FIFTEENTH ANNUAL REPORT

OF THE

METEOROLOGICAL COMMITTEE

TO THE

LORDS COMMISSIONERS OF HIS MAJESTY'S TREASURY.

For the Year ended 31st March, 1920

(*the Sixty-fifth Year of the Meteorological Office*).

Presented to Parliament by Command of His Majesty.

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REPORT.

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METEOROLOGICAL COMMITTEE.

APRIL, 1919 — OCTOBER, 1919.

Constituted by Minutes of the Lords Commissioners of H.M. Treasury, dated 20th May, 1905, 31st March, 1910, 31st March, 1915. Appointed by the Lords Commissioners of H.M. Treasury until :—

March 31st, 1920 ... Sir Napier Shaw, Sc.D., F.R.S., Director.

Sept. 1st, 1919 ... Rear-Admiral Sir J. F. Parry, R.N., K.C.B. Hydrographer to the Navy.

March 31st, 1920 ... Captain J. M. Harvey, Principal Examiner of Masters and Mates, Board of Trade. Nominated by the Board of Trade.

Dec. 2nd, 1921 ... Sir Thomas Middleton, K.B.E., C.B. Assistant Secretary of the Board of Agriculture and Fisheries. Nominated by the Board of Agriculture and Fisheries.

March 31st, 1920 ... Sir Arthur Schuster, D.Sc., F.R.S. Nominated by the Royal Society.

Feb. 26th, 1923 ... Colonel H. G. Lyons, D.Sc., F.R.S. Nominated by the Royal Society.

March 31st, 1920 ... Sir George Barstow, K.C.B. Nominated by the Treasury.

METEOROLOGICAL COMMITTEE.

OCTOBER, 1919 — MARCH, 1920.

Appointed by the Air Council.

Major-General Sir F. H. SYKES, G.B.E., K.C.B, C.M.G. Controller General of Civil Aviation. *President.*

Sir NAPIER SHAW, Sc.D., F.R.S., Director. *Chairman.*

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

Captain J. M. HARVEY. Principal Examiner of Masters and Mates, Board of Trade. Nominated by the Board of Trade.

Rear-Admiral F. C. LEARMONTH, C.B., C.B.E. Hydrographer to the Navy.

Lieut.-Colonel H. A. LEWIS, R.A. Superintendent of Experiments, Shoeburyness. Nominated by the War Office.

Colonel H. G. LYONS, D.Sc., F.R.S. Nominated by the Royal Society.

Mr. H. W. W. MCANALLY, C.B. Assistant Secretary, Air Ministry. Nominated by the Air Ministry.

Mr. L. V. MEADOWCROFT. Nominated by the Air Ministry.

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

Sir ARTHUR SCHUSTER, D.Sc., F.R.S. Nominated by the Royal Society.

Dr. E. M. WEDDERBURN, F.R.S.E. Nominated by the Royal Society of Edinburgh.

COMMITTEE OF THE METEOROLOGICAL OFFICE, EDINBURGH.

Appointed 1913.

1919-20.

The Director of the Meteorological Office (*Chairman*).

The late Sir JAMES PATTEN MACDOUGALL, Registrar-General for Births, Deaths and Marriages for Scotland.

Sir ROBERT GREIG. Nominated by the Board of Agriculture for Scotland.

Professor R. A. SAMPSON, F.R.S., Astronomer-Royal for Scotland. Nominated by the Scottish Meteorological Society.

Dr. E. M. WEDDERBURN, F.R.S.E. Nominated by the Scottish Meteorological Society.

Dr. C. G. KNOTT, F.R.S., Sec. R.S.E. Nominated by the Scottish Meteorological Society.

THE GASSIOT COMMITTEE, 1920.

Appointed by the Royal Society in accordance with Treasury Letter of 26th February, 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.

Sir Joseph J. Thomson, O.M. (*President of the Royal Society*).

Colonel H. G. Lyons (*Chairman*).

The Astronomer-Royal.

Dr. C. Chree.

Mr. W. H. Dines.

Sir Richard Glazebrook.

Mr. J. H. Jeans.

Sir Joseph Larmor.

Professor H. F. Newall.

Sir Arthur Schuster.

Sir Napier Shaw.

Mr. G. W. Walker.

Mr. C. T. R. Wilson.

ADVISORY COMMITTEE ON ATMOSPHERIC POLLUTION 1919.

Appointed by the Meteorological Committee, 12th March, 1919, at the request of the Department of Scientific and Industrial Research, to be an Advisory Committee, for the administration of a grant by the Department, for the investigation of atmospheric pollution.

Sir Napier Shaw, F.R.S. (*Director of the Meteorological Office*) *ex-officio* (*Chairman*).	Nominated by the Meteorological Committee.
Professor H. B. Baker, C.B.E., F.R.S. (*Royal College of Science*).	
Mr. J. G. Clark, F.I.C.	
Professor J. B. Cohen, B.Sc., Ph.D., F.R.S. (*Professor of Organic Chemistry, Leeds University*).	
Dr. H. A. des Voeux (*Hon. Treasurer, Coal Smoke Abatement Society*).	
Dr. J. S. Owens (*Coal Smoke Abatement Society*).	
Dr. E. J. Russell (*Director of the Rothamsted Experimental Station, Harpenden*).	
Bailie W. Smith (*Member of Departmental Committee on Smoke Abatement*).	
Mr. S. A. Vasey, F.I.C., F.C.S. (*Director of the "Lancet" Laboratory*).	
Mr. F. J. W. Whipple (*Superintendent of the Statistical Division, Meteorological Office*).	
Dr. John Robertson, nominated by the Corporation of Birmingham.	Nominated by the Municipal Authorities contributing observations.
Dr. W. Hanna, nominated by the Corporation of Liverpool.	
Dr. W. T. Howarth, nominated by the Corporation of the City of London.	
Mr. Henry Mills, J.P., nominated by the London County Council.	
Mr. W. Osborne Thorp, nominated by the Corporation of Malvern.	
Professor W. Haldane Gee, nominated by the Corporation of Manchester.	
Mr. C. T. Stapleforth, J.P., nominated by the Corporation of Newcastle-on-Tyne.	
Dr. J. B. Wilkinson, nominated by the Corporation of Oldham.	
Dr. J. R. Ashworth, nominated by the Corporation of Rochdale.	
Dr. Cates, nominated by the Corporation of St. Helens.	
Mr. John Fyfe, nominated by the Corporation of Stirling.	
Mr. W. S. Curphey (*Chief Alkali Inspector of the Local Government Board*).	Appointed by the Advisory Council for Scientific and Industrial Research.

THE STAFF OF THE METEOROLOGICAL OFFICE, AND OF THE OBSERVATORIES, CONTRIBUTIVE, AND DISTRIBUTIVE STATIONS OF THE METEOROLOGICAL COMMITTEE, MARCH, 1920.

DIRECTOR :
Sir Napier Shaw, LL.D., Sc.D., F.R.S.

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Boy and Girl Clerks ...	Miss A. Fitch, R. Graham, A. J. Wallis.

British Rainfall Organization.

62, Camden Square, N.W.1.

Superintendent	M. de C. Salter.
Professional Assistant ...	J. Glasspoole, B.Sc.
Temporary Assistant ...	W. A. Bion.
Staff Assistant	H. E. Carter.
Clerk Computer	Miss Lamport.
Boy Clerk	J. F. Oliver.

Instruments Division.

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Probationer	H. J. Bigelstone.*
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1 Messenger.

* On special leave.

Meteorological Office, Edinburgh.

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Professional Assistant ...	J. Crichton, M.A., B.Sc.
Clerical Assistants	Misses Crawford, Murray.

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Professional Assistants	C. D. Stewart, B.Sc., C. H. Kellett.
Principal Assistant	E. Boxall.
Staff Assistants	B. Francis, H. G. Harris.
Clerk Assistant	L. G. Hemens.*
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Magnetic Observatory.

Eskdalemuir, Langholm, Dumfries-shire.

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Clerk Assistant	B. G. Brame.
Mechanical Assistant	W. H. Hogg.
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	1 Caretaker. 1 Messenger.

Western Observatory.

Valencia Observatory, Cahirciveen, co. Kerry.

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Professional Assistant	P. I. Mulholland, B.Sc.
Supernumerary Clerk	M. Sugrue.
Boy Clerks	M. Morley, J. Morley.
	1 Messenger.

Aerological Observatory.

Benson, near Wallingford.

Assistant Director	W. H. Dines, F.R.S.
In charge of experiments in computation of sequence of weather by numerical process	L. F. Richardson, B.A.
Staff Assistant	H. W. Baker.
Mechanical Assistant	B. C. Lewis.

Meteorological Office, South Farnborough.

Meteorologist-in-Charge ...	R. A. Watson Watt, B.Sc., A.M.I.E.E.
Technical Assistant	C. A. Grant.
Clerk Computer	W. J. Fowler.
Supernumerary Clerk	Miss I. M. Brierley.

Weather Station, Falmouth Observatory.

Assistant-in-Charge	J. B. Phillips.
Probationer	W. A. Toms.

Northern Observatory.

At King's College, Aberdeen, under the direction of Professor Charles Niven, F.R.S.

Assistant	G. A. Clarke.
Boy Clerk	G. M. Rattray.

* On special leave

ARMY SERVICES.

Superintendent (H.Q.) ... D. Brunt, MA., B.Sc.

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Technical Assistants ... ... G. C. Baldwin, P. W. Dingle, A. C. Lloyd, H. D. K. Millar, R. G. Veryard, F. G. Whitaker, P. R. Zealley.

WEST LAVINGTON.

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Clerk Assistant ... ... C. V. Ockenden.*
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CALSHOT.

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Technical Assistants ... ... W. L. Andrews, C. F. J. Jestico, C. V. Starr.

CRANWELL.

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Staff Assistant ... ... G. A. Wright.
Technical Assistants ... ... G. R. Gentleman, S. N. Plummer.

CROYDON.

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Staff Assistant ... ... J. F. Davison.
Technical Assistants ... ... J. D. Ashton, W. R. Penfold.

DIDSBURY.

Professional Assistant ... G. L. H. D. Lane, B.A.
Staff Assistant ... ... E. S. Tunstall.
Technical Assistant ... ... E. S. Ward.

FELIXSTOWE.

Professional Assistant ... A. Walters.
Staff Assistant ... ... D. F. Bowering.
Technical Assistant ... ... J. S. Smith.

HOWDEN.

Professional Assistant ... G. Harris.

LYMPNE.

Professional Assistant ... R. S. Read, M.A., B.Sc.
Staff Assistant ... ... J. G. Goodyear.
Technical Assistants ... ... R. L. Sims; T. F. Twist.

* On special leave.

AIR MINISTRY.

FIFTEENTH ANNUAL REPORT

OF THE

METEOROLOGICAL COMMITTEE

TO

THE LORDS COMMISSIONERS OF HIS MAJESTY'S TREASURY.

For the Year ended 31st March, 1920 (the Sixty-fifth Year of the Meteorological Office).

MAY IT PLEASE YOUR LORDSHIPS,

The year 1919 is marked in the history of the Meteorological Office by two notable events, first the incorporation of the work of the British Rainfall Organization with that of the Meteorological Office, which was effected by an indenture of agreement between the Trustees of the British Rainfall Organization and the Director of the Meteorological Office dated 24th July, 1919; and secondly the detachment of the Meteorological Office from direct responsibility to the Lords Commissioners of H.M. Treasury for the grant-in-aid of the expenses of the Office in the vote for scientific investigation, which has been made year by year since 1867, and its attachment to the Air Ministry in pursuance of a decision of the Home Affairs Committee of the War Cabinet which was reached on 8th May, 1919, and has gradually been brought into operation. From the beginning of the current year the expenses of the Office have become chargeable entirely upon the votes of the Air Estimates.

The Transfer to the Air Ministry.—It was recorded in the fourteenth report of the Committee to the Lords Commissioners of His Majesty's Treasury, p. 18, that on 4th December, 1918, the Treasury notified the Committee that, subject to certain conditions, the Committee of the War Cabinet for Home Affairs had approved a resolution that the Meteorological Office should be attached to the Government through the Committee of the Privy Council which controls the grant for Scientific and Industrial Research, instead of being in direct connexion with the Treasury.

The question came before the Committee of the Cabinet again on 8th May, 1919, on the report of a Sub-Committee of the Research Committee of the Cabinet, which at the instance of the Lords Commissioners of H.M. Treasury was appointed to lay down certain principles of co-ordination for the guidance of the Meteorological Services. The conclusions of this report are set out in Appendix I. Upon their consideration the Committee of the Cabinet on Home Affairs arrived at the following decision:—

"That the Meteorological Service be co-ordinated on the lines set out in the recommendations of the Sub-Committee of

the Research Committee (R.C.12 G.T.7173) and be attached to the Air Ministry. All other departments including the Meteorological Office to be adequately represented."

The process of attachment of the Meteorological Office to the Air Ministry in pursuance of the decision has been gradual.

After correspondence with the Treasury a conference was held at the Air Ministry on 9th July, 1919, at which the Controller General of Civil Aviation and other representatives of the Air Ministry were present together with Colonel Lyons and the Director of the Office. It was arranged that a letter should be sent to the Treasury suggesting the terms upon which the Meteorological Service of the Air Ministry should be co-ordinated with the Meteorological Office as from 1st July, 1919, and the Director undertook to become informally responsible for the Meteorological Service of the Air Ministry, and divide his time between South Kensington and the Offices of the Air Ministry.

Accommodation.—One of the items in the scheme of co-ordination of the Sub-Committee of the War Cabinet is the concentration of the work of the Head Quarters of all the Meteorological Services in a single building in Westminster, within easy reach of the principal public offices and large enough for the increased staff necessary for the development of the services. The accommodation required was estimated at 39,000 square feet (inclusive of passages) to replace 26,000 square feet in the building erected for the Office in 1910 in Exhibition Road, the equivalent of about 8,000 square feet at 15, Cromwell Road, which was occupied during the war, the house of the British Rainfall Organization at 62, Camden Square, and some private accommodation used for the Investigation of Atmospheric Pollution at 47, Victoria Street.

The question of the provision of the accommodation required came before the committee of the War Cabinet on Accommodation on 17th July, 1919, when it was explained that the provision of so large an amount of accommodation as 39,000 square feet in a single building near Whitehall could not be regarded as an immediate possibility. Upon the representation that it was imperative to have at least a co-ordinated scheme of forecasting, and that the Headquarters of the Meteorological Service should be in the same building with the departments of Civil Aviation, it was arranged that the Air Ministry should devote 9,000 square feet of its accommodation for the Headquarters Staff and the Forecast Division, and that provision should be made in the same building for the lithographic press.

That arrangement has been carried through. Accommodation has been found for the Director, the separate registry of the Meteorological Office and its accounting staff in a block of rooms on the third floor of the Air Ministry Offices in Kingsway, for the Forecasting Service on the third and fourth floors, for the lithographic press in the basement, and subsequently for the Marine Division of the Office on the fifth floor. The Library and Statistical Division remain at South Kensington where also the work of the Instruments Division has been replaced from 15, Cromwell Road. The rooms on the top floor temporarily assigned in 1910 for the staff of the Science Museum and borrowed by the Meteorological

Office during the war, have again been placed at the disposal of the Science Museum. Temporary provision has been made in the building at South Kensington for chemical work in Atmospheric Pollution, but the British Rainfall Organization remains at 62, Camden Square.

Re-constitution of the Meteorological Committee.—The Meteorological Committee continued to carry on its business as before until the Committee was summoned by the Under-Secretary of State for Air (Major-General Seely) to meet at the Air Ministry on 15th October, 1919. The meeting was attended by the Under-Secretary, the Controller General of Civil Aviation, three other representatives of the Air Ministry, the Director of the Meteorological Office and three other members of the Meteorological Committee, also by the Superintendent of the Meteorological Service of the Admiralty. It was thereupon agreed that the Controller General of Civil Aviation should become President of the Committee, while the Director of the Office remained Chairman, and that the other members of the Committee should be a representative of the Admiralty, the Ministry of Agriculture, the Board of Trade, the War Office, two representatives of the Royal Society, and two of the Air Ministry (one Secretarial and one Financial). The Colonial Office was also requested to nominate a member, and subsequently a similar invitation was extended to the Royal Society of Edinburgh, in response to a representation presented by the Scottish Office. It was further agreed that the issue of publications including the Annual Report should be on the authority of the Meteorological Committee acting on behalf of the Air Council.

The invitations to nominate members of the Committee were accordingly issued. They were accepted. The Royal Society, the Admiralty, the Board of Trade, and the Ministry of Agriculture renominated the same gentlemen as their representatives; the Colonial Office named Mr. J. E. W. Flood; the War Office Lieut.-Col. H. A. Lewis, R.A.; the Air Ministry Mr. H.W.W. McAnally, C.B., Assistant Secretary, and Mr. L. V. Meadowcroft, F.E.; the Royal Society of Edinburgh named Dr. E. M. Wedderburn, F.R.S.E.

Meetings of the Committee.—During the year meetings of the old committee were held on 4th April, 28th May, 25th June, 30th July, the ninety-third to the ninety-sixth meetings. No change in the membership of the Committee took place during that period, but in the interval before the ninety-seventh meeting Rear-Admiral Sir John Franklin Parry, K.C.B., retired from the office of Hydrographer of the Navy and was succeeded by Rear-Admiral F. C. Learmonth, C.B., C.B.E. After reconstitution at the ninety-seventh meeting on 15th October, the Committee met on 5th November, 3rd December, 28th January and 24th March, the ninety-eighth to the hundred and first meetings from the time of its first appointment in 1905.

Financial Arrangements.—The first meeting of the reconstituted Committee was held on November 5th, 1919, when a letter from the Treasury to the Air Ministry dated 4th November, 1919, was read, replying to a letter of 16th July, agreeing that provision

should be taken in Air Ministry votes for 1919-20, then shortly to be laid before Parliament, for an inclusive sum as grant to the Meteorological Office in supplementation of the grant of £47,000 in Class 4 (Scientific Investigation) vote 8, sub-head B; and that in 1920-21 and succeeding years the vote in Class 4 would not be made and the extra expenditure of the Meteorological Office would be provided for in Air Ministry votes, and accounted for as a charge against those votes.

The Treasury also agreed "that as from the date of the transfer the Meteorological Committee appointed under Treasury minute should be wound up, and a new Meteorological Committee under the Air Ministry constituted, in the manner provided in the report of Mr. H. A. L. Fisher's Committee, which was approved by the Cabinet Committee on Home Affairs."

It was subsequently arranged that for the purposes of accounting the date of transfer should be taken as 1st October, 1919, and from that date any expenditure on the Meteorological Office beyond the sum included in the grant-in-aid for 1919-20, *viz.*, £47,000, has been made on authority of the Air Ministry.

Between November 5th, 1919, and January 31st, 1920, two sets of estimates of the expenses of the co-ordinated Meteorological Service have been prepared for the Air Ministry, one for the financial year 1919-20, and the other for the financial year 1920-21. In the former a sum is taken for the expenses of the Meteorological Office in supplementation of the grant-in-aid, while in the latter, provision is made for the expenses of the Meteorological Office at Head Quarters under Vote 5C, and for the expenses of the observatories and stations under Vote 8G. The financial arrangements of the Office are therefore now in charge of the financial department of the Air Ministry. The banking account of the Meteorological Committee is to be closed, and the accounting staff withdrawn.

Powers and Functions of the Committee.—On 24th March, 1920, a sub-committee was appointed to prepare a draft minute of regulations for the Meteorological Committee to replace Treasury Minute of 20th May, 1905 (Report 1905-6, p. 46) under which the work of the Office has been conducted for the past fifteen years. With some amendments the report of the sub-committee was adopted by the Committee on April 28th, 1920, and has been approved by the Air Council after reference to the Royal Society for comment. The arrangement thus arrived at is printed as Appendix II as giving the regulations under which the work of the Office is to be conducted in future.

The various Meteorological Services to be Co-ordinated.

At the beginning of the financial year now under review the Meteorological Services included:

A. The Meteorological Office.
B. The Meteorological Service of the Air Ministry.
C. The Meteorological Section, R.E.
and D. The Meteorological Service of the Admiralty.

The primary duty of the Committee was to co-ordinate these services. The problem was rendered more intricate by the fact

that the conditions and requirements of the services established during the war were rapidly changing during demobilisation. A number of duties were no longer necessary and considerable numbers of officers with practical experience were set free for other work.

A. **The Meteorological Office.**—There were comprised within the organisation of the Meteorological Office:

1. A small number of observatories and anemographic stations at which meteorological records of various kinds were obtained.

2. A number of telegraphic reporting stations which contributed observations by telegram to supplement those obtained from the observatories for the purpose of preparing the daily charts of distribution of pressure, &c., on which the forecasts are based.

3. A number of stations maintained by municipal authorities or private persons, to the number of about 500, at which daily observations of pressure, temperature, weather and rainfall are made of which copies are transmitted periodically to the Office, to supply the material of what is known in the Office as the public memory of the weather of the British Isles; and which form, with information obtained from British Ships traversing all oceans, from the Dominions, Colonies and foreign countries by an elaborate system of exchange of publications, a unique library of information about the weather extending generally over a long series of years for every part of the world.

The staff of the Central Office was responsible for inspecting and co-ordinating the work of the observers, partly by direct communication with the observers, partly by communication with the authorities of local services, and partly by the operation of international agreements arranged at successive international meetings of meteorologists dating back to the International Conference on Marine Meteorology held in Brussels in 1853.

It was also responsible for initiating and maintaining at its own observatories, observations of a routine or experimental character in meteorology, including the study of the upper air, and also at certain of its observatories in magnetism and seismology in accordance with an agreement between the Office and the Royal Society made in 1909 with the approval of the Treasury. Its contribution to the study of these subjects is represented by an elaborate series of publications including a collection of data, summaries of data in forms applicable to questions bearing upon agriculture, public health and other subjects as required by various Government departments and the general public, and accounts of discussions of the data for the use of seamen, and also a series of memoirs on researches conducted in the Office or at the observatories.

The issues included a daily weather report, originally of four pages, but recently enlarged to ten pages, containing the data received day by day by telegraph, telephone or wireless and containing forecasts based upon the charts of observations prepared in the Office. The daily weather report was supplemented by a number of special issues for the services and for the newspaper press.

It must be remarked that of necessity during the five years of the war the gradual development of meteorological and geophysical work at the Observatories belonging to the Office was stopped, and there are now many arrears to be overtaken in order to bring the work of the Office properly up to date. In particular the system of reports by wireless from Atlantic liners, which was initiated in 1909, collapsed during the war, and though temporarily restored by the Meteorological Service of the Air Ministry in connection with the Atlantic flights has now ceased to exist. It has to be restored on new lines which will be generally applicable in many parts of the world and which will provide for the special requirements of aircraft.

The available data for the daily report were supplemented in recent years by a large number of observations of the upper air obtained by the Meteorological Service of the Air Ministry and by the Meteorological Section of the Royal Engineers which was brought into operation during the war. We therefore note here the part taken by those services at the beginning of the year under review.

