

**ANNUAL REPORT**  
of the Director of the  
**METEOROLOGICAL OFFICE**  
presented by the Meteorological Committee  
to the Air Council

For the Year ended  
**March 31**  
**1932**

*The Seventy-seventh Year of the  
Meteorological Office*

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# CONTENTS

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	PAGE
LIST OF MEMBERS OF THE METEOROLOGICAL COMMITTEE ... ..	3
LIST OF MEMBERS OF THE COMMITTEE OF THE METEOROLOGICAL OFFICE, EDINBURGH ... ..	4

## REPORT

### GENERAL—

FORECASTING ... ..	5
AVIATION ... ..	10
OCEAN METEOROLOGY ... ..	14
CLIMATOLOGY ... ..	19
METEOROLOGY FOR THE ARMY ... ..	22
OBSERVATORIES ... ..	22
BRANCH METEOROLOGICAL OFFICES ... ..	30
INTERNATIONAL POLAR YEAR ... ..	35
INTERNATIONAL CO-OPERATION ... ..	36
PUBLICATIONS ... ..	38
STAFF .. ...	40

## APPENDICES

I. CLASSIFICATION OF STATIONS WHICH REPORT TO THE BRITISH CLIMATOLOGY DIVISION ... ..	41
II. GALE WARNINGS ISSUED DURING THE YEAR 1931 ... ..	42
III. FINANCIAL STATEMENT ... ..	43
IV. THE GASSIOT COMMITTEE, 1931 ... ..	44
V. THE STAFF OF THE METEOROLOGICAL OFFICE, ITS OBSERVATORIES AND BRANCHES, MARCH 31, 1932 ... ..	45
VI. PUBLICATIONS ... ..	50

## METEOROLOGICAL COMMITTEE

1931-32

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Appointed by the Air Council.

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*Chairman* :—The Under-Secretary of State for Air.

*Vice-Chairman* :—Sir ARTHUR SCHUSTER, F.R.S. Nominated by the Royal Society.

Vice-Admiral H. P. DOUGLAS, C.B., C.M.G., R.N. Hydrographer of the Navy. Nominated by the Admiralty.

Captain W. ELLERY. Nominated by the Board of Trade.

Mr. J. E. W. FLOOD. Nominated by the Colonial Office.

Bt. Colonel A. H. Loughborough, O.B.E., R.A. Superintendent of Experiments, Shoeburyness. Nominated by the War Office.

Colonel Sir HENRY LYONS, F.R.S. Nominated by the Royal Society.

Mr. J. A. WEBSTER, C.B., D.S.O. Principal Assistant Secretary, Air Ministry. Nominated by the Air Ministry.

Mr. C. N. KNIGHT, O.B.E. Assistant Secretary, Air Ministry. Nominated by the Air Ministry.

Sir THOMAS MIDDLETON, K.B.E., K.C.I.E., C.B., Development Commission. Nominated by the Ministry of Agriculture and Fisheries.

Mr. P. J. G. ROSE, C.B. Assistant Under-Secretary for Scotland. Nominated by the Scottish Office.

Professor R. A. SAMPSON, F.R.S., Astronomer Royal for Scotland. Nominated by the Royal Society of Edinburgh.

Dr. G. C. SIMPSON, C.B., F.R.S., Director, Meteorological Office.

*Secretary* :—Mr. D. BRUNT, M.A.

**The Meteorological Committee** met three times during the year, on July 8 and November 11, 1931 and March 9, 1932. At the beginning of 1932, Bt. Colonel A. H. Loughborough, O.B.E., R.A., succeeded Colonel Bond as War Office representative on the Committee.

**COMMITTEE OF THE METEOROLOGICAL OFFICE  
EDINBURGH, 1931-32**

*Chairman* :—The Director of the Meteorological Office.

*Vice-Chairman* :—Professor R. A. SAMPSON, F.R.S. Nominated by the Royal Society.

Commander LESLIE FISHER, R.N. Nominated by the Fishery Board for Scotland.

Dr. J. PARLANE KINLOCH. Nominated by the Department of Health for Scotland.

Mr. J. M. RAMSAY, O.B.E. Nominated by the Department of Agriculture for Scotland.

Professor E. M. WEDDERBURN, M.A., D.Sc., W.S. Nominated by the Royal Society of Edinburgh.

Dr. A. CRICHTON MITCHELL, F.R.S.E. Nominated by the Royal Meteorological Society.

Dr. J. E. CROMBIE, M.A., LL.D. Nominated by the University of Aberdeen.

Mr. A. G. OGILVIE, M.A. Nominated by the University of Edinburgh.

**The Edinburgh Meteorological Committee** met on June 16, and November 3, 1931 and February 29, 1932. Mr. Alan Ogilvie was nominated as representative of the University of Edinburgh. Dr. J. Parlane Kinloch, who represented the Department of Health for Scotland, died on January 31, 1932, and was succeeded by Mr. David Ronald. Dr. Parlane Kinloch had taken a very active interest in the work of the Committee and his death was much regretted.

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A list of the staff and of the divisions and establishments of the Office will be found on pp. 45 to 49.

ANNUAL REPORT of the Director of the Meteorological Office presented by the Meteorological Committee to the Air Council for the year ending March 31, 1932 (the seventy-seventh year of the Meteorological Office).

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The year ending March 31, 1932, is remarkable for the completion of three undertakings which have been the subject of much thought and preparation for several years. The first of these is the complete re-organization of the arrangements made at Headquarters in London for the preparation of weather forecasts. The second is the completion of the scheme for simplifying the exchange of meteorological information between the countries of the northern hemisphere and the third is the completion of the series of tours, which have been made by the Superintendent of the Navy Services, to the chief British naval stations of the world, in order to organize the supply of meteorological information to the Royal Navy when on foreign service.

In the other branches of the Office, the work has continued along former lines, but the increase in the demands made on the Office, which has been referred to in several previous reports, has continued and every department again shows an increase in inquiries received and information supplied.

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### FORECASTING

Before the war the Meteorological Office made forecasts which might be classified in three main groups—

- (a) the daily forecasts published in the newspapers,
- (b) gale warnings for shipping, and
- (c) special forecasts for agriculture.

When the Office was re-organized at the end of the war, an entirely new subject for meteorology had arisen, namely, aviation both military and civil. The supply of forecasts for aviation was only a part of the demands made on the Office in connexion with flying. Special observing stations had to be provided at the chief aerodromes at which there were trained meteorologists to give to aviators information regarding the existing conditions as well as to provide forecasts. In addition, a very complete and somewhat complicated system of reporting was established along the only regular civil air

route in this country which starts at Croydon and extends to the coast along which the Continental air traffic passes. A special department of the Office was established to organize this meteorological service for aviation. The issue of forecasts, whether they were required for the purposes mentioned above or for aviation, continued to be made by the Forecast Division. This arrangement continued until 1925, when the work of the Forecast and Aviation Divisions of the Office was reorganized, and the preparation of all forecasts for aviation was transferred to the Aviation Services Division, while the Forecast Division continued to be responsible for all forecasts except those dealing with aviation. Technically, the preparation of aviation forecasts is different from the preparation of the ordinary weather forecasts and, therefore, there was not very much obvious over-lapping between the original forecast service and the service for aviation. Each service prepared its own synoptic charts which were different in many respects. As time went on, however, the disadvantages of the separation of the two forecast services became apparent. The least important of these was the administrative difficulty of having two separate staffs on duty at abnormal hours and on Sundays and holidays. The chief objection was that men trained in ordinary forecasting, were unfamiliar with the technical methods employed in aviation forecasting and vice versa. Obviously, there is no fundamental difference between the two kinds of forecasting, but only differences of practice and application, and it is clearly undesirable to have trained forecasters who cannot undertake all classes of forecasting. The possibility of re-uniting the forecasting at Headquarters in one division, has been under consideration for some time, but the problem of separating the aviation forecasting from the organization for supplying meteorological information and forecasts at aerodromes, has proved very difficult. A solution has, however, been found and on December 1, 1931, the old Forecast Division undertook the preparation of all forecasts at Headquarters, while a certain amount of the work, formerly carried out by that division, in particular the control of certain observing stations, was transferred to the Aviation Division. It is still found necessary to prepare different synoptic charts for ordinary forecasts and for aviation forecasts, but by combining the work it has been possible to eliminate a certain amount of duplication, which was inevitable so long as there were two divisions making the forecasts, and the personnel of the Forecasting Division are now familiar with all types of forecasting. On the other hand, the Aviation Division retains the organization of the supply of meteorological information for aviation and is responsible still for the type of forecast provided for aviation. The re-arrangement has only been possible as the result of close co-operation between the Superintendents of the two Divisions, Mr. Corless and Mr. Entwistle, and the successful accomplishment of the re-organization of their Divisions is appreciated.

In the last *Annual Report* (page 17) a description was given of the changes which it was proposed to make in the method of distributing to other countries, the meteorological observations taken in each country and it was stated that the new arrangements were to come into force on the first day of the year now under review. These arrangements have been completed and are working satisfactorily. It is therefore desirable that the arrangements made should be described in detail.

In order to forecast coming weather, it is essential to know the existing meteorological conditions in as full detail and over as large an area as possible and with as little delay as can possibly be arranged. No country is of sufficiently large area to provide enough information to allow of successful forecasting and, therefore, each country must collect the information from surrounding countries. This is true even of such large countries as the United States of America and of Russia. Moreover, it is necessary that the observations should be taken simultaneously and that uniform methods of observing should be everywhere employed. Finally, it is necessary that the messages containing meteorological information should be in code in order to reduce to a minimum the amount of telegraphy and it is of great practical importance that the same code should be used in all messages quite independently of the country of origin. By close international co-operation, all this has been slowly attained. Standard hours of observation have been fixed, agreement has been obtained on the elements to be observed and their numerical expression and a code adopted which can be used in all parts of the world. The final difficulty of prompt dissemination has now been overcome in the northern hemisphere in the following way. Each country maintains at its own expense a number of meteorological stations at which observations are taken at the standard hours and communicated at once by telegram, telephone or wireless, to its national meteorological office. According to this scheme, the countries of Europe and the U.S.S.R. are arranged in three groups, namely, the western group, the central group and the Russian group. All countries of the western group communicate their observations according to a pre-arranged timetable, to the Central Meteorological Office 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 Leningrad or 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 of the three messages can be received if any receiving station has three receiving sets, but by an ingenious use of time-tables, it is possible for a station with only one receiving set to get most of the information which is of importance to itself.

Naturally, on the introduction of the new system by Paris on April 1, and by Hamburg on November 5, some difficulties were experienced ; but by the end of the year the new system was working with smoothness and regularity, and the increased facility in receiving the information is very gratifying while the accuracy of the transmission is remarkable. For example, a recent comparison between the British data as supplied to Paris by wireless, and the same data as received back from Paris in the Western European collective message, showed that the number of discrepancies was only about one figure in 1,000, and most of these were due to omissions and not due to mistakes.

Along the same lines, the international exchange between Europe and North America has also been established. On April 1, 1931, Great Britain commenced to issue a collective report twice a day from the Rugby wireless station. This report contains observations from a selection of stations extending all over Europe, Asia and North Africa and from ships at sea east of longitude 40°W. This message is primarily intended for reception in North America, but it can also be received in most other parts of the world. To complete the exchange, the Weather Bureau, Washington, issues a similar message giving observations from the whole of the North American Continent and from ships in the West Atlantic and the North Pacific.

Although these intercontinental messages are sent from very powerful stations, reception is not yet entirely satisfactory. The messages from America, are not yet satisfactorily received in Europe, but steps are being taken to build a new transmitter for this service, while Canada is experiencing difficulty with the messages from Rugby which it is hoped will soon be overcome.

The following table shows the information issued by the five transmissions referred to above. Under each of the sending stations is given the time at which the messages are issued, the countries supplying the information for the transmission and the number of stations provided by each country. The latter number varies slightly from day to day.

It should be remarked that the collecting and distributing of the information by these five main stations is carried out entirely at the charge of the country which has voluntarily undertaken the work, this being a typical example of the way in which international co-operation in meteorology is carried out, each country undertaking at its own expense, a certain proportion of international work, so avoiding the necessity for making international charges.

As an example of the practical result of the international co-operation described above, it may be mentioned that on March 30, 1932, observations from ships in the North Pacific were received from America so that it was possible to publish them in the current

day's issue of the *Daily Weather Report*, thus for the first time the issue for that day shows an unbroken series of observations completely round the northern hemisphere.

THE FIVE PRINCIPAL INTERNATIONAL COLLECTIVE TRANSMISSIONS FOR THE NORTHERN HEMISPHERE, WITH THE TIMES OF ISSUE (G.M.T.)

