M.O. 257.

For Official Use.

ANNUAL REPORT

OF THE

METEOROLOGICAL COMMITTEE

TO

THE AIR COUNCIL.

For the Year ended 31st March, 1922

(*The Sixty-seventh Year of the Meteorological Office*).

LONDON:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE
By BARCLAY & FRY, LTD., THE GROVE, SOUTHWARK, S.E.1.

To be purchased through any Bookseller or directly from
H.M. STATIONERY OFFICE at the following addresses:
IMPERIAL HOUSE, KINGSWAY, LONDON, W.C.2, and
28, ABINGDON STREET, LONDON, S.W.1;
37, PETER STREET, MANCHESTER;
1, ST. ANDREW'S CRESCENT, CARDIFF; or
23, FORTH STREET, EDINBURGH.

1922.

Price 2s. Net.

CONTENTS.

REPORT.

METEOROLOGICAL COMMITTEE.

1921-22.

Appointed by the Air Council.

Chairman :—Major-General Sir F. H. SYKES, G.B.E., K.C.B., C.M.G. Controller General of Civil Aviation.

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

Dr. G. C. SIMPSON, C.B.E., F.R.S., Director.

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

Captain D. FULTON, Principal Examiner of Masters and Mates, Board of Trade. Nominated by the Board of Trade. (Deceased 20-3-22).

Rear-Admiral F. LEARMONTH, C.B., C.B.E. Hydrographer of the Navy. Nominated by the Admiralty.

Lieut.-Colonel D. CLAPHAM, C.B.E., D.S.O. Superintendent of Experiments, Shoeburyness. Nominated by the Army Council.

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 Council.

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

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

Dr. E. M. WEDDERBURN, M.A., W.S. Nominated by the Royal Society of Edinburgh.

Mr. P. J. ROSE. Nominated by the Scottish Office.

Secretary :—Captain D. BRUNT, M.A.

(884) Wt. 7708/637. 625. 1.23. B. & F.,Ltd. G.93.

COMMITTEE OF THE METEOROLOGICAL OFFICE, EDINBURGH.

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

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

Professor J. G. GRAY, D.Sc. Nominated by the University of Glasgow.

Dr. C. G. KNOTT, F.R.S. Nominated by the Royal Society of Edinburgh.

Sir W. L. MACKENZIE, M.D., LL.D. Nominated by the Scottish Board of Health.

Professor W. PEDDIE, D.Sc. Nominated by the University of St. Andrews.

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

Professor R. A. SAMPSON, F.R.S. Nominated by the Royal Society.

Dr. E. M. WEDDERBURN, M.A., W.S. Nominated by the Royal Meteorological Society.

THE GASSIOT COMMITTEE, 1922.

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 CHARLES SCOTT SHERRINGTON, G.B.E. (*President of the Royal Society*).

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

The Astronomer Royal.

Professor S. CHAPMAN.

Dr. C. CHREE.

Mr. W. H. DINES.

Sir G. LENOX-CONYNGHAM.

Mr. J. H. JEANS.

Sir ARTHUR SCHUSTER.

Sir NAPIER SHAW.

Dr. G. C. SIMPSON.

Mr. G. I. TAYLOR.

Mr. C. T. R. WILSON.

ADVISORY COMMITTEE ON ATMOSPHERIC POLLUTION, 1921-22.

Sir Napier Shaw, F.R.S. (*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*).	
Sir John Russell (*Director of the Rothamsted Experimental Station, Harpenden*).	
Bailie W. Smith (*Member of Departmental Committee on Smoke Abatement*).	
Mr. F. J. W. Whipple (*Superintendent Climatology Division, Meteorological Office*).	
Dr. Cates, (*Medical Officer of Health to the Surrey County Council*).	
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. Osborn Thorp, nominated by the Corporation of Malvern	
Professor W. Haldane Gee, nominated by the Corporation of Manchester.	
Mr. C. T. Stableforth, J.P., nominated by the Corporation of Newcastle-on Tyne. (Deceased.)	
Dr. J. B. Wilkinson, nominated by the Corporation of Oldham.	
Dr. J. R. Ashworth nominated by the Corporation of Rochdale.	
Dr. Frank Hauxwell, nominated by the Corporation of St. Helens.	
Mr. J. Baxendell, nominated by the Corporation of Southport.	
Mr. John Fyfe, nominated by the Corporation of Stirling.	
Mr. A. R. Tankard, nominated by the Corporation of Hull.	
Mr. W. S. Curphey (*Chief Alkali Inspector of the Local Government Board*). (Deceased.)	Nominated by the Advisory Council for Scientific and Industrial Research.

THE STAFF OF THE METEOROLOGICAL OFFICE, ITS OBSERVATORIES, AND BRANCHES, MARCH, 1922.

THE STAFF AT HEADQUARTERS.

DIRECTOR:

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

DIRECTORATE AND GENERAL SERVICES DIVISION.

Assistant Directors ..	R. G. K. Lempfert, C.B.E., M.A., E. Gold, D.S.O., F.R.S.
Chief Clerk	H. L. B. Tarrant.
Principal Assistants ..	L. H. Powers, R. Pyser.
Clerical and Technical Assistants	13*
Officekeeper	1

*1 on special leave.

MARINE DIVISION.

Superintendent	L. A. Brooke-Smith, Commander, R.D., R.N.R.
Senior Professional Assistants	C. S. Durst, B.A., J. Hennessey, Lt. Cdr. R.N.R.
Principal Assistant ..	H. Keeton.
Clerical and Technical Assistants	10

FORECAST DIVISION.

Superintendent	J. S. Dines, M.A.
Assistant Superintendents ..	E. G. Bilham, B.Sc., W. A. Harwood, M.Sc. E. V. Newnham, B.Sc., R. Sargeant.
Senior Professional Assistants	M. A. Giblett, M.Sc., W. C. Kaye, B.Sc., Miss L. F. Lewis, B.Sc., R. M. B. Mackenzie, M.A. S. C. Russell, LL.B., Miss L. D. Sawyer, B.A., M. T. Spence, B.Sc., R. A. Watson, B.A., S. F. Witcombe, B.Sc.
Junior Professional Assistants	J. E. Cowper, M.A., Miss G. L. Thorman, B.Sc., J. Wadsworth, M.A.
Principal Assistant ..	W. Hayes.
Clerical and Technical Assistants	30

CLIMATOLOGY DIVISION.

Superintendent	F. J. W. Whipple, M.A., F. Inst. P.
Assistant Superintendent ..	C. E. P. Brooks, M.Sc.
Senior Professional Assistants	E. W. Barlow, B.Sc., Miss E. H. Geake, M.Sc., P. I. Mulholland, B.Sc.
Junior Professional Assistant	H. W. Braby, M.A.
Clerical and Technical Assistants	22

INSTRUMENTS DIVISION.

Superintendent	R. Corless, O.B.E., M.A.
Senior Professional Assistant	S. N. Sen, M.Sc., A.Inst.P.
Junior Professional Assistant	C. W. Lamb, B.Sc.
Principal Assistants ..	J. H. James, P. N. Skelton.
Clerical and Technical Assistants	7
Storemen and Packers ..	3

ARMY SERVICES DIVISION.

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

LOCAL CENTRES DIVISION.

Superintendent	A. H. R. Goldie, M.A.
Assistant Superintendent ..	F. Entwistle, B.Sc.
Junior Professional Assistant	R. H. Mathews, B.A.
Principal Assistant ..	B. Francis.
Clerical and Technical Assistant	1

BRITISH RAINFALL ORGANIZATION.

Superintendent	M. de C. S. Salter.
Senior Professional Assistant	J. Glasspoole, B.Sc., A.I.C.
Principal Assistant ..	A. T. Bench.
Clerical and Technical Assistants	4
Caretaker	1

ADVISORY COMMITTEE ON ATMOSPHERIC POLLUTION, 47, Victoria St., S.W.1.

Superintendent	J S. Owens, M.D., A.M.I.C.E., F.G.S., F.R.S.I.
Junior Professional Assistant	G. M. Watson, B.Sc., A.I.C.

NAVY SERVICES DIVISION.

Superintendent	L. G. Garbett, Commander R.N.

THE STAFF AT OBSERVATORIES AND BRANCH ESTABLISHMENTS.

METEOROLOGICAL OFFICE, EDINBURGH.

Superintendent	Dr. A. Crichton Mitchell, F.R.S.E.
Assistant Superintendent ..	A. Watt, M.A., F.R.S.E.
Junior Professional Assistant	J. E. Belasco, B.Sc.
Clerical and Technical Assistants	5
Housekeeper	1

KEW OBSERVATORY, Old Deer Park, Richmond, Surrey.

Assistant Director	Dr. C. Chree, F.R.S.
Senior Professional Assistants	E. Taylor, M.A., B.Sc., R. E. Watson, B.Sc.
Junior Professional Assistant	C. H. Kellett.
Principal Assistant ..	E. Boxall.
Clerical and Technical Assistants	5*
Caretakers and Messengers ..	4

*One on special leave.

THE OBSERVATORY, Eskdalemuir, Langholm, Dumfries-shire.

Senior Professional Assistant	C. K. M. Douglas, B.A.
Clerical and Technical Assistants	3
Housekeeper, Mechanic and Handyman	3

VALENCIA OBSERVATORY, Cahirciveen, Co. Kerry.

Assistant Superintendent ..	L. H. G. Dines, M.A., A.M.I.C.E.
Senior Professional Assistant	*N. H. Smith, B.Sc.
Clerical and TechnicalAssistants	3
Messenger	1

*Acting rank whilst on duty at Valencia.