B. **The Meteorological Service of the Air Ministry.**—This originated before the war with an establishment at Kingsnorth for the supply of information for naval aircraft, particularly for airships, and before it was transferred from the Admiralty to the Air Ministry in 1918 it had developed into an extensive service including some 40 stations at selected positions, mainly on or near the coast, at which watch was kept on the weather day and night, including observations of the winds of the upper air four times daily. Each station required one or two trained officers and some four to eight trained men. For the supervision of their work, and the application of the information received, a Headquarters' staff was maintained, first at the Admiralty, then at John Street, Adelphi, and subsequently at the offices in Kingsway by the Air Ministry.

On the cessation of hostilities the special need for meteorological information for patrolling airships and other aircraft on active service disappeared, but a new reason for the prosecution of the same kind of activity arose in connexion with the training establishments of the Royal Air Force and the requirements of Civil Aviation. The special localities where information was required were, however, entirely changed, and after prolonged consideration 20 places were named in the United Kingdom at which provision should be made for meteorological work maintained on the same lines as that of the stations of the Air Ministry during the war.

At the same time the Committee were informed that civilian meteorologists would be required for the maintenance of an establishment at Malta, which was regarded as urgent both by the Air Ministry and the Admiralty, and that in time civilian meteorologists would also be required for the service of the great air routes converging at Cairo.

C. **The Meteorological Section, R.E.**—This service was initiated by the Meteorological Office in June, 1915, at the request of the Director-General of Military Aeronautics and the Chief Engineer General Headquarters Staff, to provide information for aircraft

and for Gas Warfare on the Western Front. In the autumn of the same year the officers and men were constituted a Unit of the Corps of Royal Engineers, their functions being :

1. To act as Meteorological Advisers to the General Staff, both at General Headquarters and at Army Headquarters.
2. To supply all meteorological information required by the Royal Flying Corps (later the Royal Air Force).
3. To furnish the regular reports required for the correction of range in Artillery operations.
4. To furnish meteorological reports and forecasts for offensive and defensive gas operations.

Meteorological Sections were formed subsequently for the service of other fronts, and in 1918 the group of Sections became the Army Meteorological Service under the direction of Colonel H. G. Lyons, R.E., as Commandant—a member of the Committee of the Meteorological Office, who was at the same time Acting Director of the Office. At first the officers were supplied directly from the staff of the Meteorological Office, and after the establishment of the Sections as units of the Royal Engineers the Office continued to provide opportunities for the training of the officers as required, and to supply the fundamental reports necessary for the construction of synoptic charts for the preparation of forecasts.

The Meteorological Section included units on the Western Front, Gallipoli Front, Macedonia Front, Italian Front, North Russian Front, Independent Force R.A.F., and a Home Unit with Head Quarters on Salisbury Plain to meet the requirements of the Army. All these activities have now been suspended except the home work for the Army. The Army Council have expressed the opinion that this work should be undertaken by the Meteorological Office and three stations equipped and maintained for that purpose are to be staffed by civilians. In consequence all the officers and men of Meteorological Section, R.E., have been demobilised and, thus set free, they have formed an indispensable reserve for staffing the Office in respect of its new requirements with officers of experience of the most serviceable kind.

D. **The Meteorological Service of the Admiralty.**—Within the duties of the Naval Meteorological Service, as developed during the war, were included the meteorological requirements of the ships and vessels of H.M. Navy, which from time immemorial have been associated with the Hydrographic Office. When the Naval Meteorological Service came under the control of the Hydrographer, all the requirements of the Admiralty in regard to meteorology were co-ordinated with a special staff at Headquarters, and when the duties in respect of aircraft were transferred to the Air Ministry a small Headquarters' staff was retained at the Hydrographic Office to meet the requirements of the Navy. It has been arranged that this staff shall be accommodated with the staff of the Office at the Air Ministry and the cost charged to Air Votes.

It is the co-ordination of these four separate Meteorological Services which the Meteorological Committee has been called upon to undertake.

The Incidental Duties of the Co-ordinated Service.

Colonial Services.—It has been represented to the Committee in correspondence with the Colonial Office and in other ways that there is meteorological work of great importance to British interests with which British Dominions beyond the seas must be closely associated and which cannot properly be regarded as a matter of merely local interest. The self-governing dominions have, as a rule, meteorological organisations of their own, but the Colonies and Protectorates for the most part provide only for the climatological side. Besides the general assistance that can be given by supervision of methods and the working out of special problems for the Colonies and Protectorates, attention has been called to special requirements in respect of tropical hurricanes and other phenomena of weather which affect in succession a whole series of separate communities and in particular it has been urged and recognised that such isolated points as St. Helena, Ascension, and Bermuda, are of great importance to the study of problems of weather of wide significance.

Arctic and Antarctic Exploration.—There are other questions arising in connexion with colonial administration to the solution of which the Meteorological Office is expected to contribute, of which an example is shown by the proposal of the Colonial Office for a scientific expedition to the Falkland Islands protectorate which is set out in the Report of the Inter-departmental Committee on Research and Development in the Dependencies of the Falkland Islands. It affords an opportunity for the study of the meteorological conditions of the southern hemisphere which occurs very rarely and ought on no account to be neglected. It has always been part of the recognised duty of the Meteorological Office to afford any assistance within its resources to the Governments of the Dominions, Colonies and Protectorates, but beyond the maintenance of an anemometer at St. Helena and the loan of instruments for stations in many parts of the world it has not hitherto assumed any financial responsibility.

Another request for co-operation has come through the Foreign Office from the Norwegian Government, and has reference to special study of the meteorological and magnetic conditions of the Northern Regions in connexion with Roald Amundsen's expedition to the Arctic Ice field. Participation in this enterprise has been recommended by the Royal Society on the advice of the National Geophysical Council recently established.

With the co-ordination of the services the Committee have had to consider the additional items which have been mentioned, namely, the development of the experimental work of the Office on normal lines which was suspended during the war, the maintenance of stations for the service of the War Office, the provision of establishments for Malta, St. Helena, Ascension, and Bermuda, and the provision for meteorological expeditions on such occasions as may arise from time to time.

The Scottish Establishment.—Another development which is analagous to, and connected with, local distribution and the collection and discussion of local meteorological information, is the provision of an effective local organisation for Scotland. For many years the Scottish Meteorological Society with a grant from the Registrar-

General for Scotland and some indirect assistance from the Meteorological Office, has collected information from voluntary stations, and has compiled statistics of the weather and rainfall of Scotland for climatological purposes. The general statistical tables have been published in the reports of the Registrar-General for Scotland, which are of special interest in relation to the notable researches of Sir Arthur Mitchell and Dr. Alexander Buchan upon the relation of weather and health. Tables of monthly rainfall also have been published in the Journal of the Society. With the gradual increase in the work the Society has been less able to bear the cost of management. In 1913 an arrangement was made whereby the Meteorological Office made a contribution of £350 a year, to which was added the £100 paid by the Treasury on account of the Registrar-General, and the management of the climatological service was entrusted to a committee of which the Director of the Meteorological Office was chairman, the Registrar-General for Scotland was a member, with a representative of the Scottish Board of Agriculture and three members nominated by the Society. The work was superintended by the Secretary of the Society and was carried on by a small staff in the Society's rooms. When the general increase of prices made it necessary to make additions by way of war-bonus to the agreed payments, the Society appealed to the Meteorological Office to provide the necessary funds since the work was fully represented by official publications. The Meteorological Committee agreed to do so. At the end of the year the Scottish Meteorological Society represented that they were unable to continue the customary work on climatology and rainfall without further assistance, and in the meantime they had represented to the Committee the desirability of having a meteorological centre for the issue of daily reports in Scotland. It was apparent during the course of the war, and has long been acknowledged, that a local office dealing with the supply of daily information about the weather to the Scottish press and public would be of considerable utility, but in view of the maintenance of meteorological establishments near Edinburgh by the Service of the Admiralty, and subsequently by the Air Force, it seemed inadvisable to set up a separate establishment in Edinburgh itself without suitable arrangements for co-operation. The meteorological establishments of the northern aerodromes have now all been withdrawn, but expert meteorological assistance is required for some of the training establishments of the Royal Air Force in Scotland and also for civil aviation. The Committee are therefore making arrangements for the extension of the establishment of the Meteorological Office in Edinburgh so that it may not only continue the climatological work hitherto carried on in conjunction with the Scottish Society, but also become a centre for the discharge of duties connected with the daily weather service for the Air Ministry as well as the press and general public of Scotland.

British Rainfall Organization.—A further addition to the duty of the Office as now reconstituted is represented by the undertaking on the part of the Director of the Office to carry on, as from 24th July, 1919, the work of the British Rainfall Organization. That organization was begun in 1859 by the late George James Symons, F.R.S., who was for a time a member of Rear-Admiral FitzRoy's

staff in the Meteorological Department of the Board of Trade. The object of his organization was to collect into a single body of statistics all the available information about the rainfall of the British Isles. In 1860 there were few official rain gauges set up, as at the Royal Observatory, the Ordnance Survey Office and FitzRoy's stations, and even now there are not a hundred rain gauges in the Country maintained by Government funds. But in 1860 a considerable number of gauges had been set up by private persons in various parts of the Country and the practice was encouraged by the Royal Meteorological Society, which was established in 1850, and the Scottish Meteorological Society established in 1856. Information about rainfall is esssential in all questions of water supply and it was Symons' object to bring together all available information in order to make it applicable to the solution of current problems. The utility of the project has been amply demonstrated by the remarkable success which attended Symons' efforts and the important position which the Organization has held and still holds in all questions of water supply in the United Kingdom. Symons continued the work as a personal enterprise until his death in 1900 and a year later it was acquired by Dr. H. R. Mill who developed and improved the Organization still further, and in 1910 with a view to providing for its permanent development on scientific lines transferred the responsibility for the custody of the accumulated and accumulating records to a body of Trustees consisting of :—

The late R. M. Barrington, M.A., LL.B., Bray, Co. Wicklow.
The late Sir Alexander R. Binnie, Past President of the Institution of Civil Engineers.
Charles L. Brook, B.A., Meltham, Yorkshire.
C. J. P. Cave, M.A., J.P., Ditcham Park, Hants.
Francis Druce, M.A., London, *Treasurer*.
Douglas W. Freshfield, M.A., Royal Geographical Society.
Henry Mellish, C.B., President of the Royal Meteorological Society.
Hugh Robert Mill, D.Sc., LL.D., Past President of the Royal Meteorological Society, *Chairman*.
The late Sir John Murray, K.C.B., D.Sc., LL.D., Ph.D., Edinburgh.
James G. Wood, M.A., LL.B., London.

Its collection of statistics was at that time stated to comprise 150,000 complete annual records of rainfall in the British Isles. Dr. Mill became Director of the Organization and Chairman of the Trustees. He was also, in virtue of his control of the collection of data, the recognised adviser on all water bills and other public questions concerning rainfall. Among other responsibilities he held that of Meteorological Adviser to the London Water Authority.

A synopsis of results obtained has been given year by year in *British Rainfall*, a publication which has reached its fifty-eighth annual issue. The interest of the observers was maintained by a monthly magazine which represented the scientific and popular aspects of meteorology. As time went on more rain gauges were set up, not only by private persons but also by the authorities of water undertakings, municipal and private, and the number of

gauges reporting to the Office of the Organization in Camden Square exceeded the large total of 5,000.

It was inevitable that a work of such national importance as the collection and preservation of information about rainfall should ultimately become a national responsibility, and on the occasion of Dr. Mill's retirement from active duty in consequence mainly of impaired eyesight, an arrangement for transfer of the Organization to the Meteorological Office, which had been under consideration for many years, was brought to a conclusion by the deed of transfer dated 24th July, 1919.

By that deed the Director of the Office undertakes to continue the encouragement of the voluntary system of observation, the collection of the data, the publication of the annual volume of *British Rainfall* and the continuance of the magazine which serves the necessary purpose of a means of communication between the observers and the central authority.

For the continuance of the Organization H.M. Office of Works has acquired the premises at 62, Camden Square, which has been the central establishment of the Organization from the beginning. The work is still carried on there under the superintendence of Mr. Carle de S. Salter who was associated with Dr. Mill in the direction of the Organization.

The Study of Atmospheric Pollution.—From 1912 the study of Atmospheric Pollution has been carried on by a Committee with the Director as Chairman, and for the past three years appointed by the Meteorological Committee, with a grant from the Department of Scientific and Industrial Research. It has been arranged that the work shall be continued and the expenses charged against the votes of the Air Ministry.

Marine Meteorology.—The re-organisation has also to take account of the position of Marine Meteorology which is of fundamental importance for the Science of Meteorology, because it deals with by far the greater part of the globe from which meteorological observations are obtainable; and the meteorological conditions over the sea are of a special character, less subject to the effects of local and temporary circumstances and therefore more likely to provide a clue to regular changes than those over the land. Work on Marine Meteorology was the original purpose of the Meteorological Office, but from the circumstances of the case, before the introduction of wireless telegraphy, it was confined to the gradual compilation of a body of statistics which are represented by charts of average values of the meteorological elements over the various parts of the ocean. Before the war the transmission of observations by wireless telegraphy had provided material for the preparation in the Meteorological Office of tentative daily charts of the Atlantic and the continents on either side. Somewhat similar charts prepared by the Weather Bureau of the United States were extended to include the whole of the Northern Hemisphere and formed the subject of a special publication from January 1st, 1914. A beginning had also been made in co-operation with the Meteorological Office of the Netherlands and in supplementation of the material contained in the Daily Synoptic Charts of the Atlantic

compiled by the Danish and German Offices and issued some years after date, to study the variation of conditions over the oceans from year to year.

The war caused most serious disorganisation of all these undertakings. The transmission of observations by wireless telegraphy ceased altogether and preparation of daily charts of the Atlantic was necessarily suspended. As the remaining work was of a statistical character all the members of the staff who could undertake more strenuous duties were withdrawn. The collection of observations from the ships of the Mercantile Marine upon which the Office mainly relies for its marine observations almost ceased; the instruments lent for the purpose were mostly destroyed or disappeared in the various unforeseen changes, and finally early in 1919 the Marine Superintendent Captain Campbell Hepworth and his principal assistant Mr. W. Allingham died. Mr. W. G. James the next in order on the staff was due to retire at the end of the war having passed the age of superannuation by some years.

The events of the past six years have not been favourable for the cultivation in any ordinary sense of the Science of Meteorology among officers afloat, and the personal relationship between the Office and its marine observers was nearly at an end. A new Marine Superintendent who could take up the work again was not appointed until November, 1919, when Commander Brooke-Smith, R.D., R.N.R., was selected. The work of organising a new corps of observers under the changing conditions of the present time is necessarily a slow process, and care is more than ever necessary because the work has now to be arranged to meet new requirements, and the simple restitution of the practices established by international agreement in 1853 and 1874 does not entirely meet the case.

It has long been recognised as desirable and is now regarded as necessary, in order to keep in sufficiently close touch with the officers who are good enough to undertake the duties of observer on board ship, to have representatives of the Office with an expert knowledge of meteorological instruments and the difficulties which confront the observer at sea, stationed at the principal ports, to inspect the instrumental equipment and to discuss personally the questions that arise as to the best means of securing precision in the observations.

The principal reason for this new departure is that the new demands upon the process of observing include observations which can be incorporated individually with land observations upon the synoptic working charts. So long as the object to be attained is a trustworthy chart of mean values obtained by collecting together many individual observations, occasional inaccuracies on one side or the other may be supposed to balance each other, but when each observation has to be plotted on a chart and important inferences drawn as to conditions of weather in the future from the manner in which a particular observation fits into its surroundings, a very high degree of precision is necessary, particularly in semitropical and tropical regions to which the investigation will now be extended for practical reasons.

We have yet to find out whether it is really possible to get a chart which has a sufficient degree of accuracy for its essential purpose. Certainly the ordinary collection of observations after the event has not been found accurate enough for the intertropical seas. It is therefore imperative for the Office to turn its attention once more to its original purpose, the collection of observations from the sea with a renewed effort to improve the instrumental equipment, and the method of its use, so that not only the necessary precision, but also the extended observations, required for the guidance of aircraft may be obtained from all important areas of the sea.

The Co-ordination of the Services.

In considering the co-ordination of the services it may be convenient here to set out clearly to what extent the separate meteorological services overlapped. The Meteorological Office based its forecasts upon reports from about a hundred stations on the European Continent and the Atlantic Islands supplemented to some extent before the war by ships' observations transmitted by wireless. About 30 of the stations were organised and supported by the Office in order to give a representation of the distribution ofthe meteorological elements over the Eastern Atlantic and the adjacent continent three times a day. Of these 30 stations seven were observatories where besides the necessary daily observations self-recording instruments were maintained and provision made for researches in association with other countries in meteorology, including the study of the upper air, terrestrial magnetism and seismology. The rest were stations at which the normal daily observations alone were made and reported by telegraph. They occupied the observer's time for not more than an hour and a half each day. The work at these stations was therefore entrusted to coast-guards, lighthouse keepers and others whose regular occupation enabled them to undertake an effective lookout on the weather. The cost to the Office of the whole number of these auxiliary stations did not amount to as much as the maintenance of a single station manned by an officer and men on whole-time service. During the war an additional hour of observation in the small hours of the morning was introduced and this added considerably to the stress of the duty, both at the stations where the observations were made and at the Office where they were received and dealt with.

The development of aviation led to the introduction of observations of wind at different levels by the process of observing the motion of small balloons at the seven observatories of the Office and at the stations of the Naval Air Service. The selection of the stations for the service of the airship patrol naturally resulted in the choice of localities near the salient points of the coasts, but in many cases far out of the way of land traffic. They required a continuous watch so that they overlapped the ordinary reporting stations of the Meteorological Office which were chosen for a similar reason, but had regard only to the primary meteorological elements which could be observed equally effectively at the new stations. Most of those stations have, however, now been disestablished because the localities have no longer to be chosen for coast patrol.

The duplication has practically ceased and now the resources of the coast stations of the Office have to be supplemented in order to supply the additional information which the stations of the Air Force were able to supply as part of their ordinary duty.

More serious overlapping arose from the creation of separate Head-Quarters in London, each provided with a forecasting staff to prepare maps from the information collected in London by telegraph, telephone or wireless, and to interpret them for the guidance of the several services. This was the extent of the overlapping. The separate establishments in different parts of the country and in the theatre of war were not open to that objection because the service for aircraft requires a new type of station for the distribution of information. Up to within a year of the war all the information required for reports and forecasts was collected at the Central Office alone. The observers at the stations had merely to report their readings and were not required to draw any inferences from them. The aeronauts who wished to obtain first-hand information as to the prospects of balloon-flights were accustomed to call at the Office in London and discuss the matter with the officials in charge of the maps. A beginning had indeed been made of the new type of distributive station at South Farnborough, Upavon and Kingsnorth, at each of which an expert meteorologist was placed who was supplied with information from the Central Office and, supplementing it by observations in his own neighbourhood, could advise the local commands upon any meteorological questions which arose. It was the extension of this system to the Western Front and elsewhere that led to the organisation of the Naval Meteorological Service for the Navy and Naval Air Service and of the Meteorological Section, R.E. The tentative plans which were found to succeed during the war have now to be developed into an organised system to satisfy the requirements of aircraft during peace, as well as those of shipping, agriculture and the general public, for which the forecast service was originally created; and a further development has to be noted. With the facilities for communication that were placed at the disposal of the meteorological staff during the war the collection of information at short intervals as, for example, from hour to hour from a restricted locality proved to be of great practical utility, and now that the air passage from London to Paris is a matter of two hours only the transient changes and chances of weather have become practically a dominant feature of interest for aircraft. Consequently, it has become necessary to provide for hourly reports of weather for the successive stages of the great air routes and their vicinity. This leads to the necessity for the more detailed and intensive study of the phenomena of weather and the inclusion of such new elements as the distance of visibility and its variations, the height and extent of clouds and other details, which were not included in the older reports.

New Scheme for the Professional Staff.—When the work of the Forecast Division of the Office was removed to the premises of the Air Ministry in Kingsway the Headquarters staff of the Meteorological Service of the Air Ministry (F.O. 5) was incorporated with it. Arrangements were made for the officers of the Service to be

demobilised on December 31st, 1919; and for the greater number of them to be attached to the professional staff of the Meteorological Office upon the provisional terms which had been arranged by the Meteorological Committee for the staff of the Office.

In view of the large increase in the numbers of staff and the necessity for a definite arrangement of salaries for members of the staff rejoining the office after demobilisation, the Committee, before its own reconstruction, found it necessary to constitute two new grades of officers—namely, Assistant Directors and Assistant Superintendents—and to set up provisional scales of payment for the officers of the several grades. In the course of their inquiry they were informed that a Committee appointed by the Treasury was considering the question of the salaries of the scientific staff of a number of departments, and they decided to make their own scales provisionally and to await the conclusions of the Treasury Committee for a more permanent schedule. Subsequently they were invited by the Treasury to submit a statement of the various grades and the qualifications expected of the persons to be appointed, and of the salaries proposed. This was done, and the scales of salaries of the professional staff recommended by the Treasury Committee, approved by the Treasury, and adopted by the Air Ministry on the recommendation of the Meteorological Committee are as follows :—

	£		£		£
Director	1200	...	—	...	—
Assistant Directors (£50 allowance in addition to Directors of Observatories)	700	...	25	...	850
Superintendents	550	...	25	...	700
Assistant Superintendents ...	350	...	20	...	500
Professional Assistants, Senior...	250	...	15	...	350
Professional Assistants, Junior...	175	...	15	...	235

The salaries are in each case exclusive of war bonus, which is granted at the rates approved for the Civil Service. The appointments are pensionable on what is known as the University scheme, under which the Government contributes 10 per cent. of the total salary, and 5 per cent. is deducted to form a fund for endowment insurance. The particulars of the scheme are not yet fully developed.

The New Establishment.—To maintain the established work of the Office and for the new work which has been indicated in the preceding sections, provision was made in the estimates for 1919-20 for a staff of 374 persons in addition to the Director, who would take duty at one or other of the following establishments :—

Headquarters—

Air Ministry, Kingsway, W.C. 2.
South Kensington, S.W. 7.
62, Camden Square, N.W. (British Rainfall Organization).
47, Victoria Street, S.W. 1. (Investigation of Atmospheric Pollution).

Establishments in the United Kingdom—

Edinburgh Office, 122, George Street, since removed to 10, Rothesay Place, Edinburgh.
10 Contributive Stations (Observatories).
12 Distributive Stations for Aircraft.
2 Ditto ditto Army Services.
2 Marine Offices,

Establishments outside the United Kingdom—

Malta, St. Helena, Ascension, Bermuda.

For these establishments the staff provided is as follows :—

4	Assistant Directors.	15	Principal Assistants.
12	Superintendents.	42	Staff Assistants.
14	Assistant Superintendents.	127	Clerk Assistants and Technical Assistants.
43	Senior Professional Assistants.	94	Unclassified.
23	Junior ditto ditto		
96	Professional Staff.	278	Clerical and Technical Staff.

International Meteorology.