<b>Paris.</b> 0725, 1325, 1825	<b>Hamburg.</b> 0715, 0750, 1315, 1350, 1815, 1850.	<b>Rugby.</b> 1010, 2055.	<b>Annapolis.</b> 0400, 1600.
<i>Countries and No. of stations</i>	<i>Countries and No. of stations</i>	<i>Countries and No. of stations</i>	<i>Countries and No. of stations</i>
Azores, 2 Algeria, 12 Belgium, 4 France, 48 Gt. Britain, 40 Holland, 5 Iceland, 5 Faeroes, 1 Italy, 13 Madeira, 1 Morocco, 12 Portugal, 10 Spain, 12 Switzerland, 5 Tripoli, 3 Tunisia, 10 Pilots, 9 Ships, 19	Germany, 35 Estonia, 5 Latvia, 5 Denmark, 5 Czecho-Slovakia, 5 Sweden, 14 Hungary, 6 Austria, 5 Norway, 23 Lithuania, 2 Poland, 9 Finland, 9 Greenland, 3 Pilots, 7 Ships, 14  <b>Moscow.</b> 0820, 1420, 2020.  Russia, 148	Greenland, 1 Norway, 8 Sweden, 2 Gt. Britain, 7 Iceland, 2 Faeroes, 1 Denmark, 1 Switzerland, 1 Holland, 1 Malta, 1 Gibraltar, 1 Germany, 2 Czecho-Slovakia, 1 Austria, 1 Yugo-Slavia, 1 Greece, 1 Latvia, 1 Poland, 2 France, 4 Spain, 4 Portugal, 1 Italy, 3 Algeria, 1 Madeira, 1 Azores, 1 Tunisia, 1 Roumania, 1 Bulgaria, 1 Egypt, 5 Cyprus, 1 Russia, 18 Ships, 4	Greenland, 2 Alaska, 6 Canada, 23 U.S.A., 44 Bermuda, 1 Ships, 10

Turning now to wireless issues of a national nature, the "weather shipping" bulletin which is issued twice daily from Rugby and repeated by certain coast wireless stations and by the British Broadcasting Corporation has been revised. The "general inference"

with which this message formerly commenced, has been replaced by a very brief general statement setting out the positions of depressions and of anticyclones, with special reference to sea areas. Also the areas for which forecasts are given have been revised, and a new area, called the Northern Area, included. In order to save expense, the wording of the messages has also been abbreviated so far as possible without sacrificing essential information.

The development of the rapid collection of information for the synoptic issues by wireless has resulted in the necessity for speeding up the transmission of those messages which have to be sent by land lines. In order to meet this need the General Post Office has arranged that all meteorological telegrams containing synoptic data which are transmitted from observing stations in the British Isles to the Meteorological Office should be sent as "priority" messages. This is a concession for which the Meteorological Office is very grateful, for it is now usual for the whole of the British synoptic data to be available in London within half an hour of the hour of observation.

Another important change in the service of weather forecasts, which are broadcast by the British Broadcasting Corporation, has taken place during the last year. At the request of the Ministry of Finance, Belfast, a forecast of the sea passages to and from Northern Ireland has been added to the special Northern Ireland forecast which is sent by telegram to the station of the British Broadcasting Corporation in Belfast for issue as local news at 9.15 p.m.

The arrangements made in previous years by which a special daily forecast for the use of the East Anglian Fishing Fleet is prepared, during the autumn, and issued by the British Broadcasting Corporation, was continued.

**Gale Warnings.**—A meeting of the Gale Warning Board was held on May 11, 1931.

The gale warnings issued have as usual been checked against the actual occurrence of high winds and the results are shown in Appendix II from which it will be seen that taking the country as a whole, effective warnings were issued for 94 per cent of the gales experienced. Of the warnings issued, 76 per cent were justified by the occurrence of gales and strong winds.

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## AVIATION

As already mentioned in the section dealing with forecasting, it was formerly the Aviation Services Division of the Office which dealt with all matters of flying: the provision of distributive meteorological stations on aerodromes, the supply of forecasts both at Headquarters and at the distributive stations and the organization

of special meteorological services as required both by civil and by service aviation. As the result of the changes described in detail above, the Aviation Services Division no longer provides the actual forecasts made for aviation at Headquarters, although this Division still remains responsible for the forecasts made at the distributive stations. In all other respects, the Aviation Services Division still remains responsible for the meteorological needs of aviation and it acts as the connecting link between the Forecast Division and those who require special aviation forecasts.

In consequence of the decision of Government to suspend indefinitely the development of airships, the special Airship Services Division has been disbanded. The meteorological station for airships at Cardington, was closed down at the end of 1931, but arrangements have been made for the records from the anemometer on the tower to be maintained by the staff of the Royal Airship Works. In the future all matters concerning meteorology for airships, will be dealt with by the Aviation Services Division.

**Services for the Royal Air Force.**—The issue of routine forecasts for service aviation, has continued and increasing use has been made by the Royal Air Force of the arrangement for obtaining special forecasts in connexion with each cross-country flight.

In addition to the issue of the routine forecasts 3830 requests for information were dealt with at Headquarters from Royal Air Force units.

Members of the staff of the Meteorological Office were attached to Command Headquarters to act as advisers on meteorological conditions to the Air Officers Commanding during the Air Defence Command Exercises in July last. Temporary meteorological stations were opened at Duxford and Manston and a considerable amount of information issued for the exercises. Special arrangements were also made for the night bomber exercises held in June, and a member of the professional staff of the Office was posted to Hendon to advise the Air Officer Commanding Flying, on meteorological questions during the rehearsal and display days of the Royal Air Force Display in June.

Special arrangements were made for the supply of meteorological information in connexion with special flights and cruises of Royal Air Force units, in particular in connexion with the flight of a Fairey monoplane to Egypt in October, and again with the projected flight of the same aeroplane to South Africa in February.

Regular courses of instruction in meteorology have continued during the year at the Cadet College at Cranwell and Flying Training Schools at Digby, Grantham and Sealand. Lectures on meteorology have also been given in connexion with the Air Pilotage and Long Navigation Courses at Calshot, the School of Naval Co-operation at Lee-on-Solent and the Royal Air Force Training Base at Leuchars.

The Royal Air Force Meteorological Committee recommended that lectures should be given to Royal Air Force officers explaining the organization of the Meteorological Office for the supply of information to the Royal Air Force. In accordance with these recommendations, lectures were given to units in Inland Area and No. 1 Air Defence Group. Four lectures on meteorology were also given to each unit in Wessex Bombing Area.

Two new distributive stations at Catterick and Andover have been opened during the year, the former in response to a recommendation of the Royal Air Force Meteorological Committee to fill a gap in northern England, the latter to supply meteorological information in connection with air pilotage and cloud-flying instructions.

**Meteorological Arrangements for Civil Aviation.**—The meteorological service along the civil aviation route between Croydon and the Continent has continued to work satisfactorily throughout the year. During the summer months, it is necessary to maintain a continuous meteorological service, watch being maintained at the meteorological stations at Croydon, Biggin Hill and Lympne day and night.

As from November 1, all reports and forecasts displayed at Croydon and Lympne and issued to aircraft in flight, have been given in metric units ; that is, wind velocities in metres per second, and heights in metres, and visibility in kilometres.

Since February 2, the practice of preparing written reports for pilots has been introduced at Croydon and Lympne. A special report is prepared for each service leaving for the Continent and a copy is given to the pilot when he visits the meteorological station before departure.

Special assistance has been provided for a number of long-distance flights ; this assistance usually takes the form of discussion of the meteorological conditions likely to be met with at different points along the route, the supply of forecasts which are used to aid in deciding the moment of departure, and arrangements with foreign meteorological services to supply information at points of call. Assistance was given in this way in connexion with the long-distance flights of Captain Stack to Australia, Miss Amy Johnson to Japan, Sir Alan Cobham to Africa, Mr. C. A. Butler to Australia and Mr. Storr and Mr. Mollison to South Africa. Assistance was also given to Imperial Airways for the aeroplanes for the Cape-Cairo Service when on their initial flight to Cairo, to Messrs. Post and Gatty, when they landed at Sealand during their round-the-world flight, to Washington in connexion with several projected trans-Atlantic flights, and to the airship *Graf Zeppelin* during her cruise round the British Isles, when a temporary meteorological station was opened at Hanworth and weather reports and forecasts were passed to the

airship in flight from Croydon. Forecasts and upper-wind data were issued in connexion with the first successful flight by a glider across the English Channel.

Four new auxiliary reporting stations were opened in south-east England in connexion with the meteorological organization for civil aviation; at Aylesford, Marden, Farningham and North Foreland, while the auxiliary reporting station at Dymchurch was replaced by one at Sandgate.

During the year, experiments have been made to make further use of the recent developments in meteorology which have led to the recognition of discontinuities in the atmosphere which are usually associated with certain weather changes. This information is based on the study of the synoptic charts at Headquarters. In connexion with the same experiments, the distributive stations inform Headquarters by special messages as soon as a "front" passes the station. Information of the position, characteristics and anticipated movement of such fronts has been issued in code to distributive stations and also included in the broadcast civil aviation meteorological messages.

During the year, 3,521 requests for information for civil aviation were dealt with by the Aviation Services Division at Headquarters. This is an increase of nearly 500 on the previous year's total.

Combining the inquiries connected with both service and civil aviation, the total number received at outstations during the year was 28,814. At Headquarters, 7,351 inquiries were received for forecasts and 76 inquiries for special data regarding weather conditions affecting aviation. The former figure represents an increase of nearly 1,300 over the corresponding number for the previous year. The total number of inquiries was 36,241 against a corresponding figure for last year of 35,536.

**Observations of Upper Wind.**—The total number of pilot-balloon ascents made in Great Britain and Northern Ireland during the year, to determine the velocity of the upper winds was 15,199, and in addition, 5,010 nephoscope observations of medium and high clouds were made.

**Meteorological Flight, Duxford.**—The Meteorological Flight, R.A.F., Duxford, Cambridgeshire, has maintained a regular service of week-day reports of temperature and humidity at different heights, obtained by readings of strut-psychrometers installed on aeroplanes. Flights are normally made twice each week-day (once on Wednesdays and Saturdays) when conditions permit. The reports are of great value in forecasting, since they not only indicate whether and to what degree the atmosphere is in a stable or unstable condition, but in conjunction with ascents by pilot balloons they often give definite information as to the origin of air currents at different levels.

The control of the Meteorological Flight has been transferred to the Aviation Services Division and arrangements were made for one of the mechanics attached to the Flight, to be trained at Kew Observatory for a short time in the repairing of the meteorological instruments carried on the aeroplanes.

**Special Service for Owner-Pilots.**—Whereas a very complete organization for the supply of meteorological information to R.A.F. aerodromes and to civil aviation aerodromes on the Continental route, as described above, has been slowly built up, it is found that the needs of owner-pilots are not satisfactorily met, especially when they are about to make long cross-country flights from the numerous aerodromes in different parts of the country. The chief difficulty is that the wireless reports of present weather conditions and the forecasts are issued in the Morse code, and while many private owners have wireless fitted to their aeroplanes, they are unable to receive and interpret Morse messages. To get over this difficulty, the Automobile Association, which has an aviation branch, approached the Air Ministry with a scheme for co-operation to supply information by radio-telephony which could be picked up and utilised by the owner-pilot. As a result of co-operation between the Automobile Association, the General Post Office and the Meteorological Office, a scheme has been worked out, and the first steps to apply it were taken during the year. The Post Office has issued a licence to the wireless station at Heston air port, which has been established by the Automobile Association, permitting them to issue by wireless telephony, such meteorological messages as are provided by the Meteorological Office. The staff in charge of this wireless station intercept certain of the code forecasts issued by the Meteorological Office. These are decoded and from them a message in plain language is built up, giving the information specially required by the owner-pilot. These messages are then issued by radio-telephony at stated times. Similarly, the meteorological reports which are broadcast hourly from Croydon in code, are intercepted and re-issued in plain language.

These messages issued by Heston can be picked up by aircraft fitted with wireless receiving sets, over a large area round Heston, and in some cases they have been received by means of light portable receivers by aircraft in the air. The wireless station at Heston is the first of a chain of similar stations which it is proposed to erect in different parts of the country, and when the scheme is fully developed, pilots will be able to receive weather reports at any aerodrome in the British Isles and also when in flight in any part of the country.

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#### OCEAN METEOROLOGY

**Services for the Merchant Navy.**—The Meteorological Office was founded in 1854, by the Board of Trade, with the single object of collecting meteorological observations from ships at sea in order to

prepare charts showing the distribution of meteorological elements in each ocean of the world. Since then there has been a constant stream of such observations into the archives of the Office. These observations have frequently formed the basis of special investigations and complete meteorological charts have been published at unequal intervals for isolated parts of the oceans, but a complete reduction of all observations which would result in complete charts of the world has not been accomplished, the available resources of the Office never having been sufficient to cope with both the collection and complete reduction of all the observations received. During recent years, the development of wireless telegraphy has resulted in a material change in the attitude both of the Meteorological Office and of the seaman towards meteorological observations at sea. The possibility of a ship at sea now obtaining meteorological data from ships in its neighbourhood, and from adjacent land areas has afforded the opportunity of drawing synoptic charts at sea. Thus the observations if broadcast immediately, can be put to practical use. The young officer has been particularly attracted by this development, and synoptic charts are now drawn in many merchant ships if not as a matter of routine, as often as duties will allow. The Meteorological Office considered that it was its duty to instruct ship's officers in this new aid to navigation, and to facilitate the exchange of meteorological information between ships at sea by formulating a scheme which includes the observations to be taken, the code in which they should be transmitted and the times at which they should be distributed. Ships have been encouraged to take part in this scheme and to send in returns at the end of each voyage, of the messages which they have distributed and copies of charts which may have been prepared. This has still further reduced the amount of time available in the Marine Division for extracting and discussing the observations received in the ordinary meteorological log. In consequence, the extraction of data and the preparation of charts has tended to get still further in arrears.