THE OBSERVATORY, BENSON. Wallingford.

Assistant Director .. .. W. H. Dines, F.R.S.
Clerical and Technical Assistant 1
Mechanic 1

THE OBSERVATORY, King's College, Aberdeen.

Principal Assistant .. G. A. Clarke.
Clerical and Technical Assistant 1

THE OBSERVATORY, LERWICK, Shetlands.

Senior Professional Assistant J. Crichton, M.A., B.Sc.
Clerical and Technical Assistant 2
Caretaker 1

PORT METEOROLOGICAL OFFICE, Liverpool.

Senior Professional Assistant G. ff. H. Lloyd, Lt.-Cdr., R.D., R.N.R.
Clerical and Technical Assistant 1

ARMY SERVICE STATIONS.

METEOROLOGICAL OFFICE, Shoeburyness.

Senior Professional Assistant C. E. Britton, B.Sc.
Junior Professional Assistant L. S. Priestley, B.A.
Clerical and Tcehnical Assistants 12

METEOROLOGICAL OFFICE, LARKHILL.

Senior Professional Assistant J. Durward, M.A.
Clerical and Technical Assistants 4*

*1 on special leave.

DISTRIBUTIVE STATIONS

ANDOVER.

Assistant Superintendent .. C. D. Stewart B.Sc.
Clerical and Technical Assistants 2

BALDONNELL.

Senior Professional Assistant A. Walters.
Junior Professional Assistant W. J. Grassick, M.A.
Clerical and Technical Assistant 1

BIGGIN HILL.

Clerical and Technical Assistants 2

CALSHOT.

Senior Professional Assistants H. W. L. Absalom, B.Sc., A.R.C.S., D.I.C.
R. P. Batty, B.A.
Clerical and Technical Assistants 5

CATTEWATER.

Senior Professional Assistant G. L. H. Douglas-Lane, M.A.
Clerical and Technical Assistants 2

CRANWELL.

Senior Professional Assistant W. H. Pick, B.Sc.
Clerical and Technical Assistants 5

CROYDON.

Senior Professional Assistant G. R. Hay, M.A.
Clerical and Technical Assistants 7

FELIXSTOWE.

Clerical and Technical Assistants 2

GRAIN.

Junior Professional Assistant H. St. G. Dyke-Marsh, B.A.
Clercial and Technical Assistants 2

HOLYHEAD.

Senior Professional Assistant S. T. A. Mirrlees, M.A.
Clerical and Technical Assistant 1

LEUCHARS.

Senior Professional Assistant W. Gillon, M.A., B.Sc.
Clerical and Technical Assistants 3

LYMPNE.

Senior Professional Assistant R. S. Read, M.A., B.Sc., A.R.C.S.
Clerical and Technical Assistants 4

PORTON.

Clerical and Technical Assistants 3

PULHAM.

Senior Professional Assistant G. HARRIS.
Clerical and Technical Assistants 3

RENFREW.

Senior Professional Assistant J. J. Somerville.
Clerical and Technical Assistants 2

SHOTWICK.

Senior Professional Assistant H. F. Jackson, M.S.E.
Clerical and Technical Assistants 3

SOUTH FARNBOROUGH.

Senior Professional Assistant R. M. Stanhope, B.A.
Clerical and Technical Assistants 3

SECONDED FOR DUTY WITH OTHER BODIES.

Assistant Superintendent .. R. A. W. Watt, B.Sc., A.M.I.C.E., (Dept. of Scientific and Industrial Research).

Senior Professional Assistants Miss E. E. Austin (Imperial College of Science).
F. J. Herd, A.M.I.Radio E. (Dept. of Scientific and Industrial Research).
N.K. Johnson, B.Sc., (War Office, Porton Experimental Station).

Junior Professional Assistants F. J. Scrase, B.Sc. (War Office, Porton Experimental Station)
O. F. T. Roberts, (War Office, Porton Experimental Station).

ANNUAL REPORT

OF THE

METEOROLOGICAL COMMITTEE

TO

THE AIR COUNCIL.

For the Year ended 31st March, 1922 (the Sixty-seventh Year of the Meteorological Office).

THE ANNUAL REPORT for 1919–1920 described the steps which led up to the unification of the various meteorological organizations left by the war into one meteorological service attached to the Air Ministry; the Report for 1920–1921 was largely concerned with the assimilation of the Meteorological Office by the Air Ministry and it is necessary now to report a year of internal reorganization and consolidation.

On the reorganization of the Meteorological Office in 1919 a scheme was drawn up and presented to the Treasury and approved, which contemplated in addition to the Office in London with a total staff of 177, an Office in Edinburgh with a staff of 8; ten Contributive Stations (including the Observatories at Kew, Eskdalemuir, Valencia and Aberdeen) with a staff of 75; thirteen Distributive Stations with a staff of 86; two Army Service Stations with a staff of 24; and three Port Meteorological Offices with a staff of 5—total staff 375. Owing to the dearth of suitable assistants, and to rapidly changing needs and conditions it had not been possible at the beginning of the year under review to complete this programme, but every endeavour was being made as men became available to complete the establishment and to carry out the original programme with certain minor changes due to the altered distribution of aviation stations.

Early in the year the Meteorological Office, in common with all other Government Departments, was called upon to review its expenditure and if possible to reduce it. The whole position was therefore considered, and it became clear that the full sanctioned programme must be abandoned and replaced by a modified programme which would need only the personnel already in the Meteorological Office.

Throughout the year endeavour has therefore been made to reorganise the work on this basis. This has been particularly difficult at the out-stations, as the Royal Air Force required new stations at Leuchars, Shotwick and Andover, the staff for which was ultimately found when the stations at Felixstowe, Pulham and Manchester were closed. The establishment originally sanctioned contemplated that each Distributive Station should have a staff of at least five men, that being the minimum number required to carry on the work which continues every day in the year, so that arrangements have to be made for attendance on Sundays and public holidays. In view of the prevailing conditions work at most of the out-stations has been carried on with less than the sanctioned establishment, and throughout the year there have been four instead of five men at an ordinary Distributive

Station and practically all stations have had one or two men less than the full complement. This reduction leaves just sufficient men to work the stations under normal conditions, and there is no reserve for leave, sickness or other emergencies. The work at a meteorological station is not similar to work in most offices, for it must be done to a fixed time table and cannot be left to accumulate. During the year 1921 it was found possible, owing to the natural elasticity in an organization still in a state of flux, to meet most emergencies as they arose, but it is anticipated that there will be considerable difficulty in doing so in future years if the reduced establishment is maintained.

Much attention has been given at Headquarters to reorganizing the work so as to make it possible to effect a small reduction in staff. By arranging for the Observatories (Kew, Eskdalemuir, Valencia and Aberdeen) to prepare their own data for publication in the Meteorological Year Book it has been found possible to reduce the staff of the Climatology Division by two, while a readjustment of the work in the Forecast Division has made it possible to dispense with 12 temporary assistants. The Marine Division was in great need of further help, the existing staff being fully occupied and many more data arriving than could be handled. As an increase in staff was out of the question the only solution was to reduce the flow of data. This decision was reluctantly reached, and the Superintendent of the Marine Division was instructed to reduce the number of ships supplying information and to suspend the development of the work of his Division to which he had given much time and thought.

Throughout the year the work of the Instruments Division has been very heavy, due to the introduction of new methods of store-keeping, indenting and account-keeping and it has not been possible to reduce the staff of this Division.

The result of these endeavours has been to reduce the total staff at headquarters by 14 during the year, while the work of the out-stations, in spite of the restrictions mentioned, has necessitated an increase of 9. Thus the total whole time staff of the Meteorological Office and its out-stations has changed from 266 to 261 during the year under review.

An important change in the organization of the Office was introduced on the 1st January, 1922.

Previously certain divisions at Headquarters were grouped together under each of the two Assistant-Directors while other divisions reported directly to the Director. By the reorganisation the two Assistant-Directors at Headquarters, Mr. Lempfert and Lieut.-Col. Gold, were given administrative charge of the Department as a whole, Mr. Lempfert being in charge of all questions dealing with Personnel, Preparation of Annual Parliamentary Estimates, Publications, Library, Stationery, Establishment of New Stations, Inspections (arrangements of personnel) and Lieut.-Col. Gold of questions dealing with Meteorological Observations, Instruments, Equipment and Stores, Works and Buildings, Collection of Information, Distribution of Information, Inspections (stations to be inspected).

The normal procedure is for a Superintendent to deal himself with all matters appertaining to his division, the policy and procedure regarding which has previously been laid down. All matters, however,

involving new expenditure or new policy are referred to the appropriate Assistant-Director for instructions. The Assistant-Director either deals himself with the questions submitted or passes them to the Director for orders.

In this way the Superintendents remain in executive control of their divisions while uniformity of treatment is secured in matters common to one or more divisions.

British Rainfall Organization.—When the British Rainfall Organization was taken over in 1919 by the Meteorological Office it remained at 62, Camden Square, where it had been established in 1858 shortly after Mr. Symons had created the Organization. The practical inconvenience of having this portion of the office with a staff of seven persons detached from the main office was considerable, but there were strong reasons against effecting a change. In the first place the British Rainfall Organization depends upon the good will of nearly 5,000 voluntary observers who had been brought into touch with the Organization mainly through the personal influence of Mr. Symons and Dr. H. R. Mill. These two former Directors of the Organization had built up an *esprit de corps* which was focussed on the offices of the Organization at 62, Camden Square.