The general scheme of meteorological observations of all kinds is based upon certain international arrangements which began with the International Conference for Maritime Meteorology held at Brussels in 1853, and were extended to Climatology and Weather Telegraphy by the International Congresses of Vienna in 1873 and Rome in 1879, and further extended to take in the study of the upper air by the appointment of an International Commission for Scientific Aeronautics in 1896, and the agreement for the publication of the results on an international basis concluded at Petrograd in 1904. In accordance with these international conventions a vast store of meteorological data has been accumulated.

The international organisation which grew out of the various congresses was based upon a periodic conference of the Directors of Institutes and Observatories meeting every ten years, and an International Meteorological Committee consisting of seventeen representatives elected by the Conference to conduct the international business of meteorology between the consecutive conferences. Of the Committee, as constituted in 1914, the Director of the Meteorological Office was President and the Director of the Prussian Royal Meteorological Institute was Secretary. This Committee was in no way concerned with funds. The expenses of the meetings were defrayed by the establishments which issued the invitations. The only financial arrangement was the contribution for the publication of the results of the investigation of the upper air in which the subscription was represented by a proportional number of copies.

The war brought complete confusion to these international arrangements from which they have not yet recovered, though the groundwork remained; but during the war the details were naturally altered to suit the altered conditions and special circumstances; the conventional messages were increased in number, enlarged in substance and to a certain extent changed in form.

Towards the end of the war steps were taken to provide new international institutions. The first were those of the Scientific Academies of the Allies who sought to establish National Councils for the study of Astronomical and Geophysical subjects under the control of the respective Academies which could be associated in International Councils with suitable provision of bureaux, funds, etc. Meteorology, Terrestrial Magnetism and Seismology were among the subjects considered. After preliminary meetings in London and in Paris it was arranged that the first general assembly of the new organisation should be held in Brussels on July 18 to 28. This was duly carried out and a suitable "cotisation" defined by which each country would contribute to funds for a central bureau and its operations.

The scheme of organisation is indicated by the following appointments :—

General assembly of the International Research Council (which will meet ordinarily every three years).

Executive Committee—Prof. E. Picard (*President*) ; Sir Arthur Schuster (*Secretary*) ; Profs. G. E. Hale, V. Volterra and G. Lecointe.

The Unions that it established are given in the following list :

Astronomical Union—M. B. Baillaud (*President*) ; Professor A. Fowler (*Secretary*).

Geodetic and Geophysical Union—M. C. Lallemand (*President*) ; Colonel H. G. Lyons (*Secretary*).

Geodesy—Major W. Bowie of the U.S. Coast and Geodetic Survey (*President*) ; Col. E. Perrier of the Service Géographique de l'Armée (*Secretary*).

Seismology—As the pre-war Association remains until 1st April, 1920, no appointments were made. M. Rothé continues to act for the present as General Secretary.

Meteorology—Sir Napier Shaw (*President*) ; Dr. C. F. Marvin, U.S. Weather Bureau (*Secretary*).

Terrestrial Magnetism — Professor A. Tanakadate (*President*) ; Dr. L. A. Bauer, Carnegie Institution of Washington (*Secretary*).

Physical Oceanography — (*President*) Prince Albert of Monaco Professor H. Lamb (*Vice-President*) and Dr. Magrini of the Hydrographic Service of Venice (*Secretary*).

Vulcanology — Professor A. Riccó, Etna Observatory (*President*) since deceased ; Dr. Malandra (*Secretary*).

Chemical Union — M. Moureu (*President*), M. J. E. Gérard (*Secretary*).

Other unions including one on Scientific Radio-Telegraphy are under consideration.

The next step was taken in January, 1919, apparently independently of the action reported above. A communication was received from one of the permanent Secretaries of the French Académie acting as Président du Comité d'Action des Services Météorologiques Français intimating that it was proposed to summon a meeting of Inter-allied Meteorologists about the middle of the summer of 1919 to discuss the establishment of a code for the transmission of meteorological observations which will satisfy modern needs, particularly those of the Air Services. The Meteorological Office concurred in the proposal for a meeting, and took steps to inform the Dominions and Dependencies, and to suggest that the occasion might usefully be made the opportunity for a meeting of the Meteorologists of the British Dominions, which had been often projected but not hitherto realised. The suggestion

was favourably received, but no further progress was possible at the time because on inquiry the Office was informed that the conference in Paris could not be summoned before the conclusion of Peace, the terms of which were not then settled.

Meanwhile, in the spring of 1919, the Meteorologists of the Scandinavian Countries began to make enquiries as to their position on the one hand with respect to the meteorological organisations which existed before the war, on the other hand with respect to the new organisations which were being considered.

It therefore seemed desirable to have an informal meeting of the meteorologists of allied and neutral countries to review the general situation and consider what steps were possible or desirable with regard to reopening co-operation on on international basis. Accordingly the Director of the Office as President of the International Meteorological Committee invited the surviving members of the Committee representing allied and neutral countries, within comparatively easy reach, with Professor Hildebrandsson, of Upsala, former member, in place of the late H. E. Hamberg (Sweden), a representative of Norway in place of the late H. Möhn, to a meeting in London on 3rd-9th July. Dr. Bauer, Director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, was authorised to attend on behalf of the Chief of the Weather Bureau of the United States. The minutes of that meeting have been printed and circulated.

It was further arranged that the Conference in Paris, summoned by the French Government, which it was then understood would include neutrals, should be held on September 30th and following days, and that the preliminary meeting of Meteorologists of the British Dominions should be held in London in the rooms of the Royal Society on September 23rd and following days.

These meetings were duly held. The meeting of Dominion Meteorologists considered a number of subjects of common interest, and concluded with the following resolution :—

> "That this Conference of representative Meteorologists of the British Empire assembled together for the first time agree to continue as an association for the exchange of their views from time to time by correspondence upon scientific matters concerning the achievements, requirements and organisation of their services, and hereby elect Sir Napier Shaw their first President, and invite the members to submit rules for the guidance and acceptance of the Association."

The meeting in Paris took the form of a normal Conference of Directors of Meteorological Institutes and Observatories, and received and approved the recommendation of rules for the Organisation of International Meteorological Work which was drawn up originally in 1907 at a meeting in Paris, and was intended for presentation at a Conference which it was proposed to hold at Utrecht in 1915 on the invitation of the Meteorological Institute of the Netherlands.

The Procès-Verbaux of the proceedings of the Conference at Paris have been issued by the Bureau Central Météorologique of

Paris. They include the appointment of a new International Meteorological Committee in continuation of the old with the Director of the Meteorological Office, London, as President, the Director of the Bureau Central Météorologique, Paris, as Vice-President, and the Director of the Meteorological Institute of the Netherlands as Secretary. They record also provision for the appointment of a number of commissions.

But meanwhile, quite independently of the organisations already mentioned, the question of International Meteorology was included in the subjects dealt with in the Convention relating to Aerial Navigation which has recently been made public as Cmd. Paper No. 670. 1920. By Article 35 of this instrument "The High Contracting Parties undertake, as far as they are respectively concerned, to co-operate as far as possible in international measures concerning (*a*) the collection and dissemination of statistical, current and special meteorological information in accordance with the provisions of Annex G." Annex G (with minor modifications) gives forms for messages of the detailed kind which have been in use in connexion with the Army of Occupation and are still used in this country, but which no other country has yet fully adopted.

It still remains to decide what steps the various countries concerned, allied or neutral, will take to determine the precise significance of the phrase "as far as possible," whether they will entrust the consideration of such questions to the deliberations of experienced meteorologists in an ordinary international assembly, or whether the decision will be arrived at by the Governments as a condition of associating themselves with the Allied Powers in further aerial development.

Publications.

The following Libraries and Institutions have been added to the list of recipients of presentation copies of official publications :—

Cambridge, Trinity College; Edinburgh, Advocates Library; Pangbourne, Nautical College; Chosen, Meteorological Observatory; Osaka, Meteorological Observatory; Johannesburg, Observatory; Vancouver, Meteorological Station; Boston, Academy of Arts and Sciences; Iowa, State University.

Exchange of publications has been arranged with :—

Christiania, Geophysical Commission; Madrid, Institute Español de Oceanografia; Rome, R. Servizio Aerologico Italiano; Nantung, Chensham Meteorological Observatory; Urbana, Illinois University; Habana, Biblioteca de la Escuela de Ingenieros Agromomos y Azucareros.

Exchange of publications has been renewed with the following former enemy countries :

Jurjev, Tartu Ulikooli Observatory; Frankfurt, Meteorologisch-Geophysikalisches Institut; Hamburg, Hauptstation für Erdbebenforschung; Hamburg, Deutsche Seewarte; Karlsruhe, Zentral-Bureau für Meteorologie u Hydrographie; Leipzig, Geophysikalisches Institut der Universität; Munich, B. Landeswetterwarte; Vienna, Zentralanstalt für Meteorologie u Geodynamik.

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 Supplement.

(For further particulars *see* pages 34, 45.)

Monthly Meteorological Charts of the North Atlantic Ocean [to date]. (*See* page 34).

Monthly Meteorological Charts of the East Indian Seas [to date]. (*See* page 34).

The British Meteorological and Magnetic Year Book, comprising—

Part I.—**The Weekly Weather Report** with Quarterly and Annual Summaries [to date, with the exception of the maps, which have not been issued since 1914].

Part II.—**The Monthly Weather Report,** with a summary for the year [to date].

Part III. (1).—**Daily Readings** at meteorological stations of the first and second orders [to December, 1919].

Part III. (2).—**Geophysical Journal.** Daily Readings in meteorology, solar radiation, seismology, atmospheric electricity and terrestrial magnetism, and the results of observations in the upper air [to February, 1919].

Part IV. —**Hourly Values from Autographic Records.** Hourly values for terrestrial magnetism, atmospheric electricity and meteorology for five Observatories. [Volume for 1916 issued.]

Part V.—**Réseau Mondial.** Monthly and Annual Summaries of pressure, temperature and precipitation at land stations, generally two for each 10-degree square of latitude and longitude. [Volume for 1910 in preparation].

(For further particulars *see* page 35).

Observer's Handbook, 1919 edition.

Calendar, with notes and diary of operations for the use of observers, for 1920.

The Meteorological Magazine [to date]. (*See* pages 22, 35, 62).

OCCASIONAL.—

The Barometer Manual, Ninth Edition.

The Computer's Handbook, Section 5—*contd.* A collection of Correlation Coefficients from Meteorological Papers and a Note on the Partial Correlation Coefficient, by Capt. E. H. Chapman, R.E.

The Book of Normals of Meteorological Elements of the British Isles. (*See* page 36).

Section I.—Monthly Normals for Stations.

Section II.—Weekly, Monthly, Quarterly and Seasonal Normals for Districts.

Geophysical Memoirs :—

No. 13. The Characteristics of the Free Atmosphere. By W. H. Dines, F.R.S.

No. 14 Soundings with Pilot Balloons in the Isles of Scilly, November and December 1911. By Capt. C. J. P. Cave, R.E., and J. S. Dines, M.A.

No. 15. The Climate and Weather of the Falkland Islands and South Georgia. By C. E. P. Brooks, M.Sc.

Professional Notes :—

No. 4. Upper Air Temperatures at Martlesham Heath February 1917 to January 1918. By Lt. W. F. Stacey.

No. 5. On the Use of the Normal Curve of Errors in Classifying Observations in Meteorology. By Capt. E. H. Chapman, R.E.

No. 6. The Variation of Wind Velocity with Height. By Capt. E. H. Chapman, R.E.

No. 7. The Climate of North-West Russia.

No. 9. An Analysis of Cloud Distribution at Aberdeen during the years 1916–18. By G. A. Clarke.

Minutes of a Meeting of Members of the International Meteorological Committee held at the Meteorological Office, London, July, 1919.

Other publications for which authority has been given and which are in preparation are as follows :—

The Book of Normals of Meteorological Elements of the British Isles.

Section III. Maps of the Normal Distribution of Temperature, Rainfall and Sunshine.

Geophysical Memoirs :—

No. 16. Aids to Forecasting :—Types of Pressure Distribution, with Notes and Tables for the Fourteen Years 1905–18. By E. Gold, F.R.S.

No. 17. Percentage Wind Frequencies at various Altitudes in Macedonia. By Capt. E. Kidson, R.E.

Professional Notes.

No. 8. Temperatures and Humidities in the Upper Air ; Conditions favourable for Thunderstorm Development, and Temperatures over Land and Sea. By Capt. C. K. M. Douglas, R.A.F.

No. 10. Methods of Computation for Pilot Balloon Ascents. By J. S. Dines, M.A.

The publication of the following papers, &c., may also be mentioned :—

By Sir Napier Shaw, F.R.S., Director—

Meteorology, the Society and its Fellows. Presidential Address of the Royal Meteorological Society, 1919. Q.J.R. Met. Soc., 45, 1911, pp. 95–111.

Manual of Meteorology, Part IV. Cambridge University Press.

By Colonel H. G. Lyons, F.R.S.—

The Supply of Meteorological Information, Aero. J. 123, 1919, pp. 397–406.

By Dr. Charles Chree, F.R.S.—

Magnetic Storms of March 7–8 and August 15–16 1919, and their discussion. London Proc. R. Soc. 96, 1919 (ser. A), pp. 32–55.

Magnetic Storms, London. Inst. Elec. Engin., 57, 1919, pp. 591–609.

By W. H. Dines, F.R.S.—

Correlation between Sunshine, Temperature and Health. London, Q.J.R. Met. Soc , 45, 1919, pp. 309–310.

Meteorology in relation to Aeronautics. London Aero. J., 22, 1918, pp. 17–29.

By Lieut.-Col. E. Gold, D.S.O., F.R.S.—

Meteorology and Aviation. Edin. J. Scot. Meteor. Soc., 18, 1919 pp. 68–76.

Meteorology in Three Dimensions, Nature. London, 104, 1920, p. 505.

Unification of the British Meteorological Services. Symons's Met. Mag., London, 1919, pp. 86–88.

By F. J. W. Whipple, M.A.—

Absolute Scales of Pressure and Temperature. London, Proc. Phys Soc. 31, 1919, pp. 237–241.

The Laws of Approach to the Geostrophic Wind. London, Q.J.R. Met. Soc., 46, 1920, pp. 39–53.

Equal Parallel Cylindrical Conductors in Electrical Problems. Roy. Soc. Proc. A, vol. 96, 1920, p. 465.

By Captain C. J. P. Cave, M.A., and J. S. Dines, M.A.—

Further Measurements on the Rate of Ascent of Pilot Balloons. London, Q.J.R. Met. Soc., 45, 1919, pp. 277–283.

By J. S. Dines, M.A.—

A new formula for the Rate of Ascent of Balloons. London, Q.J.R. Met. Soc., 46, 1920, pp. 33–34.

By Captain E. M. Wedderburn, D Sc.—

Meteorology and Gunnery. Edin. J. Scot. Met Soc. 18, 1919, pp. 86–92.

The Application of Meteorology to Gunnery, 1918. Published by Munitions Inventions Department.

By Captain D. Brunt, M.A.—

A Periodogram Analysis of the Greenwich Temperature Records. London, Q.J.R. Met. Soc., 45, 1919, pp. 323–338.

By L. F. Richardson, M.A.—

The measurement of Water in Clouds. London, Proc. R. Soc., 96, 1919, pp. 19–31.

Atmospheric Stirring measured by Precipitation. London, Proc. R. Soc., 96, 1919 (ser. A.), pp. 9–18.

By C. E. P. Brooks, M.Sc.—

Charts of Mean Temperature in Africa. London, Q.J.R. Met. Soc., 45, 1919, pp. 251–2.

The Secular Variation of Rainfall. Q.J.R. Met. Soc., 45, 1919, pp. 233–245.

The Meteorology of Hebron, Labrador, 1883–1912. Q.J.R. Met. Soc., 45, 1919, pp 163–167.

The Climate of the Fiji Islands. Q.J.R. Met. Soc., 46, 1920, pp 96–99.

The Distribution of Temperature in Nigeria. Q.J.R. Met. Soc., 46, 1920, pp. 204–214.

Historical Data on the Variation of Rainfall in Chile. U.S. Monthly Weather Review, 47, 1919.

By E. G. Bilham, B.Sc.—

Barometric Pressure and Underground Water-level. London, Q.J.R. Met. Soc., 46, 1920, pp. 35–8.

By Capt., C. K. M. Douglas—

The Use of Aeroplanes in Meteorology. London, Symons's Met. Mag., 54, 1919, pp. 127–130.

Optical Phenomena and the Composition of Clouds. Edin. J. Scot. Met. Soc., 18, 1919, pp. 83–86.

By Major G. M. B. Dobson—

Winds and Temperature Gradients in the Stratosphere. London, Q.J.R Met. Soc, 46, 1920, pp. 54–62.

By Lieut. W. F. Stacey—

Practical Exercises on the Weather and Climate of the British Isles and N.W. Europe. Cambridge, 1919, 8vo, pp. 64.

By Lieut. J. Logie—

The Origin of Anticyclones and Depressions. Edin. Proc. R. Soc., 39, 1918–19, p. 56.

The following papers have been received and transmitted to the societies named :—

Professor S. Chapman, D.Sc., F.R.S. and E. A. Milne, B.A., Fellow of Trinity College, Cambridge, "The Composition, Ionisation and Viscosity of the Atmosphere at Great Heights"—Royal Meteorological Society.

W. H. Dines, F.R.S., "The Ether Differential Radiometer"—Royal Meteorological Society.

L. F. Richardson, B.A., "The Supply of Energy to Atmospheric Eddies"—Royal Society.

L. F. Richardson, B.A., "Convective Cooling and the Calculus of Dimensions"—Physical Society.

Harold Jeffreys, D.Sc., "Tidal Friction in Shallow Seas"—Royal Society.

Guy Harris and John Logie, "Summary of Facts learned from the Montcalm Expedition."

During the year 1919-20 the **Daily Weather Report** has been issued in three sections :—(1) The British Section issued daily at noon ; (2) the International Section issued on the morning of the day following that to which the report refers ; (3) the Upper Air Supplement issued at noon with the British Section.

The Monthly Meteorological Charts of the North Atlantic and East Indian Seas have been re-arranged as regards explanation on face and contents of back. The curves of magnetic variation have been expunged. Isobars have been drawn over land and sea ; air isotherms over the sea.

A series of articles mainly of seasonal interest have been published on the backs of the charts, the object being to set out information of meteorological and oceanographical interest in simple language for the benefit of seamen.

Negotiations have been in progress with the Stationery Office with a view to improving the means of selling these charts and publications. It would seem that commercial methods might be adopted in this with advantage, and some advertisement is necessary.

For publication on the charts special cables were received monthly during the ice season from Quebec giving the state of the ice along the Canadian and Newfoundland coasts, and, during the summer, from Simla, relating to the South-west Monsoon, its appearance and its character, and also noting the occurrence of cyclones about the Arabian Sea and the Bay of Bengal.

Remarks and explanatory letterpress and maps of pressure distribution at various levels have been prepared for a new edition of Monthly Meteorological Charts of the Mediterranean Basin.

The Meteorological Charts of the Southern Ocean between the Cape of Good Hope and New Zealand (Official Publication No. 123), and Monthly Wind Charts of the South Atlantic (No. 168) have undergone revision for the issue of new editions.

The Year Book.—The Statistical publications of the Office, which represent the public memory of the weather of each year for the purpose of future reference, are grouped together under the general title "The British Meteorological and Magnetic Year Book." Some account of the several parts of the Year Book will be found in Circular 001.

Part I. Weekly Weather Report.—Observations at Rauceby and at Bawtry had been utilised for the computation of District Values. These stations having been given up, their places have been taken by Fulbeck and Worksop. The place of Hereford had been filled temporarily by Ross-on-Wye, but since January 1st, readings from the former station have again been adopted for District Values.

Part II. Monthly Weather Report.—The Monthly Weather Report was increased in size at the beginning of 1920 by the addition of a new table containing additional values of rainfall. This table is prepared by the British Rainfall Organization: practically all the data used in the construction of the full page map of the rainfall of the month are now printed.

Part III. (1). Daily Readings at Meteorological Stations of the First and Second Orders.—No alteration has been made in the form of this publication.

Part III. (2). Geophysical Journal.—The monthly parts of the Journal are now appearing within a year. The Annual Supplements for 1917 and for 1918 contain new tables exhibiting the upper air temperatures observed by means of aeroplanes.

Part IV. Hourly Values from Autographic Records.—For the years 1911 to 1913 "Hourly Values from Autographic Records" appeared in two sections. The issue of the first section, which contained hourly values of the meteorological elements was interrupted by the war, and has not yet been resumed, so that meteorology is only represented by the averages for the months for the several hours. The magnetic tables are still published in full. The 1916 volume, published in the year under review, contains a paper by Dr. Chree on a comparison of the observations of electrical potential gradient at Kew and Eskdalemuir Observatories.

Part V. Reseau Mondial.—The first four parts of the Year Book are devoted to British meteorology. In the fifth part observations from selected stations covering the whole globe in a "Réseau Mondial" are tabulated, material from the library being supplemented where necessary by manuscript returns. The volume for the year 1913 was issued in 1918, and, as data for 1914 were not available during the war, that for 1910 was prepared and is now in the press The preparation of the material for 1914 has been completed as far as possible.

The Meteorological Office Circular—The Circular, which contained official notices and also other matter likely to be of interest to observers was issued monthly up to February 1920, since which date it has been incorporated (with Symons' Meteorological Magazine) in The Meteorological Magazine.

The Superintendent of Statistics and the Superintendent of the British Rainfall Organization act as joint editors of the Magazine.

The Book of Normals.—Statistics representing the normal climatology of the British Isles have been scattered in various publications hitherto. In the Book of Normals of Meteorological Elements, which is now being prepared in Sections, the data will be more readily accessible. Section I, which gives the normal rainfall for over 200 stations and the temperature and duration of sunshine for as many as possible, has been issued; it replaces Appendix IV of the Weekly Weather Report, 1913, which is now out of print.

Three numbers of the second volume of *Geophysical Memoirs* have been published during the year, and five numbers of the series of *Professional Notes*. Further numbers of both these publications are in course of preparation. An addition has been made by Capt. E. H. Chapman to the *Computer's Handbook* (Section V. continued) in the shape of tables of correlation coefficients collected from various meteorological papers.

The first edition of *Cloud Forms according to the International Classification* is now out of print; a second edition is in course of preparation.

In consequence of the removal of the Forecast Service from South Kensington to the Air Ministry, new arrangements for the printing of the Daily Weather Reports became necessary, and after careful consideration of the alternatives the recommendation of the Meteorological Office that the lithographic press in the basement of the Office at South Kensington should be transferred to the basement of Canada House, Kingsway, was approved by H.M. Stationery Office, who re-installed the press in Kingsway, and added a third machine to the equipment. The result is eminently satisfactory for the work of the Office, since it is possible by this means to continue to issue printed weather reports, with maps and forecasts, within four hours of the time at which the individual observations are made throughout Western Europe. The removal of the press was carried out in January and February, 1920.

*Inquiries.