In March, 1931, the President of the Board of Trade received a letter from the Honourable Company of Master Mariners pointing out the demand that exists amongst seamen for up-to-date meteorological charts of all oceans and asking that such charts might be provided in the near future. This letter was forwarded by the Board of Trade to the Air Ministry and was considered by the Meteorological Committee, which appointed a small sub-committee to go into the whole question of the preparation of meteorological charts for the oceans. The sub-committee reported that there already existed in the Marine Division of the Meteorological Office sufficient data for the preparation of meteorological charts from practically all oceans without the addition of further information from other meteorological services. A large proportion of these data, however, is still in the original logs and to extract it and make the necessary computations to produce charts would be a very

large and expensive undertaking. On the other hand the sub-committee considered that there was a real need for these data to be made available so that they could be used for the rapid computation of any special information required for different parts of the oceans. The development of aviation will, no doubt, lead to the establishment of air lines traversing wide stretches of the oceans and information of a more detailed character than is available at present will then be required. In order to make the data available for this purpose it is necessary that they should be extracted from the original meteorological logs and co-ordinated in some form ready for use. The most suitable form for this purpose appears to be the punching of the observations on to Hollerith cards. This has been done for a large proportion of the observations taken since 1922; in fact from 1922 to 1927 the data from practically all new logs were extracted and punched on Hollerith cards. From 1928 onwards, however, this work of extraction has very largely decreased for reasons which have been explained in previous *Annual Reports*. The sub-committee therefore recommend that every endeavour should be made to punch on Hollerith cards all the data in the logs which have not already been extracted, and until this work is completed to reduce materially the collection of new data, which should be confined as far as possible to those regions of the oceans from which information is scanty.

In view of the impossibility of obtaining a grant specially to carry through this work in present economic conditions the sub-committee recommended the cessation of certain work now being carried out in the Marine Division with a view to setting free a certain amount of clerical help which could be employed on the work of extraction. The Meteorological Committee has adopted these recommendations and steps are being taken to carry them into effect. The number of log-keeping ships has been reduced from between 120 and 130, at which it has stood for many years, to approximately 60, and the other reductions of work will be carried out as opportunity offers.

The normal work of the Marine Division has continued as in past years. The establishment of a Port Meteorological Office at the London Docks last year has made it possible to reduce the work at the marine agencies in the various British dependencies and to concentrate all agency work abroad upon Sydney and Hong Kong. This has made it possible to close the marine agencies at Vancouver and Fremantle. It is regretted that in consequence the co-operation of Mr. T. S. H. Shearman at Vancouver and Captain J. J. Airey at Fremantle comes to an end. The Meteorological Office is very grateful to these two agents for the help they have given in organizing the voluntary marine meteorological service in British merchant ships based on their two ports.

**Services for the Royal Navy.**—As mentioned in an early paragraph of this *Report*, the Superintendent of the Navy Services Division has now completed his visits to naval stations abroad.

These were carried out as follows :—

Mediterranean Station	...	...	November—December, 1925
China & East Indies Stations	...	...	December, 1929—April, 1930
America & West Indies Station	...	...	October—December, 1930.
Africa Station	...	...	January—March, 1932.

The object of these visits was, by conferences with the officers of the Fleet and with the meteorological services, to organize the supply of meteorological information to the Fleet and the use of that information within the Fleet. In all cases arrangements were made for the local meteorological service to issue special fleet synoptic messages on a uniform plan and in accordance with international procedure. The arrangements made at the various conferences are now being successfully carried out on most of the stations. The first fleet synoptic message was issued from Hong Kong on January 1, 1932, and effect has also been given to the majority of the recommendations at the Hong Kong conference. Also a fleet synoptic message is now being issued from Seletar giving readings from Malayan stations.

Unfortunately, owing to the prevailing financial stringency, H.M. Indian Government has not yet been able to inaugurate a fleet synoptic message for the benefit of H.M. Ships on the East Indian station; the Government of Ceylon has, however, agreed to the transmission of the portion of the proposed fleet synoptic message comprising reports from stations in Ceylon, and it is hoped that it is only a matter of a short time before H.M. Indian Government will be in a position to give effect to the recommendations of the conference held in India.

As a result of the conference in Bermuda it was decided to establish a new meteorological service in that island, and the developments on the America and West Indies Station are largely bound up with the establishment of this new service in Bermuda. The Meteorological Office has given as much assistance as possible to the Government of Bermuda in the establishment of the new service and Lieut.-Commander H. B. F. Moorhead, R.N., has been appointed the first Director of the new service. This officer received a course of meteorological training in the Meteorological Office in 1928 and has since that time been responsible for meteorological work in one of H.M. aircraft carriers. On his appointment Lieut.-Commander Moorhead was attached to the Navy Services Division for four weeks in order to study the proposed development of fleet meteorology on the America and West Indies Station. He then proceeded to Toronto and Washington in order to confer with the heads of the meteorological services of Canada and the United States of America. He

arrived in Bermuda on March 1, 1932. With the establishment of this new service at Bermuda the development of meteorology on the America and West Indies Station should be considerably accelerated.

Commander Garbett left for his final conference in South Africa in January, 1932. He proceeded to Simonstown *via* the east coast of Africa and took the opportunity of meeting at Mombasa Mr. Walter, the Director of the new East Africa Meteorological Service. The possibility of co-operation between that service and the fleet was discussed and Mr. Walter expressed great readiness to help in all ways possible. Commander Garbett then proceeded to Pretoria, where he met Mr. Cox, acting head of the meteorological service in South Africa, and together they proceeded to the naval conference in Simonstown. The conference was entirely successful and it is hoped that it will lead to further development of meteorology in South Africa and to close co-operation between the official meteorological service and the Royal Navy.

There can be no doubt that these conferences have been extremely valuable as they have given opportunities to discuss local problems (of general meteorology as well as fleet meteorology) with the directors of the various meteorological services and to put them into touch with the personnel of the Navy. Without exception, the local meteorological services concerned have expressed their gratification at the success of the various conferences. In addition to the value of the co-operation now ensured between the meteorological services concerned and the Navy there can be no doubt that the conferences have brought them into closer touch with the Meteorological Office in London, all of which will tend to improve the meteorological services of the Empire.

The training of selected naval officers in meteorology was continued during the year. Eight officers attended twelve-week courses, three attended four-week courses, and sixteen attended one-week courses.

The names of all officers qualifying after taking the twelve-week courses are now distinguished in the Navy List by the prefix "Met." and are shown also in a special list of officers qualified in meteorology.

Lieut.-Commander T. R. Beatty has continued his investigation on single-observer forecasting.

The Navy continues to make valuable observations of the upper atmosphere. 535 observations of upper winds and 68 observations of upper air temperatures were received from H.M. Ships during the year.

At the request of the Admiralty, strut thermometers have been issued to Fleet Air Arm aircraft for use in navigation over the sea, and it has been decided to issue pilot-balloon outfits to all ships carrying aircraft in view of the importance to naval aircraft of information regarding upper winds.

## CLIMATOLOGY

**British Climatology.**—The collection and publication of climatological data for the British Isles has continued along the customary lines. Observations are taken at a large number of stations in all parts of the country. These stations vary greatly in equipment and personnel. On the one hand there are the observatories maintained by the Meteorological Office where continuous records of all meteorological elements are obtained, and on the other hand the 5,000 rainfall stations, where the equipment is restricted to a rain-gauge which is read once a day. In Appendix I the particulars are given of the number of stations of the various types in each district into which the British Isles are divided. From this table it will be seen that 345 stations provide climatological data, while rainfall records are received from 5,316 rainfall stations. It is important to notice that practically all the rainfall stations and the stations classified as climatological stations in Appendix I are maintained by local authorities or private persons, who supply information without charge to the Meteorological Office. The observers at these stations carry out at considerable personal inconvenience a real public service.

The data collected are published for general use in the following publications :—

*The Weekly Weather Report.*—This publication which is issued annually, contains data from a certain number of selected stations, arranged according to weeks ; it is designed for special use in agricultural problems for which the week is a useful unit of time.

*The Monthly Weather Report* contains data from all stations at which observations are taken, arranged according to months. The numbers are issued monthly.

*British Rainfall.*—This annual publication contains data supplied by the large number of rainfall stations with a description of the distribution of rainfall, and articles on interesting features connected with the rainfall of the year.

*The Observatories' Year Book* contains data from the five observatories, hourly values being given for most of the elements. The data are not confined to those of climatology, but data of terrestrial magnetism, atmospheric electricity and seismology are also contained in the *Year Book*. A section is devoted to observations made in the upper air.

All these publications have been kept up to date throughout the year.

The number of inquiries for meteorological information has again increased and during the year 1,798 general or scientific

inquiries for particulars of past weather, including 178 legal inquiries, were dealt with. These figures represent an increase of 27 per cent on those for last year.

Rainfall data were supplied in connexion with various water-supply schemes, and a considerable increase occurred in the number of inquiries for data connected with rainfall insurance.

It was mentioned in the last *Annual Report* that the preparation of normal values of temperature by means of charts was under consideration. A further study of the question of the necessity for publishing a new edition of Section I of the "Book of Normals" has led to the conclusion that it will be best to prepare the data for this Section of the "Book of Normals" instead of introducing provisional normals in the way proposed.

The usual annual course of training for observers was held on October 6 and 7, 1931. Sixteen observers attended, eight from health resorts and eight from "crop-weather" stations. The course was held at South Kensington as last year and a visit to Kew Observatory was included. Special attention was devoted to the methods of tabulating sunshine in view of the trouble which had been experienced at certain stations during the summer.

**World Climatology.**—The collection of meteorological data from all parts of the world outside the British Isles, especially from British Colonies and Protectorates, has continued throughout the year. The data are mainly collected from the publications of the various official meteorological services. Where no such publication takes place an endeavour is made to obtain copies of the observations in manuscript form. Such manuscript returns have been received from six foreign stations, from 65 stations in British Colonies and from ten Air Ministry stations in the Middle East, Iraq and Palestine.

Many meteorological data are published as appendices to the annual reports of various Colonial Governments. The circulation of such official papers is extremely limited. An arrangement has, therefore, been made with the Colonial Office for the supply to the Meteorological Office of 200 copies of reprints of each of these summaries. Collections of the summaries are then distributed to the meteorological services on the exchange list of the Office. Thirty-four Colonies and Protectorates supplied reprints for 1930 containing data from 534 stations, an increase of 158 on the previous year. This increase is mainly accounted for by the inclusion in the summaries of data for additional stations in Malaya, British Guiana and the Fiji Islands. An introduction entitled "Notes on Meteorological Observations made in British Colonies and Protectorates 1930" is being prepared for issue with each set of these reprints.

The work of the preparation of the *Réseau Mondial* has progressed steadily. The volume for 1924 has been issued; the manuscript for that for 1925 is complete and the preparation of the tables for 1926 is well advanced.

The International Meteorological Committee at their meeting in Vienna in 1926 expressed the desire for the publication of long series of meteorological observations taken in all parts of the world. A committee was formed to carry out this work and Mr. H. H. Clayton, Massachusetts, U.S.A., has acted as editor of the volume, the cost of publication being generously met by Mr. John A. Roebling. This volume, entitled "World Weather Records," contains monthly values of temperature, pressure and rainfall up to the end of 1920 for stations in all parts of the world. The volume has proved extremely valuable and many researches in climatology have been made possible by the use of the data contained in it. It has now been decided to publish a supplement extending the data from 1920 to 1930 and Mr. Clayton has agreed to edit this supplement also. The Meteorological Office undertook to collect for this supplement data for Africa, Australasia and the Oceanic Islands as in the case of the original publication. This work has now been completed and tables for 28 stations, prepared in the Meteorological Office, and for 51 stations received from other meteorological services, have been forwarded to Mr. Clayton.

Valuable work was carried out by Dr. R. S. Taylor, Principal Medical Officer at Berbera, Somaliland, who made regular pilot-balloon ascents throughout the year.

**Library.**—The additions to the library during the past year included 609 new books and pamphlets and 13,331 daily weather reports. The number of periodicals received was 4,850. Books issued on loan during the year numbered 1,608.

Author and subject catalogues have been kept up to date and the preparation of the monthly list of meteorological papers, and the brief abstracts calling attention to those of special interest have been continued. A list of papers bearing on agricultural meteorology has been forwarded monthly to the Ministry of Agriculture and Fisheries, for incorporation in that Ministry's monthly report on the "crop weather" scheme.

It has been the practice in the past, for certain members of the professional staff to prepare abstracts of the more important meteorological papers which have been received in the library. These abstracts have then been manifolded and circulated in sets to the branches and establishments of the Office. This scheme, which involved a considerable amount of work, was not entirely satisfactory because many of the most important papers were not abstracted so that the collection of abstracts was not really representative. It has, therefore, been decided to cease this series of abstracts and to replace it, if possible, by a collection of short summaries of all important meteorological papers. The summaries are to be classified according to subject and filed in the library for reference. It is hoped that by this means, the library will ultimately contain a complete collection of short abstracts of all meteorological

papers of importance. One thousand such abstracts have already been collected all referring to papers published during the past ten years.