A still more important reason for making no change was that ever since 1858 meteorological observations, especially rainfall observations, had been made in the garden of the house, and these observations form a unique series of meteorological data from the interior of a great city.

In spite of these objections to removal reasons of administration and economy made it imperative in 1921 to transfer the Organization from 62, Camden Square to the Meteorological Office in South Kensington. Under the terms of purchase of the Organization from the Trustees of the British Rainfall Organization, the Meteorological Office was required to consult Dr. Mill before any such change could take place. This was done in September, 1921, and Dr. Mill, while expressing his great regret that a change was necessary, admitted the force of the reasons given and raised no opposition.

The transfer was made in March, 1922, and at the same time the Trustees of the British Rainfall Organization transferred the remainder of the lease of 62, Camden Square to the Royal Meteorological Society on conditions that they would charge themselves with the maintenances of the observatory until the lease falls in 1944. Thus an important change in the meteorological history of the British Isles was carried through, and it can be but hoped that by careful consideration of the needs and wishes of the 5,000 voluntary observers it will be possible for them to retain the same close co-operation with a Government Department that they maintained with a private organization.

The Mercantile Marine.—Partly as a result of the war and partly as the result of the activities of the Marine Division the sailor is beginning to realize that the change from sail to steam has not made him independent of the weather and that, with the present price of coal, it is economical to drive his ship in accordance with the weather conditions he may expect to encounter during his voyage.

The original programme of the development of the office provided for the establishment of three Port Meteorological Offices at Liverpool, Glasgow and Filton, It was intended that the officers in charge of

these offices should be experienced seamen and that they should act as local agents of the Meteorological Office, supplying instruments and literature to ships with the object of obtaining more meteorological data from the oceans in all parts of the world. On April 30th, 1921, the first Port Meteorological Office was opened in Liverpool in charge of Lieutenant-Commander G. ff. H. Lloyd, R.D., R.N.R. The office has been successful from the first, and has proved of great value both to the Mercantile Marine and to the Meteorological Office.

On June 1st, 1921, an extension in the supply of information to seamen was introduced by adding to the meteorological message broadcasted by wireless telegraphy from Poldhu six code groups giving the pressure, wind and visibility at five British coast stations. With this information and the observations made on his own ship, with possibly further information gathered by wireless telegraphy from surrounding ships, a captain approaching Europe can construct a synoptic chart from which he is able to forecast the weather likely to be experienced during the remainder of his voyage. Considerable use has already been made of these messages, and all indications point to an extended use of weather forecasting by synoptic charts on ships at sea. The year has seen a great increase in the interest of seamen in weather information, and it is greatly to be regretted that this increased interest should coincide with conditions which have made it imperative to reduce rather than extend the activities of the Marine Division.

School of Meteorology.—The Office has continued to co-operate with the School of Meteorology, and the facilities for classes and lectures which exist at the Meteorological Office, South Kensington, have again been placed at the disposal of Sir Napier Shaw. Miss E. E. Austin, a Senior Professional Assistant on the staff of the Office, has been seconded for a second year as assistant to Sir Napier Shaw, and Dr. C. Chree and Captain D. Brunt have given courses of lectures during the session. Seven members of the office staff have attended the various classes.

Aberdeen Observatory.—Owing to the increased work necessitating increased staff at the meteorological observatory at Aberdeen, it was found desirable to review the relationship between the Meteorological Office and the University. This relationship has always been extremely cordial, and under the superintendence of Professor C. Niven, F.R.S., the observatory has done much valuable meterological work. In place of the annual subvention, which was paid in the past in acknowledgment of the supply of regular observations, the University has agreed to a scheme under which the Meteorological Office retains, rent free, the use of the rooms in King's College occupied by the observatory staff and instruments, subject to certain annual charges for repairs, service, heating, water, &c; the Office taking over all other charges.

This brings the Observatory at Aberdeen into line with other stations maintained by the Meteorological Office, and has made it possible for the staff employed at Aberdeen to be brought on to the establishment of the Meteorological Office. The thanks of the Meteorological Committee are due to the University Court for their generosity in providing the rooms rent free and for the way in which they have exhibited their willingness to co-operate with the Office.

Falmouth Observatory.—The relationship between the Meteorological Office and the Falmouth Observatory has undergone many vicissitudes. The Observatory was one of seven First Order meteorological observatories organized by the Meteorological Committee in 1867. The administration of the observatory was undertaken by the Royal Cornwall Polytechnic Society and the Committee granted a small subsidy. In 1913 the Polytechnic Society was compelled for financial reasons to give notice to the Meteorological Office that it was unable to continue the work of the Observatory, but the Meteorological Committee was able to make an arrangement with the Society under which from 1st July, 1913, the use of the Observatory and premises was given to the Office free of rent in consideration of the Office becoming responsible for its upkeep and the salaries of the staff, &c. It was the intention then of the Meteorological Committee to make Falmouth Observatory a centre for meteorological research, but before the plans could be fully carried out the war came and all such schemes had to be put into abeyance. After the war, there were so many new meteorological stations with professional staff attached, that the need for Falmouth as a research station was no longer felt, but it served a useful purpose in the scheme for a wide distribution of stations in connexion with aviation. The development of aviation has not proceeded so rapidly as was anticipated, and when the need for economy was felt so acutely it was decided that some saving could be effected by closing the Falmouth Observatory. Notice was therefore given to the Royal Cornwall Polytechnic Society to terminate the agreement on the 31st December, 1921, on which date the staff provided by the Meteorological Office was withdrawn.

It is gratifying to be able to report that the Falmouth Town Council in a public spirited and sympathetic manner came to the help of the Polytechnic Society, and arrangements have been made for the Society to continue the work of the Observatory under the Superintendentship of Mr. J. B. Phillips, who was in charge of the Observatory under the Meteorological Office. Thus the continuity of the valuable series of meteorological observations, which has extended for over 52 years, is assured, and the close co-operation between the Royal Cornwall Polytechnic Society and the Meteorological Office is not to be finally severed.

Staff.—The Meteorological Committee desires to express its appreciation of the services of the staff of the office and of the assistance given to the Director in the preparation of the Annual Report by the Superintendents of Divisions.

Two members of the staff have retired during the year under the age limit. At the end of February, 1922, Mr. A. H Bell retired from the position of Principal Assistant which he had held since January, 1921; he had served in the Office for 45 years, and had been responsible for a long period for the preparation of the *Monthly Weather Report*, work in which his knowledge of the traditions of the Office and his conscientious attention to detail were invaluable. Mr. R. Sargeant, whose service dated from 1871, retired at the end of March, 1922; he had been associated with the Forecast Division throughout the greater part of his career and since April, 1920, had held the position of Assistant-Superintendent in it. The Office has also lost the services of Dr. Harold Jeffreys, M.A., who joined the staff

during the war as special assistant for work on the mathematical application of meteorological results to problems in ballistics and other subjects arising out of the needs of the Services. From July, 1920, Dr. Jeffreys was in charge of the Office library. He has resigned his appointment in order to resume his academic work at Cambridge University. During the 4½ years Dr. Jeffreys was in the Office he published much important work bearing on the application of mathematics to meteorological problems.

The staff has been joined by Mr. W. A. Harwood, M.Sc., late of the Meteorological Service of the Government of India, with a view to his taking charge of the Branch Meteorological Office in Malta.

Finance.—The year under review, 1921–22, is the second in which the cost of the Meteorological Office has been borne on Air Ministry Votes. The accounts are not yet closed, it is therefore impossible to give the exact amounts for the expenses and receipts of the Meteorological Office, but the following tables give the approximate figures:—

EXPENDITURE ON METEOROLOGICAL OFFICE 1921–22. (Approximate).

	£ s. d.	£ s. d.
H.Q. Staff at Air Ministry, South Kensington & British Rainfall Organization:—		
Salaries etc. .. .. .. (Includes 2 years' contributions under University Superannuation Scheme on behalf of the Professional Staff.)	57,676 0 2	
		57,676 0 2
Out-Stations:—		
Salaries, etc. .. .. .. (Includes 2 years' contributions under University Superannuation Scheme.)	42,623 4 10	
Rent, Fuel, and Incidental Expenses	1,216 9 11	
Maintenance of Buildings, etc.	2,356 7 5	
Maintenance of Kite Balloons	218 15 7	
Payments and Subventions to Telegraphic Reporting and other stations	1,418 3 9	
		47,833 1 6
Miscellaneous:—		
Superannuation	1,838 1 5	
Instruments and Stores ..	10,086 4 7	
Transport and Subsistence Allowances	3,645 7 2	
Cablegrams, Wireless Reports, etc.	2,086 0 10	
Expenses British Rainfall Organisation	254 14 11	
Expenses Atmospheric Pollution Committee	71 10 1	
Research Fund	208 10 0	
		18,190 9 0
		£123,699 10 8

RECEIPTS FOR 1921–22. (Approximate).

Instruments and Carriage ..	£5,286	
Daily Weather Reports, Inspections, departmental charges in respect of harvest forecasts, miscellaneous forecasts, publications	1,500 (approx.)	
National Debt Office (Annuities)	562	
Royal Society (Rosse and Gassiot Funds)	542	
		£7,890 (Approx.)

Meteorological Committee.—The Committee met five times during the year: on 22nd June, 27th July, 26th October, 25th January, and 15th March.