The inquiries dealt with during the year were 842, of which 550 were by letter, the rest being personal inquiries. The following table gives a classification of the inquiries with the corresponding figures for previous years :—

	For Scientific or Commercial purposes.	For Evidence in Legal Proceedings.	From Newspaper Correspondents for Special Information.	Miscellaneous.	Answered by Letter.	Answered Personally.	Total.
1914–15 ...	639	92	56	34	468	353	821
1915–16 ...	498	133	21	27	431	248	679
1916–17 ...	414	115	19	16	397	167	564
1917–18 ...	400	127	15	28	400	170	570
1918–19 ...	542	175	17	12	526	220	740
1919–20 ...	610	194	29	9	550	292	842

* The inquiries included in this table are concerned with the "keeping of the public memory" of the weather and are exclusive of those referred to in paragraph 9 of the Report of the Forecast Service (page 47).

Library.

The Author Card Catalogue has been kept up-to-date. The index numbers corresponding with the classification adopted in the International Catalogue of Scientific Literature are entered on the cards so that the subject catalogue can be prepared directly from them.

The Subject Card Catalogue for the books added to the library since the last list of additions was printed *in extenso*, as an appendix to the Report of the Meteorological Council for the year 1904-5, has been kept up-to-date. Considerable progress has also been made in preparing cards for the subject card catalogue for books received before 1905, and 4,000 cards have been prepared.

The additions to the library received during the past year include about 300 books and pamphlets and 100 periodicals. The total number of books in the library, excluding unbound pamphlets and periodicals, is now 16,000.

A separate register of volumes received in the library is now kept, and the work of registering books received since 31st December, 1900, is being proceeded with. Books received before this date are entered in the original author catalogue.

Among the most important presents to the library during the past year may be mentioned :—

"The Australian Environment" (especially as controlled by rainfall), by Griffith Taylor.

"Le Nubi," parts I. and II., a cloud-atlas, by Luigi Taffara.

"Cloud Atlas," by the London Admiralty, Naval Meteorological Service.

"Pression atmosphérique en Pologne et en Europe," by M. Gorczynski.

"La pluie en France," by E. Mathias.

"Manuel pratique de Météorologie," by J. Rouch.

"Tipi isobarici principali e loro azione sull'Italia," by Cesare Fabris.

"British Antarctic Expedition, 1910-13," Meteorology, vols. I. and II., by G. C. Simpson, D.Sc., F.R.S.

Among those acquired by purchase have been :—

"Dynamische Meteorologie," by Felix M. Exner.

"World power and evolution," by Ellsworth Huntington.

"The Oxford Survey of the British Empire," edited by O. J. R. Howarth.

"Methods of measuring temperature," by Ezer Griffiths.

"Applied aerodynamics," by L. Bairstow.

"South : the story of Shackleton's last expedition, 1914-1917," by Sir Ernest Shackleton:

"Meteorologia aeronautica," by G. Crestani.

"Meteorologie für Flieger," by Eugen Alt.

Administration and Staff.

It was noted in the fourteenth Annual Report, p. 15, that with the sanction of the Treasury, Colonel H. G. Lyons, F.R.S., was appointed Acting-Director as from 22nd May, 1918, for the period of the war. By letter of 12th April, 1919, Colonel Lyons expressed the opinion that the time had come for the arrangement to be terminated and Sir Napier Shaw resumed the administrative duties of the Directorship on 28th April, 1919.

As a step in the direction of increased provision for assistance of the Director in the general administration of the establishments of the Office, two Assistant Directors on the staff at Head Quarters were appointed on 30th July: Mr. R. G. K. Lempfert, C.B.E., who had been in charge of the Forecast Division throughout the war, for the general work of the contributive stations, and its relation to the Office; and Lieut. Col. Ernest Gold, D.S.O., F.R.S., who was Superintendent of the Statistical Division before the war and was in charge of the Meteorological Section, R.E., in France from 1915 till the close of the war, for the Forecast Service including the Forecast Division at Headquarters and the distributive stations of the Air Ministry.

At the same time provision was made for the appointment of a Superintendent of the meteorological establishments for the Army, and Captain David Brunt, M.A., B.Sc., of Trinity College, Cambridge, a former Isaac Newton student in the University, was selected. During the war he was in charge of the Meteorology for the Independent Air Force, and took over the superintendence of the meteorological work at West Lavington and afterwards at Shoeburyness on his return to England.

Other appointments of superintendents have been Mr. J. S. Dines to be superintendent of the work of forecasting, and Major A. H. R. Goldie, to be superintendent at Head-quarters of the distributive stations in England, Wales and Ireland for the Air Ministry. Major Goldie joined the office in 1913, as professional assistant at Falmouth, went out with one of the first commissions for meteorological duty in France and on Lieut. Colonel Gold's return was in charge of the Meteorological Section of the Army of Occupation.

Subsequently Commander L. A. Brooke-Smith, R.D., R.N.R., a Younger Brother of Trinity House, late Commanding Officer of H.M.S. "Heroic," was appointed Superintendent of the Marine Division. He kept a number of Meteorological logs for the Office as an Officer of the Orient Line. He was in command of the "Omrah" and the "Orontes," in 1913, and served in the Royal Navy in many capacities from October, 1914.

Many other changes have taken place in the membership and grouping of the staff, the results of which are indicated in the list given on pp. 8-11. Here it is only necessary to record that four members of the staff who had passed the age of sixty-five during the war retired on superannuation allowance on the 31st December 1919, namely, Mr. F. J. Brodie, after 50 years' service, chiefly in the Forecast Division, Mr. W. G. James, after 46 years' service in the Marine Division, of which he was principal draughtsman, Mr.

J. Sheerman, after 37 years' service in connection with the work of the Observatories, and Mr. R. F. Wallace, who after 36 years' service was principal assistant in the Instruments Division.

Mr. H. Harries, who had also reached the age of superannuation in 1917 after 45 years' service in the Marine Division and Forecast Division, was retained in order that he might continue to act as Assistant Superintendent in the Marine Division, until 31st March 1920, when he retired, and at the same time Mr. T. Duncan Bell, Chief Clerk retired, after serving in various capacities for fifty years.

Obituary.—The Committee record with regret that Mr. R. F. Wallace died suddenly at South Kensington Station on 24th January 1920, little more than three weeks after his retirement. They also regret to record the death on 21st of May, of Mr. Richard Henry Curtis, who had retired from the position of Superintendent of the Instruments Division in March, 1912.

Finance.

Accounts for 1919-20.—The grant-in-aid for the year 1919-20 was fixed by the Treasury in February, 1919, at £47,000. That has been supplemented during the year by three sums drawn from Air Ministry votes to cover :

(1). The increase of war bonus of the staff allowed by the Committee on the approval for the Civil Service of Awards 84 and 101.

(2). The sum of £5,584 6s. for the purchase of the assets of the British Rainfall Organization.

(3). The sum of £11,750 to meet the deficit on account of the completion of orders for meteorological instruments which were placed with instrument makers before the armistice. The estimated value of the stock-in-hand, which has been taken on charge for the Air Ministry is £21,932 8s. 2d.

A statement of the receipts and expenditure for the year is given on page 40.

The Statement of Receipts and Expenditure of the Edinburgh Office for the year ending 31st March, 1920, is as follows :

Receipts.	£	s.	d.
Balance brought forward ..	16	3	2
From the Meteorological Committee— Grant including War Bonus	587	5	2
On account of Reports supplied to the Registrar-General for Scotland	100	0	0
	£703	8	4

Expenditure.	£	s.	d	£	s.	d.
Salaries (including Bonus)						
Superintendent ..	402	0	10			
Assistants	258	13	4			
Occasional Assistance	21	18	0			
				682	12	2
Workmen's Compensation Insurance					11	10
National Health Insurance ..				1	10	6
Furniture and Fittings				3	1	6
Binding Official Reports					10	0
Telephone, Rent for one year ..				6	0	0
Registration of Telegraphic Address				1	1	0
Postages, Telegrams and Petty Outlays				5	19	0
				£701	6	0
Balance carried forward				2	2	4
				£703	8	4

Account of Receipts and Payments for the year ended 31st March, 1920, subject to alteration upon audit by the Comptroller and Auditor-General.

Receipts.

	£ s. d.	1919-20. £ s. d.
Balance from year 1918-19	—	108 10 0
Parliamentary Vote:		
Scientific Investigation	—	47,000 0 0
Air-votes, for War Bonus	—	7,282 3 3
" " British Rainfall Organization	—	5,584 6 0
" " Stock of Instruments	—	11,750 0 0
Departmental Expenses Repaid:		
Forecasts, &c.	77 4 6	
Marine, Statistical, and Administrative ..	108 2 9	
Instruments	669 8 3	
		854 15 6
Incidental Expenses Repaid:		
D.W. Report	844 10 7	
Divisional	165 16 10	
Advertising Account ..	7 8 9	
		1,017 16 2
S. O. Publications and Forms	—	190 5 8
Telegraph Charges Repaid	—	58 12 10
Telephone Charges Repaid	—	114 10 5
Inspections	—	156 0 0
Sales of Instruments:	—	12,172 16 11
Superannuation Account:		
Annuities	519 7 6	
Interest on Investment	50 2 8	
		569 10 2
Observatories, Branch Offices & Stations:		
Richmond	580 9 8	
Eskdalemuir	1,042 10 2	
Cahirciveen	39 17 0	
Farnborough	120 5 8	
British Rainfall Organization	0 5 0	
Falmouth	—	
Benson	—	
Edinburgh		
Investigation of Atmospheric Pollution ..	474 5 0	
Miscellaneous	165 8 7	
		2,423 1 1
Salaries refunded	—	1 5 7
		£89,283 13 7

Payments.

	£ s. d.	1919-20. £ s. d.
Adviser and Director ..	—	1,411 5 0
Acting Director	—	13 8 9
Office Salaries (including Insurance):		
Monthly	26,134 8 2	
Weekly	3,254 0 3	
		29,388 8 5
Expenses of Office:		
Rent, Heating, and Lighting	717 8 0	
Furniture and Equipment	111 5 7	
Library	27 15 4	
Insurances and Repairs	15 0 0	
Incidental Expenses and Consumable Stores	981 14 11	
Advertising Account ..	5 10 8	
		1,858 14 6
Post Office:		
Postage	1,379 15 3	
Telephones	137 14 10	
Telegrams	4,945 10 0	
		6,463 0 1
Stationery Office	—	146 0 10
Travelling Expenses	—	413 4 2
Superannuation:		
Pensions not chargeable on Fund	3 9 10	
Pensions chargeable on Fund	194 13 6	
Annuities	504 7 6	
Contribution to fund ..	—	
		702 10 10
Cost of Instruments:	—	22,627 0 6
Observatories, Branch Offices & Stations:		
Richmond	3,902 3 2	
Eskdalemuir	2,690 15 3	
Cahirciveen	1,507 4 5	
Farnborough	925 17 10	
British Rainfall Org. ..	1,129 5 5	
" " (Capital)..	5,584 6 0	
" " (Stamp) ..	11 5 0	
Falmouth	586 5 0	
Benson	1,302 18 11	
Edinburgh	605 14 5	
Aberdeen	530 11 4	
Investigation of Atmospheric Pollution ..	841 13 9	
Shoeburyness	1,686 11 10	
West Lavington ..	546 10 11	
Croydon	184 0 6	
Lympne	2 17 0	
Calshot	142 11 4	
Didsbury	20 4 10	
Biggin Hill	30 18 10	
Cranwell	0 6 3	
Miscellaneous	1,325 11 1	
		23,557 13 1
Balance due to Bank on 1st April, 1919 ..	—	49 0 4
Balance:		
Cash at Bank	2,629 11 8	
" at Office .. .	23 15 5	
		2,653 7 1
		£89,283 13 7

NOTE.—On 31st March the amount of Government securities held for provision of Superannuation Annuities was £26 14s. 2d. 2½ per cent. Consols and £989 9s. 6d. 5 per cent. War Loan.

The following abstract shows approximately the net payments for this year and the preceding year, together with the increase or decrease in 1919-20 as compared with 1918-19 :—

Net Charges.	1918–19.	1919–20.	Increase.	Decrease
Salaries :	£	£	£	£
Adviser	1,000	1,411	411	—
Acting Director	148	13	—	135
Office	22,860	29,388	20,475	—
Observatories		13,947		
General Administration of Central Office :				
Rent, Heating, and Lighting	703	717	14	—
Furniture and Equipment	44	111	67	—
Library	15	28	13	—
Insurances and Repairs ...	57	15	—	42
Incidental Expenses, Consumable Stores, and Advertising Account.	47	534	487	—
Stationery Office (*see* below).				
Postage	1,025	817	—	208
Telegrams	3,143	4,887	1,744	—
Telephones	148	23	—	125
Travelling Expenses ...	177	257	80	—
Instruments (*see also* below)				
Superannuation	99	133	34	—
Observatories, &c. (exclusive of Salaries) :—				
Richmond	257	391	134	—
Eskdalemuir	559	730	171	—
Cahirciveen	135	164	29	—
Farnborough	103	—	—	103
British Rainfall	55	5,959	5,904	—
Falmouth	143	179	36	—
Benson	65	251	186	—
Edinburgh	478	509	31	—
Aberdeen	295	353	58	—
Atmospheric Pollution ...	177	445	268	—
Shoeburyness	—	16	16	—
West Lavington	—	8	8	—
Croydon	—	1	1	—
Lympne	—	3	3	—
Calshot	—	11	11	—
Didsbury	—	17	17	—
Biggin Hill	—	3	3	—
Cranwell	—	1	1	—
Miscellaneous	216	237	21	—
Total Expenditure ...	31,949	61,559	30,223	—
Net Credits.				
Sale of Publications, &c.	50	44	—	6
Instruments	2,473	—	—	2,473
Total Net Expenditure £	29,426	61,515	30,223	2,479

The outstanding obligations of the Office at the close of the year were on Superannuation account £2476 8 6 and on account of Schuster Readership £43 15 0.

Net Charges.	1918-19.	1919-20.	Increase.	Decrease.
Net Income.				
Parliamentary Grants:				
M.O. Vote (Scientific Investigation)	29,750	47,000	17,250	—
Air Votes M.O. for War Bonus	—	7,282	7,282	—
" " *Stock of Instruments*	—	11,750	11,750	—
" " *for British Rainfall Organization*	—	5,584	5,584	—
Royal Society Vote ...	1,000	1,000	—	—
Advisory Committee Atmospheric Pollution.	476	474	—	2
Royal Society:				
Gassiot Trust	339	567	228	—
Rosse Trust	4	18	14	—
	31,569	73,675	42,106	—

The different divisions of the Office work have been maintained; they are:—

The Forecast Service including the Forecast Division and the Distributive Stations;
The Marine Division;
The Statistical Division;
British Rainfall Organization;
The Instruments Division;
The Meteorological Office, Edinburgh;
The Contributive Stations (Observatories).

Separate reports under these headings by the officers in charge are given below.

FORECAST SERVICE.

Report by Lieut.-Col. E. Gold, D.S.O., F.R.S., Asst. Director.

During the first 6 months of the period under review the Forecast Division was mainly occupied in resuming pre-war activities which had been curtailed or in abeyance during the war, and in supplying information still required by the Navy, Army, and Royal Air Force.

After the decision to include all the meteorological services in the organisation of the Meteorological Office and attach the latter to the Air Ministry, it became necessary to arrange for the provision of expert meteorologists in different centres to interpret for local requirements the deductions of the Central Office and generally to furnish such local meteorological reports as were required for flying and other purposes.

The Forecast Division was accordingly reconstituted as a Forecast Service with two divisions, one division to continue and develop the work of forecasting at the Central Office and the other division to train and organise the service of local meteorologists.

The co-ordination of the work of the Central Office with the work of the local meteorologists is an essential feature in the successful development of this service. The directions in which progress should be made in the practical application of the expert knowledge available are usually indicated to the *local meteorologist* because he is more closely in touch with those who are using the meteorological information in their daily work: the necessary arrangements to permit of progress in these directions and the investigations necessary to solve the problems which present themselves depend largely on the co-operation and enthusiasm of the experts at Headquarters.

During the period since the combined service was initiated, the first division has taken over the work previously performed by the Headquarters staff of the Meteorological Service of the Royal Air Force, while the efforts of the second division have been mainly directed to the application of the general principles in connexion with the Flying Service between London and the Continent and to the training of personnel for the selected centres in other parts of the country.

Separate reports on the work of the two divisions of the service are given below.

1. Headquarters.

1. General.—By the close of the financial year 1918-19, most of the special war demands upon the Forecast Service had ceased and the process of post-war development was beginning. The issue of gale warnings and of forecasts for agriculturists on pre-war lines was resumed in April, 1919, and during the summer following. These were the last of the pre-war activities which had been curtailed or in abeyance during the war. The requirements of the Armies of Occupation and of the Expeditionary Forces to North Russia made demands upon the Forecast Service until October, 1919: data were supplied regularly to Meteorological Sections, R.E., at Cologne and Wimereux, Murmansk and Archangel.

2. Reports from and to Foreign Countries.—One of the features of the year has been the development of the use of wireless telegraphy for the transmission of synoptic data between different countries, such messages being sent out daily from the following European countries by the close of the year:—

Belgium.	Great Britain
Czecho-Slovakia.	Holland,
Denmark.	Italy.
Esthonia.	Poland.
France.	Spain.
Germany.	Sweden.

Considerable difficulties still arise in this method of transmission; and it is only from two or three countries that the synoptic data have been picked up with sufficient regularity in London to compare at all favourably in practical utility with transmission by cable.

As regards the supply of data from Great Britain to countries abroad, W/T messages have been transmitted three times daily from the Air Ministry station and twice daily from Carnarvon (after March 24th, 1920, from the Admiralty W/T station at Aberdeen). Messages by cable have also been transmitted to the following countries :—

Denmark.	Norway.
France.	Sweden.
Holland.	Switzerland.
Italy.	

During the summer of 1919, when Trans-Atlantic aviation was making considerable demands upon the meteorological services of the different countries, numerous messages reporting observations from ships at sea were received by W/T and charted.

3. Observations received. Changes of Stations.—Surface observations have been received throughout the year from the regular telegraphic reporting stations, with the exception of one or two occasions when the telegraph service from Lerwick was interrupted and of the period 15th December, 1919 to 31st March, 1920, when the telegraph service from Castlebay was out of action.

The telegraphic reports from Deerness, Oban and Hartland Quay, referred to in last year's report, were discontinued after December, 25th, 1918, January 14th, 1919 and December 21st, 1918, respectively.

Reports from the following new stations of the Forecast Service commenced during the period under review :—

Calshot.	Croydon.	Biggin Hill.
Beachy Head.	Lympne.	Felixstowe.
Cranwell.	Howden.	Baldonnel.

With the cessation of hostilities at the close of 1918 and the gradual demobilization of the meteorological personnel of the Army and Royal Air Force, considerably less information concerning upper winds was available during 1919 than 1918 ; but reports continued to be received from the Observatories of the Office and from certain stations of the Royal Air Force. Upper wind reports are being commenced at the newly established stations of the Forecast Service.

Baldonnel (from 9th January, 1920) and Upavon also contribute daily observations of upper air temperature and humidity obtained from aeroplanes when conditions permit. Occasional reports of upper air temperatures are also received from the station of the Army Meteorological Service at Shoeburyness ; and from the Royal Aircraft Establishment at South Farnborough. During the first six months of the period they were also received from the Meteorological Section, R.E., with the Armies of Occupation.

4. Night Service.—The preparation of a chart upon the 1h. observations has been continued nightly throughout the year, with the exception of two nights at Christmas, 1919, the first occasion on which the Forecast Division had been closed for a single hour for more than two years (since 19th November, 1917). A report, reproduced by duplicator, and a considerable number of telegraphic forecasts based on this 1h. chart have been issued nightly.

5. Gale Warnings.—On the resumption of this service, it was decided that warnings issued to Coastguard stations should be distributed through the District Intelligence Officers of the Admiralty, while the warnings to Lighthouses and representatives of local interests should be sent direct from the Office as previously. This dual system was continued throughout the year, but after an extended trial and after consultation between the Meteorological Office and the Hydrographic Department of the Admiralty, it was decided to revert to the practice of warning all stations direct from the Meteorological Office and this practice is being recommenced from 1st May, 1920.

The issue of warnings to the Naval and Air Services has been continued. The warnings are regularly checked by comparison with the winds subsequently experienced.

6. Lithographed and Duplicated Reports.—The Daily Weather Report has been issued throughout the year in the form indicated in the last annual report. In addition the "A" report has been issued upon the 1h. chart; the "BB" report as a preliminary issue upon the 7h. chart; and "C" report upon the 13h. chart; and the "D" report upon the 18h. chart. The "BB" and "C" reports are drawn up with a special view to the requirements of aviation on the London-Paris Aerial route.

Since 1st January, 1920, isobars have been drawn upon all official charts for the following intervals in place of the 5 mb. interval previously adopted :—

Charts on scale	1 : 5,000,000	1 mb.	intervals.
,, ,,	1 : 10,000,000	2 mb.	,,
,, ,,	1 : 20,000,000	4 mb.	,,

7. Transfer to Air Ministry, Kingsway.—The Forecast Service was transferred from South Kensington to Kingsway on 18th November, 1919, and three days later the work of forecasting previously carried out by the Meteorological Service of the Air Ministry was included in the duty of the Meteorological Office.

The transfer of the printing press should have been effected at the same time as the transfer of the Forecast Service, and indeed the latter was postponed from the date originally desired to permit both transfers being effected at the same time, but difficulties arose and the printing press had to be left temporarily at South Kensington, where the printing of the Daily Weather Report continued; this necessitated the despatch of the transfers after completion at Kingsway to South Kensington. As foreseen, the arrangement proved very unsatisfactory in practice, and resulted in such serious delays that the "B" report frequently failed to catch the 1.30 post from Mount Pleasant Post Office. At length, on 20th January, 1920, printing presses were installed in the basement of India House,

Air Ministry, and from that date the Daily Weather Report was again printed in the building in which it was prepared. From the same date the distribution of the Report, which had for some time been effected by the Registry, was again undertaken by the Forecast Service.

8. **Harvest Forecasts.**—During the summer of 1919 Harvest Forecasts were issued in response to requests received from 10 persons.

Notifications of spells of settled fine weather were issued on 10 occasions to 14 recipients.

The first "Spell Notification" was issued on June 16th to recipients in E. England and S.W. England. Weather was very fine in East Anglia up till the morning of the 20th and generally fair in the south-west until the evening of that day.

On July 7th, a notification was sent to subscribers in E. England, S.W. England, S. Wales, N. Wales, N.W. England, N.E. Ireland, and S.W. Ireland. Subsequent weather until the evening of July 11th was in general agreement with the prediction.

A notification issued on July 9th, to S.E. England, E. Midlands, and N.W. Ireland was followed by fine weather until the evening of the 12th.

The next notification was sent out on July 26th to all districts and was generally successful except in East Anglia where drizzle occurred on the three subsequent days.

Two spell notifications were issued in August, the first on the 1st to S.E. England, E. Midlands, and S.W. England, and the second on the 6th to the same districts together with S.W. England, S. Wales, N. Wales, N.W. England, N.W. Ireland and S.W. Ireland. Both were completely successful.