It was mentioned in last year's *Annual Report* that a draft classification of meteorological literature on the decimal system based on that employed at the International Institute of Bibliography Brussels, had been constructed in collaboration with the Science Library, and that copies had been circulated for consideration. Further work was done on the classification on receipt of the replies and copies of the revised classification were submitted to the International Commission for the *Réseau Mondial*. The suggestions made by the members of this Commission, have been incorporated in a final draft which now awaits approval by the International Meteorological Committee.

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### METEOROLOGY FOR THE ARMY

The work of the Army Services Division has undergone no change during the year. The stations at Shoeburyness and Larkhill have been maintained and temporary stations have been opened at summer artillery practice camps as in previous years. Financial stringency has necessitated a reduction of staff at Shoeburyness, by three grade III clerks.

Lectures have been delivered from time to time by the officers-in-charge at Shoeburyness and Larkhill, to officers and men of different units.

The Meteorological Section of the Reserve of the Royal Air Force was called up for a fortnight's training at Cranwell during May. This reserve section has now attained a high standard of efficiency.

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### OBSERVATORIES

The Meteorological Office maintains five first-order observatories, namely Kew, Eskdalemuir, Aberdeen, Lerwick and Valentia, at which meteorological and geophysical observations are made. These observatories are well spread over the country, being situated in south-east England, southern Scotland, northern Scotland, the Shetland Islands and south-west Ireland, respectively.

At all these observatories self-recording instruments are installed which give continuous records of all meteorological elements which it is possible to record automatically; eye observations are taken at regular intervals to control the recording instruments and to keep a record of such elements as cannot be automatically recorded. All observatories except Lerwick send observations by telegram to London at the standard hours of 7h., 13h. and 18h.

In addition to meteorological observations, self-recording instruments are installed at Eskdalemuir and Lerwick for giving a continuous record of terrestrial magnetism; atmospheric electricity is recorded at Kew, Eskdalemuir and Lerwick; while the seismographs at Kew give a complete record of earthquake activity.

Since 1922 the results obtained at the observatories have been published in a special publication entitled the *Observatories' Year Book*, of which the volume for 1929 was issued during the year under review.

#### Kew

**Meteorology.**—In 1929 a new pressure-tube anemograph was installed in place of the Robinson-Beckley cup anemograph. The vane of this anemograph is over the centre of the building at a height of 75 ft. The older pressure-tube instrument has its vane at a height of 65 ft. at a corner of the building. For two years hourly tabulations of the records from the two instruments have been made and compared. The figures are now under discussion. It is intended to dismantle the older anemograph and also the structure which was erected in 1912 to facilitate anemometer comparisons.

The observations of temperature at 1 ft. and 4 ft. below the surface of the ground have been made hitherto with Symons thermometers which are suspended in iron tubes. The substitution of a vulcanite tube for the iron tube is an improvement which has been introduced in Sweden. Observations which are in progress at Kew, indicate that the apparent annual range of temperature at 4 ft., is slightly reduced by the use of the vulcanite tube, presumably because heat is conveyed up and down by the iron tube. It is satisfactory, however, that the difference in the thermometer readings is only of the order of  $0.1^{\circ}\text{F}$ . and therefore of little practical importance.

A thermograph by Negretti and Zambra, is in use to record the earth temperature at depths of 10 cm. and 20 cm. The results obtained below ground covered with turf, have been analysed by Mr. H. L. Wright\*. The turf was removed from the ground above the thermograph bulbs in November, 1931, and the records of the temperature under bare soil are being tabulated for the year 1932.

The rainfall chronograph in use at the Observatory, is designed to indicate the time at which very slight rainfall occurs. It is the practice of the Meteorological Office in dealing with the records of autographic raingauges, to determine the duration of rain falling at a rate not less than 0.1 millimetres per hour. The question how much the estimates are affected by this limitation is of considerable interest. For the year 1930, the duration of the rainfall at a rate between 0.05 and 0.1 mm./hr. has been estimated from the records

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\* *Mem. R. Meteor. Soc.*, 4, No. 31, 1931.

of the rainfall chronograph. The total for the year was 130 hours, whereas the duration of the rain at a greater rate than 0·1 mm./hr. was 438 hours. Thus the inclusion of the lighter rain would increase the nominal duration by 30 per cent. It may be noted for comparison that an earlier investigation had shewn that the exclusion of rain, at rates between 0·1 and 0·2 mm./hr., would reduce the nominal duration by 10 per cent.

**Atmospheric Pollution.**—On behalf of the Research Committee for Atmospheric Pollution of the Department of Scientific and Industrial Research, comparisons have been in progress for some years of the rainfall and of the solid substances collected by the pollution gauges. Much attention has been directed to the excess of rainfall collected in the pollution gauges as compared with the indications of ordinary rain-gauges. It has been found that a frequent source of error with pollution gauges is the entrance of water into the gauges round the corks of the bottles into which the water flows from the gauges. When this error is guarded against the discrepancies between pollution gauges and ordinary rain-gauges are negligible. As was to be anticipated, the gauges are less consistent as collectors of solid matter than as collectors of rainfall. The amount of solid matter collected in a year in two gauges, alongside one another, may differ by 10 per cent.

**Air Waves from Gunfire.**—The investigation of the propagation to great distances of the air waves from gunfire, has been continued. The Universities of Birmingham, Bristol and Nottingham co-operated again as well as Dr. Shaxby of Cardiff and Mr. R. H. Angus of the Officers' Training Corps at Cambridge. The Superintendent of the Research Division at Woolwich arranged for signals during the firing there, and the British Broadcasting Corporation gave facilities for broadcasting the signals. There were six Woolwich trials. Advantage was also taken of firing near Spithead by H.M.S. *Iron Duke*, during which, by the courtesy of the Admiralty, signals were broadcast from the ship. The apparatus used in the experiments is kindly provided by the War Office.

The observations made during the year presented no very novel features but provide much interesting material for discussion. The object of the experiments is to obtain information as to the conditions in the atmosphere at the height of about 40 Km. above the ground from which the air waves return to earth. The temperature at that height is higher than that near the ground. An account of the observations made during the year is being published in the *Quarterly Journal of the Royal Meteorological Society*.

**Atmospheric Electricity.**—When the underground laboratory designed for observations in atmospheric electricity was constructed in 1929, the roof was made about a foot above ground level on account of the risk of flooding. Experience having shown that this departure

from a flat surface affected considerably the electric field, the level of the ground round the underground laboratory has been brought up to the level of the roof of the laboratory. At the same time a sliding horizontal door was installed. After the alterations had been carried out, measurements showed that the strength of the electric field over the test-plate flush with the roof was identical with that over the ground near by. The arrangement is so convenient that it has been decided to adopt the observations of the electric charge induced on the test-plate for standardising the records of potential gradient at the Observatory. The measurements of potential gradient and of the air-earth current are directly comparable and the conductivity of the air close to the ground is estimated from these measurements.

In February, 1932, a radio-active (polonium) collector was substituted for the historic water-dropper of the Kelvin electograph. This change eliminates the risk of loss of record through the freezing up of the water jet or other mischances.

In this connexion, it may be noted that periodic tests of a polonium collector have demonstrated that the rate of deterioration is roughly the same as the rate of decay of polonium ; the efficiency of the collector is therefore not affected by the deposition of dirt or by washing by rain. A collector with a fresh coating of polonium will be provided for the electrograph every six months.

A year of continuous operation of the recorder of the air-earth current was completed in May, 1931. The records for the year have been discussed by Mr. F. J. Scrase ; his report will be published shortly as a *Geophysical Memoir*. The most striking discovery made with this apparatus is that in fog the air-earth current may be reversed. It is thought that this effect is due to the precipitation from the fog of negatively charged droplets, the negative charge being due to the discharge from the twigs of high trees in the strong electric field which prevails during fog.

Apparatus designed to give continuous records of the conductivity and ionization of the air, has been under trial during the year. For the operation of this apparatus air is aspirated through tubes by an electric fan. The principal difficulty in obtaining reliable records, the regulation of this fan, has now been overcome.

A remarkable discovery made by the study of the charts from this apparatus, was announced by Mr. P. A. Sheppard in a letter published in *Nature* (Jan. 30, 1932). The ionization of the air, instead of being fairly uniformly distributed, appears to be highly concentrated, so that the apparatus receives doses of ions at intervals comparable with a quarter of a minute. This discovery may well prove to be of fundamental importance in atmospheric electricity.

Measurements of the quantity of electricity discharged from a point at the top of a mast, have been made throughout the year by

means of a voltameter. Photographic records of the discharge current have been obtained during several showers, together with simultaneous records of the potential gradient.

**Seismology.**—The Galitzin seismographs have been in operation without interruption. The *Seismological Bulletin* has been issued monthly.

The arrangements for the addition of data regarding earthquakes to the ordinary meteorological broadcast messages, have continued. During the year ended March 31, 1932, particulars regarding earthquakes were added to the synoptic messages issued by the Air Ministry on 15 occasions, and during the same period 16 reports of earthquakes were received in the meteorological messages issued by the Weather Bureau, Washington.

The outstanding event of the year was the occurrence of an earthquake with epicentre under the North Sea near the Dogger Bank early on June 7, 1931. It is believed that this earthquake was felt over a larger area than any which has occurred in the immediate neighbourhood of the British Isles, at any rate since the ready circulation of news of such events became possible.

A close study has been made by Mr. Scrase of the records of the earthquake which occurred on February 20, 1931, with its focus near the sea of Japan, at a depth of about 250 miles. Some 160 seismograms, kindly supplied by the directors of observatories in all parts of the world, have been examined. The results of the investigation will be published shortly.

One of the objects of the study of earthquakes is the estimation of the thickness of the different strata of the earth's crust. It is believed that below the sedimentary layer, there is a layer of granite and one or two layers of rock of basaltic type. A paper on this subject has been published by Mr. A. W. Lee, as well as one on the North Sea earthquake of January 24, 1927. Mr. Lee has also in the press, papers on the microseismic activity in Great Britain in January, 1930, and on the theory of the propagation of microseisms through stratified rocks.

Applications from foreign investigators for the loan of seismograms have been numerous. Seismograms have been sent to Japan, Belgium, Denmark, Germany and the United States.

**Visibility.**—The appointment of Mr. M. G. Bennett to undertake a special investigation on visibility on behalf of the Interdepartmental Visibility Committee was referred to in last year's *Annual Report* (page 32). Mr. Bennett has continued his investigations of the distance to which lights of various candle-power can be seen in different circumstances. This question is important in connexion with the design of beacons and lighthouses for navigation by sea or air. The brightness of the background against which the light is seen and the transmission factor in the atmosphere are two of the

controlling factors in this problem, and Mr. Bennett has published a paper on this subject during the year. The problem of extending the measurements of visibility now made at all Meteorological Office stations to observations taken during the night, has been the subject of investigation. Proposals for methods of making night observations of visibility have been suggested, but as they involve the provision of suitable electric lights it has not yet been found possible to adopt the scheme.

Attempts to determine the height of a fog by means of instruments used on a small captive balloon have been continued. The most promising method is that suggested by Mr. Brunt in which the balloon carries instruments for measuring the amount of light received at each height from the fog below. It is clear that during sunlight as the balloon approaches the limit of the fog the amount of light reflected will increase. It is hoped by this method to find some simple means of determining the height of fog during day time.

Mr. Bennett has also discussed with officers of other Government Departments and of private firms other aspects of visibility which are of practical importance.

**Investigation of the Upper Atmosphere.**—The full international programme of sounding-balloon ascents has been carried out and 32 soundings were made during the year. This number is less than half of that recorded in the last *Annual Report*, but there has been no slackening in the amount of work. The ascents are made according to a programme drawn up by an international commission which selects certain days and certain groups of days for ascents. More groups of days happened to fall in the previous year than in the year under review.

Of the 32 soundings made this year 21 yielded results, the instruments being lost in the remaining eleven ascents. The heights reached were as follows :—

20 kilometres and upwards ...	6
15 to 20 kilometres ... ..	9
10 to 15 kilometres ... ..	1
Below 10 kilometres ... ..	5

Records of humidity in the upper air are obtained by means of a hair hygrometer ; these have shown for some years that on passing through a cloud a state of supersaturation apparently sometimes exists. This phenomenon was so little understood that heretofore its occurrence has not been indicated in the published data. During the year further research was made into the behaviour of the hair hygrometers, which has put the matter on a little better footing. It

is still not possible to give quantitative figures of supersaturation, but the data are now being published in such a form as to show clearly when the phenomenon occurs, and to indicate roughly its magnitude.

At the request of the Aeronautical Research Committee an investigation has been undertaken to determine the velocity of ascending and descending air currents in thunderstorms. Balloons carrying instruments are sent up into thunderstorms and, at a pre-determined height, the instruments are released and fall on parachutes. The rate of ascent of the balloon and the rate of descent of the parachute in still air are known. The instrument carried by the balloon records its height on a drum driven by clockwork. It is, therefore, possible from the record to determine the actual rates from minute to minute of the ascent and descent. By comparing these actual observations with the known rate of ascent and descent in still air it is possible to evaluate the actual velocity of the ascending and descending currents. A number of instruments have been made and distributed to certain stations where they are kept ready to be sent up immediately a thunderstorm passes over the station. During the year fourteen soundings with these instruments were made, but none of them succeeded in reaching the active part of a thunderstorm.