In April, 1921, Mr. P. J. Rose was nominated by the Scottish Office as their representative on the Committee.

Captain D. Fulton succeeded Captain J. M. Harvey as representative of the Board of Trade on 22nd June, 1921. Captain Fulton died suddenly on 20th March, 1922. His successor on the Committee has not yet been nominated.

Captain D. Brunt, Superintendent of Army Meteorological Services, was nominated Secretary of the Meteorological Committee on 22nd June, 1921.

Edinburgh Advisory Committee.—A meeting of this Committee was held in Edinburgh on 4th November, 1921.

The Director gave a brief historical account of the relations which had subsisted in the past between the Government and Scottish meteorology and explained the formation and constitution of the Committee.

A resolution was passed recommending the issue of a Daily Weather Report in Edinburgh.

A discussion then followed as to the needs of the Fishery Board, the Board of Health and the Board of Agriculture in meteorological matters and how these needs could be met.

International Meteorological Committee.—The International Meteorological Committee, like all other international organizations, was seriously affected by the war. From the outbreak of war it was in abeyance until 1919, when the Government of France convoked a Conference of Directors at Paris. At this Conference a new International Meteorological Committee was appointed which practically re-established the long line of pre-war Committees. Certain changes in the constitution of the Committee were made at the same time, the chief being the enlargement of the Committee from seventeen to twenty members. It was not felt desirable to appoint the full twenty members in Paris, but fifteen were chosen and given power to add the other five at their discretion. After election the Committee met to appoint the "Bureau," but did not transact any meteorological business. The Bureau elected in Paris consisted of Sir Napier Shaw (Britain), President; M. Angot (France), Vice President; and M. van Everdingen (Holland), Secretary. As no business meeting of the full Committee had been held since the meeting in Rome in 1913, it was felt that a meeting should be held in 1921, and London was chosen as the place of assembly.

The Committee was invited to meet in London on September 12th, 1921, but arrangements were made for several of the Commissions to meet during the preceding week so that they could report to the Committee when it assembled. During the week, September 5th to 10th, meetings of the following Commissions were held:—

(a) Polar Commission, *President*: Sir Napier Shaw;
(b) Commission du Réseau Mondial, *President*: Sir Napier Shaw;
(c) Commission for Marine Meteorology, *President*: Professor E. van Everdingen;
(d) Commission for the Application of Meteorology to Aerial Navigation, *President*: Lieut.-Colonel Saconney;
(e) Commission for Weather Telegraphy, *President*: Lieut.-Colonel E. Gold;

The Commission for the Study of the Upper Air (*President*, Professor V. Bjerknes), had met during July, 1921, in Bergen.

When the International Meteorological Committee met on September 12th the following took part in its deliberations:

Members of Committee: Sir Napier Shaw (*President*), MM. Angot, van Everdingen, Chaves, Hesselberg, Jaumotte, Maurer, Ryder.

Presidents of the Commissions: MM. Bjerknes, Saconney, Lieut.-Colonel E. Gold.

By Invitation: MM. Delcambre, Gorczynski, Matteuzzi, Melander, Okada, Simpson, Wallén, Fujiwhara, Richardson.

Twelve meetings were held and a full report has been published.*

In consequence of the rule which requires each member of the Committee to be the Director of an independent meteorological establishment, Sir Napier Shaw and M. Angot retired from the Committee and the Director of the British Meteorological Office and the Director of the Office National Météorologique de France were appointed to succeed them.

Professor Okada was elected to the Committee in place of Professor Nakamura who tendered his resignation to the Committee in view of his early retirement from the directorship of the Tokyo Observatory.

Dr. Axel Wallén, Director of the Meteorological and Hydrographical Service of Sweden, was elected to fill one of the five vacant places on the Committee.

At a meeting held on the last day of the session, the new Committee considered the appointment of a new Bureau in view of the retirement of Sir Napier Shaw and M. Angot, and the following appointments were made:

President: Sir Napier Shaw (special appointment: see full report).
Vice-President: Professor van Everdingen (Holland).
Secretary: Director Hesselberg (Norway).

The remaining members of the Committee are:—

Colonel Chaves (Azores), Colonel Delcambre (France), Dr. Eginitis (Greece), Mr. Hunt (Australia), Commandant Jaumotte (Belgium), Professor Marvin (U.S., America), Dr. Maurer (Switzerland), Professor Okada (Japan), Professor Palazzo (Italy), Captain Ryder (Denmark), Dr. Simpson (Britain), Sir Frederick Stupart (Canada), Dr. Walker (India), Dr. Wallén (Sweden).

**Report of the Eleventh Ordinary Meeting of the International Meteorological Committee.* M.O. 248. 1922.

MARINE DIVISION.

Following on the activities of the Maine Division since the war, as shown in last year's report, it became evident that closer co-operation with shipping and seamen was desirable for general efficiency. The Marine Superintendent has, therefore, during the current financial year visited all ports in Great Britain where there are Marine Agents and many others of the more important ports. Addresses on the application of the work at sea have been given by the Superintendent to the Chamber of Shipping of the United Kingdom, shipowners, masters, and mates, whose views have been ascertained as far as possible ; based upon these, and experience, a report has been submitted outlining a scheme for the better fulfilment of the modern requirements of shipping and seamen.

Voluntary Observing Fleet and Observers.—On the 1st April, 1921, there were in all 383 vessels whose officers regularly co-operated with the Meteorological Office. Of these, 133 merchant vessels were equipped with official instruments for keeping meteorological logs ; 9 ships of the Royal Navy kept meteorological logs with Admiralty instruments ; 1 North Atlantic liner, *R.M.S. Mauretania* was equipped with office instruments for making coded reports by wireless telegraphy. During the first part of the year many offers to co-operate were received ; it was not possible to accept these for keeping meteorological logs, but as far as possible offers were accepted to keep Forms 121 (Ocean Meteorological Reports) using the ships' instruments. These forms have been invaluable in showing that a large number of observations are now taken at sea. It is, therefore, only necessary to organize the interchange of observations between ships by wireless telegraphy to make it possible for any ship to construct valuable synoptic charts.

Early in October, 1921, it was patent that further increase of regular marine observers to the Office would be detrimental to efficiency, because the staff of the Marine Division was not sufficient to cope efficiently with more data. All marine agents were, therefore, circulated and the total number of ships in the voluntary observing fleet restricted to about 500.

As foreshadowed in last year's report the number of full logs provided by the 133 merchant vessels and 9 surveying ships of the Royal Navy then co-operating yielded more observations than could be coped with by the data section. These have, therefore, been reduced to 125 merchant vessels and 9 of His Majesty's ships. The voluntary observing fleet now consists of :—

125	Merchant vessels keeping meteorological logs with office instruments.
17	Atlantic Liners making coded wireless telegraphy reports working on continuous wave.
9	Ships of the Royal Navy keeping meteorological logs with Admiralty instruments.
8	Cross channel steamers making telegraphic reports using office thermometers.
3	Cadet Training Establishments. School ship *Conway*, Thames Nautical Training College, *Worcester*, and Nautical College, Pangbourne, have kept the Cadets' Meteorological log.
341	Merchant vessels keeping Ocean Meteorological Reports, Form 121, using the ships' instruments.
Total 503	ships.

The senior cadets of the *Conway* and the *Worcester* were examined.

The observational activity has been spread out over all the more important trade routes, and also over various unfrequented areas; special attention has been paid to the Pacific as far as possible with the means available. Every ship borne on the lists of the observing fleet has sent in logs or returns within a reasonable period. All instruments which were adrift at the armistice have been recovered or accounted for. Forty coast stations and light vessels are equipped for taking observations of sea and air temperature, wind, and weather, twice daily, and all with the exception of 2 Irish stations have regularly contributed returns. Observations at 6 West Indian Light Stations, and at Falkland Island Light Station have been continued. On behalf of the Ministry of Agriculture and Fisheries the collection of water samples by steamers on the Liverpool to West Indies and Liverpool to South America routes has commenced. The first ship sailing, to undertake this work, was s.s. *Pancras*, Captain Torrible.

A tabular statement for the past ten years is given on page 23.

Obituary.—It is recorded with regret that the death of the following former marine observers occurred during the year:—

Captain Alexander Simpson, Aberdeen White Star Line, who kept no less than 52 "excellent" logs.

Sir Ernest Shackleton, C.V.O., R.Y.S. *Quest.*

Captain F. J. Mossley, Marine Superintendent, Union Castle Line.

Captain E. Cook, R.M.S. *Empress of France.*

Excellent Observers.—A list is appended on page 24 of captains and officers, with the names of their ships, who have received awards for "excellent" logs or wireless telegraphy registers.

Classification of Meteorological Logs.—Generally the meteorological logs show an improvement, particularly with regard to the recording of the set and drift of current, though the number classed "excellent" has slightly fallen off.

264 logs in all were received which have been classed as follows:

Excellent	66
Very Good	185
Good	13

Port Meteorological Officers and Marine Agencies:—The Port Meteorological Office at Liverpool was established in charge of Lieutenant-Commander G. ff. H. Lloyd, R.D., R.N.R., on April 30th, 1921. It has proved a most valuable development, resulting in increased co-operation and goodwill from Liverpool shipping and nautical interests, with mutual benefit to the Port and the Meteorological Service. A great many offers to observe regularly were received through this Office at Liverpool, but owing to the reasons stated above it was possible to accept only a limited number of them.

