptic meteorology are set out with great lucidity.

STAFF

Details of the staff and its distribution will be found on pp. 53–7. The developments of the work mentioned in the earlier part of this Report have made necessary some increase in the authorised establishment, the principal items of increase being the starting of stations at Manchester, Pembroke Dock and Andover. On the professional side it has been possible to fill the new posts without making new appointments from outside, as the staff who had been absent on special duty in connexion with the International Polar Year became once more available for normal office work in the autumn of 1933 Four new appointments of clerical officers have been made, and at the end of the year there were 12 vacancies for clerical officers.

APPENDIX I

CLASSIFICATION OF STATIONS WHICH REPORT TO THE BRITISH CLIMATOLOGY DIVISION

	Districts	Stations						Autographic Records					
		Observatories	Distributive	Telegraphic	Crop Weather	Climatological	Rainfall only	Sunshine	Rainfall	Wind	Pressure	Temperature	Humidity
0	Scotland, N. ...	1	0	3	0	9	140	14	1	3	6	0	0
1	,, E. ...	1	1	2	2	29	351	18	5	3	2	2	2
6A	,, W. ...	1	1	1	1	22	369	19	6	3	2	2	1
2	England, N.E. ...	0	2	2	3	13	280	18	4	6	6	3	1
3	,, E. ...	0	2	1	7	17	419	23	5	6	6	2	2
4	,, Midlands	0	1	4	5	39	1048	30	16	1	5	3	2
5	,, S.E. ...	0	7	3	4	32	921	41	25	9	9	8	8
	London District ...	2	0	0	0	12	54	7	8	1	1	2	0
8B	England, S.W. ...	0	1	2	5	31	611	28	6	3	6	3	3
7A	,, N.W. ...	0	1	1	1	21	495	24	8	3	2	0	0
7B	N. Wales ...	0	2	0	1	5	179	7	3	5	5	2	2
8A	S. ,, ...	0	0	1	2	8	229	11	3	1	1	1	0
9	Ireland, N. ...	0	1	3	0	6	130	6	2	3	6	1	1
10	,, S. ...	1	0	2	0	15	121	9	2	3	6	0	0
6B	Isle of Man ...	0	0	0	0	1	9	1	0	0	0	0	0
11	Scilly and Channel Isles	0	0	2	0	1	27	4	0	1	2	1	1
	Total	6	19	27	31	261	5383	260	94	51	65	30	23
	Corresponding number for last year ...	6	18	27	31	262	5329	257	82	48	65	30	23

APPENDIX II

GALE WARNINGS ISSUED DURING THE YEAR 1933

Districts	Summary of occasions of gales		Summary of warnings issued			
	Total number of occasions when warnings were necessary	Percentage of occasions of gales effectively warned	Total number issued	Issues justified by gales, force 8 and above	Issues justified by strong winds, forces 6 and 7	Percentage justified by gales and strong winds
1. Scotland N.E. ...	12	92	40	11	20	77
2. Scotland, E. ...	7	71	13	5	5	77
3. Scotland, N.W. ...	13	85	40	11	15	65
4. Scotland W. and North Channel ...	6	83	28	5	17	79
5. Ireland, N.	10	100	39	10	17	69
6. Ireland, S.	8	75	27	6	15	78
7. Irish Sea	4	100	21	4	16	95
8. St. George's Channel	11	82	20	9	9	90
9. Bristol Channel ...	8	88	21	7	10	81
10. England, S.W. ...	16	88	23	14	7	91
11. England, S.... ...	8	100	20	8	10	90
12. England, S.E. ...	8	100	15	8	6	93
13. England, N.E. ...	3	33	14	1	10	79
14. England, E.... ...	11	91	15	10	5	100
Totals	125	87	336	109	162	81

APPENDIX III

FINANCIAL STATEMENT

The year under review, 1933–4, is the thirteenth in which the cost of the Meteorological Office has been borne on Air Ministry Votes. The accounts are not yet closed, but the following tables give the approximate figures for the expenses and receipts of the Meteorological Office :—

APPROXIMATE STATEMENT OF EXPENDITURE AND RECEIPTS IN RESPECT OF METEOROLOGICAL SERVICES DURING THE YEAR 1933–4.