#### ESKDALEMUIR

When the magnetographs were erected at Eskdalemuir in 1910 it was decided to measure the three components of the earth's magnetic field along the geographical co-ordinates, that is, the components in the north direction, N; in the east direction, E; and in the vertical direction, V. For certain purposes, chiefly for mathematical computations, these three geographical components are the most convenient. On the other hand it is the practice at many observatories to measure the value, of the earth's horizontal field, H, and of the vertical field, V, and the declination, D. There are very many practical advantages in measuring these latter components rather than the components along the geographical directions, and the possibility of changing at Eskdalemuir has been frequently seriously considered, but, owing to the great reluctance to change the method of observing, no decision was made. In connexion with the programme of magnetic observations during the Second Polar Year it became necessary for the International Commission to decide what magnetic components should be measured, and after serious consideration it was decided to recommend the use of H, D and V at all stations taking part in the work of the Polar Year. As Eskdalemuir will be one of the most important base stations during the Polar Year it was thought desirable that the instruments should be changed so as to provide the information required by the International Commission for the Polar Year. The

change was accordingly made on January 1, 1932, from which date the magnetic records for Eskdalemuir will give horizontal force, declination and vertical force.

During the year a Schuster-Smith coil for the absolute determination of the horizontal magnetic force was installed at Eskdalemuir and brought into use in October. This instrument has the great advantage that a complete measurement of the horizontal force can be made in a very few minutes and the value obtained is that at an instant of time rather than the mean for a relatively long period, as is the case when the Kew magnetometer is used.

In addition to the standard autographic records, auxiliary records of declination, horizontal and vertical force have also been maintained. The sensitivity of the auxiliary records is about half that of the corresponding standard records in order that values may be obtained when the record on the more sensitive standard instruments has passed beyond the limits of the paper.

Hourly values of magnetic declination have been tabulated and supplied for publication in the *Colliery Guardian* and the *Iron and Coal Trades Review*. The publication of the data in the latter was suspended in January, but owing to the general demand for the information from mining surveyors the journal resumed publication after an interval of six weeks.

The work of the Observatory in meteorology and atmospheric electricity has continued throughout the year without appreciable change.

#### ABERDEEN

A detailed account was given in last year's *Annual Report* of the interference with the wind records obtained at Aberdeen through the development of building in the neighbourhood of the anemometer. The investigation of the wind records in order to obtain a continuous record freed from the influence of the obstructions has necessitated a large amount of computing work at the Observatory.

#### LERWICK

The Lerwick Observatory was established 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, temperature and sunshine are maintained.

The work has continued satisfactorily throughout the year, but further trouble has been experienced with the V instrument of the magnetographs. The instrument in use was found to have a very large temperature coefficient which it was impossible to remove.

The repair and re-adjustment of the instrument necessitated putting it out of use during October and November. During this interval a satisfactory V magnetometer was constructed in the workshop.

The usual aurora watch was maintained throughout the winter and photographs were taken on the few suitable occasions.

The normal routine of meteorological observations has been maintained.

#### VALENTIA

Valentia Observatory was established chiefly with the object of obtaining complete meteorological records for south-west Ireland. This work has been continued without a break since 1867, but during recent years the work of the Observatory has developed largely as a reporting station for the Forecast Division. 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.

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### BRANCH METEOROLOGICAL OFFICES

#### EDINBURGH

The Edinburgh Meteorological Office acts as a local centre for the organization 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. The Edinburgh Office also receives the monthly registers and autographic records from 8 telegraphic stations in Scotland before they are forwarded to London.

New climatological stations have been started during the year at Balerno, Bothwell, Dunfermline, Kilmarnock (Kay Park), Ayr, Fort William and Auchincruive, the last mentioned being in continuation of the station carried on by the West of Scotland Agricultural College at Kilmarnock. A new station of the health-resort class has also been started at Prestwick.

A monthly summary of the weather in Scotland, together with statistics for certain large towns has been prepared as usual for the Registrar-General.

The total number of inquires dealt with was 176, of which 59 were by correspondence and 117 by interview or by telephone.

Meteorological data were supplied on several occasions in connexion with investigations of the incidence of crop or animal diseases, also in connexion with flooding. Particulars of rainfall in a

large number of towns were supplied for an inquiry on working time in the building industry. The question of humidity came up in connexion with an investigation on the drying of ink which was undertaken for Messrs. J. and A. Constable by the Printers' Research Association. The largest number of inquiries of a smaller nature were in connexion with losses or damage sustained by fishing vessels.

In addition special composite reports regarding weather conditions at Scottish stations were occasionally supplied to the Royal Automobile Club.

A comprehensive meteorological exhibit was staged for the Highland and Agricultural Society's Show at Edinburgh in June, 1931.

Further work has been done on an analysis of the Bell Rock anemometer records from the point of view of wind structure and an effort has been made to find some way of analysing the Lerwick and other auroral observations in relation to the magnetic registrations, but the difficulties in the way seem very great.

#### MALTA

No change has occurred in the normal observation work of the office, full observations of surface conditions having been made regularly three times daily, and pilot-balloon ascents twice daily. Other routine work continued to develop along normal lines, and, as before, reports for the Services formed the most important feature of the work, although requests for information by local authorities and institutions continued to increase.

Reporting and forecasting for the Royal Navy made the greatest demands on the office staff, although the requirements of the Army, the Royal Air Force and of civil aviation continued to increase. The inauguration of a regular air-mail service from Malta to Syracuse and Tripoli, by an Italian air line, has caused a marked increase in the reports required for civil aviation.

The receipt of synoptic reports has improved considerably with the development of the collective issues from France and Germany, although the data contained in these issues are not sufficient for local forecasting. Many of the national issues cannot yet be taken, and there has been little, if any, improvement in the data received from North African districts, particularly the Sahara. There was a marked and welcome improvement in the latter half of the year in the number of reports received from merchant ships in the Mediterranean.

The absence of early morning reports from Mediterranean countries continued to be felt on the many occasions when early reports were required for aviation.

**The Navy.**—Synoptic messages continued to be issued twice daily. The new code which was brought into use on January 1, 1931, has given general satisfaction, and the messages appear to be useful both to H.M. Ships and to merchant ships in the Mediterranean.

The numbers and the reliability of reports from H.M. Ships have been maintained and the reports have again proved of great value. On the average 136 reports were received monthly, and in July, during the summer cruise, as many as 341 reports were received. In addition the number of observations of upper air temperature received from aircraft operating from carriers continued to increase.

The meteorological and navigating officers of aircraft carriers and other ships continued to take an active interest in the work of the Office, and they made frequent visits to discuss their observations and the reports received during cruises. A close liaison has been maintained with these officers and in particular with the Master of the Fleet.

Climatological summaries for ports visited during cruises in the Mediterranean were supplied from time to time to the Master of the Fleet.

**The Royal Air Force.**—Close liaison has been continued with Royal Air Force Headquarters in Valletta and with the units established in Malta. Daily reports and forecasts have been issued to units as a matter of routine and reports for special flights have been supplied on request. Climatological data have been supplied from time to time.

Route reports and forecasts have been supplied to various R.A.F. squadrons on trans-Mediterranean flights. The usefulness of these reports has been greatly enhanced by the fact that direct communication was almost always maintained between the R.A.F. W/T station and the aircraft, whether air borne or water borne.

Observations of upper air temperatures were continued by 202 (F.B.) Squadron at Calafra. There has been an increase in the number of these observations, and in particular the Air Force authorities have co-operated whenever possible in making special observations on "international days".

**Civil Aviation.**—In addition to reports for flights by R.A.F. units, frequent reports and forecasts were supplied for flights by civilian aircraft. An encouraging feature of this work is that, whenever possible, the pilots of these machines visited the office to discuss the meteorological organization for their flights.

A development of the services of the *Navigazione Aerea S.A.*, whereby Malta became a port of call on the Syracuse-Tripoli route, necessitated a re-organization of reports. From December, W/T facilities were provided by the R.A.F. and regular reports have been transmitted daily to Syracuse or Tripoli. In addition, frequent

reports have been supplied to aircraft in flight. These reports, which were originally supplied in Italian for transmission by cable, have been sent in English from the date of inauguration of the W/T service.

**The Army.**—The principal work for the Army continued to be the supply of "meteors" for artillery practice. There has been, however, an increasing demand for climatological data particularly in connexion with works and health services.

**Merchant Shipping.**—The number of reports from merchant ships showed a marked improvement in the latter part of the year, an average of 70 per month having been received during the last four months. Most of these were received direct by the office W/T staff.

Reports and forecasts for local and cross-channel shipping were frequently supplied. In this work, the Captain of the Ports has continued in close touch with the office, and reports of local conditions have been supplied to him from time to time in connexion with delays to mail steamers.

**Local Authorities and Institutions.**—Local authorities have continued to show an increasing interest in the reports and forecasts issued by the office, and the number of local daily weather reports increased from 20 to 23. Local reports and warnings posted up in the Customs House have been much used by local fishermen and, according to statements made by the Captain of the Ports, are much appreciated.

Close touch has been maintained with the University Observatory and useful data have been received from time to time.

Reports and forecasts to the local press have been continued. At the end of the year, official forecasts were being published in four newspapers, a decrease from the previous year owing to one paper having ceased publication.

Several requests were again received from local agencies for reports of weather conditions at specified times in connexion with delays to shipping.

#### METEOROLOGICAL SECTION, MIDDLE EAST.

In November, 1931, the Director visited the Meteorological Section in the Middle East, inspected their headquarters at Heliopolis, and the stations on the aerodromes at Aboukir, Ismailia, Ramleh and Amman, and on his return to England he was accompanied as far as Rome by the Superintendent and took the opportunity of discussing certain problems with the head of the meteorological service in Rome. The Superintendent then returned to Heliopolis via Athens, in order to consult the head of the Greek Meteorological Service.

There has been little change in the supply of meteorological information in Egypt, Palestine and Transjordan for the Royal Air Force. A change in the route of Imperial Airways on their main line to India has, however, caused a re-arrangement of the supply of information for aeroplanes on that route. After leaving Brindisi, the Indian route now goes by way of Athens and Crete to Samakh on the Sea of Galilee. Information regarding the meteorological conditions along this route was very scanty in Cairo, and considerable difficulty was experienced in providing reports and forecasts to the pilots. However, as the result of the Director's visit to Rome and the Superintendent's visit to Athens, arrangements were made for a great improvement in the supply of information to the Imperial Airways pilots from the meteorological services of Italy and Greece.

A number of small changes in connexion with the wireless communication has resulted in an improvement in the supply of data, in particular the central European collective message broadcast from Germany contains sufficient satisfactory information from south-east Europe to have made it possible to discontinue the direct reception of the messages issued from Esthonia, Czecho-Slovakia and Austria.

In 1928, arrangements were made to obtain records of the vertical temperature gradient over the desert at Ismailia. This information was required primarily in connexion with the mooring of airships, but it is also of great theoretical and practical importance in meteorology. In order to keep down expenses, attempts were made to operate the very complicated and delicate instruments by the personnel attached to the Meteorological Section in the Middle East. Frequent difficulties were met with and it became clear, that if the investigation were not to be abandoned—which would be regrettable in view of the amount of time, trouble and money which had already been expended on the installation—it would be necessary to provide a professional assistant who was in a position to devote the whole of his time to this investigation. Mr. W. D. Flower, who had already had experience with the instrument, was put on special duty for this purpose in order that a complete year of uninterrupted observations might be obtained. Mr. Flower left England for this purpose in August, 1931, but it was not until October, that he had got the instruments in thorough working order. The investigation, therefore, will continue until next October, when it is hoped that a series of extremely valuable observations will become available for scientific research.

#### IRAQ.

Until the present year, the meteorological requirements of the Royal Air Force in Iraq have been met by Royal Air Force officers and men who have received a short course of training in meteorology.

Although the service had worked satisfactorily, there were many difficulties associated with using R.A.F. personnel for this specialised work, and for several years, representations had been made for the Meteorological Office to take over the meteorological service in Iraq. The difficulties, however, were great; but ultimately it became necessary to make the change, and it was carried through at the beginning of 1932.

The new civilian meteorological service attached to the Royal Air Force in Iraq consists of an assistant superintendent, a senior professional assistant, three grade II clerks and nine locally recruited clerks.

The head office is situated in Hinaidi and local observing stations have been established at Mosul, Shaibah and Diwaniyah, while at Rutbah, the observations are taken by an employee of the Iraq Posts and Telegraphs Department.

The chief work of the section, is the supply of information to the Royal Air Force, but considerable information is also required by civil aviation as Imperial Airways, the French Air Orient, the Royal Dutch K.L.M. and the Junkers *Luftverkehr* all have lines passing through Iraq.