On September 8th, subscribers in S.E. England, E. England, E. Midlands, S. Wales, S.E. Ireland, and S.W. Ireland were notified, and on the 9th notifications were sent to N.W. England, E. Scotland, and N.E. Ireland.

The 9th and 10th were fine generally, but rain fell in most parts of Ireland and Scotland on the 11th. Most of the recipients however had three days of fine weather.

A notification was sent to S.W. Ireland and E. Scotland on September 13th and on September 15th this was extended to S.E. England, S. Wales, N.W. England, N.E. Ireland and S.E. Ireland. Fair weather continued generally over the 16th and 17th but some rain fell in Ireland, S. Wales, and N.W. England on the 18th and conditions had become generally unsettled on the 19th.

9. **Regular Supply of Information to Meteorological Correspondents of Newspapers.—Provision for general enquiries.**—Prior to the war arrangements had been made for putting at the disposal of newspaper correspondents, who attended at the Office, the latest reports received and charts of the most recent information. During the war this arrangement had been in abeyance; it was partially resumed in 1919 and it was further extended after the transference of the Service to Kingsway and the absorption of the work of the Royal Air Force Meteorological Service.

At the same time arrangements were made for the staff, which dealt with this work, to undertake the supply of information to the general public and to refer questions to the forecasters only when they could not be answered by reference to the data or to the written forecasts. During the four months December, 1919, to March, 1920, 187 enquiries by telephone or telegram were received and 64 personal enquiries; about 100 of the 187 were referred to the Forecaster or the Assistant Superintendent for S.E. England.

II. Distributive Stations.

10. The organisation of a network of Local Meteorological Centres commenced on 10th November: it is intended finally to have about 20 such centres. Each centre will be staffed by a trained professional meteorologist, assisted by trained technical staff. The duties of the staff are:—

(*a*) To make all the necessary local observations, especially of upper wind, visibility and cloud.

(*b*) To collect simple meteorological reports from other places in the area.

(*c*) To receive by wireless telegraphy or by ordinary telegram, the necessary collective reports for the preparation of synoptic charts.

(*d*) To advise especially the Aviation Services in the area and generally to supply expert meteorological information and advice for all services.

11. It was evident that some time must elapse before staff for all the proposed centres could be provided and trained. Attention was therefore first directed to the most urgent needs of the situation, *i.e.*, the provision of adequate reports and forecasts for the London–Paris–Brussels Aerial Routes.

On 25th November, at a Conference with representatives of the Society of British Aircraft Constructors, proposals were made and an agreement was reached regarding the nature of the reports which the Office should supply in connexion with commercial Aerial Routes. The fundamental information required from points along any route was considered to be:—

(*1*) Wind at surface and at 2,000 feet.
(*2*) Weather (present and past) in general terms.
(*3*) Amount and height of any low cloud.
(*4*) Visibility.
(*5*) (For seaplanes). The state of the sea, particularly in regard to the nature and amount of the swell, which greatly affects the power of a machine to rise from the water.

The representatives of the Society of British Aircraft Constructors were so strongly of the opinion that the weather reports should contain no reference to fitness or unfitness for flying, even of supplementing the detailed particulars of the different elements as weather, that it was agreed to omit the estimate of fitness from the reports, and the following slightly modified form of the code for abbreviated reports given in Annex G. (Appendix IV) of the

Convention relating to International Air Navigation, Paris, 1919, was adopted as providing for existing requirements:—

DDFS.S ALBMh wwWWV

where the symbols have the significance explained in Annex G and S_1 refers to a code for sea disturbance supplementary to S and specifying in particular the *swell* and whether or not the waves are breaking. It was further agreed that information given by wireless telephone to machines in the air should be in plain language and not in code.

12. **South-East England.**—From 22nd November, an acting Assistant Superintendent took charge of the preparation and issue of reports in connection with flying in South-East England. At the end of the month arrangements were completed for opening the first Distributive Centre at *Hounslow* Aerodrome and for the interchange of information with the Central Office. On 1st December, work commenced with one Professional and one Technical Assistant. Reports—in so far as they were available—were received there hourly from 7.30 a.m. to 2.30 p.m., and forecasts for the London–Paris–Brussels routes, prepared at the Central Office, were transmitted to Hounslow at about 9.30 a.m. and 2.30 p.m. daily. Reports of conditions in S.E. England were also prepared and transmitted by wireless to Paris hourly from 07.45 to 14.45 daily. These became gradually more complete as stations were opened and from 20th February they were sent in the form specified above.

Certain additional issues were also made from the Central Office. From 3rd December a statement was prepared for the press each evening on the weather prospects for the following day on these routes. From 11th December, the new "BB" report was issued daily at 9.30 a.m. together with a forecast for the ensuing period of daylight, and the "C" report was supplemented by a similar statement. In the preparation of these reports, the lack of definite and suitable information along the routes was much felt, and the information from the French side in particular was irregular in arrival and defective in detail and frequency. The occurrence of a flying accident at Caterham on 11th December emphasised the recognised need of a reporting station on the North Downs; frequent difficulty was experienced there by pilots on account of low cloud.

Further staff having become available it was possible to open a station at *Lympne* Aerodrome (on similar lines to that at Hounslow) on 14th January, and a subsidiary station with only a single observer at *Biggin Hill* on 17th February. The former station, in addition to the normal reports, supplies meteorological information in connexion with the experimental work carried out at the Small Arms School, Hythe, Kent. A point of interest is that information is supplied from this station to machines in the air by wireless telephone.

Arrangements have been made with the Admiral Commanding Coastguards and Reserves for the Coastguard Station at *Beachy Head* to act as a telegraphic reporting station with a view to improving the weather reports for Cross-Channel flying. These arrangements came into operation from 2nd February.

The arrangements for reporting weather in South-East England were now—from the flying point of view—reasonably satisfactory, and steps were next taken to secure inprovement in the reports from France. On March 15th, Captain Gain of the Service Météorologique de la Navigation Aèrienne and Captain Franck of the French Wireless Service visited the Air Ministry. An informal conference took place between the British and French Meteorological and Wireless representatives as a result of which it was decided that certain hourly observations should be made at several stations in each country and that these should be transmitted by the French at 30 minutes past the hour and by the British at 35 minutes past the hour and that the arrangement should take effect from 13th April, 1920. It was also agreed to ask the Belgians to fall into line with this arrangement and to transmit at 25 minutes past the hour. Reports from Brussels on these lines commenced on April 22nd.

On 28th March the terminal aerodrome on the British side was transferred from *Hounslow* to *Croydon* and the meteorological station moved on the same day.

13. **Special Reports.**—In addition to the routine work above described, special cases for advice or consideration have arisen from time to time. Synoptic data and forecasts have been supplied daily from Headquarters to the meteorological representative of the Aircraft Transport and Travel Company.

Reports have been prepared for the information of the Accidents Investigation Branch of the Air Ministry in connection with reported accidents to aircraft.

In connection with the flights to Australia special reports for the London—Lyons region were prepared from December 1st to 5th for Captain Howell, the pilot of the Martinsyde machine. Similar reports were provided for Lieutenant MacIntosh on the morning of the 24th.

On 3rd February, Lieut.-Colonel Van Ryneveld and Captain Brand visited the Office with reference to the conditions for the first day's flight (London—Turin) of the "Silver Queen" *en route* for Cape Town. Conditions being favourable over France and Italy, they decided to start on the following morning.

14. **Other Districts.**—Concurrently with the development of local centres in South-East England, arrangements were proceeding for the establishment of stations in other districts. The stations which it was intended eventually to establish were arranged in a provisional order of priority according to the urgency of their various requirements.

Fortunately several of the newly appointed staff had had previous meteorological experience in a military capacity and were able to take up duty almost immediately. Most, however, had first to undergo a course of instruction.

Additional delay and inconvenience have in most cases been caused by the difficulties of obtaining housing accommodation for the staff, particularly at service aerodromes and seaplane bases.

On 14th January the R.A.F. Station at *Cranwell* was taken over by civilian staff. The duties of the Meteorologist-in-charge there comprise, in addition to the normal routine, lectures and instruction in meteorology at the Royal Air Force Cadet College. He has also been requested to arrange next winter for special lectures to the officers and staff of the College.

On 19th January a meteorologist was sent to take charge of the station at *Pulham* in connection with the flight of R.34 from East Fortune. On 20th March all the airships were safely transferred from Pulham to *Howden*, the station at Pulham being then closed, and the meteorologist transferred to Howden. So far it has not been possible to supply further civilian staff for this station and the routine duties are carried out by service personnel lent by the R.A.F.

On 2nd February the R.A.F. stations at *Calshot* and *Felixstowe* were taken over and the routine work in both cases was carried on uninterruptedly. The duties of the Meteorologist-in-charge of the former include the delivery of lectures in meteorology, which form part of the syllabus of instruction for the School of Naval Co-operation and Aerial Navigation. The period allotted for this instruction is 60 hours. The station at Felixstowe is attached to the Seaplane Base there.

On 24th February, staff were sent to open a new station at *Didsbury* Aerodrome, near Manchester. As office accommodation and furniture had to be obtained and instruments installed, some delay of necessity occurred before this station was able to commence work.

The station at *Baldonnel* has continued to function uninterruptedly under Service personnel.

15.—**Buildings.**—During February plans were prepared for meteorological huts for local centres to meet the various requirements which would arise. After discussion of the question with Mr. Watson Watt of Farnborough, agreement was reached as to the best means of housing the new type of lightning recorder. No new huts have, however, been erected so far, and it is certain that the cost will now greatly exceed the original estimates (of an average of £400 per hut) made in 1919.

At the existing stations small huts in some cases already existed. In the other cases office accommodation of a temporary nature has been obtained.

16.—**Upper Air Temperatures from Aeroplanes.**—Arrangements were made with the Royal Air Force for four Service pilots and machines to be detailed specially for meteorological work at Baldonnel and at Upavon. Observations commenced at Baldonnel on 9th January and continued very satisfactorily until 9th March, when one of the pilots was taken ill at 15,000 feet, and in consequence was ordered a month's leave by the medical board.

Between 9th January and 31st March over 50 ascents were made mostly to heights of over 10,000 feet.

The unit at Upavon began to make observations on 29th March.

17.—**Stations not yet in Operation.** The following stations have been authorised :—

Grain.
Andover.
Cattewater.
Orkney.
Guernsey.

These will be opened and the full activities of the other stations developed as staff become available.

REPORT OF WORK IN THE METEOROLOGICAL SECTION, R.A.F., FOR THE PERIOD APRIL—SEPTEMBER, 1919, INCLUSIVE.

By Squadron-Leader Gendle, O.B.E.

1.—**General** — During the whole period under review, this section has had to face increasing demands for weather forecasts in connection with Cross-Atlantic Flights, Aerial Routes and Demonstration Flights, with a continual decrease in the personnel; the consequence has been that at Headquarters, Air Ministry, and at stations on the aerial routes, both officers and men, have in most cases had to work for longer hours than during the period of hostilities.

2.—**Forecast Section.**—The general routine of this section has proceeded uninterruptedly throughout the period under review. Weather maps have been drawn up at six hour intervals from information supplied by a network of Stations of the Royal Air Force and Meteorological Office. Reports and forecasts covering various aerial routes have been prepared and issued, together with maps showing the speed and direction of the upper wind over the country, to heads of departments in the Air Ministry and pilots of machines undertaking flights to and from various parts of the United Kingdom.

Special attention has been given to the London-Paris route and a service of weather reports along this route has been maintained. It was not possible to make as complete arrangements as desired, especially in France, but the reports of the weather at other stations on the route in terms of a "Weather Fitness Scale" were sent to each control station every hour from 0700-1900 (7 a.m. to 7 p.m.) throughout the six months. An officer and one man were stationed at Buc to receive and distribute the information sent each hour from this section. This officer was also supplied with the necessary apparatus for determining the wind speed and direction at various altitudes.

To enable the conditions over the country to be readily understood by applicants for information, a system of pin discs and maps was devised and exhibited in the Air Ministry.

Cross-Atlantic Flights.—For the competition organised by the "Daily Mail" to encourage Cross-Atlantic Flights, the necessary meteorological arrangements were made to ensure that competitors received all the information available. Meteorological officers and men were sent to St. John's, Newfoundland, Azores and Lisbon, together with sufficient equipment to enable observations of the upper air and general weather conditions to be obtained. In addition the Portuguese Government was approached and gave all assistance possible. With the co-operation of the Controller of Communications, very complete arrangements were made for the collection and transmission of the weather reports of the United States to St. John's, Newfoundland, and to the Air Ministry. The United States gave every facility in obtaining a rapid system of weather reporting from America, and took steps to ensure that the system was maintained and improved as occasion demanded. Further arrangements were made with the Marconi Company for the transmission of synoptic weather reports for the British Isles by wireless from Carnarvon and for weather reports by wireless from ships at sea. The ships' reports, when received regularly, were of great assistance in drawing synoptic charts of the Atlantic. The flight was accomplished by Capt. J. Alcock and Lieut. A. W. Brown on June 14-15, 1919.

For the flight of R.34 similar arrangements were made: also two Meteorological Officers were sent out on each of the battle cruisers, "Tiger" and "Renown." Those ships were stationed North and South of the usual Atlantic steamship line, and the observations sent by them were of great assistance in drawing up weather maps of the Atlantic, and were of considerable value as a check on the ordinary ships' reports. In accordance with a special request from the Deputy Chief of the Air Staff, an officer from FO.5. was sent on R.34.

During the flight (July 2nd-6th, and 10th-13th) small synoptic maps of the Atlantic were prepared and distributed to the heads of all departments in the Air Ministry, together with complete reports and forecasts, which were also issued to the Press.

In connexion with Cross-Atlantic flying generally, an expedition organized by the Air Ministry to investigate the practibility of using kites from ships for work over the Atlantic, which was sent out on S.S. "Montcalm" towards the end of March, returned at the beginning of May. A report has been made embodying the important results obtained.

Special Reports were issued as follows:—

(*a*) **Amsterdam.**—During the Aircraft Exhibition reports and forecasts covering the route were issued twice daily to Hounslow, Felixstowe and Lympne.

(*b*) **Madrid.**—In connection with flights by R.A.F. machines to Madrid, weather reports and forecasts were issued daily just previous to their flights. Similar reports and forecasts have also been issued to private firms.

(*c*) **Egypt.**—Special reports and forecasts were sent to Bircham Newton, three times daily in connexion with flights by a number of machines from Bircham Newton to Egypt. These reports covered the route as far as Rome.

(*d*) **Scandinavia and Denmark.**—Reports and forecasts were issued three times daily to Felixstowe in connection with the demonstration seaplane flights to these countries.

(*e*) **Rome.**—Reports and forecasts of the conditions between the French coast and London were issued to the British Air Attaché, Rome, for the use of the Italian pilots flying to England.

(*f*) **Miscellaneous.**—Reports and forecasts were also issued for the flight of R.34 over Germany and to N.S.11 in connection with her flight round the North Sea.

III.—Conferences.—(*a*) A conference was held in the Air Ministry on April 30th, 1919 on the "Detection of thunderstorms by Directional Wireless." As a result of this conference, approval has been obtained for the erection of a Standard R.A.F. Meteorological Hut at Biggin Hill to conduct experiments.

(*b*) A conference between representatives of the Admiralty Wireless Board, the Air Ministry and Meteorological Services was held in the Air Ministry on Sept. 2nd, 1919 on the transmission of weather messages by wireless from ships. As a result of this conference a small sub-committee was appointed to revise M.O. Circular 201 which deals with the compilation of these messages.

(*c*) Various conferences were held on aerial routes London-Paris, England to Australia, Cairo to Karachi.

IV.—Research and Statistical Work.—In connexion with aerial routes various reports on the weather conditions have been made out at the request of the Controller General of Civil Aviation. There have also been drawn up diagrammatic representations of the weather for the following routes and places: London–Melbourne, Shanghai–Hong-Kong, London–Cape, aerial route across inland Persia, and in the islands of the Western Pacific.

In connexion with the Cross-Atlantic Flights, a considerable amount of research and statistical work was undertaken to help the various competitors. The chief work in this respect consisted of a series of charts showing the typical and extreme conditions in the North Atlantic during the months of April, May and June; tables were prepared showing the approximate times of flight under these conditions. This information, together with an explanation of the difficulties of the flight, appeared in the Press on Monday, 14th April, 1919.

In connexion with the Cape to Cairo route, a statement has been drawn up for a commercial firm showing the months when a regular service could be maintained.

A cinematograph film was made by the Photographic Section of the R.A.F. giving a record of meteorological work for instructional purposes.

V.—Miscellaneous.—This section has been visited by representatives from the meteorological services of Norway, Italy, Spain and Holland. These representatives were given all the information they required and were shown round the section.

Various officers and civilian pilots undertaking demonstration and other flights, have visited the branch and have been afforded all information available. In addition, civilian Aviation Companies are furnished with all the reports they demand at present free of charge.

VI.—Honours and Awards.—One O.B.E.; one A.F.C.; ten Mentions in Despatches.

MARINE DIVISION.

Report by Commander L. A. Brooke-Smith, R.D., R.N.R., Marine Superintendent.

Collection of Information.—During the past year systematic efforts have been made to enlist the co-operation of old and new observers of the Mercantile Marine, in the collection of ocean meteorological data, which received such a serious set-back during the war. An active campaign by means of circulars and personal letters to captains and owners of ships has been carried on; the services of Agents at the ports have been made use of; and in addition an Officer belonging to the Office staff has been detailed to visit ships lying in the Port of London for the purpose of recruiting new observers by personal interview and for instructional purposes.

There has been a gratifying response to our appeals, and 70 ships have been supplied with instrumental equipment for keeping a four-hourly log, bringing the total so equipped on 31st March, 1920, to 104. In addition 117 ships have contributed observations twice daily on Forms 121 and 122, and their number is still increasing.

Many definite offers to keep four-hourly logs have been received from captains and there is abundant evidence that the voluntary observing fleet can be increased very largely whenever instruments are available.

The following table shows for the purpose of comparison the numbers of the various ocean documents received from ships during the past seven years. It is anticipated that the coming year will show a more marked increase, when the results of recent activities come to hand.

Year ending March 31.	Full Log.	Short Log.	Form 121.	Form 122.	Form 138.	Total.
1914 ...	279	4	1,427	170	858	2,738
1915 ...	224	2	974	90	410	1,700
1916 ...	147	—	790	92	20	1,049
1917 ...	115	1	546	124	—	786
1918 ...	59	—	111	33	—	203
1919 ...	22	—	17	4	—	43
1920 ...	67	—	435	68	—	570

Continuous meteorological registers have also been received from six lighthouse stations in the British West Indies, and from Cape Pembroke Lighthouse, Falkland Islands.

The collection of observations of sea and air temperatures, weather, and fog intensity, taken twice daily at selected coastguard stations and on board light vessels, has been continued.

Meteorological Logs.—The logs received have been submitted to careful examination, with the result that 43 were classed "Excellent" and 24 "Very Good."

Supplementary Information. The arrangements for obtaining meteorological information from the captains and officers of ocean-going ships who offer their co-operation, but who are unable to keep the full four-hourly log, have been continued, the observers have used the ship's instruments. The set hours of observation for this class of information are 8 a.m. and 8 p.m., ship's time, but all occurrences, such as ice, derelicts, water-spouts, etc., and special observations are remarked as in the meteorological log. Immediately upon receipt the returns are closely examined for any information that can add to the interest of the Monthly Meteorological Charts of the North Atlantic Ocean and of the East Indian Seas, or add to the knowledge of the Pacific. In this connexion co-operation is not confined to the personnel of British ships. A list of observers given in Circular No. 001 (J), contains the names of Dutch, Belgian, and Japanese Captains.

A number of barograms have been received from some of the ships of the Royal Navy, which give continuous records of pressure in various parts of the world. The number of contributions received, classified according to the different lines of route, is shown in the following lists;—

Four-hourly Logs.

North Atlantic	United States	9
	West Indies	2
Africa, S. and E. coasts		2
South America, E. coast		6
South America, W. coast, *via* Magellan and Panama		2
East Indies, *via* Suez		13
China and Japan, *via* Suez		8
China, coasting		1
Australia	*via* Cape of Good Hope	1
	via Suez	8
	Out via Cape of Good Hope, *home via* Suez	3
	Out via Cape of Good Hope, *home via* Panama	1
New Zealand *via* Panama		7
Trans-Pacific		1
Orkneys		1
United Kingdom Coasts (Cable work)		1

North Atlantic Registers (Form No. 121) and East Indian Seas Registers (Form No 122).

Routes.	Form No. 121.	Form No. 122.
U.S.A. and Canada	369	—
West Indies	6	—
Africa, West Coast	24	—
South America, East Coast	22	—
Mediterranean	13	—
North Sea	1	—
India *via* Suez	—	21
India *via* Cape	—	3
East Indies *via* Suez	—	25
China and Japan *via* Suez	—	8
Australia *via* Suez	—	3
Australia *via* Cape of Good Hope, *home via* Panama	—	4
Trans-Pacific	—	4
Totals	435	68

"Excellent" Observers.—In Circular No. 001 (J) is given a complete list of the ships from which the four-hourly logs were received, the names of their captains and of the officers who shared between them the duties of observing the elements recorded in the logs. Several of these have maintained their connexion with the Office, as observers, through many years, and some of them have contributed numbers of logs which have been awarded an "Excellent" character. Among these should be mentioned Captain W. Stanley, s.s. "Oxfordshire," whose total to date is 25 logs; Captain C. J. Higgins, s.s. "Clan MacGillivray," who has kept 24 logs all "Excellent"; and Commr. A. W. McKellar, R.D., R.N.R., s.s. "Ruapehu," 21 logs.

Those captains whose names appear in the list of "Excellent" observers for the first time are :—

Captain H. Alder	Olympia.
Captain D. Arthur	Laomedon.
Commr, Sir William de M. Baynham, K.B.E., R.D., R.N.R.	Ormonde.
Captain N. E. Bower	Hororata.
Captain F. W. Chambers, D.S.C. ...	Digby.
Lieut. C. H. Christian, R.N.R. ...	Kenuta.
Lieut. Commr. I. J. Hayes, R.D., R.N.R.	Orontes.
Captain F. A. Hemming	Rimutaka.
Captain W. Mackenzie	Newby Hall.
Lieut. D. Mansfield, R.N.R. ...	Peleus.
Captain N. Martorell	Kenuta.
Commr. C. G. Matheson, D.S.O., R.N.R.	Orvieto.
Commr. R. A. Milne, R.D., R.N.R.	Margha.

Captain R. E. Oliver, D.S.C., L.R.S.M.	Worsley Hall.
Commr. F. W. Parker, R.D., R.N.R.	Newby Hall.
Captain M. J. Sarson	Osterley.
Lieut. J. H. Squires, R.N.R. ...	Kaikoura.
Commr. H. G. Staunton, C.B.E., R.D., R.N.R.	Ormonde.
Lieut. A. Taylor, R.N.R.	Rotenfels.
Captain T. A. Tyson	Blackwell and Malakand.
Captain W. K. Wallace	Teucer.