On May 2nd, 1921, Lieutenant Commander J. Hennessy, R.D., R.N.R., late Commander of ss. *Uranium*, who served during the war as Lieutenant in H.M.S. *Carmania*, and in command of H.M. Ships *Hussar* and *Harebell*, was appointed Senior Professional Assistant, with a view to being posted as Port Meteorological Officer, Glasgow.

The relief of a number of Marine Agents, who were unable to devote the necessary time from their official duties, has been continued. The Marine Agents at all ports in Great Britain are master mariners.

The following appointments have been made during the year:—

Glasgow	Captain M. C. Corrance and Captain J. T. Russell, Board of Trade Surveyors.
Southampton ..	Captain D. Forbes, of the Nautical Academy.
South Shields ..	Commander E. S. MacLeod, R.D., R.N.R., Board of Trade Surveyor.
Hull	Captain G. B. Sturdy, Assistant Marine Superintendent, Ellerman Wilson Line.

The agency at Hong Kong is now developed, and has been taken over by Lieutenant-Commander R. Gregory, R.N., Superintendent Admiralty Chart and Chronometer Depôt. The agency at Vancouver has been developed under T. S. H. Shearman, Esq., of the Canadian Meteorological Service. The Australian Agency is being developed under the direction of the Commonwealth Meteorologist, who, with the permission of the Director of Navigation, is obtaining the assistance of the Deputy Directors of Navigation at Sydney, Melbourne and Fremantle.

Data Extraction and Research :—The new system of extracting data from logs for all parts of the world, commenced on April 1st, 1920, has been continued without interruption. This system was further improved in June, 1921, by use of a Hollerith Electrical Sorting and Tabulating Machine similar to that with which the last census of population was computed. Briefly the system is as follows :—

The logs are prepared as in the past, with the addition that all elements for extraction are coded. The coded logs are passed to the Statistical Division of the Air Ministry, who punch specially prepared cards to correspond with the code figures in the logs. A double check is used. The cards are then systematically stored in the Marine Division. In 1920-21, on the average 51 sets of observations were extracted per man per day, including Sundays and holidays. With the Hollerith Machine in use for 10 months out of the 12 in 1921-22 this average was 55. There is little difference in the volume of extraction, but the work is more thoroughly done ; more care is devoted to the extraction of ocean current observations which are still entered by hand in the data books, and a more complete and accessible index is made of phenomena which are required for investigations. The principal advantages of the Hollerith Machine are accuracy, speed and economy in computing, as it will sort, total, or group elements on the cards, each of which contains a complete 4-hourly set of observations, at the rate of 10,000 cards an hour. The total number of sets of observations extracted during the year is 75,061*. The distribution of these is shown on the Atlantic Chart for June, 1922. Seventy-six per cent. of meteorological logs received, which reached the high standard required, have been prepared for extraction. Ocean Meteorological reports (Forms 121) though not extracted, are indexed, and provide most useful data for many purposes, including the answering of inquiries concerning missing ships, etc.

The following investigations have been continued :—

Tropical Cyclones.

Fog and other weather at sea in order to prove the utility to navigators of Wireless Weather Reports and Weather Charts.

*There are also 14,664 observations prepared for extraction for which cards have not yet been punched.

Conditions during the South-west Monsoon along the route homeward Colombo to Perim, including the district adjacent to Cape Guardafui.

Having regard to experience in navigation at sea, and working with Ekman's theory as a hypothesis, research has been undertaken with regard to the relationship of wind to current.

Exchange of Data.—Information regarding ice and derelicts reported in the North Atlantic has been forwarded as received to Lloyd's List for publication. Information regarding all ice reported in the North Atlantic has been forwarded monthly to the Danish Meteorological Institute.

Data of a cyclone in the Arabian Sea in November, 1920, were exchanged with the Dutch Meteorological Institute.

The question of international exchange of marine data was discussed by the International Maritime Meteorological Commission at the meeting in London in September, 1921.

Publication of Information for Seamen :—

Weather forecasting in the Eastern North Atlantic and Home Waters for Seamen, M.O.246, by Commander L. A. Brooke Smith, R.D., R.N.R.

The Marine Observer's Handbook, 3rd Edition, with cloud plate.

The articles on applied marine meteorology on the backs of the Monthly Meteorological Charts have been continued. Amongst these were :—

Gibraltar to Plymouth, with Wireless Telegraphy Reports as an Aid.

Steamship Route from Colombo and the East to Perim during the S.W. Monsoon, with a brief survey of currents, wind, cloud, and conditions of visibility in the region of Sokotra and Cape Guardafui.

Weather in Australian Waters, by Commander L. A. Brooke Smith, R.N.R.

A Mechanical Means of Extracting Data from Meteorological Logs and of working up averages.

Notes on Barometer Errors.

Currents on the Panama—New Zealand Track, by Mr. C. S. Durst.

Hurricanes of the West Indies, by Lieut.-Commander G.ff. H. Lloyd, R.D., R.N.R.

Cyclone in the Arabian Sea, November, 1920, by Lieut.-Commander J. Hennessy, R.D., R.N.R.

Frequency of Fog in the North Atlantic and the Adjacent Seas of the British Isles.

Swell, by Mr. H. Keeton.

Clouds.

The Ice in the North Atlantic, by Mr. A. G. W. Howard.

Marine Meteorology, History and Methods, by Mr. H. T. Smith.

Weather Charts and Forecasts made on board R.M.S. "Kinfauns Castle," by Mr. C. H. Williams, with notes and comments by Commander L. A. Brooke Smith, R.D., R.N.R.

Exhibits.—By the courtesy of the committee of the Shipping, Engineering and Machinery Exhibition held at Olympia in September, 1921, the following exhibits were made :—

The "Excellent" log of the Cable Steamer *Stephan.*

Recent Ocean Meteorological Charts, back and front.

The Marine Observer's Handbook. M.O. 246.

Information Required in Connection with the Investigation of Dissappearances of Missing Ships, and other Maritime Casualties.—The work in this connection has been heavy. Forms 121, as well as meteorological logs, have enabled us to answer many inquiries. The new system of data extraction has proved valuable in finding the required observations.

Reports by Wireless Telegraphy from North Atlantic Liners.—This service has been developed by leading liners in the North Atlantic, fitted for continuous wave, working through Devizes Post Office wireless telegraphy station. A high state of efficiency has been reached. Seventeen steamers participate and as soon as possible this number will be increased to 25.

During the year 1,472 weather reports have been received by wireless telegraphy, and checked in the Marine Division on receipt of registers, from positions between the 100 fathoms line to the westward of the British Isles and Long. 54° 11′ W. Of these 274 were received within 1 hour of observation, 307 were received within 1 to 2 hours of observation and 288 were received within from 2 to 4 hours of observation. The remainder, 603, were over 4 hours in transmission.

Code for Weather Reports by Wireless Telegraphy.—The trial of the Provisional International Code for ships having been carried out with success, the Sub-Committee for Marine Meteorology considered a report which included the views of the captains of the ships which made the trial and advised as to the steps to be taken with a view to the confirmation of the code. This code was discussed by the International Maritime Meteorological Commission, who drew up and recommended two codes, one with check figures and the other without, based on the aforesaid Provisional Code but only containing the most essential elements. The International Meteorological Committee decided that these two codes should be circulated to the Directors of Meteorological Services interested, or likely to be interested in ships reports, in order that a vote might be taken as to which of the two should be definitely internationalized.

When agreement is reached it is proposed that the International Code shall be published for general use between ships at sea as well as for reporting to meteorological centres. By this agreement, ships of nations subscribing thereto will be able to exchange coded reports by wireless telegraphy of the more important weather elements and position, and different countries will be able to add such information, in code, as they desire, until from time to time further international additions are made.

The Use of Wireless Telegraphy in the Practice of Marine Meteorology.—A simple coded report giving observations at five coast stations on the western and southern coasts has been issued twice daily through Poldhu wireless telegraphy station since June 1st, 1921. Notification of the issue of this report was given in *Notices to Mariners*. The first weather charts and forecasts made at sea and based on these reports and ships' observations, to be received were those by Mr. C. H. Williams 3rd Officer, of ss. *Kinfauns Castle* (Captain J. George, O.B.E.), since then a number have been received. Many shipmasters have reported the benefit derived from the Polhdu report.

From information received it is evident that weather reports, which have been exchanged at sea by wireless telegraphy from as far back as 1911, are increasing, and that they are being made in a more uniform manner, as suggested in *Weather Forecasting in the Eastern North Atlantic and Home Waters for Seamen*,* and that they more often synchronize.

Interesting reports of experiences in different parts of the world indicate that reports by wireless telegraphy of weather and set and drift of current have been conducive to safety and economy.

Barometric observation shows steady signs of improvement; in fact reports by wireless telegraphy are giving information which is not only of assistance at the time, but is leading to a better understanding by seamen of the laws of weather.

* M.O. publication No. 246.

DETAILS OF VOLUNTARY OBSERVING FLEET AND COAST STATIONS.