Mr. R. P. Batty, the officer in charge of the new service, arrived in Hinaidi on December 1, 1931, and the other members of his staff followed shortly afterwards. The civilian service gradually took over from the Royal Air Force service and the exchange was completed before the end of the year, when the new civilian service was completely established and working smoothly.

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#### THE INTERNATIONAL POLAR YEAR, 1932-33.

In the two previous *Annual Reports*, an account has been given of the arrangements and progress of the scheme to hold a second Polar Year during 1932-33. In spite of the great financial difficulties, the number of countries which have arranged to take part in this international undertaking is sufficient to secure its success. The British Government has approved of the proposals put forward and made a grant of £10,000, to be spread over three years, towards the expense of participation by this country. A committee has been formed under the auspices of the Royal Society of London and the Royal Society of Edinburgh, on which other scientific societies and Government Departments interested are represented. The British contribution consists of the despatch of two parties, one to Fort Rae on the Great Slave Lake, North-west Territories, Canada, and the other to Tromsø in Norway.

As soon as Government approval was received, Mr. J. M. Stagg proceeded to Fort Rae on a preliminary visit to inspect the site and make arrangements for the main party in 1932. Mr. Stagg left

England on May 23, 1931, and returned on August 15, 1931. The party for Fort Rae will be under the charge of Mr. Stagg and will consist, in addition to the leader, of two members of the professional staff of the Meteorological Office, of a surveyor, who has had experience in Greenland, of an observer from the technical staff of the Meteorological Office and a mechanic. The party is expected to reach Fort Rae during June, 1932; during the 13 months of the Polar Year, August 1932 to August, 1933 both inclusive, they will be occupied in taking observations of meteorological conditions, both surface and upper air, of terrestrial magnetism, atmospheric electricity and aurora.

The party which is to go to Tromsø will be under the direction of Professor E. V. Appleton, F.R.S., and will be engaged exclusively in the investigation of the conducting layers in the upper atmosphere, which play such a large part in the transmission of wireless waves, in an endeavour to obtain more information of the conditions in these layers and of the causes of the ionisation which are responsible for the layers. This party will consist of three observers in addition to Professor Appleton, but it is not expected that the whole party will remain at Tromsø throughout the Polar Year; Professor Appleton and one observer will return as soon as the station is completely established.

The Meteorological Office has been chiefly concerned with the organisation of the work at Fort Rae. The collection of stores, both scientific and domestic, has involved a great deal of work in the Instruments Division and in the workshop at Kew Observatory. At the end of the year under review, the arrangements were well in hand for the departure of the party during May.

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## INTERNATIONAL CO-OPERATION.

International Climatology Commission.

International Commission for Terrestrial Magnetism and Atmospheric Electricity.

International Commission for the Polar Year, 1932-33.

These three Commissions held meetings in Innsbruck during August, 1931. As the Director was prevented from attending, Mr. A. H. R. Goldie, Superintendent of the Meteorological Office, Edinburgh, represented the Office. Important work in connexion with the scientific programme to be carried out during the Polar Year, occupied the attention of the Commissions for Terrestrial Magnetism and the Polar Year. Complete details of the observations to be taken were drawn up and recommendations submitted for the approval of the International Meteorological Committee.

The Climatology Commission was created at the International Meteorological Conference at Copenhagen and the meeting at Innsbruck was the first which has been held. The Commission passed a number of resolutions with the object of obtaining uniform methods of observation of climate in all parts of the world.

**International Meteorological Committee.**—The chief authority of the international meteorological organisation is the Conference of Directors which is held every six years. In order to carry out the business of the organisation in the interval between two meetings of the Conference an International Meteorological Committee consisting of 20 members is appointed at the Conference. This Committee meets usually every three years.

Resolutions passed by a commission become effective only if they have been approved either by the International Meteorological Conference or Committee. In view of the fact that several commissions had drawn up schemes for work during the Polar Year which required the early approval of the Committee in order that they could be communicated at once to those taking part, it was decided to hold a meeting of the Committee in Locarno immediately after the meetings of the commissions mentioned above at Innsbruck. The meeting was held from October 5–8, 1931, and was attended by the Director who is a member of the Committee. Reports from the following Commissions were received by the Committee :—

Commission for the Exploration of the Upper Air.

Commission for Terrestrial Magnetism and Atmospheric Electricity.

Climatology Commission.

Commission for the Polar Year, 1932–33

and a report from the Sub-Commission for the Organisation of Wireless Meteorological Messages from the Oceans. Twelve members of the Committee attended.

Following the meeting of the International Meteorological Committee, a meeting of the small Executive Council, which has recently been appointed to control the finances of the Secretariat of the International Meteorological Organization held their first meeting. This Council consists of five members, of whom the Director is one. All five members were present at the meeting at Locarno.

A sub-commission appointed by the International Cloud Commission held a meeting at Frankfürdt from December 7 to 9, 1931. Mr. C. K. M. Douglas attended. The chief business of the sub-commission was the preparation of a programme for observations of clouds in all parts of the world during the Polar Year.

**International Commission for Air Navigation.**—At the meeting of the International Commission for Air Navigation held in London in June, 1931, the Commission approved of the revision of Annex G

of the International Air Convention. The revised text of the Annex, which is now incorporated in the Convention, gives complete and detailed instructions in regard to the organisation and operation of meteorological arrangements along international air routes.

Lieut. Colonel E. Gold, who is Chairman of the Meteorological Sub-commission of the International Commission for Air Navigation represented the Meteorological Office at the meeting.

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## PUBLICATIONS

A list of the publications issued by the Office or contributed by members of the staff to outside publications is given on pages 50-4. The number of *Geophysical Memoirs* and *Professional Notes* that have appeared is smaller than usual in consequence of a request from the Controller of the Stationery Office that, as a measure of economy during the present financial crisis, printing action should be deferred whenever practicable. As a consequence only two *Memoirs* have appeared during the year.

The first of the *Memoirs* is contributed by Major A. H. R. Goldie, and is entitled "Characteristics of rainfall distribution in homogeneous air currents and at surfaces of discontinuity." The paper forms a continuation of some earlier researches, the results of which were published in a paper appearing in the *Proceedings of the Royal Society of Edinburgh* in 1927. In the present paper Major Goldie examines the influence of diurnal variation on the occurrence of cloud and rain in different parts of a depression and reaches the interesting conclusion that a definite relation can be established. The conception of a cyclonic depression as a travelling agent which sprinkles precipitation independently of the nature of the region over which it is passing or independently of the time of day can no longer be regarded as in accordance with the facts.

The second *Memoir* "The structure of wind over level country," gives the results of one of the most important experimental investigations which the Office has ever been called upon to initiate—the detailed examination of wind eddies carried out at the Royal Airship Works, Cardington. Some account of this investigation was given by Mr. Lempfert in his Presidential Address to the Royal Meteorological Society in January, 1931. In the present *Memoir* the equipment is described in greater detail, and numerous examples are given of quick-run wind records obtained from a network of anemometers distributed over an area comparable in size with the dimensions of an airship. Material is thus provided for a study of the variations of wind to which such a structure may be exposed and consequently of the stresses which it must be able to withstand. A beginning is also made in the classification of eddies and wind

types. The investigation was commenced under the supervision of the late Mr. M. A. Giblett and his name consequently appears on the title page as joint author, but, as explained in the preface, the work was essentially a piece of team work in which many members of the Office Staff have taken a share. Mr. C. S. Durst contributes a theory of wind structure which is in many respects novel, and which is set out under his name in Part III of the *Memoir*.

The contributions made by members of the staff to outside publications, again range over a wide field. In the interesting series of articles appearing in the *Quarterly Journal of the Royal Meteorological Society* under the title "Some problems in modern meteorology," Captain Douglas reviews the present position of weather forecasting, and Messrs. E. L. Davies and O. G. Sutton that of turbulent motion in the atmosphere. If in the former Captain Douglas takes a somewhat despondent view of the progress made in the science of forecasting as distinct from the organisation for collecting and arranging the observations which the forecaster needs, his article at any rate, suggests many points where the attack may be pressed home with the prospect of definitely enlarging the boundaries of our knowledge. The study of turbulent motion is a comparatively recent development of meteorology which is now claiming a large share of attention in many countries. No fewer than three major papers in this year's list, in addition to the wind-structure report to which reference has already been made, deal with it in one form or another, *viz.* Mr. Davies's paper describing a portable temperature-gradient recorder, Mr. Best's paper on horizontal temperature differences over small distances, both appearing in the *Quarterly Journal* and a paper on a theory of eddy diffusion contributed by Mr. O. G. Sutton to the *Proceedings of the Royal Society*.

The magnetic work of the Office is represented in a paper by Major Goldie appearing in the *Transactions of the Royal Society of Edinburgh* in which the characteristics of magnetic disturbances occurring at Eskdalemuir and Lerwick are compared and the conclusion is reached that in very great magnetic storms the associated electric current centres during the afternoon hours are frequently situated just to southward of Lerwick. During the night and early morning hours the system appears to be invariably to northward of Lerwick.

Seismology is represented by two contributions by Mr. Scrase, one to the *Proceedings of the Physical Society*, the other to those of the Royal Society. Mr. A. W. Lee discusses the North Sea earthquake of January 24, 1927, in a paper appearing in the *Monthly Notices of the Royal Astronomical Society* in which he traces the origin of the disturbance to a point in the North Sea just south of the sixtieth parallel approximately mid-way between Shetland and the Norwegian coast.

## STAFF

Details of the staff and its distribution will be found on pages 45-49. The decision of Government to discontinue work in connexion with airships has rendered necessary the absorption of the meteorological staff stationed at Royal Airship Works, Cardington, in other branches of the work of the Office. Fortunately, it has been possible to do this without having to dispense with the services of trained staff.

Two professional officers were required by the newly-established civilian meteorological service in Iraq, to which reference is made on page 35. Mr. R. P. Batty, B.A., who had recently returned to the service of this Office after a period of secondment for meteorological work in India, was selected for the senior professional post with promotion to the grade of assistant superintendent. The second post is held by Mr. G. J. W. Oddie, B.Sc.

Three professional officers, Mr. J. M. Stagg, M.A., B.Sc., Mr. P. A. Sheppard, B.Sc., and Mr. W. R. Morgans, M.Sc., will be employed during the coming year on special work in connexion with the International Polar Year, and during the year under review they have been able to devote a considerable part of their time to the necessary preparation for that work. Mr. W. D. Flower, B.Sc., A.Inst.P., has been employed on special work on the temperature-gradient recorder at Ismailia to which reference is made on p. 34.

It will be recalled that at the end of last year there were no fewer than twelve vacancies on the clerical staff. During the year there have been four retirements, one resignation and one death among the established clerical staff. Eighteen vacancies would, therefore, have had to be filled during the year, but for the fact that curtailment of research work at Shoeburyness made it possible to dispense with three posts. There was no difficulty in absorbing the clerical staff set free by the decision to discontinue meteorological work at Cardington. In addition nine clerks were assigned to the Office by the Civil Service Commission. The slowness with which recruits are forthcoming from the Commissioners' examination remains a source of anxiety.

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## 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	8	136	13	1	3	6	0	0
1 " E. ...	1	1	2	2	30	355	19	5	3	2	2	2
6A " W. ...	1	1	1	0	22	336	18	5	3	2	2	1
2 England, N.E. ...	0	2	2	3	14	283	17	3	5	5	2	0
3 " E. ...	0	3	1	7	17	487	23	6	6	6	2	2
4 " Midlands ...	0	1	4	5	38	1035	29	14	1	5	3	2
5 " S.E. ...	0	8	3	4	33	843	42	16	8	9	8	8
London District ...	2	0	0	0	11	58	7	10	1	1	2	0
8B England, S.W. ...	0	1	2	5	31	620	29	3	3	5	2	2
7A " N.W. ...	0	0	1	1	21	476	21	8	3	3	0	0
7B N. Wales ...	0	2	0	1	5	169	7	3	5	5	2	2
8A S. " ...	0	0	1	2	7	220	10	2	1	1	1	0
9 Ireland, N. ...	0	1	3	0	6	131	6	3	3	6	1	1
10 " S. ...	1	0	2	0	17	131	9	2	3	6	0	0
6B Isle of Man ...	0	0	0	0	1	10	1	0	0	0	0	0
11 Scilly and Channel Isles ...	0	0	2	0	1	26	4	0	1	2	1	1
TOTAL ...	6	20	27	30	262	5316	255	81	46	64	28	21
Corresponding number for last year ...	6	17	27	25	273	5180	236	68	44	44	27	17

## APPENDIX II

## GALE WARNINGS ISSUED DURING THE YEAR 1931

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. { A	18	100	42	18	16	81
{ B	7	100	34	7	12	56
2. Scotland, E. ...	13	77	30	10	10	67
3. Scotland, N.W. ...	16	87	45	14	22	80
4. Scotland W. and North Channel ...	12	100	41	12	15	66
5. Ireland, N. ...	12	100	53	12	27	74
6. Ireland, S. ...	13	100	48	13	29	87
7. Irish Sea ...	10	100	38	10	19	76
8. St. George's Channel	13	92	38	12	20	84
9. Bristol Channel ...	17	100	36	17	11	78
10. England, S.W. ...	23	83	47	19	21	85
11. England, S....	12	100	32	12	14	81
12. England, S.E. ...	11	100	30	11	12	77
13. England, N.E. ...	7	86	23	6	9	65
14. England, E....	12	92	26	11	8	73
<b>TOTALS ...</b>	<b>196</b>	<b>94</b>	<b>563</b>	<b>184</b>	<b>245</b>	<b>76</b>

## APPENDIX III

## FINANCIAL STATEMENT

The year under review, 1931-32, is the eleventh 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 1931-32.