As a mark of recognition and appreciation of valuable co-operation, the practice of former years of presenting various publications of the Office to the captains and officers, who have returned well-kept meteorological log books, has been maintained.

The publications which have been chiefly used for this purpose are :—Monthly Wind Charts of the South Atlantic; Monthly Wind Charts for the Coastal Regions of South America; Meteorological Charts of the Red Sea; Charts showing the Surface Temperature of the Atlantic, Indian and Pacific Oceans; Monthly Current Charts for the Atlantic Ocean; Monthly Current Charts for the Indian Ocean; Quarterly Current Charts for the Pacific Ocean; single and bound copies of the Monthly Meteorological Charts of the North Atlantic, and also of the East Indian Seas; The Barometer Manual; The Seaman's Handbook of Meteorology; The Marine Observer's Handbook; The Meteorological Glossary and Weather Map; and the Weather of the British Coasts.

Use of Information received.—Work on extraction of data has been carried on for the region of the North Atlantic from Lat. 20° to Lat. 60°. The month of September having been completed in the previous year, data books have been opened for the remaining 11 months and a considerable volume of information has been extracted.

Form 112, the data book, has been revised as Form 112A. These data books have been provided with the intention of extracting data for all Oceans from meteorological logs, Navigating Officers-Remark-Books, and Meteorological Reports as they arrive, which will eventually greatly facilitate the work of the Division in producing computed results and answering inquiries. Inquiries by Froeign Meteorological Services, Government Departments, Scientific Societies, Local Authorities, Lawyers, Shipowners, etc., entail much work, thereby tending to delay the progress of Marine Meteorology with the existing staff. This method of extraction of data will it is considered in time obviate this delay, provided it is not interrupted during the first few years after initiation.

It is intended to facilitate the exchange of data with other nations.

In connection with the investigations respecting the disappearance of ships and other maritime casualties, information contained in meteorological logs has been supplied to the legal representatives of the parties concerned.

At the request of the Hydrographer to the Navy, the information as to the monthly distribution of mist and fog over the North Sea and Baltic areas has been revised and brought up to date.

Monthly Meteorological Charts.—(*See p.* 34).

Weather Reports by W/T and Synoptic Meteorology at Sea have been considered and proposals submitted which are considered practicable at sea.

Cadets' Meteorological Log.—With promise of co-operation from the Officers' Training Ships, Conway, Worcester and Pangbourne Nautical College, a Cadets' Meteorological Log, has been drawn up and printed.

The four-hourly meteorological log, and the corresponding original note book have been revised and brought into line with current requirements.

Reports of Weather and Sea-Temperature round the British Isles.—An investigation by means of correspondence has been conducted for obtaining these data. A scheme drawn up has been circulated. It is hoped that a trial by Coastal and Cross-Channel Steamers will be made from May 1st.

CLIMATOLOGY AND STATISTICS DIVISION.

Report by F. J. W. Whipple, M.A., Superintendent.

Organization.—The normal work of the Statistics Division is the collection of meteorological observations and of autographic records and the preparation of the several parts of the British Meteorological and Magnetic Yearbook.

Mr. C. E. P. Brooks, who had been serving with the Forecast Division was appointed to the Statistics Division in August and has been in charge of the Réseau Mondial Section since that date.

Mr. J. Sheerman, who had been Principal Clerk in the Division since 1914, retired at the end of 1919, his place being taken by Mr. A. R. Simpkins. Mr. Sheerman came to the Office in 1882, and has devoted the greater part of his time to work in connection with the tabulation and analysis of the readings from the autographic instruments at the Observatories.

Climatology of the British Isles.—*Distribution of Stations.*—A list of stations in connection with the Office, in which particulars are given of the orders of the stations and of the official publications for which returns have been prepared, is issued as a separate Circular 001 (J.). An alphabetical list of the stations accompanies the Introduction to the Monthly Weather Report.

The following table gives the distribution by Districts of the stations of different types and also indicates where autographic records are being kept.

	Stations.			Autographic Records.					
	Observatories.	Other Telegraphic Stations.	Climatological Stations.	Sunshine.	Rainfall.	Wind.	Pressure.	Temperature.	Humidity.
0. Scotland, N.	0	4	11	6	0	1	4	0	0
1. „ E.	1	2	31	12	1	5	3	3	2
2. England, N.E. ...	0	3	17	13	0	2	2	0	0
3. „ E.	0	3	20	15	0	4	2	0	0
4. „ Midlands ...	0	2	37	22	0	1	2	1	1
5. „ S.E. ...	0	2	44	35	0	3	2	0	1
London District ...	1	0	8	9	3	2	2	2	1
6. Scotland, W., and Isle of Man.	1	1	25	13	1	2	3	2	2
7. England, N.W., and N. Wales.	0	2	29	21	1	3	3	1	0
8. England, S.W., and S. Wales.	0	2	38	27	1	4	2	1	1
9. Ireland, N.	0	3	7	4	1	1	3	0	0
10. „ S.	1	2	17	8	1	4	6	1	1
11. Scilly and Channel Islands	0	2	3	4	0	1	3	0	0
Total	4	28	287	189	9	33	37	11	9

Only such autographic records as are regularly received at the Office are shown. It should be noted that the records from observatories such as those at Oxford, Glasgow and Southport, are available on occasion. The records made at the new "Distributive Stations" are preserved locally at present. They are not included in the above list.

Additional rainfall stations which have been shown in similar tables in preceding reports are omitted as they are now dealt with by the British Rainfall Organization.

Changes in Stations associated with Division III.—Observations interrupted owing to the War have been resumed at the following stations: Hereford (Belmont Priory) in June, Rugeley (Beau Desert) in August, Folkestone in October and Lowestoft in December, Clongowes Wood in January. Mr. J. Sherwen, who had been incapacitated by illness, recommenced observations at Egremont in January.

New stations have been started at *Walton-on-the-Hill*, by Lieut. G. R. Crompton, and at *Luton* by Mr. E. A. Mander. Observations are also being received regularly from the Royal Naval Cordite Factory, *Holton Heath*.

The following stations have been given up during the year: *Bawtry*, *Beddgelert*, *Carnforth*, *Minehead*, *Rauceby* and *Stonehenge*. The station at Hesley Hall, *Bawtry*, was maintained by Mr. B. I. Whitaker, J.P., and the observations cover nearly forty years. The observations at Beddgelert have ceased owing to the departure from England of the observer Mr. A. Lockwood; there is now no climatological station in North Wales except on the coast. Mr. W. Farrer, who maintained an anemograph as well as the ordinary climatological station at Carnforth, has changed his residence. Records from Rauceby had been received from Mr. Arthur Willson and his predecessors for nearly 20 years.

Reference must be made to the death of the Rev. Walter Sidgreaves, S.J., Director of the Stonyhurst College Observatory. Father Sidgreaves, who had an international reputation as an Astronomer, was closely associated with the Meteorological Office at an interesting period of its development when the transfer of the Office from the Board of Trade to the Meteorological Committee of the Royal Society was followed by the establishment at seven observatories of recording instruments of uniform pattern to provide material for the scientific study of the weather. In the case of Stonyhurst, the records were only maintained by the Office up to 1884, since which time they have been maintained independently.

Climatology of the Globe.—A list of the foreign and Colonial stations from which documents are received is given in Circular 001 (J). In most cases these returns were not interrupted by the war, and they have been examined and summarised month by month. Certain new stations have been established, including one on Ascension Island.

For climatological information with regard to most countries the Office depends on publications received in the Library. For many purposes this information has to be worked up, long term averages or frequencies being derived from the daily or monthly values found in the publications.

Publications. The Statistical Division is responsible for the preparation of the periodical publications grouped under the title "The British Meteorological and Magnetic Year Book," and referred to on p. 35, also for the Meteorological Office Circular, now incorporated in the Meteorological Magazine, and for the Book of Normals (*see* pp. 35, 36).

The Meteorological Atlas.—The Joint Committee of the Meteorological Office, the Royal Meteorological Society, has been revived, and some progress has been made with arrangements for the publication of a Meteorological Atlas of the British Isles, material for which had been worked up to a great extent before the War. Mr. W. A. Bion, formerly of the Meteorological Service of India, has been engaged on this work.

Returns for Registrars-General.—A weekly summary of the weather at certain large towns has been prepared for the report of the Registrar-General for England and Wales. A quarterly and annual summary of weather in Ireland is furnished in like form for the report of the Irish Registrar-General.

Admiralty Pilots.—The handbooks issued by the Admiralty for the use of navigators are provided with climatological tables prepared in the Meteorological Office. The tables for the following volumes were completed during the year :—

Pacific Islands Pilot, Vol. 3.
West Indies Pilot, Part 3,

Information for Aeronauts.—Much climatological information has been supplied during the year in connexion with the preparation of route reports. Attention has also been devoted to the discussion of statistics relating to upper air temperatures and to wind strength aloft.

BRITISH RAINFALL ORGANIZATION.

Report by M. de Carle S. Salter, Superintendent.

Transfer to Meteorological Office. — The British Rainfall Organization was transferred to the Meteorological Office on July 24th, 1919, and this Report refers only to work done during the period July 24th, 1919, to March 31st, 1920. At the date of the transfer Dr. H. R. Mill retired from the Directorship of the Organization, the remaining members of the staff accepting posts under the Meteorological Office. Owing to the exigencies of the war the staff was below normal requirements,

Staff.—Mr. R. Lamport resigned his post in October 25th; Mr. J. Glasspoole, B.Sc., resumed duty with the status of Professional Assistant after absence on war service; Miss Lamport was appointed temporary clerical assistant on October 27th and Mr. W. A. Bion, formerly of the Indian Meteorological Service, temporary cartographical assistant on February 3rd, 1920.

Re-organization.— A considerable amount of time has been expended in reorganizing the work of the department to suit the altered condition involving re-arrangement of the duties of the staff and modification of the existing systems of filing and of supply. Arrangements have been made for the closer co-operation with the statistical division of the Office, under which observers who have been in the habit of reporting to both institutions are relieved of the trouble of making duplicate returns. Somewhat similar arrangements are being made also with the Meteorological Office, Edinburgh.

Premises. — Two rooms on the second floor formerly in private occupation by Dr. Mill have been equipped as Offices. Shelving has been erected in them for the purpose of re-storing the original rainfall returns at present preserved in an office at the bottom of the garden, which has proved to be damp.

Publications. — (*a*) *British Rainfall, 1918.* — At the date of transfer the preparation of the annual volume was proceeding and it was issued on November 10th under the editorship of Dr. H. R. Mill and Mr. Salter. Following the usual practice reprints of the General Tables of Rainfall (Part III), have been presented to 500 contributing observers. This issue was made on November 19th. The statistical material given in *British Rainfall, 1918.* included :—

Records of Percolation	at	7	Stations.
Records of Evaporation	,,	13	,,
Complete Climatological Observations	,,	1	,,
Monthly number of rain days ...	,,	100	,,
Lists of droughts	,,	100	,,
Lists of Rain Spells	,,	100	,,
Duration of Rainfall	,,	60	,,
Heavy Rains in Short Periods.			
Heavy Daily Rainfalls.			

Monthly Rainfall	at 300	Stations.
Monthly Rainfall. Percentage of average	„ 103	„
Seasonal Rainfall	„ 103	„
Annual Rainfall. Percentage of average	„ 209	„
Annual Rainfall. Total Fall ...	„4,998	„

The total number of complete records in each country and the change since the previous year were as follows :—

England	3,931	−60
Wales and Islands	439	−17
Scotland	770	− 8
Ireland	268	− 2
British Isles	5,398	−87

The figures show a small decrease in each case, but there has been an improvement in distribution. In all 280 new records have been printed, and 367 old records dropped out. The deaths were recorded of 95 observers, 21 of whom had carried on observations of rainfall for 30 years or upwards.

(*b*) *Symons' Meteorological Magazine*, Volume 54, including the issue for January, 1920, was completed on the old lines, and an Index was issued with the January number. In February the Magazine was amalgamated with the Meteorological Office Circular, under the title *The Meteorological Magazine*. It has been edited jointly by the Superintendents of the British Rainfall Organization and of the Statistical Division of the Meteorological Office. The Climatological Tables for the British Empire have been re-modelled and enlarged, and an article dealing with the weather of the world in the preceding month has been introduced. The magazine, whilst retaining its character as the organ of the British Rainfall Organization, becomes in addition that of the combined Meteorological Services.

(*c*) Contributions to the *Monthly Weather Report*.—From January, 1920, a Supplementary Table of Rainfall at approximately 200 stations has been prepared monthly, in addition to the map showing the distribution of total rainfall based on about 1,000 records.

(*d*) *Rules for Rainfall Observers*.—A revised and enlarged edition of this pamphlet has been prepared and issued.

Supply of Information.—A very large number of requests for rainfall data and for advice have been received from the public and the newspapers and these have been in every case complied with. Except in the case of data required for scientific or educational purposes, a small charge has been made to cover the time expended. The total sum received was £87. 14*s*. 6*d*.

Professional Work.— Monthly Reports with Tables and Maps dealing with the Rainfall of the Thames and Lea Valleys have been supplied to the Metropolitan Water Board; also deferred annual reports for the years 1917–18 and 1918–19.

Monthly Tables of rainfall in the Thames Valley have been supplied to the Thames Conservancy.

Report, Tables and Maps have been supplied to the Corporation of Birmingham, Bradford (Yorks.) and Newport (Mon.) and to the Neath Rural District Council.

The Superintendent attended and gave evidence for the Neath R.D.C. in connexion with the Swansea Borough Extension Provisional Order, and evidence has been prepared in connexion with the Newport Corporation (Water) Bill, 1920.

A Retainer was received in the Dartmoor Hydro-Electric Scheme (dropped) and subpœnas in Croydon Gravel Co. *v* Smith, and in Sitwell *v* Wells (not yet heard).

Permanent Files.— All returns of rainfall, evaporation and percolation and of duration of rainfall, received up to the end of 1919 including those too late for publication in *British Rainfall, 1918*, have been entered in the permanent files, which now contain a homogeneous series of monthly rainfall totals extending back to 1677.

Returns for 1919.— Approximately 4,500 returns of rainfall in 1919 have been received in response to the Annual Circular sent out on December 29th, and the compilation of *British Rainfall, 1919* is in hand. A preliminary article on the rainfall of 1919 was supplied to *The Times* of January 30th, 1920.

Returns for 1920.—About 1000 returns are received monthly, these have been tabulated to date.

Climatological Observations.—Complete daily observations have been maintained at Camden Square throughout the year, and the results supplied for publication in the *Daily* and *Monthly Weather Reports*. Owing to the growth of trees the exposure of the sunshine recorder has become defective and arrangements are being made to remove it to a better position in the neighbourhood. The Fernley self-recording rain gauge on test has been dismounted and a Mark V. Hyetograph substituted.

Rainfall Maps.—The incomplete average rainfall map of the British Isles on the scale of 2 miles to 1 inch has been revised or extended in parts of Yorkshire, Monmouthshire, Glamorgan, Carmarthenshire and Brecon, and the small-scale Index Map has been brought up to date. Preliminary work has been put in hand on the compilation of small-scale average rainfall maps of the year and of each month for the climatological Atlas of the Royal Meteorological Society.

The series of maps of the rainfall of each month and year has been kept up to date and the revision of those for 1919 for reproduction in *British Rainfall, 1919*, is in an advanced stage.

Inspection of Stations.—The following numbers of stations have been inspected :—

London	2	Somerset	2
Surrey	4	Gloucestershire	8
Sussex	5	Worcestershire	11
Hertfordshire	1	Glamorgan	3
Devonshire	3	Brecon	5

In addition, sites have been inspected for two stations in Somersetshire, and five in Wales. The inspections include one complete climatological station.

Testing Rain Gauges.—Certificates were issued for 19 standard rain gauges, 58 measures and 1 hyetograph. Certificates were refused in three cases. The fees received in respect of the issue of certificates were £5 3*s.* 9*d.*

INSTRUMENTS DIVISION.

Report by R. Corless, O.B.E., M.A., Superintendent.

The year has been one of unusual difficulty in many respects. The instruments division was brought back from 15, Cromwell Road to the Office in Exhibition Road. The transfer of the Office to the Air Ministry involved the transfer to the Instruments Division of the instruments and stores kept by the former Air Ministry branch F.O. 5 at the R.A.F. Store Depôt, Kidbrooke, and of the equipment which had been supplied by that branch to about 40 R.A.F. Stations, mainly in the British Isles. Many of these stations have since been closed; others have been reorganized under the Forecast Service, while new stations have been equipped to meet the requirements of Civil Aviation. The large accumulation of instruments which were used by the Meteorological Section, R.E., in the various theatres of war was returned. The marine division resumed its pre-war activities. There are now large stocks of certain kinds of stores but acute shortages still persist in others. The position in comparison with what it was before the war is illustrated by the statements that the value of the instruments and stores on charge on 31st March, 1914, was £421; while the corresponding figure for 31st March, 1920, excluding the greater portion of the stores returned by the Meteorological Section, R.E., which were not then unpacked, was £21,932. A considerable amount of surplus stores has been disposed of by sales both at home and to Dominions, Colonies, and Foreign Meteorological Institutes. Fuller details of the above statements are given below.

Removal from Cromwell Road to Exhibition Road.—The removal of the Marine division and of the printing press to the Air Ministry in February made it possible for accommodation for the Instruments Division to be found on the second floor of the Office building in Exhibition Road, with the addition of the large room in the basement formerly occupied by the press, for a store. The temporary premises at 15, Cromwell Road, which had been occupied since September, 1918, were accordingly vacated in the week ending 6th March. Stevenson screens and a number of packing cases for which no accommodation could be found in the Office are stored temporarily in the large hall of the uncompleted Science Museum by kind permission of the Director of the Science Museum.

Transfer of Stores from Kidbrooke.—About one week after the division had returned to Exhibition Road, the instruments and stores which had been kept at the R.A.F. Store Depôt at Kidbrooke for the former Air Ministry branch F.O.5, amounting in estimated value to £3,628, were received, and had to be arranged in time for the annual stocktaking on 31st March.

Stations at Aerodromes.—Lists of equipment noted by F.O.5 branch as on charge at R.A.F. aerodromes and stations have been issued to the officers responsible, for reacceptance, and in most cases, the equipment has been duly accounted for. The difficulty of tracing equipment has been great in view of demobilisation and of other connected reasons. A statement of the instruments which will be required to equip all the proposed contributive and distributive stations has been drawn up and compared with the equipment which is available and it appears that of the kinds of instruments used at those stations 39 cup anemometers, 23 large Stevenson screens, 37 pairs of goggles, and 38 sunshine recorders, (total value £900) will be surplus to these requirements.

Surplus Stores.—Besides the instruments just referred to as being surplus to requirements there are certain other surpluses, of stores not used at contributive or distributive stations, especially aneroid barometers as supplied to the Navy, and balloons. It is reasonable to suppose that the aneroid barometers will be absorbed by the Navy in the course of about five years. There are some 15,000 rubber balloons (48″ size) which have been in stock since 1918 and for which there is now very little demand. These are perishable and their value when new was £375.

A letter was addressed to the Colonial Office in January, 1920, calling attention to the store of instruments of approved type which were available for supply on repayment, and, as a result, a number of requisitions have been received from various Colonies through the Crown Agents for the Colonies. Instruments have also been sold to the self-governing Dominions, and to foreign institutes as noted below.

Store Accounts and Stocktaking.—The store accounts of instruments in the charge of the Committee at the Office, Observatories, Official Stations, and on board ships of the Mercantile Marine have been reaccepted by the authorities who are in charge of them, and authority has been obtained for the writing off of certain equipment which was unserviceable.

At the end of the year the annual stocktaking of stores in this division was carried out, and the discrepancies of stock from ledger balances were reported.

In consequence of the transfer of the Office to the Air Ministry, a considerable amount of information regarding the activities of the Instruments Division has been supplied to the Finance Department of the Ministry; particularly in regard to the methods of holding stores on charge at observatories, out-stations and ships, the supply of instruments on repayment, and the general procedure within the division: and it has been arranged that, as soon as the necessary forms have been printed, the new system of dealing with movements of stores which has been ordered for adoption within the R.A.F. as

from 1st. April, 1920, and described in Air Ministry weekly orders 247–255 of 1920, shall be followed in the Instruments Division, with such simplifications as are possible from the nature of the case, and with a modification in regard to Order 253, (which deals with issues on repayment) which provides that the Office shall continue in the case of supplies to its voluntary observers, to render the bills direct to the observers; instead of obtaining for the Finance Department a receipt for the goods from the observer and leaving the bill to be rendered subsequently by the Finance Department.

The new system is worked entirely by means of registered loose vouchers, and the day-book record of transactions carried out will be discontinued.

It has also been arranged that the Instruments Division should be responsible for the store accounts of wireless stores obtained by the Controller of Communications for Civil Aviation Stations, where there is no Civil Aerial Transport Officer who can take them on charge locally on his books.

Exhibitions.—Exhibits of meteorological instruments were prepared for a conversazione of the Royal Society on 28th. May, 1919; for the exhibition of British Scientific Products, Central Hall, Westminster, July, 1919; for the summer meeting of the Royal Meteorological Society at Kew Observatory, July 2nd. 1919; and for an At-Home held at the Office on July 3rd. 1919, while a large collection of meteorological instruments was despatched for exhibition at the Royal Agricultural Show at Cardiff, June 24–28, 1919.

Investigations, &c.—A new specification of the sphere of the Campbell-Stokes sunshine recorder has been drawn up in consultation with Messrs. Chance Bros.

Makers' specifications for all instruments which are articles of common supply are being prepared to complete the set which was started many years ago, and which has been added to from time to time.

Working instructions and a table for computing the velocity-height ratio by means of observations of the Fineman Nephoscope, Mark II, have been prepared for publication.

A revised specification of the standard Stevenson Screen has been drawn up to meet the objections to the present design.

A clock which rings a bell every minute and a warning bell every 5 seconds before the end of the minute has been adapted in the workshop for use in watching pilot balloons, as an automatic time-keeper for observations every minute.

A hyetograph of the Mark IV type has been converted in the workshop in a simple manner to give a straight line time scale.

Tests by the National Physical Laboratory upon the heads of the new Dines pressure tube anemometers with direction recorders, show that the pressure difference given by the heads in wind currents of various speeds are such that the corresponding records of wind speed obtained from them in conjunction with the standard recorder are correct to within 3 %.

Detailed experiments have been made upon the Richard hair hygrograph, simple hair hygrometers, ordinary dry and wet bulbs, rotated dry and wet bulb thermometers, and an Assmann psychrometer with a view primarily to the formulation of definite instructions to observers for the management of the Richard hygrograph. Incidentally a considerable amount of useful information has been accumulated and is now being put into form for publication.

The following is a statement of the regular work of the division during the year:—

Supply of Instruments to the Navy.—The new system of supply of instruments to H.M. Ships and Dockyards on receipt of requisitions from the Admiralty or from Dockyards, which was referred to in last years' report, has been continued throughout the year, and continues to give satisfaction. A comparison is made every six months between the out-of-pocket expenses of this service and the amounts recoverable from the Admiralty under the scheme. The recoverable amounts have been very slightly larger than 5% in excess of the expenses incurred. A margin of 5% is required to cover departmental expenses.