	At 31st March.									
	1922	1921	1920	1919	1918	1917	1916	1915	1914	1913
Number of Ships equipped with sets of instruments keeping full logs	125	133	104	—	—	—	—	192	209	192
No. of H.M. Ships keeping full logs ...	9	9	2	2	—	—	1	3	4	6
No. of Ships contributing Ocean Forms, using Ship's Instruments.	341	216	117	7	—	—	—	—	—	—
No. of Ships equipped especially for W/T Weather Reports ...	17	1	—	—	—	—	—	9	11	12
No. of Coast Stations equipped with Instruments for Form 129A.	40	42	53	52	49	49	58	59	62	61
No. of ships equipped with Instrumentsfor Home Waters Telegraphic Reports ...	8	24	—	—	—	—	—	—	—	—
No. of ships whose logs are overdue ...	0	2	19	—	—	—	—	—	—	—
Number of Barometer Errors ascertained or checked ...	1025	365	—	—	—	—	—	—	—	—

	Receipts for the year ended 31st March.									
	1922	1921	1920	1919	1918	1917	1916	1915	1914	1913
Meteorological logs	264	204	67	22	59	115	147	224	279	290
Ocean Forms 121.	1717	1068	503	21	144	670	882	1064	1597	1628
Forms 129A...	460	437	381	334	324	340	351	510	682	680
Lighthouse Registers ...	16	16	12	16	15	14	15	14	15	17
Ocean W/T Report Registers	98	—	—	—	—	—	—	—	—	—
Home Waters Telegraphic Reports ...	1066	1808	—	—	—	—	—	—	—	—
Cadets Meteorological Logs...	9	6	—	—	—	—	—	—	—	—
Logs extracted (New data extraction)	155*	169	—	—	—	—	—	—	—	—

* There are also 37 logs prepared for extraction for which cards have not yet been punched.

LIST OF CAPTAINS AND OFFICERS WHO HAVE BEEN AWARDED "EXCELLENT."

Captain.	Chief Observing Officer.	Ship.
*Beadnell, F.E., Commr., R.N.R.	Heenan, J.A.	*Celtic* / *Baltic*
*Bradshaw, J.	Doughty, J.	*Lapland*
Burton Davies, J.	Dee, T.	*Whakatane*
Byers, G.	Mr. Lough.	*Yingchow*
Campos, V., O.B.E., Lt.-Commr., R.N.R.	Muir, A. S.	C.S. *Colonia*
*Carlton, G. F., O.B.E., Commr., R.N.R.	Hegarty, L. J.	C.S. *Stephan*
*Cartmer, G. E., O.B.E.	McMillan, J. S.	H.M.P.S. *Kurmark*
Chambers, F. W., D.S.C.	Pascoe, J.	*Digby*
*Charles, Sir J. T. W., K.B.E., C.B., Com., R.N.R., R.D.	Denby, A. J.	*Aquitania*
Collyer, R.M.M., Commr. R.N.R.	Edwards, L. J.	*Nore*
Cornish, N.P.	Barker, G. W.	*Matheran*
Cottell, S. C.	Catchpole, E. C.	*Port Victor*
David, H. F., Capt., R.N.R., R.D.	Eales, G. D. R. / Dyer, A. E.	*Cedric* / *Adriatic*
Diggle, E. G., Capt., R.N.R., R.D.	Thelwell, R. G.	*Caronia*
Fishwick, A. T.	Rigden, T. H.	*Port Albany*
*Forbes, C.D., Lt.-Commr. R.N.R.	Holland, S. J.	*Nyanza*
*French, H. E., M.B.E.	Rowson, F. S.	*Kovno*
*Geary Hill, S. A., D.S.O., Commr. R.N.	Turner, H. E., Lt. R.N.	H.M.S. *Endeavour*
Glennie, R. W., C.M.G., Capt., R.N.	Stanley, A. H., Lt. R.N.	H.M.S. *Mutine*
Griffiths, E.	Davies, H. H.	*Empress of Britain*
Hall, J.	Leicester, R.	*Pretorian*
*Hamilton, W. Y.	Wiles, N. / Rowlands, A. L.	*Arracan*
Hayes, Sir B. F., K.C.M.G., D.S.O., Com., R.N.R., R.D.	Butcher, A. F.	*Olympic*
*Hearn, G. W.	Moore, A. S.	*Port Stephens*
Henderson, W.	Campbell, A. F.	*Bosworth*
Higgins, C. J.	Wigglesworth, T.W	*Clan Macgillivray* / *Clan Malcolm*
Hoad, A. C.	Harris, G. T. C.	*Port Caroline*
Horscroft, A.	—	*Wangaratta*
Hoskins, D. H.	Williams, C. H.	*Kinfauns Castle*
*Lainson, W. H.	Carr, T. W.	*Orduna*
*Lear, A. W. H.	Cole, A. F.	C. S. *Britannia*
Ledsome, J. S.	Church, A. T.	*Lexington*
Lockyer, H. R. C.	Williams, P.	*Hypatia*
McKellar, A. W., Capt., R.N.R., R.D.	Angell, A. / Freeman, H. D.	*Ruapehu*
*Metcalfe, G. R., Lt.-Commr., R.N.R.	Eales, G. D. R. / Heenan, J. A.	*Cedric*
Parry, H.	Davies, H. H. / Mories, H. G.	*Melita*
*Reilly, J. V.	Charlwood, W. S.	*Woodarra*
Robinson, C. A.	Moore, A. S.	*Port Stephens*
Shelford, W. S., Lt.-Commr., R.N.R.	O'Brien, A. O. H.	*Orvieto*
Taylor, A., O.B.E., Lt. R.N.R.	Rhodes, A.	*Frankenfels*
*Taylor, J. C.	Robertson, L.	*Easonian*
*Turnbull, J., C.B.E., Capt., R.N.R., R.D.	Davies, H. H.	*Melita*
	Bell, L. de H.	*Metagama*
Wallace, W. K.	Hetherington H.P.	*Elpenor*
Warrington, A.F.G., F.R.G.S.	Cave, L. J.	*Hatarana*
*Wigger, W.	—	*Wangaratta*

*Those marked with an asterisk appear in the list of "excellent" observers for the first time.

FORECAST SERVICE.

General.—The year now ended completes the first twelve months of the use of the new International code for incoming British reports. A few slight modifications were introduced in January, 1922, to meet the changes agreed to at the meeting of the International Meteorological Committee in the autumn of 1921. In spite of the increased amount of work involved in the new methods of observation and the additional information required, the demand has been met in a way that reflects great credit on the observing staff at telegraphic reporting stations.

A pneumatic tube has been installed at the Air Ministry between the Communications room and the Forecast room, and is used for all incoming and outgoing wireless reports. Telegraphic messages are dealt with by telephone direct to the Central Telegraph Office.

In December the Forecast Service vacated the suite of rooms on the fourth floor which it had occupied since October, 1919, when first transferred to the Air Ministry. Accommodation has been provided on the fifth floor, but the number of rooms is less, and in consequence a large part of the collection of foreign Daily Weather Reports in the charge of the Division has had to be returned to South Kensington owing to lack of space.

Towards the end of the year certain reductions in staff were made; this resulted in the withdrawal of a telephone operator from night duty, and other economies. Subsequently in a further re-organization of the work the staff assistant on night duty was replaced by a technical assistant. The night work is now performed by one Senior Professional Assistant and one Technical Assistant.

Several Papers have been prepared by members of the Staff for publication as *Professional Notes* and communications have also been contributed to the *Geografiska Annaler* (Stockholm), the *Proceedings of the Royal Soc.*, *Quarterly Journal of the R. Met. Soc.*, and to *Nature*.

Observations Received.—(a) *British Reports.* Surface observations from the regular reporting stations have been received throughout the year. Telephonic communication with Malin Head has been interrupted at times, and telegraphic communication between Stornoway and Castlebay and the mainland has not been possible from 10th January to the end of the financial year. This difficulty has been met by the establishment of communication by wireless telegraphy from the Hebrides to the mainland. Owing to the withdrawal of the Coast-guard from Blacksod Point some difficulty was experienced in carrying on the work. The Admiralty, however, arranged to have a rating as caretaker, and the sub-postmistress has also been instructed in the work, so that apart from a short interval observations have been maintained throughout.

On the 21st June, Leith ceased to be a reporting station, and on the 23rd a new station was opened on the Island of Inchkeith. For the first few months observations were taken at 7h., 13h., and 18h.

only, but at the end of October 1h. observations were included, these taking the place of the reports hitherto sent from Eskdalemuir..

Leuchars, a new local centre, began to send reports on the 19th September, and upon the closing of Manchester Aerodrome the Meterological Staff was transferred to Shotwick and observations have been received from that station since 31st October.

Pendennis Castle replaced Falmouth Observatory as a telegraphic reporting station at the beginning of December.

Reports from the following stations ceased during the year :—

Howden on December 11th.
Pulham on March 31st.
Felixstowe on March 31st.

Upper wind reports have been received from local centres and observatories, and observations of upper air temperature have been taken by means of aeroplanes when conditions permitted at

Andover	Duxford	Grain
Baldonnel	Leuchars	South Farnborough

Observations from Atlantic liners have been transmitted by wireless telegraphy since the end of March, 1921. The messages have usually arrived in good time and have been of great value in the work of the division.

(b) *Foreign Reports.* Several Continental Countries have now adopted the new international code. These include Norway, Sweden, Holland, Belgium, France (for hourly route reports only), Finland, Roumania, Jugo-slavia, Czecho-slovakia, Egypt (Cairo), Greece and the Azores. The reports from Gibraltar and Malta are also received in the new code.

Almost all European countries have now adopted the use of wireless telegraphy for the dissemination of weather reports each day. Those from the nearer countries are received with great regularity by this means. The exchange of reports by cable with certain countries continues, but it is growing evident that, owing to the increased efficiency of the wireless service, it will shortly be possible to dispense with this service. Already the exchange with France has been limited to reports from certain stations not included in the wireless issues, and with Holland to one report only per day in either direction.