Expenditure.	*Amount.*	
	£	£
Salaries and Wages—H.Q. Establishments	49,437	
„ „ —Out-station Establishments ...	64,482	
		113,919
Fuel and Light		410
Transport of Personnel and Equipment		3,745
Instruments, Equipment and Stores		6,561
Research (including Polar-Year Work)...		4,648
Minor Works Services, Rents, Repairs and Maintenance of Buildings		2,328
Telegrams, Telephones ... ... Subventions to Reporting Stations and miscellaneous charges		15,525
Superannuation		1,175
Total ...		£148,311

Receipts.	
Receipts from Royal Society	2,843
„ „ National Debt Commissioners (Annuities)	113
Sale of Instruments, Carriage, etc.	3,408
Daily Weather Reports, Forecasts, etc.	2,887
Receipts from War Office and Admiralty	6,201
Total ...	£15,452

APPENDIX IV

THE GASSIOT COMMITTEE, 1933

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

The President of the Royal Society (Sir F. G. HOPKINS).

Sir HENRY LYONS (*Chairman*).

The President of the Royal Astronomical Society (Professor F. J. M. STRATTON).

The Director of the Meteorological Office (Dr. G. C. SIMPSON).

Sir NAPIER SHAW.

Professor A. FOWLER.

Sir GERALD LENOX-CONYNGHAM.

Sir GILBERT WALKER.

Professor S. CHAPMAN.

Mr. J. EVERSHED.

Dr. G. M. B. DOBSON.

Professor G. I. TAYLOR.

APPENDIX V

THE STAFF OF THE METEOROLOGICAL OFFICE, ITS OBSERVATORIES AND BRANCHES, MARCH 31, 1934

THE STAFF AT HEADQUARTERS

DIRECTOR :
G. C. Simpson, C.B., D.Sc., F.R.S.

Assistant Directors	... ...	R. G. K. Lempfert, C.B.E., M.A., F.Inst.P. E. Gold, D.S.O., F.R.S.
Senior Professional Assistants		Miss E. E. Austin, M.A. ; A. C. Best, B.Sc.

GENERAL SERVICES DIVISION.

Chief Clerk	... ...	H. L. B. Tarrant, M.B.E.
Clerk, Grade I	... ...	R. M. Poulter.
Clerks, Grades II & III	...	9 (one vacancy).

MARINE DIVISION.

Superintendent	... ...	L. A. Brooke Smith, Captain R.N.R. (retd.), R.D.
Senior Professional Assistants		E. W. Barlow, B.Sc. ; J. Hennessy, Cdr. R.N.R. (retd.), R.D.
Clerk, Grade I	... ...	H. Keeton.
Clerks, Grades II & III	...	11

BRITISH CLIMATOLOGY DIVISION.

Superintendent	... ...	E. G. Bilham, B.Sc., A.R.C.S., D.I.C.
Assistant Superintendent	...	E. V. Newnham, B.Sc.
Senior Professional Assistants		J. Glasspoole, M.Sc., Ph.D. ; Miss L. F. Lewis, B.Sc.
Clerk, Grade I	... ...	A. G. W. Howard.
Clerks, Grades II & III	...	16
Draughtsman	... ...	1

GENERAL CLIMATOLOGY DIVISION.

Superintendent	... ...	C. E. P. Brooks, D.Sc.
Senior Professional Assistants		A. F. Crossley, M.A. ; Miss E. H, Geake, M.Sc. ; Miss L. D. Sawyer, B.A. ; Miss G. L. Thorman, B.Sc., A.K.C.
Clerk, Grade I	... ...	A. T. Bench.
Clerks, Grades II & III	...	7

FORECAST DIVISION.

Superintendent	... ...	R. Corless, O.B.E., M.A.
Assistant Superintendents	...	H. W. L. Absalom, B.Sc., A.R.C.S., D.I.C. ; C. K. M. Douglas, B.A. ; W. C. Kaye, B.Sc.
Senior Professional Assistants		R. F. Budden, M.A. ; G. A. Bull, B.Sc. ; E. A. Cope, B.Sc. ; F. H. Dight, B.Sc. ; J. S. Farquharson, M.A. ; A. G. Forsdyke, Ph.D., A.R.C.S., D.I.C. ; C. H. Kellett, B.Sc. ; A. L. Maidens, B.Sc. ; P. I. Mulholland, B.Sc.
Clerk, Grade I	... ...	W. Hayes.
Clerks, Grades II & III	...	22
Telephone-Typists	... ...	8

APPENDIX V—*continued*

AVIATION SERVICES DIVISION.