The number of requisitions dealt with under this heading during the year was 70.

Supply of Instruments to the Army.—Two meteorological stations are maintained by the Meteorological Office in conjunction with the War Office (*see* p. 83) at Shoeburyness and at Lavington, Salisbury Plain, and the meteorological equipment required for these has been supplied on repayment. The number of requisitions received during the year on this account was 88.

Supplies to the Royal Air Force.—Equipment and consumable stores were supplied to the R.A.F. meteorological stations on repayment by the Air Ministry up to the end of August, 1919, when the Office became responsible for the work done at these stations. From 1st September, 1919, no charge has been made for these supplies, which have thus been charged on M.O. funds. The number of requisitions received from Air Ministry (F. O. 5), during the nine months to 31st December, under this heading was 146. From 1st January, supplies were made direct and are included under official stations, below.

Supplies to Observatories and Official Stations.—The equipment at observatories and official stations has been maintained, and consumable stores have been supplied for observations of pilot balloons, photographic recording of meteorological, magnetic, electrical and seismic elements, and other purposes. It is proposed to supply new Dines' pressure-tube anemometers with direction recorders to Spurn Head, Gorleston, Holyhead and Aberdeen, as soon as the necessary arrangements can be made. The number of requisitions dealt with was 485.

Supplies on repayment to voluntary observers reporting to the Office. These were made on demand, upon the terms set out in Circular 001. The number of requisitions dealt with was 63.

Supplies to observing Ships.—The active resumption by the Marine Division of the pre-war arrangements for obtaining meteorological observations from ships of the mercantile marine, under which the Office lends approved instruments to Captains of Ships who are willing to make and forward the observations, coupled with the heavy loss of Office instruments formerly carried by ships of the mercantile marine which were sunk during the war, has led to a shortage of mercurial barometers, which will be relieved as other instruments sent to makers for repair are returned in serviceable condition. The process is however a slow one since the repair of mercurial barometers is a specialised industry which is carried on by only a few firms, who still find considerable difficulties in obtaining suitable supplies of the special glass tubing from the glass makers. The number of requisitions dealt with under this heading was 66.

Supplies to the Dominions and Colonies, and to Foreign Institutes.—A resumption of the pre-war activities in this direction has been notable, and demands have in particular been received from Scandinavia, Denmark and Holland, which it has been possible to meet. The Scandinavian countries have now ordered supplies of Mr. W. H. Dines' balloon meteorographs, and the manufacture of these instruments by a London firm has been arranged. Ten balloon theodolites were supplied to the Meteorological Service of Canada, while other supplies have been made to South Africa, New Zealand, Egypt and to various Colonies. The total number of requisitions under this heading was 71.

Supplies to other Government Departments on repayment and other miscellaneous issues and loans amounted to 160 in the year, and the total number of requisitions dealt with was 1149.

METEOROLOGICAL OFFICE, EDINBURGH.

Report by Andrew Watt, M.A., F.R.S.E., Superintendent.

During the year the following changes have taken place in the staff. Miss W. Hume, after six years' service, resigned her position as at 31st October in view of her approaching marriage. Miss A. E. Murray was appointed in Miss Hume's place as from 1st October. On January 21st, 1920, Mr. John Crichton, M.A., B.Sc., Senior Professional Assistant, was attached to the staff. As in former years, a temporary assistant was employed during the summer (for nine weeks).

It has not been possible to do much beyond the ordinary routine work of the Office, which has proceeded on the usual lines. The Registrar-General for Scotland has been supplied with a Monthly Report each Month, and also with a comprehensive Annual Report, and statistical summaries of observations at Scottish stations have been regularly prepared and forwarded to the Meteorological Office, London, for publication in the *Monthly Weather Report*. In

addition a general descriptive note of the weather over Scotland from month to month has been supplied. Returns of Daily Readings in absolute units for two stations have been prepared for publication.

The Observing Stations.—During the year observations were seriously interrupted at Fort Augustus; and also at Lathallan, where the outlook is uncertain. At Kingussie Mrs. De Watteville was able to continue work until 31st December, but the local authorities at that place have so far not responded to suggestions that they should assume responsibility for a climatological station. The death of Mr. Magnus Spence, who had retired after long service as an observer in Orkney, may be noted.

As indicated in recent reports, weakness has developed at some of the voluntary stations, and the general position in Scotland should be reviewed as soon as possible. There is urgent need for at least a skeleton system of carefully distributed stations, at which continuity and permanence could be relied on, and it would be unwise in present-day circumstances to look mainly to voluntary effort for adequate representation. In various districts the distribution of rainfall stations leaves much to be desired.

Inspections.—During the year the following stations were inspected by Mr. A. Watt:—Carnoustie, Dalkeith, Helensburgh, Kilmarnock, Perth and St. Andrews. By Dr. A. Crichton Mitchell, of Eskdalemuir Observatory:—Cally, Colmonell, Ford, Fort Augustus, Fort William, Glencarron, Inverness, Kingussie and Oban. By Mr. G. A. Clarke, of Aberdeen Observatory:—Banff and Montrose.

Inquiries.—Numerous inquiries continue to be dealt with either by correspondence or at an interview. In twelve cases, most of them in connexion with marine insurance risks, fees were charged for information supplied, the total fees amounting to £6 6s. 0d.

The Superintendent attended at the London Office for about a week in May, 1919. As for some years past, he delivered a course of lectures in elementary meteorology at The Edinburgh and East of Scotland College of Agriculture.

OBSERVATORIES.

CENTRAL OBSERVATORY, KEW OBSERVATORY, RICHMOND, SURREY.

Report by
C. Chree, Sc.D., LL.D., F.R.S., Director of Observatories.

Buildings.—Only a few small repairs have been executed during the year by H.M. Office of Works.

Staff.—The following have joined the staff: Mr. C. H. Kellett (resident observer) in April, 1919; Mr. H. E. Brooking in August, 1919; Mr. H. W. Mizen in September, 1919; and Mr. H. G. Harris in January, 1920. Mr. and Mrs. Lampard were appointed caretaker and housekeeper in March, 1920.

The following departures have occurred: Mr. N. H. Smith in June, 1919; Mr. L. G. Hemens (allowed three years' special leave) in September, 1919; and Messrs. A. C. Lloyd and H. W. Mizen in February, 1920.

Mr. W. Corrin died in August, 1919. Mrs. Corrin discharged the duties of caretaker and housekeeper until the end of March, 1920. The death has also to be recorded of Mr. T. W. Baker, who entered Kew Observatory in 1860, and served as chief assistant for many years before his retirement in 1912.

Self-recording Instruments and Eye Observations.—A new direction-recording apparatus has been fitted to the pressure tube anemometer. A new hemi-cylindrical lens was fitted to the electrograph, so as to utilise the full width of the sheet. The tube of the photographic dry bulb thermograph was broken in May, 1919, and a new tube was fitted. The new tube does not pair very well with the wet bulb tube, and the bore has been found to possess a small local irregularity. The substitution of another tube will probably be undertaken as soon as a suitable tube is available. The tape of the "nilometer" broke early in February, 1920, and a number of weeks elapsed before the instrument could be fully repaired, so that considerable loss of trace occurred.

A Barr and Stroud range finder has been received. It has been used to check the distances of some of the more distant objects used in connexion with visibility observations, and also for determination of cloud heights.

New fibres were fitted by the Cambridge Instrument Company to the second Ebert apparatus, but they did not continue to behave satisfactorily, and the instrument has remained out of use. The older of the two Ebert apparatus has remained in use, but its behaviour is less satisfactory than it used to be. If the original makers were available, an overhaul would be desirable. The "neutral" head for the pressure tube which was on trial for some time on the roof has been dismounted and returned to the National Physical Laboratory.

All the meteorological records obtained except those from the pressure-tube anemograph, the float barograph, the micro-barograph and the Callendar thermograph have been tabulated for each hour at the Observatory. The electrograms have been measured each day at 3h., 9h., 15h. and 21h., and the daily electrical "character" has been assigned up to the end of February, 1920. The tables of hourly values of potential gradient for the years 1918 and 1919, from ten selected quiet days a month have been completed. Tables of two-hourly mean values of magnetic declination have been prepared and sent weekly to the Institution of Mining Engineers and to two mining journals. Information is also supplied as to the magnetic "character" of the day, as based on declination only, and as to specially disturbed hours.

At the end of each month particulars are got out of the mean diurnal inequality from all days, with the exception of the highly disturbed days of "character" 2, and the most recent information on this point with corresponding information for the previous year,

appears on the weekly sheet issued. All the declination and horizontal force curves for the international quiet days for the first six months of 1919 have been measured. The list of selected quiet days for the last quarter of the year has not yet been received. Magnetic "character" figures according to the international standard have been got out up to the end of 1919, and have been transmitted to De Bilt.

The seismograms have been studied up to the end of April, 1919. A list of earthquakes has been transmitted monthly to the Office, and particulars have also been sent to the Seismological Institute of the British Association at Shide. The water-level curves from the "nilometer" in the basement have been studied up to the time of its breakdown in February, 1920, and the results have been sent monthly to the Office.

Regular cloud observations have been made with the Fineman Nephoscope in connexion with the investigation of the upper air. On days of bright sunshine observations of the intensity of solar radiation have been made with the Ångström pyrheliometer within half an hour of noon. Observations of the air-earth vertical electric current have been made with the Wilson apparatus, and observations of the positive and negative charges per cubic centimetre associated with the more mobile ions in the atmosphere have been taken with the Ebert apparatus. These electrical observations have been taken on most fine afternoons between 14½h. and 15½h. All the regular observations made with either the Wilson or the Ebert apparatus up to the end of January, 1920, have been reduced and checked.

In addition to the work represented by the tables of results published in the *British Meteorological and Magnetic Year Book*, the following observational and experimental work has been conducted at the Observatory:

Fog and Mist.—The observations of a series of distant objects have been continued as in previous years, as well as observations in accordance with the general schemes recently adopted at the Office.

Pilot Balloon Wind Observations.—Pilot balloons have been sent up daily under suitable weather conditions, and the results communicated by telephone to Hounslow aerodrome or recently to Croydon.

Antarctic Magnetic Observations.—The MSS. discussing the magnetic observations taken in the Antarctic in 1911-12 by the Scott Expedition went to press in the course of the year. All has now appeared as proof in slip, and a beginning has been made with the reproduction of selected magnetic curves. The tabulated hourly values derived from the magnetic curves of the Australasian Antarctic Expedition of 191-213 have been dealt with so far as received from New Zealand. A good deal of material has still to be received.

Publication of the Results.—The *Geophysical Journal* (*British Meteorological and Magnetic Year Book*, Part III, Section 2) give month by month particulars of barometric pressure, air temperature humidity, wind direction and velocity, amount of cloud and weather

at two fixed hours daily, also the daily totals of rainfall and duration of bright sunshine. It further includes for each day the minimum temperature on the grass, earth temperature at two depths, level of underground water, values of the electric potential gradient at four fixed hours, and the electric and magnetic "character." The results are also given of the absolute magnetic observations, the observations of solar radiation with the Angström pyrheliometer, the electrical observations made near 15h. with the Ebert and Wilson apparatus, and the seismic movements.

Summaries of the diurnal and seasonal variation of the magnetic declination and horizontal force and of the electric potential gradient in the atmosphere are given in *Hourly Values, Geophysical Section*, Part IV. Section 2 of the same publication, which also contains mean monthly values of magnetic inclination, total force, and north and west components, along with a table giving recent mean values of the magnetic elements at the observatories whose publications are received at Kew Observatory.

The following papers by the Superintendent relating to the work of the Observatory have appeared during the year.

"Magnetic Storms of March 7–8 and August 15–16, 1918, and their discussion." *Royal Society, Proc. A.*, Vol. 96, *p.* 32.

"Magnetic Storms." *Institution of Electrical Engineers' Journal*, Vol. 57, *p.* 591.

Instructions to Meteorological Observers.—A total of 15 observers completed courses of instruction, including more especially the observation of pilot balloons, between April and December, 1919. None have been under instruction as yet in 1920.

Verification Work.—A collimator magnet has been tested for Stonyhurst Observatory. A number of observations were taken with it before and after changes made by the makers, to supply data for the intercomparison of Stonyhurst and Kew values of horizontal force. Some preliminary work has been done on a pattern of magnetograph devised by Mr. Krogness of Tromsö, Norway, as a preliminary to the construction of some instruments of the type in London. Some trial has also been made of a vertical force magnet of the Watson type.

Carpenter's Shop.— During the year the carpenter has been principally engaged in the construction of marine screens, of which 51 have been completed. He also made 24 special hygrometer boards of mahogany. His other work has included repairs to the fence, the construction of boxes, and a variety of small jobs.

Library.—The arrangement and classification of the books has continued as usual.

Loan of Instruments.—The following is a list of the instruments, apparatus, &c., the property of the Meteorological Office, which is at the present date out of the custody of the superintendent on loan from the Observatory :—

To Whom Lent.	Articles.	Date of Loan.
New Zealand Government.	Dip circle by Barrow, with one pair of needles and bar magnets, and a tripod stand.	1899
" "	Unifilar Magnetometer by Jones, marked N.A.B.C.	1909
Board of Education, Science Museum, South Kensington.	Articles specified in the list given in the Annual Report of the Kew Committee for 1893.	1876
" "	Articles specified on p. 52 of the 10th Annual Report of the Meteorological Committee to the Lords Commissioners of His Majesty's Treasury for the year ended 31st March, 1915.	1914 and 1915
Admiralty	Old declinometer.	1918

MAGNETIC OBSERVATORY.—ESKDALEMUIR OBSERVATORY, LANGHOLM, DUMFRIES-SHIRE.

Report by A. Crichton Mitchell, D.Sc., Superintendent.

Staff.—The following changes in the staff occurred during the year :—

Miss E. M. Anderson ...	Temporary Clerk.	Resigned
Miss M. Ure	do.	
R. Leggat	Mechanic.	
Mrs. Leggat	Housekeeper.	

Mr. P. N. Skelton, transferred to Instruments Division.

Mr. R. A. Watson	... Junior Professional Assistant	Appointed
Miss M. N. Wilson	... Temporary Clerk.	
Miss I. H. Graham-Yooll,	do.	
Mrs. Murray ...	... Housekeeper.	
W. Hogg... ...	... Mechanic.	

Buildings and Grounds.—It was stated in last year's report that during the war, maintenance work on the buildings of the Observatory had been cut down to the barest minimum by the Office of Works. The results were shown clearly during the year under report. Leakage through the main outer walls of the main Observatory block and the Superintendent's house was particularly bad, and a recent examination has shown that this is largely due to the masonry pointing having been washed out, thereby allowing rain to be driven by wind into the walls. The process of repair will be costly; it has now been undertaken by the Office of Works.

The Underground Magnet House was in much the same condition as detailed in last year's report, and would have been much better if leakage through the roof at two places could have been stopped. I have hopes that the current year will show a considerable improvement.

The question of diurnal variation of temperature in the Underground Magnet House was investigated during the year, the matter being of some importance in connection with the calculation of diurnal inequalities of the vertical component of magnetic force. One junction of a thermo-electric circuit, enclosed in a vacuum flask packed in sawdust, was buried at a depth of 9 feet below ground level. The other junction was enclosed in a zinc box, close to the vertical force magnetograph. The circuit included a galvanometer whose deflections were photographed on a revolving drum. The whole arrangement having been carefully calibrated, observations extending over three months shewed that the diurnal range in temperature in the magnetograph room is less than 0°·04C, and so long as it does not reach double this amount, the effects are negligible.

The adequacy of the water supply gave rise to some anxiety during the prolonged autumn drought of 1919, and it was only by the most rigid economy that enough water was obtainable. Gas supply was satisfactory and occasioned practically no trouble. Drains were choked twice and had to be cleared.

Reference to such matters may seem out of place in a report such as this, but the isolated position of the Observatory, far removed from facilities immediately available in towns, has to be remembered as introducing peculiar difficulties.

Terrestrial Magnetism.—The work in this section was continued on the lines detailed in full in last year's report.

The annual review for 1917 of the principal magnetic results of the year was prepared for the *Year Book*, which was passing through the press at the close of the year.

In last year's report, reference was made to the methods then adopted for the assignment of magnetic character, and to the use of the squared daily ranges of the three components for this purpose. This was continued during the year and was found to answer nearly all requirements. In order to ascertain whether it could be made the basis for selection of international quiet days, a request was made to the authorities in charge of the different magnetic Observatories throughout the world for information as to the maximum and minimum values of the magnetic elements during each day of October, 1919. These returns had not been all received before the close of the year, but meanwhile it may be stated that they will yield some interesting results beyond those for which they have been obtained.

At the end of the year under report the work of magnetic tabulation and reduction was practically eleven months behind as compared with the corresponding date in 1914. This is due to the fact that during the war the staff was numerically weaker, while on the other hand the volume of work involved in the tabulation was practically

doubled. Efforts are being made at present to bring the work more nearly up to date, but it has to be pointed out that much remains to be done in order to bring even our *published* results into a state approaching homogeneity. Successive improvements in methods of reduction and more extended scope of tabulation have only been applied each year as they have been introduced, and nothing has been done to bring the previous years' results to the same state. The question will have to be considered and some decision arrived at with regard to it before long. It is almost entirely a matter of strength in the computing staff, and the present conditions place a limit to this at Eskdalemuir.

During the past three years, as time and opportunity have allowed, special enquiries have been carried on with regard to particular subjects in terrestrial magnetism. Among these may be mentioned (1) the lunar inequality ; (2) inequality on quiet days of high and low atmospheric pressure ; (3) periodicity of large disturbance ; (4) frequency distribution of absolute daily ranges ; (5) frequency distribution of times of occurrence of maxima and minima ; (6) several matters bearing on recent attempts to frame a theory of magnetic storms, particularly the interval between "sudden commencement" and the maximum phase of disturbance ; (7) annual variation of phase angles in diurnal inequalities ; (8) daily magnetic "activity" since 1st January, 1911. Of these (4), (5), (7), and (8) were completed during the year under report. No. (1) has been held up and cannot be proceeded with for lack of sufficient data ; (2) gave inconclusive results, while (6) is still in hand.

During the year, the declination magnetograph formerly at Falmouth Observatory was erected and started. Its records are not so reliable as might be desired, for the clockwork is worn and the drum revolves at a varying rate.

Last year's Report gave particulars of an installation of apparatus intended to record pulsations of the vertical component of terrestrial magnetic force. The record had to be discontinued owing to the cable, which is laid over the open moor, having been damaged. It is hoped that the work will be resumed very shortly.

Meteorology.—The system of meteorological observation consists of (1) autographic records of pressure, temperature at Observatory and at two levels 150 metres apart vertically, humidity, wind-speed and direction, rainfall, sunshine, (2) eye observations made at 1h, 7h, 9h, 13h, 15h, 18h, 21h, (3) a close watch on general weather phenomena, except for the interval between 1h. and 7h. (4) pilot balloon ascents twice or thrice daily if conditions are suitable.

The information thus collected was employed in the preparation of weather telegrams despatched at 1h, 7h, 13h, 18h, and at such other times as were necessary. In all, 1,852 such telegrams were despatched during the year, as compared with 1,643 in 1918–19, and 1,505 in 1917–18. The number of pilot balloon ascents during the year was 387, as compared with 201 in the previous year.

I have again to report that there were frequent interruptions and delays in the telephone service. The former, due to breaks in the line, were long in being repaired. Some of the latter were due to

inattention and careless manipulation at the Langholm Exchange It has now been arranged that telegrams despatched between 18h. and 8h. are telephoned by a switch line, via Longtown to Carlisle, and thence by trunk line to Glasgow, from which centre they are telegraphed to London. The arrangement has worked fairly well, except that the hearing on the wire to Glasgow is bad at times of large magnetic disturbance.

The tabulation of values from autographic records proceeded on the usual lines and was kept punctually up to date. In addition, some of the years for which hourly values have not been published, and for which no copies were retained here, were completed.

The record of temperature at the top and bottom of Dumfedling Hill, 150 metres vertically apart, has been continued and has given some interesting results which have been forwarded to the Meteorological Office.

Atmospheric Electricity.—The atmospheric potential gradient, obtained from a water-dropper standarised by absolute observations in the open, was recorded continuously throughout the year, except for occasional interruptions of a few hours. The observations in the open were taken on fine days, about six per month, and the scale value of the electrograph was determined at the same time. The scale value was changed at the end of July, 1919, when a change was made in the potential of the needle. Insulation tests were also applied every few days. The curves obtained have been read once to the end of the year under report, and twice to the end of 1919. Diurnal inequalities have been made out for selected days for each month in 1918 and 1919. The first four harmonic co-efficients expressing the diurnal inequality have been computed for "Oa" days in each month of the years 1913 to 1918.

Seismology.—The work of this section continued on former lines, the only interruptions being due to occasional irregularities in action of the clockwork which drives the recording drum. The seismograms were used to compile the monthly earthquake bulletin, and the daily measurement of microseismal amplitude and period. These are published in the *Geophysical Journal.*

A serious obstacle in this branch of our work is the difficulty, if not impossibility of deciphering the seismograms of a large earthquake. The two horizontal instruments record on the same sheet, the two traces being distinguished by one being interrupted every alternate second. The reading of the trace is easy in the case of moderate disturbance, but with large earthquakes, involving rapid oscillations of the recording galvanometer, the two traces get mixed up to an extent which renders it extremely difficult to disentangle them. In addition the interrupted light gives a feeble photographic impression. In these circumstances I have recommended that the two horizontal components should be recorded on separate sheets. This involves the construction of another recording drum with its necessary clock-work.

WESTERN OBSERVATORY, VALENCIA OBSERVATORY, CAHIRCIVEEN, CO. KERRY.

Report by L. H. G. Dines, M.A., A.M.I.C.E., Superintendent.

Staff.—There have been no changes in the regular staff during the year. Mr. R. M. Stanhope acted as an additional Professional Assistant for two months in the autumn of 1919.

The work of the observatory has proceeded on very similar lines to those followed in recent years ; there has been some reduction of activity in certain directions and an increase in others. With the return to peace conditions increased holiday leave has had to be provided for, which has slightly reduced the working capacity of the staff as a whole.

Provision has in general been made for relays of the staff to be on duty on week days from 7 or 8 a.m. according to season till 6 p.m., while the Superintendent has, as before, acted as resident observer.

Buildings.—During the year some decorating was done in the Observatory and Superintendent's house, and certain improvements tending to the greater comfort and convenience of the latter were carried out, together with some improvements in the water supply.

The policy of temporary letting for cultivation of part of the Observatory property not at present required has been continued, both in order to comply with the compulsory tillage order and also at the same time to improve the land.

Meteorology.—The Observatory has been maintained as a first order meteorological station keeping a continuous record of the weather, with notes on any interesting or abnormal phenomena which may be observed. Cloud observations with a nephoscope have been made on the prescribed days whenever the conditions were suitable, in connection with the international investigation of the upper air. A monthly rain gauge has been established on a neighbouring mountain at about 400 feet above sea level.