A pamphlet* giving full particulars of European Wireless Issues, together with the codes used, has been published.

Observations from the Norwegian station established on the Island of Jan Mayen were first received on the afternoon of October 20th and have since come regularly. They afford valuable information on a part of the map from which no observations were previously reported.

Reports from Scandinavian and French ships are now added to the wireless issues of Norway and France. Some of the observations from the former countries' ships have proved of great service, for the vessels take a course much to the north of that followed by the British liners.

Distribution of Information.—Some detailed modifications have been made in the British wireless synoptic reports, but essentially

* *Particulars of Meteorological Reports issued by Wireless Telegraphy in Great Britain and the countries of Europe and North Africa.* M.O. publication 252. Published by His Majesty's Stationery Office. Price 2*s.* 6*d.*

these have remained unchanged throughout the year. The reports are issued five times each day from the Air Ministry, the 2h issue being repeated at 6h. The report containing 7h observations has been retransmitted from Aberdeen at 8h 30m since the 1st September for the benefit of Northern European countries.

Since May ships' observations from the Atlantic have been included in these reports. On the 15th July the times of issue were altered to 2h, 8h, 14h, 19h, being the hours recommended by the meeting of the Commission for Weather Telegraphy in November, 1920.

From the 15th June the wireless messages issued from Poldhu have included synoptic data from Stornoway, Blacksod Point, Holyhead, Scilly and Dungeness in addition to the Western Seaboard forecast.

A "further outlook" has been added to the "General Inference" issued by wireless telegraphy on Friday mornings since the last Friday in May.

A detailed examination has been made of errors in the British wireless reports as received by foreign countries on certain days in December. The results show that out of 26,200 figures included in the messages for which returns were received 1·57% were received erroneously.

The number of countries receiving synoptic messages by cable remains unaltered, though the number of groups sent has been reduced. Since the end of December the Horta message has been transmitted to the London office of the All Russian Co-operative Society for retransmission to the Geophysical Institute at Petrograd.

Requests have been received from time to time from the Admiralty for forecasts required in connection with special operations.

Special reports and forecasts were sent to Bedford in June, July and August in connexion with the trial flights of the R 38 airship.

British and foreign data together with forecasts were sent to the Meteorological Office representative at the Royal Agricultural Society's show at Derby from June 28th to July 2nd.

A full demonstration of the use of wireless telegraphy for the reception of meteorological information was given at the British Association meetings at Edinburgh from 7th–14th September; synoptic charts were drawn from data picked up by wireless telegraphy, for which arrangements were made by the Controller of Communications of the Air Ministry and a special duplicated report was issued.

Forecasts were sent to H.M. Yacht *Victoria and Albert* from July 29th to August 8th in connexion with His Majesty's cruise.

From the 15th July all coded forecast telegrams sent to aerodromes and out-stations have been in the new Meteorological Forecast Code. This has superseded the Admiralty cypher which came into use during the War.

Lithographed and Duplicated Reports.—The *Daily Weather Report* has been published in three sections, British, International and Upper Air, throughout the year. On the 1st April, 1921, the British section of the *Daily Weather Report* was re-modelled so as to include the full observations received in the new code; rainfall being published separately for the day and the night, and the maximum temperature referring to the day only, the minimum temperature to the night. "Atmospherics" recorded at Croydon have been published in the British Section since 1st December.

Duplicated reports containing advance copies of the maps for 1h, 7h, 13h and 18h and forecasts based on them have been prepared for distribution and have been issued regularly with the exception that the report for 1h was not prepared on two nights at Christmas. The report for 7h is not prepared on Sundays and that for 13h on Saturdays or Sundays.

The Monthly Supplement was revised with the January number. It has been issued regularly on the 1st of each month except when that day fell on a Sunday or public holiday. Correction sheets to the *Daily Weather Report* for each month of 1921 and for January and February, 1922, have been prepared and published, and also title pages for the first three quarters of 1921.

Gale Warnings.—The gale warning service has been maintained throughout with little variation. During September arrangements were made to supply the Halifax Corporation Tramway Service with gale warning messages in order that special precautions might be adopted for the safety of cars on exposed sections of the line.

Warnings for issue by wireless stations are now repeated at intervals, about once every 24 hours, while the gale cone is flying so that ships coming within range of the wireless station may be supplied with the warning.

Examination of the returns from the signal stations showed that the percentage of messages delivered within two hours varied from 96% to 81% during the day time, and at night from 49% in September to 17% in October.

The warnings issued during 1921 have been checked and the table on the following page gives the results.

Harvest Forecasts.—During the four months June to September daily forecasts were sent to 24 subscribers for varying periods, and there was a total of 76 subscribers for notifications of spells of settled weather. These were issued on 13 occasions.

Supply of information to the Press and Public.—Forecasts for issue to the Press have been prepared three times each day except on Sundays and Bank Holidays when no morning forecasts are issued.

Remarks on the weather of the day over north-west Europe, together with a tabular statement of weather experienced at a number of health resorts have been issued each evening, while during the summer months these have been supplemented by a midday issue of the last named report.

From March 1st an additional set of weather forecasts has been issued each evening. These cover the sea districts around the British Isles and have been widely circulated to the Press.

Special week-end forecasts are prepared each Thursday and Friday for the benefit of certain provincial newspapers in the eastern and south-eastern counties.

Regular meteorological press correspondents have been supplied with current information each evening except Saturday.

An experimental sale of the *Daily Weather Report* containing special sea passage forecasts was made at Victoria Station by arrangement with W. H. Smith and Son. These reports were available at the time of departure of the afternoon boat trains and the trial was carried on from 23rd December to 11th March, when, owing to the small demand for the reports, it was discontinued.

Gale Warning Checking, 1921. Summary of Results.

DISTRICTS.	Summary of occasions of warning.		Summary of Warnings issued.			
	Total number of occasions upon which warnings were necessary.	Percentage of occasions of gales effectively warned.	Total number issued.	Issues justified by subsequent force 8 and above	Issues justified by subsequent forces 6 and 7	Percentage justified either by gales or strong winds.
1. Scotland N.E. A	11	91	32	10	13	72
1. Scotland N.E. B	3	100	30	3	16	63
2. Scotland E.	5	100	23	5	10	65
3. Scotland N.W.	6	100	33	6	14	61
4. Scotland W. and North Channel.	4	100	29	4	21	86
5. Ireland N.	11	82	28	9	8	61
6. Ireland S.	6	83	28	5	16	75
7. Irish Sea.	10	90	28	9	18	96
8. St. George's Channel.	7	86	23	6	13	83
9. Bristol Channel.	9	78	24	7	13	83
10. England S.W.	13	69	25	9	12	84
11. England S.	6	100	23	6	12	78
12. England S.E.	10	90	22	9	9	82
13. England N.E.	3	100	12	3	8	92
14. England E.	3	67	16	2	10	75
All districts	107	87	376	93	193	76

Many inquiries have been dealt with regarding weather conditions prevalent during shipping casualties. These have covered areas in various European waters in most cases, but in one or two instances information for Asiatic districts was required.

During April the large map at the main entrance to Adastral House was renovated and the area covered increased. Isobars and barometric changes are shown and permanent metal holders are provided for displaying the station observations. A general inference and London forecast have been exhibited on a blackboard beside the chart since August.

Inquiries were received by telegram or telephone on 1385 occasions, and there were 529 personal inquiries at the Press Room.

INQUIRIES.

	1919–20		1920–21		1921–22	
Month	By Telephone or Telegram	Personal	By Telephone or Telegram	Personal	By Telephone or Telegram	Personal
April	—	—	37	8	76	21
May	—	—	83	32	54	21
June	—	—	73	17	82	39
July	—	—	166	36	197	65
Aug.	—	—	86	20	124	38
Sept.	—	—	54	13	110	32
Oct.	—	—	53	23	145	60
Nov.	—	—	72	23	119	56
Dec.	24	8	87	42	82	40
Jan.	39	10	85	32	147	67
Feb.	48	27	66	23	86	31
Mar.	43	18	67	30	163	59
TOTAL			929	299	1,385	529
GRAND TOTAL			1,228		1,914	

CLIMATOLOGY DIVISION.

Organization.—The normal work of the Climatology Division is the collection of meteorological observations and of autographic records, the preparation of summaries of the observations for publication and the discussion of all information bearing on climate. The Library has been incorporated in the Division since 1920. On October 1st, 1921, the editing of the occasional publications of the Office, Geophysical Memoirs, Professional Notes, etc., a duty formerly assigned to the staff of the Instruments Division, was transferred to this Division. A list of the occasional publications issued during the year is given on page 57.