Superintendent	F. Entwistle, B.Sc.
Assistant Superintendent ...	R. S. Read, M.A., B.Sc., A.R.C.S., F.Inst.P.
Senior Professional Assistant	C. S. Durst, B.A.
Clerk, Grade I	F. M. Dean.
Clerks, Grade III	3

NAVAL DIVISION.

Superintendent	L. G. Garbett, Cdr., R.N. (retd.).
Assistant Superintendent ...	W. A. Harwood, D.Sc.
Senior Professional Assistants	A. H. Nagle, B.Sc., A.R.C.S., D.I.C. ; E. Taylor, M.A., B.Sc.
Clerk, Grade III	1

ARMY SERVICES DIVISION.

Superintendent	D. Brunt, M.A., B.Sc.

INSTRUMENTS DIVISION.

Superintendent	J. S. Dines, M.A.
Senior Professional Assistant	J. E. Belasco, B.Sc.
Junior Professional Assistant	A. E. Mayers, B.Sc.
Clerk, Grade I	P. N. Skelton.
Clerks, Grade III	7
Draughtsman	1
Instrument Designer	1
Storeman, Packer and Porter	3

THE STAFF AT OBSERVATORIES AND BRANCH ESTABLISHMENTS

METEOROLOGICAL OFFICE, 6, Drumsheugh Gardens, EDINBURGH, 3.

Superintendent	A. H. R. Goldie, M.A., F.R.S.E.
Assistant Superintendent ...	M. T. Spence, B.Sc.
Senior Professional Assistant	D. N. Harrison, D.Ph.
Clerks, Grade III	5 (and one research post).

METEOROLOGICAL OFFICE, MALTA.

Superintendent	G. R. Hay, M.A.
Senior Professional Assistants	D. W. Johnston, B.Sc. ; A. Walters.
Clerk, Grade II	1
Clerks (locally entered) ...	4

METEOROLOGICAL OFFICE, MIDDLE EAST.
HELIOPOLIS.

Superintendent	J. Durward, M.A.
Senior Professional Assistants	C. V. Ockenden, B.Sc. ; G. J. W. Oddie, B.Sc.
Clerk, Grade I	R. Pyser.
Clerk, Grade II	1 (vacancy).
Clerks (locally entered) ...	4

ABOUKIR, AMMAN, ISMAILIA AND RAMLEH.

Clerks, Grade II	4
Clerks (locally entered) ...	4

APPENDIX V—*continued*

METEOROLOGICAL OFFICE, IRAQ.

HINAIDI.

Assistant Superintendent ...	R. H. Mathews, B.A.
Senior Professional Assistants	F. E. Coles, B.Sc., A.R.C.S., D.I.C. ; T. W. V. Jones, B.Sc.
Clerk, Grade II	1
Clerks (locally entered) ...	7

DIWANIYAH, MOSUL, RAMADI, SHAIBAH.

Clerks, Grade II	2
Clerks (locally entered) ...	4

KEW OBSERVATORY, Old Deer Park, Richmond, Surrey.

Assistant Director	F. J. W. Whipple, Sc.D., F.Inst.P.
Senior Professional Assistants	A. W. Lee, M.Sc., A.R.C.S., D.I.C. ; F. J. Scrase, M.A., B.Sc.
Junior Professional Assistant	C. J. Boyden, B.A.
Clerk, Grade I	E. Boxall.
Clerks, Grades II & III ...	5
Caretaker and Handyman ...	2

KEW OBSERVATORY (Upper Air Section), Richmond, Surrey.

Assistant Superintendent ...	L. H. G. Dines, M.A.
Instrument Maker	1
Mechanic and Carpenter ...	2

VALENTIA OBSERVATORY, Cahirciveen, Co. Kerry.

Assistant Superintendent ...	H. F. Jackson, M.S.E.
Clerks, Grade III	4
Messenger	1

THE OBSERVATORY, ESKDALEMUIR, Langholm, Dumfriesshire.