The self-recording equipment has been maintained in operation as in former years. Efforts have been directed towards improving the accuracy of the records of some of the older instruments, and detail-improvements have been effected both in the case of the Beckley Rain Gauge and the Photographic Barograph. Several clinometers and balloon theodolites have been tested for the Instruments Division at different times, and a good deal of work has been put into systematic comparisons between different types of self-recording rain gauges.

All the meteorological records obtained have been tabulated for each hour and the work checked at the Observatory, with the exception of the micro-barograph, hair hygrograph, and pen thermograph and barograph. C.G.S. units are almost entirely employed. Copies of the tabulated hourly values of all the meteorological elements are now kept at the observatory.

Telegraphic reports to the Forecast Division were made regularly at 7h, 13h, and 18h throughout, and at 10h and 16h in addition since the end of December. Until the beginning of November regular reports were sent to the Air Station at Pembroke Dock three times daily. From the beginning of January a daily weather forecast has been received from the Forecast Division and after editing has been forwarded to the Cahirciveen Post Office for exhibition. As the Observatory still lacks permanent telegraphic communication with London, the staff of the Wireless Station on Valencia Island have rendered assistance by sending telegraphic reports at certain hours as before.

Pilot balloon ascents have been made regularly for the morning map of the upper air supplement to the Daily Weather Report on every occasion that an ascent was possible, and at such other times of day as seemed desirable. Three hundred and fifty-six ascents have been made in all, as against 519 in the previous year, and in all cases where a sufficient height was reached data of the ascent were prepared for subsequent publication in the *Geophysical Journal.*

The mean height of the latter has improved on the previous year, and the remarkable results obtained by the use of light filters are likely to cause further improvement in future.

Generally, one theodolite only was employed, but during one spell of particularly favourable weather two theodolites were used on a number of occasions.

During the year notes on the following meteorological subjects have been drawn up :—

A comparison between thermometers exposed in two different screens at Valencia Observatory.

The relation between the records of the Pressure Tube anemographs and the geostrophic wind at Valencia.

Tables expressing the mean relation between the simultaneous readings of the Pressure Tube and Robinson anemographs at Valencia Observatory.

The time of occurrence of the minimum temperature on the grass at Valencia Observatory.

Vertical currents in the atmosphere during October and November, 1919 at Valencia, and the rate of ascent of weighted pilot ballcons.

A comparison between the Fernley and Beckley type of self-recording rainguage.

The defects of the Beckley raingauge.

Magnetic Work. Absolute observations of magnetic declination, inclination and horizontal force have been made at fixed hours at least twice per month. Formerly the superintendent was the only observer, but other members of the staff are now trained or in training Only the results of such observations as were taken at times of reasonably quiet magnetic conditions have been utilised, and these will be published in the *Geophysical Journal.*

A special series of observations of declination, taken every two minutes over a period of 6½ hours on May 29th, were taken at the request of the Carnegie Institution of Washington.

A number of repairs and other general work have been executed in the workshop from time to time, making the Observatory largely

self-supporting in this respect. There being no mechanics on the staff, instrumental work is done by the superintendent, while carpentry is undertaken by an indoor assistant who is being trained in it. A few tools have been added to the equipment, but the greater part still consists of tools belonging to the Superintendent and temporarily lent to the Observatory.

The time standard for all purposes has been G.M.T. throughout.

AEROLOGICAL OBSERVATORY AT BENSON, 1919.

Report by W. H. Dines, F.R.S., Director of Aerological Investigations.

The ordinary work of the station of sending the telegraphic messages and keeping the automatic recording instruments in action was continued without any serious break throughout the year.

The difficulty of obtaining satisfactory registering balloons mentioned in the report for 1918 continued. A supply of moderately good balloons was obtained at the beginning of the year, and from January to July inclusive seven successful ascents were obtained. After July the balloons burst during the process of filling or before they had reached a five-thousand feet height and no subsequent successful ascent was obtained. In all 12 balloons were sent up and seven records reaching to nine kilometres or more were obtained.

During the summer an instrument for measuring the back radiation from the sky after sunset was designed and since then observations have been made with it on suitable evenings.

Mr. Richardson has had the use of the workshop and field and some assistance from the staff for investigations in which he has been engaged since March, 1919. Mr. Lewis came as Assistant Mechanic in May.

Experiments on Numerical Prediction.

Report by L. F. Richardson, B.A.

A certain scheme of numerical prediction, which waits for publication, has been provided with an opening chapter. But as this scheme demands much fuller observational data than any now available, most of the year has been devoted to contriving new observational methods for the upper air, to supplement what is now done by aeroplanes. The following are some of these methods :

Wind above Fog or Low Cloud has been measured up to a height of 600 metres by shooting up a steel sphere from a gun slightly inclined towards the wind. On winter mornings there is sometimes an astonishingly rapid increase of wind with height just above a layer of surface mist.

Temperature Measurements.—(1) An attempt is in progress to measure temperature by comparing the time of flight of a sphere with its muzzle velocity when it is shot nearly vertically upwards. The attraction of this procedure is that it would be serviceable in thick weather. The difficulty is to measure the muzzle velocity accurately enough.

(2) A signal has been obtained from a balloon carrying a light apparatus consisting of an electric battery, an explosive ignitable by electric current, and a thermometer which completes the circuit when the temperature falls to a pre-arranged value. The apparatus weighs about 130 grammes. It is serviceable in clear weather and can be calibrated to about 0·2°C.

(3) A rubber balloon has been converted into a gas-thermometer by enclosing it within an inextensible case of very light fabric. The balloon expands as it rises until it touches a trigger which causes a piece of white cloth to drop off. In this way a signal is obtained of the ratio of pressure to temperature. This apparatus is simpler and cheaper than the electric one, but needs a number of corrections, particularly one for radiation.

(4) Experiments are in progress with balloons carrying reflectors which flash back sunlight as the balloon rotates. The angle between the reflectors is obtained by timing the intervals between the flashes.

A Photometric Study of Clouds has been continued by two instruments of different principle, one with a lamp, the other with photographic paper.

In addition to these new observational methods, *an analysis of barograms* is in progress.

Turbulence.—Two papers are being printed by the Royal Society (1) On measurements, mostly done in France; (2) Analysing the circumstances in which turbulence will increase or decrease.

The above mentioned work has been carried out at Benson Observatory in consultation with Mr. W. H. Dines, F.R.S., and with the assistance of Mr. H. W. Baker, F.R.Met.Soc., and Mr. B. C. Lewis.

ABERDEEN OBSERVATORY.

The ordinary work of the Observatory, which includes observations of pilot balloons in addition to the routine of a first-order station with telegraphic reporting has been carried on as usual.

BRANCH METEOROLOGICAL OFFICE AT SOUTH FARNBOROUGH.

Report by

R. A. Watson Watt, B.Sc., A.M.I.E.E., Meteorologist-in-Charge.

Observations, Issue of Forecasts, Data, and Time Signals.—Forecasts and upper air reports for aviation, meteorological data for aerodynamical computation and for mechanical engineering, climatological data for studies in military hygiene, for testing of fabrics, and for heating and ventilating engineering, rainfall data for civil engineering purposes, continued to be circulated in similar amount to that of the preceding year. Time signals to Aldershot Command, and to Head Quarters, Borden Camp, based on the time signals from Eiffel Tower, have been sent daily from M.O. Radio Station,

and this service has benefited by the loan of a chronometer from Kew Observatory. The work of a telegraphic reporting station (7h., 13h., and 18h.) has been continued, and frequent telephonic reports of existing weather conditions, and, in the first half of the year, of fitness for flying were supplied. Casual inquiries on a wide variety of subjects have been dealt with.

The Upper Air Work of the year included 258 one-theodolite ascents in which the 1 k. level was passed, the mean height sounded being 2,650 m., the maximum nominally 25·5 k., the longest observed trajectory 95 k. In 41 ascents the balloon was lost below 1 k. During the year the previous maxima for Farnborough ascents were surpassed in the following elements, viz. :—height sounded in individual ascent, monthly mean height sounded, length of individual observed trajectory. Collection of upper air temperatures, observed by the experimental staff of the Royal Aircraft Establishment, was continued.

A series of experiments on the use of light filters in pilot balloon observing was carried out with considerable success. The exceptional sounding to 26 k. and trajectories of 95 and 84 k., were obtained with filters. Reports and notes on this work were prepared and a set of filters was lent to Valencia Observatory (*see* page 78).

With the kind co-operation of the Director of Inspection of Optical Supplies, Woolwich Arsenal, and Barr a Stroud height and rangefinder, 2 metre base, was obtained on loan from November, 1919, for the further prosecution of the work initiated at Farnborough in 1917.

A telephone system, for use in winter ascents, was fitted between the theodolite station and the computing room. A model of a proposed modification of the pilot balloon slide-rule was constructed.

Preliminary trials were made of Bolton's method of computation for pilot balloon ascents, and the method was shown to be very rapid compared with the normal slide rule methods. The work has not yet, however, been prosecuted to the construction of a permanent Bolton-calculator.

Minor Experimental Work included comparisons of Assmann and Screen Psychrometers, measurements of pressures, rate of leak, etc., in pilot ballons, and selection of a suitable paraffin-alcohol pair for differential pressure-gauges. In this last the help of the Chemical Department, R.A.E., was invaluable ; a convenient pair, giving (in the gauge used) a six-fold magnification of the water scale, was adopted.

The Radio-telegraphic Inquiry into the Location of Thunderstorms was further developed. The designs for the projected installations were revised to overcome the obstacles which had arisen in the way of provision for these stations, and a cheaper and simpler type of apparatus was adopted. Components for five sets have been constructed and collected, and a standard set was demonstrated at the Summer Meeting of the Royal Meteorological Society at Kew Observatory. As in former years the evolution of the set involved much detail work, including the design of a large but light frame

aerial, and the comparison of amplifiers of various types. An Admiralty amplifier was finally selected, and the Admiralty has promised to lend the required number of amplifiers of this type.

The quantitative recorder mentioned in last report has been considerably improved, but further improvement and modification can be effected when time permits.

Experiments have been made on the application in the inquiry of the Turner Oscillatory Valve Relay, two types of which were lent by Chief Experimental Officer, Signals Experimental Establishment, Woolwich, to whom special thanks are this year due for cordial co-operation and advice.

The vital problem of a directional recorder to deal with individual impulses stands where it did at the date of last report, save that a six-string Einthoven Galvanometer set has been received on trial, and might be applied to the solution of the problem on lines suggested early in 1916, whenever time and personnel are available.

The observational work included the study of two local storms in September, 1919. This study demonstrated the usefulness of the standard set in dealing with storms so near as five miles from the observer, so that results have now been obtained for ranges of five miles and one thousand miles.

The graticule of a Gnomonic Chart of Western Europe, on a scale of 1 to 3×10^6, centered 52° 30′ N., 5° W., has been computed for use in the inquiry.

A report on the thunderstorms already located, with tabular comparisons of the radiotelegraphic and meteorological evidence, was prepared; various other reports and notes have also been submitted.

The correspondence in Captain Cave's investigation of Winter Thunderstorms has been dealt with at the Branch Office, and the card index of thunderstorms from January 1st to March 31st, 1920 compiled.

Shortage of staff continued to impair the usefulness of the work of the Branch Office, and particularly to impede progress in the radio-telegraphic work. Save for three and a half months in summer the Office was without a Professional Assistant. Changes of junior staff have been somewhat numerous.

M.O. Radio Station has continued to grow by the accretion of temporary huts of varying patterns. Steps have been taken towards the more convenient housing of the inquiry, and it is proposed to combine with this change the provision of a subsidiary climatological station to supply data specifically applicable to Aldershot Camp.

The programme of assistance by Admiralty Stations was revised, but the occasions on which useful observations can be obtained by these stations continue to be infrequent.

It is a matter of real urgency that the broad geophysical problem of the propagation of electromagnetic waves, natural or artificial, should be attacked on an adequate experimental scale, and the Meteorologist-in-charge would urge that the responsibility for the conduct of this research should devolve upon the Meteorological Office as the official Geophysical Institute of this country. Outstanding problems of Aerial Navigation, Meteorology, Atmospheric Electricity,

and Commercial Radio-telegraphy could be resolved by one inclusive investigation, by an expenditure infinitesimal in relation to the probable return in the solution of any one of these problems. The thunderstorm inquiry can only reach a satisfactory stage when it is prosecuted as a sub-section of a research into the origin, nature, and travel of radio-telegraphic strays in general, and this wider research must depend for success on a collateral study of the deviations and perturbations of the artificial wave trains emitted by radio-telegraphic transmitters.

The thanks of the Committee are again due to the radio-telegraphic authorities mentioned in the last report, for continued assistance and advice, and to the Royal Aircraft Establishment for help in many of the activities of the Branch Office.

WEATHER STATION.—FALMOUTH OBSERVATORY.

Report by J. B. Phillips, Assistant-in-Charge.

The ordinary work of the Observatory has been carried on during the year. Telegraphic reports have been sent to the Meteorological Office at 1h., 7h., 13h. and 18h. In accordance with the arrangement made with the Falmouth Corporation the 18h. observation has usually been made by the Corporation Observer. The self-recording instruments at the Observatory have been kept in continuous operation throughout the year. Oversight has also been given to the working of the Dines Pressure Tube Anemometer at Pendennis Castle. The Observatory Records of the Robinson Anemograms and the Beckley Rain Gauge have been tabulated for each hour. Tabulations and analysis of the Dines Pressure Tube Anemograms at Plymouth, tabulations of the Robinson Anemograms and analysis of the Dines Pressure Tube Anemograms at Scilly, and analysis of the Dines Pressure Tube Anemograms at Pendennis Castle have also been made. On 3rd September, 1919, the daily exhibition of telegraphic forecasts in frames erected by the Office, at the Custom House, which had been discontinued during the war, was resumed. The exhibition of daily climatological data from the Observatory and of the Anemograph Chart from Pendennis Castle, at the Custom House, was also recommenced on that date. The Forecasts for S.W. England have been checked at the Observatory since 14th February.

Mr. W. J. Fowler, after demobilization, reported for duty on 8th December and left for South Farnborough on the 20th March. Mr. B. Francis, from Kew Observatory, was in charge during August, and Miss L. D. Sawyer, from the London Office, from the commencement of September to the 11th October, during the absence of members of the Staff on annual leave. During the rest of the year the Observatory was in charge of Mr. J. B. Phillips.

ARMAGH.

Regular meteorological observations have been made at the Observatory at Armagh since 1833, and less systematic records are available from 1793. Observations have been published by the Office since 1869. The growth of large trees in the immediate neighbourhood of the Observatory had seriously affected the exposure of the anemograph, but at the request of the Governors of the Observatory, the owner has been so good as to consent to the removal of the trees and it is hoped that the wind records will now be of greater service.

SOUTHPORT.

At the Fernley Observatory, Southport, a meteorological station of the First Order is maintained under a trust administered by the Corporation. A valuable series of reports, prepared by Mr. J. Baxendell, Meteorologist to the Corporation, has been published. A grant-in-aid of the publication of the report for the year 1918 was made by the Office in 1919, the station being recognised as a Meteorological Observatory of the First Order.

ARMY SERVICES.

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

At the request of the War Office, made in January, 1919, the Meteorological Committee undertook (Minute 739 of 29th January, 1919) to carry out all meteorological work required by the War Office. The requirements were provisionally fixed at five meteorologists, and 16 technical assistants, to provide for the stations at Shoeburyness, West Lavington, and Porton.

Captain D. Brunt, who was in charge of the detachment of the Meteorological Section, R.E., at New Ranges, Shoeburyness, was appointed Assistant Superintendent as from April 1st, to take charge of the civilian staff to be provided by the Meteorological Office when required. On demobilization in June, 1919, he continued in charge of the station at Shoeburyness, assisted by Mr. N. K. Johnson, Senior Professional Assistant, and the men of the Meteorological Section, R.E., were replaced on their demobilization by Technical Assistants. By October, 1919, the staff at Shoeburyness consisted of :—

1 Senior Professional Assistant.
1 Junior „ „
1 Staff Assistant.
8 Technical Assistants.

The work at Shoeburyness consists of :—

(a) Observations of Wind and Temperature in conjunction with Range and Accuracy Trials ; reports being rendered in a form suitable for direct application to the reduction of the trials.

(b) Ballistic computations. Evaluation of weighting factors for wind, density, temperature and elasticity. This work is carried out in conjunction with the Ordnance Committee, Woolwich.

At the end of July, 1919, Captain D. Brunt left Shoeburyness to take up work at the Meteorological Office, being appointed Superintendent of Army Meteorological Services from August 1st, 1919. Mr. Johnson, aided by Mr. C. E. Britton, Junior Professional Assistant, was left in charge of the station at Shoeburyness.

The work of providing Meteorological reports for the Artillery Ranges at Lavington, was carried out by the Meteorological Section, R.E., until its disbandment on November 28th, 1919. From this date the work was taken over by the Meteorological Office. Captain J. Durward, who had hitherto been in command of the Meteorological Section, R.E. (Home), being appointed Senior Professional Assistant in charge, aided by Lieut. R. P. Batty, Junior Professional Assistant. Four Technical Assistants were sent to this station, the number being later reduced to three when the work decreased.

Up to the end of March, 1920, no action was taken with regard to providing a civilian Meteorological Staff for Porton, pending the decision by the War Office, as to the peace-time-programme relative to gas-warfare.

NAPIER SHAW
(*Chairman*).

Meteorological Office, Air Ministry,
28th July, 1920.

APPENDIX I.

RESEARCH COMMITTEE OF THE WAR CABINET.

Recommendations contained in the Report of Sub-Committee on Meteorological Services.

We recommend that :—

(*a*) The provision for the Meteorological Office be so increased as to enable it to perform the functions of a central State Meteorological Service.

(*b*) The Admiralty, the War Office, and the Air Ministry should be represented on the Board of Management of the Meteorological Office with other State Departments for whose operations meteorological information is required, and with members selected in respect of special knowledge of meteorological science.

(*c*) The Meteorological Office should be removed from South Kensington to some place within easy reach of the Admiralty, the War Office, and the Air Ministry, and should be in direct communication with the General Post Office and a wireless station.

(*d*) The collection of current meteorological observations should be a general service. Provision should be made for the collection of supplementary area observations required for local or area forecasts. The Air Ministry should have power to establish meteorological stations required in connection with aerial routes, although not otherwise necessary for the general meteorological service. The observations made at such stations should be reported for record and reference at the central Meteorological Office, as ship observations now are.

(*e*) The Meteorological Office building should be suitable for the accommodation of a service on a much larger scale than at present, and should include rooms for officers detailed by the several War Departments of State for meteorological duties there.

(*f*) These officers should have ready access to the library and records available at the Meteorological Office for reference, and should carry on their work in due relation to the general service of collection of information for the Office.

(*g*) The special arrangements for the Meteorological Service which the central office could render to each Department, War or Civil, should be made between the authorities of the Meteorological Office and those of the Department concerned. Departments other than the Meteorological Office should keep that office informed as to any changes in the nature and extent of their meteorological requirements, and should not themselves make provision for these unless it is found that the needs cannot be supplied by the general service.

(*h*) Current reports and general forecasts for publication as from the central office should be issued only on the authority of the Director of the Meteorological Office, local forecasts and secondary forecasting stations on the authority of the several officers in charge of stations. Forecasts embodying specific state-

ments as to "flying conditions" should be published only on such authority as the Air Ministry directed. Similarly other statements implying expert advice in specific applications of meteorological information should be subject to the authority of the Departments concerned.

(*k*) The Central State Service embodying the existing Meteorological Office should be, as that office has hitherto been, the channel for international meteorological arrangements.

H. A. L. FISHER
(*Chairman*).
F. G. OGILVIE
(*Secretary*).

18th March, 1919.

APPENDIX II.

CONSTITUTION AND FUNCTIONS OF THE METEOROLOGICAL COMMITTEE.

1. The Meteorological Committee shall be constituted as follows :—

1	The Controller-General of Civil Aviation (Chairman).			
1	Director of the Meteorological Office (ex officio).			
2	Representatives nominated by the Air Ministry (including one for Finance).			
1	The Hydrographer of the Navy representing the Admiralty.			
1	Representative nominated by the			War Office.
1	"	"	"	Ministry of Agriculture and Fisheries.
1	"	"	"	Board of Trade.
1	"	"	"	Colonial Office.
2	"	"	"	Royal Society.
1	"	"	"	Royal Society of Edinburgh.

(A Secretary shall be appointed by the Chairman.)

2. The Director of the Meteorological Office shall be appointed by the Air Council.

3. The Controller-General of Civil Aviation shall act as Chairman of the Committee, and shall be responsible as a member of the Air Council for reporting to that Council. In his absence a Vice-Chairman, elected for the ensuing year by the Committee and selected from among the representatives of the Royal Society and the Royal Society of Edinburgh at the last ordinary meeting in each year, shall take the chair.

4. The members of the Committee shall be appointed by the Air Council, and, subject to the discretion of the authorities by which they are respectively nominated, will hold office for a period not exceeding five years ; but will be eligible for re-appointment.

5. The members of the Committee will not receive remuneration for their services, but travelling and subsistence expenses will be allowed in the case of members not residing in the Metropolis.

6. The Chairman shall call six ordinary meetings each year, and such extraordinary meetings as he shall consider necessary. The dates of the ordinary meetings in each year shall be approved at the last ordinary meeting of the preceding year. The notice of any extraordinary meetings together with the Agenda to be transacted at such meeting shall be circulated not less than a week before the date of the meeting.

7. The Committee shall :—

(i.) Receive the Annual Report prepared by the Director and, if approved, transmit it to the Air Council.

(ii.) Consider, and, if approved, transmit to the Air Council the financial programme in connection with the estimates for the coming year, and decide upon any important modifications of the programme which may be found desirable during the course of the year.

(iii.) Review the scientific and observational activity of the Office, and consider such proposals as may be submitted to them by the Director for experimental work, the establishment of observatories or stations, and the allocation of the staff to be employed.

(iv.) Delegate, by special instructions to be recorded in the minutes, such functions as they may think fit to the Director of the Meteorological Office, or to any Sub-Committee appointed for a special purpose.

(v.) Appoint Assistant Directors and Superintendents, after consideration of the recommendations of the Director.

(vi.) Submit annually to the Committee, appointed by the Council of the Royal Society under the Gassiot Trust, proposals respecting the allocation of the income from the Trust for magnetic and meteorological observations or other physical investigations in accordance with the Trust.

8. The Director of the Meteorological Office will act generally as adviser to the Committee on all meteorological and geophysical subjects, and shall be responsible for :—

(i.) The administration of the Office and the execution of the duties delegated to him by the Committee.

(ii.) The appointment of all members of his staff, other than those referred to in 7 (v.) above.

(iii.) The issue of all meteorological publications authorized by the Committee.

(iv.) Bringing before the Meteorological Committee for their consideration, all matters of importance relating to the application, progress and development of the Science of Meteorology in which the Meteorological Service might share.

(v.) Referring to the Finance Department of the Air Ministry proposals for expenditure to be incurred by the Office before submission to the Committee.