<i>Expenditure.</i>	<i>Amount.</i>	
	£	£
Salaries and Wages—H.Q. Establishments ... ..	50,966	
"    "    —Out-station Establishments ... ..	57,904	
		108,870
Fuel and Light ... ..		421
Transport of Personnel and Equipment ... ..		4,635
Instruments, Equipment and Stores ... ..		8,612
Research ... ..		393
Minor Works Services, Rents, Repairs and Maintenance of Buildings ... ..		6,338
Telegrams, Telephones ... ..	}	14,757
Subventions to Reporting Stations and miscellaneous charges ... ..		
Superannuation ... ..		1,763
	Total ...	<u>£145,789</u>
<i>Receipts.</i>		
Receipts from Royal Society ... ..		599
"    "    National Debt Commissioners (Annuities) ... ..		113
Sale of Instruments, Carriage, etc. ... ..		2,911
Daily Weather Reports, Forecasts, etc. ... ..		2,879
Receipts from War Office and Admiralty ... ..		6,675
	Total ...	<u>£13,177</u>

## APPENDIX IV

## THE GASSIOT COMMITTEE, 1931

*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.*

Lord RUTHERFORD, O.M. (*President of the Royal Society*).

Colonel Sir HENRY LYONS (*Chairman*).

The Astronomer Royal.

Professor S. CHAPMAN.

Sir JAMES JEANS.

Sir NAPIER SHAW.

Dr. G. C. SIMPSON.

Professor G. I. TAYLOR.

## APPENDIX V

THE STAFF OF THE METEOROLOGICAL OFFICE, ITS  
OBSERVATORIES AND BRANCHES, MARCH 31, 1932

## THE STAFF AT HEADQUARTERS

## DIRECTOR :

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

<i>Assistant Directors</i> ... ..	R. G. K. Lempfert, C.B.E., M.A., F.Inst.P. E. Gold, D.S.O., F.R.S.
<i>Senior Professional Assistants</i>	Miss E. E. Austin, M.A. ; J. M. Stagg, M.A., B.Sc.
<i>Junior Professional Assistants</i>	C. J. Boyden, B.A. ; A. E. Mayers, B.Sc. ; W. R. Morgans, M.Sc. ; (one vacancy).

## GENERAL SERVICES DIVISION.

<i>Chief Clerk</i> ... ..	H. L. B. Tarrant, M.B.E.
<i>Clerk, Grade I</i> ... ..	R. M. Poulter.
<i>Clerks, Grades II &amp; III</i> ...	9
<i>Officekeeper</i> ... ..	1

## MARINE DIVISION.

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

## BRITISH CLIMATOLOGY DIVISION.

<i>Superintendent</i> ... ..	E. G. Bilham, B.Sc., A.R.C.S., D.I.C.
<i>Assistant Superintendent</i> ...	E. V. Newnham, B.Sc.
<i>Senior Professional Assistants</i>	J. Glasspoole, M.Sc., Ph.D. ; P. I. Mulholland, B.Sc.
<i>Clerk, Grade I</i> ... ..	A. G. W. Howard.
<i>Clerks, Grades II &amp; III</i> ...	16
<i>Draughtsman</i> ... ..	1

## GENERAL CLIMATOLOGY DIVISION.

<i>Superintendent</i> ... ..	C. E. P. Brooks, D.Sc.
<i>Senior Professional Assistants</i>	Miss E. H. Geake, M.Sc. ; S. T. A. Mirrlees, M.A. ; Miss L. D. Sawyer, B.A.
<i>Junior Professional Assistant</i>	Miss G. L. Thorman, B.Sc., A.K.C.
<i>Clerk, Grade I</i> ... ..	A. T. Bench.
<i>Clerks, Grades II &amp; III</i> ...	7

## FORECAST DIVISION.

<i>Superintendent</i> ... ..	R. Corless, O.B.E., M.A.
<i>Assistant Superintendents</i> ...	H. W. L. Absalom, B.Sc. A.R.C.S., D.I.C. ; C. K. M. Douglas, B.A. ; W. C. Kaye, B.Sc.
<i>Senior Professional Assistants</i>	R. F. Budden, M.A. ; G. A. Bull, B.Sc. ; A. F. Crossley, B.A. ; C. W. G. Daking, B.Sc. ; F. H. Dight, B.Sc. ; J. S. Farquharson, M.A. ; C. H. Kellett, B.Sc. ; Miss L. F. Lewis, B.Sc. ; M. J. Thomas, B.Sc.
<i>Junior Professional Assistants</i>	J. C. Cumming, M.A. ; R. Frost, B.A. ; A. L. Maidens, B.Sc.
<i>Clerk, Grade I</i> ... ..	W. Hayes.
<i>Clerks, Grades II &amp; III</i> ...	20 (one vacancy)
<i>Telephone-Typists</i> ... ..	8

## APPENDIX V—continued.

## AVIATION SERVICES DIVISION.

<i>Superintendent</i>	...	...	F. Entwistle, B.Sc.
<i>Assistant Superintendent</i>	...	...	R. S. Read, M.A., B.Sc., A.R.C.S., F.Inst.P.
<i>Senior Professional Assistants</i>			C. S. Durst, B.A. ; S. C. Russell, LL.B.
<i>Clerk, Grade I</i>	...	...	F. M. Dean.
<i>Clerks, Grade III</i>	...	...	3

## NAVY SERVICES DIVISION.

<i>Superintendent</i>	...	...	L. G. Garbett, Commander, R.N. (retd.).
<i>Senior Professional Assistants</i>			A. H. Nagle, B.Sc., A.R.C.S., D.I.C. ; E. Taylor, M.A.
<i>Clerk, Grade III</i>	...	...	1

## ARMY SERVICES DIVISION.

<i>Superintendent</i>	...	...	D. Brunt, M.A., B.Sc.
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## INSTRUMENTS DIVISION.

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

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 THE STAFF AT OBSERVATORIES AND BRANCH ESTABLISHMENTS

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

<i>Superintendent</i>	...	...	A. H. R. Goldie, M.A., F.R.S.E.
<i>Assistant Superintendent</i>	...	...	J. Crichton, M.A., B.Sc., F.R.S.E.
<i>Senior Professional Assistant</i>			D. N. Harrison, D.Ph.
<i>Clerks, Grade III</i>	...	...	5 (and one research post).

## METEOROLOGICAL OFFICE, MALTA.

<i>Superintendent</i>	...	...	G. R. Hay, M.A.
<i>Senior Professional Assistants</i>			D. W. Johnston, B.Sc. ; R. C. Sutcliffe, Ph.D.
<i>Clerk, Grade II</i>	...	...	1
<i>Clerks (locally entered)</i>	...	...	4

## METEOROLOGICAL OFFICE, MIDDLE EAST.

## HELIOPOLIS.

<i>Superintendent</i>	...	...	J. Durward, M.A.
<i>Senior Professional Assistants</i>			W. J. Grassick, M.A., B.Sc. ; C. V. Ockenden, B.Sc.
<i>Clerk, Grade I</i>	...	...	R. Pyser.
<i>Clerks (locally entered)</i>	...	...	4

## ABOUKIR, AMMAN, ISMAILIA AND RAMLEH.

<i>Senior Professional Assistant</i>			W. D. Flower, B.Sc., A.Inst.P. (Ismailia)
<i>Clerks, Grade II</i>	...	...	4
<i>Clerks (locally entered)</i>	...	...	4

APPENDIX V—continued.

METEOROLOGICAL OFFICE, IRAQ.

HINAIDI.

<i>Assistant Superintendent</i> ...	R. P. Batty, B.A.
<i>Senior Professional Assistant</i>	G. J. W. Oddie, B.Sc.
<i>Clerk, Grade II</i> ... ..	1
<i>Clerks (locally entered)</i> ...	5

DIWANIYAH, MOSUL, RAMADI, SHAIBAH.

<i>Clerks, Grade II</i> ... ..	2
<i>Clerks (locally entered)</i> ...	4

KEW OBSERVATORY, Old Deer Park, Richmond, Surrey.

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

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

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

VALENTIA OBSERVATORY, Cahirciveen, Co. Kerry.

<i>Assistant Superintendent</i> ...	M. T. Spence, B.Sc.
<i>Clerks, Grade III</i> ... ..	4
<i>Messenger</i> ... ..	1

THE OBSERVATORY, ESKDALEMUIR, Langholm, Dumfriesshire.

<i>Assistant Superintendent</i> ...	R. E. Watson, B.Sc., Ph.D.
<i>Senior Professional Assistant</i>	H. L. Wright, M.A.
<i>Clerks, Grade III</i> ... ..	3
<i>Housekeeper, Mechanic and Handyman</i> ... ..	3

THE OBSERVATORY, King's College, ABERDEEN.

<i>Clerk, Grade I</i> ... ..	G. A. Clarke.
<i>Clerks, Grade III</i> ... ..	2

THE OBSERVATORY, LERWICK, Shetlands.

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

PORT METEOROLOGICAL OFFICE, LIVERPOOL.

<i>Senior Professional Assistant</i>	M. Cresswell, Cdr. R.N.R.
<i>Clerk, Grade III</i> ... ..	1

PORT METEOROLOGICAL OFFICE, LONDON.

<i>Senior Professional Assistant</i>	C. H. Williams, Lt.-Cdr. R.N.R.
<i>Clerk, Grade III</i> ... ..	1

## APPENDIX V—continued.

## AVIATION SERVICES STATIONS

	ALDERGROVE.	
<i>Junior Professional Assistant*</i>	F. E. Coles, B.Sc., A.R.C.S., D.I.C.	3
<i>Clerks, Grades II &amp; III</i>	...	3
	ANDOVER.	
<i>Assistant Superintendent</i>	W. H. Pick, B.Sc., F.Inst.P., F.C.P.	1
<i>Clerk, Grade III</i>	...	1
	BIGGIN HILL.	
<i>Clerks, Grades II &amp; III</i>	...	5
	BOSCOMBE DOWN.	
<i>Senior Professional Assistant</i>	C. W. Lamb, M.C., B.Sc.	3
<i>Clerks, Grades II &amp; III</i>	...	3
	CALSHOT.	
<i>Assistant Superintendent</i>	H. F. Jackson, M.S.E.	...
<i>Junior Professional Assistant</i>	L. H. Starr, M.Sc.	...
<i>Clerks, Grades II &amp; III</i>	...	4
	CATTERICK.	
<i>Senior Professional Assistant</i>	W. Gillon, M.A., B.Sc.	3
<i>Clerks, Grades II &amp; III</i>	...	3
	CRANWELL.	
<i>Assistant Superintendent</i>	W. A. Harwood, D.Sc.	...
<i>Senior Professional Assistant</i>	R. M. Stanhope, B.A.	...
<i>Clerks, Grades II &amp; III</i>	...	4
	CROYDON.	
<i>Assistant Superintendent</i>	S. F. Witcombe, B.Sc.	...
<i>Senior Professional Assistant</i>	T. W. V. Jones, B.Sc.	...
<i>Clerks, Grades II &amp; III</i>	...	9
<i>Telephone-Typists</i>	...	2
	FELIXSTOWE.	
<i>Senior Professional Assistant</i>	A. Walters.	3
<i>Clerks, Grades II &amp; III</i>	...	3
	HOLYHEAD.	
<i>Clerks, Grades II &amp; III</i>	...	3
	LEUCHARS.	
<i>Senior Professional Assistant</i>	R. H. Mathews, B.A.	3
<i>Clerks, Grades II &amp; III</i>	...	3
	LYMPNE.	
<i>Assistant Superintendent*</i>	R. A. Watson, B.A.	6
<i>Clerks, Grades II &amp; III</i>	...	6
	MOUNT BATTEN.	
<i>Junior Professional Assistant*</i>	E. A. Cope, B.Sc., A.R.C.S.	3
<i>Clerks, Grades II &amp; III</i>	...	3

\* Held against vacancy for Senior Professional Assistant.

APPENDIX V—continued.

RENFREW.

*Junior Professional Assistant\** A. G. Forsdyke, Ph.D., A.R.C.S., D.I.C.  
*Clerks, Grade III* ... .. 2

SEALAND.

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

SOUTH FARNBOROUGH.

*Senior Professional Assistant* W. H. Bigg, B.Sc.  
*Clerks, Grades II & III* ... 3

UPPER HEYFORD.

*Senior Professional Assistant* N. H. Smith, B.Sc.  
*Clerks, Grades II & III* ... 3

WORTHY DOWN.

*Senior Professional Assistant* S. P. Peters, B.Sc., A.Inst.P.  
*Clerks, Grades II & III* ... 3

ARMY SERVICES STATIONS

METEOROLOGICAL OFFICE, SHOEBURYNNESS.

*Assistant Superintendent* ... C. E. Britton, B.Sc.  
*Junior Professional Assistant* J. Pepper, M.A., B.Sc.  
*Clerks, Grades II & III* ... 9

METEOROLOGICAL OFFICE, LARKHILL.