Assistant Superintendent ...	J. Crichton, M.A., B.Sc., F.R.S.E.
Senior Professional Assistant	L. Dods, B.Sc.
Clerks, Grade III	3
Housekeeper, Mechanic and Handyman	3

THE OBSERVATORY, King's College, ABERDEEN.

Clerk, Grade I	G. A. Clarke.
Clerks, Grade III	2

THE OBSERVATORY, LERWICK, Shetlands.

Senior Professional Assistant	B. C. V. Oddie, B.Sc.
Clerks, Grade III	3
Caretaker	1

PORT METEOROLOGICAL OFFICE, LIVERPOOL.

Senior Professional Assistant	M. Cresswell, Cdr. R.N.R.
Clerk, Grade III	1

PORT METEOROLOGICAL OFFICE, LONDON.

Senior Professional Assistant	C. H. Williams, Cdr. R.N.R. (retd.)
Clerk, Grade III	1

APPENDIX V—*continued*

AVIATION SERVICES STATIONS

ABBOTSINCH.

Senior Professional Assistant	W. J. Grassick, M.A., B.Sc.
Clerks, Grades II & III ...	3

ALDERGROVE.

Senior Professional Assistant	D. Dewar, B.Sc.
Clerks, Grades II & III ...	3

ANDOVER.

Assistant Superintendent ...	W. H. Pick, B.Sc., F.Inst.P., F.C.P.
Clerk, Grade III	1

BICESTER.

Senior Professional Assistant	N. H. Smith, B.Sc.
Clerk, Grade III	1 (vacancy).

BIGGIN HILL.

Clerks, Grades II & III ...	5 (one vacancy).

BIRCHAM NEWTON.

Senior Professional Assistant	W. H. Bigg, B.Sc.
Clerk, Grade III	1

BOSCOMBE DOWN.

Senior Professional Assistant	C. W. Lamb, M.C., B.Sc.
Clerks, Grades II & III ...	3 (one vacancy).

CALSHOT.

Assistant Superintendent ...	R. A. Watson, B.A.
Junior Professional Assistant	J. Pepper, Ph.D., M.A., B.Sc.
Clerks, Grades II & III ...	3

CATTERICK.

Senior Professional Assistant	W. R. Morgans, M.Sc.
Clerks, Grades II & III ...	3

CRANWELL.

Assistant Superintendent ...	R. P. Batty, B.A.
Senior Professional Assistant	R. M. Stanhope, B.A.
Clerks, Grades II & III ...	3

CROYDON.

Assistant Superintendent ...	S. F. Witcombe, B.Sc.
Senior Professional Assistant	C. W. G. Daking, B.Sc.
Clerks, Grades II & III ...	9 (one vacancy).
Telephone-Typists	2

FELIXSTOWE.

Senior Professional Assistant	R. C. Sutcliffe, Ph.D.
Clerks, Grades II & III ...	3

HOLYHEAD.

Clerks, Grades II & III ...	3

LEUCHARS.

Senior Professional Assistant	S. T. A. Mirrlees, M.A.
Clerks, Grades II & III ...	3

APPENDIX V—*continued*

LYMPNE.

*Assistant Superintendent** ...	R. E. Watson, B.Sc., Ph.D.
Clerks, Grades II & III ...	7 (two vacancies).

MANCHESTER.

Senior Professional Assistant	J. J. Somerville, B.A., B.L.
Clerks, Grades II & III ...	3

MANSTON.

Senior Professional Assistant	1 (vacancy).
Clerks, Grades II & III ...	3 (one vacancy).

MOUNT BATTEN.

Senior Professional Assistant	M. J. Thomas, B.Sc.
Clerks, Grades II & III ...	3

PEMBROKE DOCK.

Senior Professional Assistant	L. H. Starr, M.Sc.
Clerk, Grade III	1

SEALAND.

Senior Professional Assistant	W. D. Flower, B.Sc., A.Inst.P.
Clerks, Grades II & III ...	3

SOUTH FARNBOROUGH.

Senior Professional Assistant	1 (vacancy).
Clerks, Grades II & III ...	3

UPPER HEYFORD.

Senior Professional Assistant	J. C. Cumming, M.A.
Clerks, Grades II & III ...	3

WORTHY DOWN.