*Senior Professional Assistant* L. Dods, B.Sc.  
*Clerks, Grades II & III* ... 4

METEOROLOGICAL OFFICE, PORTON.

*Clerks, Grades II & III* ... 5

SECONDED FOR DUTY WITH OTHER BODIES

*Assistant Superintendent* ... C. D. Stewart, B.Sc. (Colonial Office, Malaya).  
*Senior Professional Assistants* R. G. Veryard, B.Sc. (R.A.F., India).  
 A. C. Best, B.Sc. }  
 E. L. Davies, M.Sc. } (War Office, Porton  
 H. Garnett, M.Sc. } Experimental Station).  
 O. G. Sutton, B.Sc. }  
 L. G. Hemens, B.Sc. (Indian Government).

\* Held against vacancy for Senior Professional Assistant.

## APPENDIX VI

## PUBLICATIONS

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, 1932).

**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 December, 1931).

**Seismological Bulletin.** A diary of seismological disturbances recorded on the Galitzin Aperiodic Seismographs at Kew Observatory, Richmond (to February, 1932).

**British Rainfall, 1930.** A report on the distribution of rain in space and time over the British Isles as recorded by over 5,000 observers.

**Observatories' Year Book, 1929 and 1930.** Comprising the meteorological and geophysical results obtained from autographic records and eye observations at the observatories at Lerwick, Aberdeen, Eskdalemuir, Cahirciveen (Valentia Observatory) and Richmond (Kew Observatory), and the results of soundings of the upper atmosphere by means of registering balloons.

**Réseau Mondial, 1924.** Monthly and annual summaries of pressure, temperature, and precipitation based on a world-wide network of observing stations.

**Southport Auxiliary Observatory. Annual Report** and results of meteorological observations, 1930. By J. Baxendell.

**Weekly Weather Report** for the period March 2, 1930 to February 28, 1931. Particulars of temperature, rainfall and bright sunshine for each week.

## OCCASIONAL :—

**Hygrometric Tables** for the computation of relative humidity, vapour pressure, and dew point from the readings of dry and wet bulb thermometers exposed in Stevenson screens. 3rd edition, 1931.

**Meteorological Observer's Handbook. Supplement No. 3.** Instructions to observers at normal climatological stations. 2nd edition, 1931.

APPENDIX VI—continued.

OCCASIONAL :—continued.

**Meteorological Observer's Handbook. Supplement No. 4.** Instructions to observers of climatological stations at health resorts. 2nd edition, 1931.

**Geophysical Memoirs :—**

Vol. VI :—

53. Characteristics of rainfall distribution in homogeneous air currents and at surfaces of discontinuity; notes on diurnal variation and on relationships with cloud, wind speed, pressure, etc. By A. H. R. Goldie, M.A., F.R.S.E.
54. The structure of wind over level country. Report on experiments carried out at the Royal Airship Works, Cardington. By the late M. A. Giblett, M.Sc., Superintendent of the Airship Division of the Meteorological Office, and other members of the staff of the Office.

**Professional Notes :—**

Vol. V :—

62. Barometer fluctuations at Malta. By R. C. Sutcliffe, Ph.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.—

Low altitude aurora. *Nature*, 127, 1931, p. 663.

Maurice Alfred Giblett. *Météorologie, Paris*, 7, 1931, pp. 31–33.

The second Polar Year, 1932–33. *Polar Record*, Cambridge, 1931, pp. 28–29; 64–67.

Some meteorological factors which may affect health. *Proc. Soc. Med.*, 1932. p. 639.

By R. G. K. LEMPFERT, C.B.E., M.A., F.Inst.P.—

The scientific work of the Meteorological Office, Cardington. Presidential Address delivered before the Royal Meteorological Society. *London, Q. J. R. Meteor. Soc.*, 57, 1931, pp. 119–131.

By F. J. W. WHIPPLE, M.A., Sc.D., F.Inst.P.—

A note on the secular changes of rock temperature on the Calton Hill. *Edinburgh, Proc. R. Soc.*, 51, 1931, pp. 19–24.

The investigation of air waves from explosions. *Progress in England. London, Q. J. R. Meteor. Soc.*, 57, 1931, pp. 331–335; also in (*Procès-verbaux.....Com. Intern. Explor. Haute Atmos., Madrid, mars, 1931*), *Publ. Intern. Meteor. Organiz.*, No. 8, 1931, pp. 80–86, pl.

On methods of estimating the heights reached by the air-waves which descend in zones of "abnormal audibility". *Beitr. Geophysik, Leipzig*, 31, 1931, pp. 158–168.

A note on the theory of the general circulation of the atmosphere. *London, Q. J. R. Meteor. Soc.*, 57, 1931, pp. 465–468.

By E. G. BILHAM, B.Sc., A.R.C.S., D.I.C.—

Photography and the meteorologist. *Photography in industry and commerce*, London, 1, No. 2, June 1931, pp. 22–23.

Measuring atmospheric pollution. *Nature*, 129, 1932, pp. 103–104.

By C. E. P. BROOKS, D.Sc.—

Climatic changes since the ice age. *London, Trans. Victoria Inst.*, 1931, pp. 23.

The correlation of pluvial periods in Africa with climatic changes in Europe. Appendix B to "The Stone Age cultures of Kenya Colony", by L. S. B. Leakey. (Cambridge University Press, 1931), pp. 267–270.

## APPENDIX VI—continued.

By D. BRUNT, M.A., B.Sc.—

Release of energy by convection. *London, Q. J. R. Meteor. Soc.*, **57**, 1931, pp. 431-432.

The distribution of pollution around Norwich. *London, Dept. Sci. Indust. Res., Report on Atmospheric Pollution*, **17**, 1931, pp. 50-58.

The combination of observations. 2nd Edn. Cambridge University Press. Pp. x+239.

By J. S. DINES, M.A.—

Meteorological instruments [at the Twenty-Second Annual Exhibition of the Physical and Optical Societies]. *London, Inst. Physics, J. Sci. Instr.*, **9**, 1932, pp. 69-71.

By J. DURWARD, M.A.—

Rotation of dust devils. *Nature*, **128**, 1931, pp. 412-413.

By F. ENTWISTLE, B.Sc.,

The meteorological aspects of gliding and soaring flight. *London, J. R. Aeron. Soc.*, **35**, 1931, pp. 423-449, disc., pp. 449-459.

By A. H. R. GOLDIE, M.A.—

The electric field in terrestrial magnetic storms. *Edinburgh, Trans. R. Soc.*, **57**, 1931, pp. 143-177.

By L. H. G. DINES, M.A.—

Potential temperature and entropy at the base of the stratosphere over the British Isles. *Nature*, **127**, 1931, pp. 815-816.

An electric time marker for self-recording instruments. *London, Inst. Physics, J. Sci. Instr.*, **8**, 1931, pp. 199-200.

On the accuracy of the Dines balloon meteorograph as a recorder of temperature and relative humidity at different pressures. *London Q. J. R. Meteor. Soc.*, **58**, 1932, pp. 19-22.

By C. K. M. DOUGLAS, B.A.—

Some problems of modern meteorology. No. 4. The present position of weather forecasting. *London, Q. J. R. Meteor. Soc.*, **57**, 1931, pp. 245-253.

A problem of the general circulation. *London, Q. J. R. Meteor. Soc.*, **57**, 1931, pp. 423-429, disc., pp. 429-431.

Note on the thunderstorms of June 5, 1931. *London, Q. J. R. Meteor. Soc.*, **57**, 1931, pp. 470-472.

Structure and development of temperature inversions in the atmosphere. *Nature*, **129**, 1932, pp. 245-246.

By E. V. NEWNHAM, B.Sc.—

Radiation from the earth's surface and other factors controlling the temperature of objects out of doors at night. *London, Min. Agric., Rep. Agric. Meteor. Conf.*, 1930, (London, 1931), pp. 1-5, duplicated.

Measurement of pressure and temperature in the upper atmosphere. *Nature*, **128**, 1931, pp. 878-879.

By W. H. PICK, B.Sc., A.Inst.P., F.C.P.—

A note on the relationship between fog and relative humidity. *London, Q. J. R. Meteor. Soc.*, **57**, 1931, pp. 288-291, disc. pp. 292-295.

The effect of smoke upon horizontal visibility at a rural station in England. *London, Q. J. R. Meteor. Soc.*, **57**, 1931, p. 412.

By W. H. PICK, B.Sc., A.Inst.P., F.C.P. with D. F. BOWERING.—

A further note on cirrus movement and the advance of depressions. *London, Q. J. R. Meteor. Soc.*, **57**, 1931, p. 274.

## APPENDIX VI—continued.

- By C. D. STEWART, B.Sc.—  
The rainfall of Malaya. *Malayan Agric. J.*, 1930, Nov. Pp. 11, maps 4.
- By R. A. WATSON, B.A. with N. R. McCURDY, B.Sc.—  
The cyclone season 1929–30 at Mauritius. *Mauritius, Royal Alfred Observatory, Misc. Publ.*, No. 12, [1931]. Pp. 3, pls.
- By M. G. BENNETT, M.Sc.—  
A visibility meter. *London, Inst. Physics, J. Sci. Instr.*, **8**, 1931, pp. 122–126.
- By A. C. BEST, B.Sc.—  
Horizontal temperature differences over small distances. *London, Q. J. R. Meteor. Soc.*, **57**, 1931, pp. 169–175, pl. disc., pp. 175–176.
- By E. L. DAVIES, M.Sc.—  
A portable temperature-gradient indicator. *London, Q. J. R. Meteor. Soc.*, **57**, 1931, pp. 177–181, disc., p. 181.
- By E. L. DAVIES, M.Sc. with O. G. SUTTON, B.Sc.—  
Some problems of modern meteorology. No. 5. The present position of the theory of turbulent motion in the atmosphere. *London, Q. J. R. Meteor. Soc.*, **57**, 1931, pp. 405–411.
- By W. D. FLOWER, B.Sc., A. Inst.P.—  
An analysis of the cold front over Egypt on March 7, 1929. *London, Q. J. R. Meteor. Soc.*, **57**, 1931, pp. 275–285, disc., pp. 285–287.
- By J. GLASSPOOLE, M.Sc., Ph.D.—  
Rain-gauge funnels of different depths. *Washington, D. C., U.S. Dept. Agric., Monthly Weath. Rev.*, **59**, 1931, pp. 157–158.  
Rainfall and run-off records. *Water and Water Engin., London*, **33**, 1931, pp. 465–466.  
The wettest places in the British Isles. *Water and Water Engin., London*, **33**, 1931, pp. 560–562.
- By A. W. LEE, M.Sc., A.R.C.S., D.I.C., A.Inst.P.—  
The determination of thicknesses of the continental layers from the travel times of seismic waves. *London, Mon. Not. R. Astr. Soc. Geophys. Supp.*, **3**, 1932, pp. 13–21.  
The North Sea earthquake of 1927 January 24. *London, Mon. Not. R. Astr. Soc., Geophys. Supp.*, **3**, 1932, pp. 21–30.
- By S. T. A. MIRRLEES, M.A.—  
Meteorological log in the Antarctic, November 1908 to February, 1909. *London, Q. J. R. Meteor. Soc.*, **57**, 1931, pp. 201–216.  
Remarks on "The present position of theories of the general circulation of the atmosphere". *London, Q. J. R. Meteor. Soc.*, **57**, 1931, pp. 457–459.
- By F. J. SCRASE, M.A., B.Sc., A.I.C.—  
The instrumental phase-difference of seismograph records ; an illustration of the properties of damped oscillatory systems. *London, Proc. Physic. Soc.*, **43**, 1931, pp. 259–274.  
The reflected waves from deep focus earthquakes. *London, Proc. R. Soc.*, **132(A)**, 1931, pp. 213–235.
- By J. M. STAGG, M.A., B.Sc.—  
Diurnal variation of barometric pressure at Lerwick, Shetland. *London, Q. J. R. Meteor. Soc.*, **58**, 1932, pp. 69–71.  
The second Polar Year. *Polar Record, Cambridge*, **2**, 1932, pp. 33–35.

APPENDIX VI—*continued.*

By O. G. SUTTON, B.Sc.—

Note on the variation of the wind with height. *London, Q. J. R. Meteor. Soc.*, **58**, 1932, pp. 74-76.

A theory of eddy diffusion in the atmosphere. *London, Proc. R. Soc.*, **135(A)**, 1932, pp. 143-165.

By H. L. WRIGHT, M.A.—

The variation of soil temperature below turf : a discussion of observations at Kew Observatory. *London, Mem. R. Meteor. Soc.*, **4**, No. 31, 1931, pp. 1-18.

By W. R. MORGANS, M.Sc.—

A continuous atomic matrix. *Phil. Mag., London, (7 Ser.)*, **13**, 1932, pp. 664-673.

By P. A. SHEPPARD, B.Sc.—

Character of atmospheric ionisation. *Nature*, **129**, 1932, p. 169.

By P. R. ZEALLEY.—

Upper air investigations over the Jordan. *London, Q. J. R. Meteor. Soc.*, **58**, 1932, pp. 58-61.

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