Senior Professional Assistant	S. P. Peters, B.Sc., A.Inst.P.
Clerk, Grade III	1

ARMY SERVICES STATIONS

METEOROLOGICAL OFFICE, SHOEBURYNESS.

Assistant Superintendent ...	C. E. Britton, B.Sc.
Junior Professional Assistant	R. Frost, B.A.
Clerks, Grades II & III ...	11 (two vacancies).

METEOROLOGICAL OFFICE, LARKHILL.

Senior Professional Assistant	H. L. Wright, M.A.
Clerks, Grades II & III ...	4 (one vacancy).

METEOROLOGICAL OFFICE, PORTON.

Clerks, Grades II & III ...	5

SECONDED FOR DUTY WITH OTHER BODIES

Senior Professional Assistants	R. G. Veryard, B.Sc. (R.A.F., India).
	E. L. Davies, M.Sc. }
	L. G. Hemens, B.Sc. } (War Office, Porton
	P. A. Sheppard, B.Sc. } Experimental Station).
	O. G. Sutton, B.Sc. }
	H. Garnett, M.Sc. (Indian Government).
	J. M. Stagg, M.A., B.Sc. (Royal Society).

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* Held against vacancy for Senior Professional Assistant.

APPENDIX VI

PUBLICATIONS

The publications prepared by the Office are generally issued by His 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 the Stationery Office is sent free to any applicant.

The official publications issued or signed for press during the year are as follows :—

PERIODICAL :—

The Daily Weather Report issued in three sections (to date) :—

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

The Monthly Weather Report with a summary for the year (to February, 1934).

The Marine Observer (to date).

The Meteorological Magazine (to date).

Monthly Frequency Tables, being summaries of observations of horizontal visibility, height of base of low cloud and speed and direction of surface and upper winds in the form approved by the International Commission for Air Navigation (to January, 1934). *Not on sale.*

Seismological Bulletin. A diary of seismological disturbances recorded on the Galitzin Aperiodic Seismographs at Kew Observatory, Richmond (to February, 1934). *Not on sale.*

British Rainfall, 1932. A report on the distribution of rain in space and time over the British Isles as recorded by over 5,000 observers. 15*s*.

Southport Auxiliary Observatory. Annual Report and results of meteorological observations, 1932. By J. Baxendell. *Not on sale.*

Weekly Weather Report for the period February 26, 1933 to March 3, 1934. Particulars of temperature, rainfall and bright sunshine for each week. (*In the Press.*)

OCCASIONAL :—

Gazetteer of British Meteorological Stations used in the preparation of synoptic reports. **Overseas Supplement.** 2*s*.

Meteorological Observer's Handbook. Supplement No. 2. Instructions to observers at auxiliary climatological stations. 2nd edition, 1933. 3*d*.

A Short Course in Elementary Meteorology. By W. H. Pick, B.Sc., F.C.P., F.Inst.P. 4th edition, 1933, 2*s*. 6*d*.

Averages of Temperature for the British Isles, for periods ending 1930. 9*d*.

Geophysical Memoirs :—

Vol. VII :—

59. A survey of the air currents in the Bay of Gibraltar 1929–30. By J. H. Field, C.S.I., M.A., and R. Warden, Ph.D., M.Eng. 5*s*.
60. Observations of atmospheric electricity at Kew Observatory. A survey of the results obtained from 1843 to 1931. By F. J. Scrase, M.A., B.Sc. 2*s*.

APPENDIX VI—*continued*

OCCASIONAL—*continued.*

Professional Notes :—

Vol. V :—

63. Maximum day temperatures and the tephigram. By. E. Gold, F.R.S. 2*d.*

64. Vertical extent of north-westerly winds over Iraq in summer. By S. P. Peters, B.Sc., A.Inst.P. 3*d.*

65. Winds of Berbera. Discussion of the observations made under the supervision of R. S. Taylor, M.B., Ch.B., Principal Medical Officer. By C. E. P. Brooks, D.Sc. and C. S. Durst, B.A. 6*d.*

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

By G. C. SIMPSON, C.B., D.Sc., F.R.S.—

The astronomical radiative stability. *Nature*, **131**, 1933, pp. 875–6.

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