Climatology of the British Isles. Distribution of Stations.—The following table gives the distribution by districts of the stations of different types and also indicates where autographic records are being kept. The list refers to March, 1922 :—

	Stations.				Autographic Records.					
	Observatories.	Distributive Stations.	Other Telegraphic Stns.	Climatological Stations.	Sunshine.	Rainfall.	Wind.	Pressure.	Temperature.	Humidity.
0. Scotland, N. . .	0	0	4	10	5	0	1	4	0	0
1. ,, E. . .	1	1	2	33	15	2	5	4	3	3
6*a*. Scotland, W. . .	1	1	0	24	13	1	2	3	2	2
6*b*. Isle of Man . .	0	0	0	1	1	0	0	0	0	0
2. England, N.E.	0	1	2	17	13	1	4	3	1	1
3. ,, E. . .	0	2	2	22	21	2	4	3	2	2
4. ,, Midlands	0	2	1	38	22	0	1	2	0	1
5. ,, S.E.	0	10	2	45	33	6	5	7	8	7
London District	1	0	1	8	8	4	2	2	2	1
7*a*. England, N.W,	0	1	1	22	18	1	2	1	0	0
7*b*. N. Wales . .	0	1	0	5	6	2	1	2	2	2
8*a*. S. ,, . .	0	0	1	8	7	0	0	2	0	0
8*b*. England, S.W.	0	0	1	27	23	1	3	5	2	2
9. Ireland, N. . .	0	0	3	6	5	1	1	3	0	0
10. ,, S. . .	1	1	2	20	8	2	5	7	1	2
11. Scilly and Channel Isles	0	0	2	1	3	0	1	1	0	0
	4	20	24	287	201	23	37	49	23	23

Only such autographic records as are regularly received at this Office are shown. It should be noted that the records from observatories such as those at Oxford, Paisley and Southport are available on occasions. The records from the Distributive Stations * at the aerodromes are now examined at South Kensington month by month and returned for preservation locally. The records of rainfall in the possession of the British Rainfall Organization are not shown in the table.

Changes in Stations associated with the Climatology Division :—New stations have been started at Newport (Isle of Wight), Alfriston (Near Lewes), and Newton Barry (Co. Wexford).

Observations at Deal were resumed during the year.

The principal observations at Huddersfield have been made since January 1st, 1922, at a new site (Ravensknowle) on the opposite side of the town.

The following stations have been given up during the year :—Cahir, Woking, Princetown, Sheepstor, Wokingham, and Midhurst.

The Director of the Glasgow Observatory discontinued his weekly and monthly returns to the Office as from April, 1921.

* The stations of the Army Meteorological Service, Shoeburyness and Larkhill, are counted with the Distributive Stations in the table.

The following observers to whom the Office is indebted for long series of observations have retired :— Mr. A. MacDonell, Shaftesbury ; Mr. John Ridges, Lisburn ; Mr. Delbridge, Over Court, Gloucestershire.

The deaths of Mr. P. C. Steventon, Observer at Torquay, and of Mr. J. Firth, Observer at Huddersfield, occurred during the year.

Climatology of the Globe.—Returns from a number of foreign and colonial stations have been examined and summarised month by month. Returns have been received for the first time during the year under review from Belize (British Honduras), St. John's (Antigua), Sandakan (British North Borneo), and from certain stations on the Gold Coast, Nigeria and Uganda. The supply of information from several other Gold Coast stations has been discontinued. Observations at Fanning Island have been recommenced under Commonwealth supervision.

A bibliography of climatological data, including several thousand entries, has been compiled in manuscript. A bibliography of upper air data is in hand.

Publications.—This division is responsible for the preparation of the climatology publications of the Office. Since 1911 these have been grouped under the title *The British Meteorological and Magnetic Year Book* but certain changes have been made as from the beginning of 1922. The general title *British Meteorological and Magnetic Year Book* will not now be used. *The Weekly* and *Monthly Weather Reports* and the *Réseau Mondial* are to be regarded as independent publications and an *Observatory Year Book* is to contain the records of the Eskdalemuir, Kew, Valencia and Aberdeen Observatories.

For economical reasons the publication of *Daily Readings at Stations of the First and Second Orders* is terminated, and the proposal to issue an annual volume containing summaries of observations in the Crown Colonies mentioned in last year's report has been postponed indefinitely.

The question of units for use in meteorological publications has been under consideration and from the begininng of 1922 the partial use of the "Absolute" scale of temperature in the *Weekly* and *Monthly Weather Reports* has been given up. In the wind summaries in the same publications miles per hour and metres per second are being tabulated in parallel columns.

In the *Geophysical Journal* for 1921 the tables giving the results of Pilot Balloon observations have been omitted, information of this character being available in the Upper Air Supplement of the *Daily Weather Report*.

During the year under review Parts I—III of the *British Meteorological and Magnetic Year Book* were kept up to date. Of Part IV, *Hourly Values from Autographic Records*, the 1917 volume was issued, 1918 was passed for press.

The *Réseau Mondial* tables for 1914 were issued. Those for 1915 were completed as far as possible, and those for 1916 begun.

Returns for the 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. Quarterly and annual summaries are also supplied. Information in like form is furnished quarterly to the Irish authorities.

Admiralty Pilots.—The handbooks issued by the Admiralty for the use of navigators are provided with climatological tables prepared in the Meteorological Office. The text of the meteorological portion of twelve *Pilots* was revised during the year and tables for 44 stations were prepared in the division. Tables for 57 other stations were received from Meteorological Services abroad and forwarded to the Hydrographer.

Special Investigations.—Many replies were received to a notice in the newspapers asking for details of observations of "ball lightning." A summary of these was published in the *Meteorological Magazine.*

The results of a similar inquiry as to the audibility in England of the great explosion at Oppau in Germany were negative.

A discussion by Mr. Brooks of the conditions producing drought in the British Isles was incorporated in a paper written by Mr. Brooks in collaboration with Mr. Glasspoole and read before the Royal Meteorological Society in February. It appears from this paper that by the study of the distribution of pressure over the northern hemisphere two or three months' warning of a coming drought may be feasible.

Among other memoranda prepared for aeronautical purposes may be mentioned a Chapter on Meteorology for the Royal Air Force Field Service Pocket Book.

Library.—The library was in the charge of Dr. H. Jeffreys until February 28th, when Captain H. W. L. Absalom took over the duties of librarian temporarily.

The exchange of publications with the Austrian Hydrographic Service was fully resumed in December and in August the exchange of publications with the Central Physical Observatory, Petrograd, was partially resumed. An exchange of publications has been established with Reale Osservatorio Marittimo Italiano, Naples.

The additions to the library during the past year include 316 new books and pamphlets. The number of periodicals received was about 200. 4,132 books were lent during the year.

The Author Card Catalogue has been kept up to date. The Subject Card Catalogue has been kept up to date so far as books added to the library during the year are concerned : owing to pressure of other work the preparation of the cards for books received before 1905 has not progressed much beyond the stage reported last year ; the work has now been carried as far as "Rowell."

The preparation of the shelf catalogue has been continued ; 35 shelves have been numbered and catalogued, 65 shelves have been partially done.

Dr. Chree's report on Terrestrial Magnetism in connection with the British Antarctic Expedition 1910-1913 was presented by the Committee of the Captain Scott Antarctic Fund. Several volumes containing the results of the scientific work of Sir Douglas Mawson's Australasian Antarctic Expedition 1911-14, were also presented.

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

Milankovitch, M.	*Théorie Mathématique des Phénomènes thermiques produits par la radiation solaire.*
Spitaler, R.	*Das Klima des Eiszeitalters.*
Salter, M. de C. S.	*The Rainfall of the British Isles.*

Berlin Preuss Meteor, Inst. *Klima Atlas von Deutschland*
Bibliotheca Chemico Mathematica. Vols. I & II.
Berget, Alphonse. *Où en est la Météorologie?*

Among those acquired by purchase are :—

Smith, J. Warren	*Agricultural Meteorology.*
Stenhouse, E.	*Simple Lessons on the Weather*
Jenkins, J. T.	*A Text Book of Oceanography.*
Davison, C.	*Manual of Seismology.*
Clarke, G. A.	*Clouds.*
Ramsay, W.	*Gases of the Atmosphere.*
Milham, W. I.	*Meteorology.*
Mead, D. W.	*Hydrology.*
Richardson, L. F.	*Weather Prediction by Numerical Process.*

Inquiries.—The inquiries dealt with during the year were 1,041 (exclusive of those dealt with by the forecast service) of which 757 were by letter and 284 personal. These figures compare with a total of 964 for the previous year, of which 742 were by letter and 222 personal. Those requiring information for legal purposes numbered 140 as against 211 in 1920–21. 553 requisitions for Office publications were dealt with.

INSTRUMENTS DIVISION.

General.—The work of this division has been continued on the general lines of the preceding year. The work connected with the sub-editing of publications and forms was transferred to other divisions of the Office as from October, 1921.

Store Accounts.—The number of Store Accounts now kept, each of which details the equipment on charge and accounted for by the Office at a single station or on board a ship, is 704. Each store account has been verified on inspection or by correspondence with the custodian during the course of the year, and all discrepancies revealed have been investigated and disposed of in consultation with the relative accounts branch of the Air Ministry when necessary.

Store Audit and Stocktaking.—Air Ministry auditors visited the Division from 13th to 17th June and on 28th November, 1921, to audit the Store Accounts from December, 1920 to September, 1921. Stock was taken of the instruments, etc., held at the central store at South Kensington as on 30th September, 1921, and 31st March, 1922, and compared with the ledgers.

Surplus Stores.—Further sales of surplus stores have been made during the year to foreign meteorological services as well as to those of the dominions and Colonies. The total amount realised by sale during the year was more than £6,000.

Demands.—The total number of demands dealt with during the year was 1,970.

Supply of Equipment to Official Stations.—The equipment at Official Stations has been maintained in serviceable condition. Among the more noteworthy issues may be mentioned the following:—

Middle East Area, R.A.F. Large consignments of standard instruments have been forwarded to Egypt for the establishment of meteorological stations in Egypt, Palestine, Iraq and Persia in connexion with the Air Route to India.

Anemometers. A new recording anemometer has been erected at Spurn Head to take the place of an instrument which had been put out of action by the blown sand which is a remarkable feature at Spurn Head. Special precautions against the ingress of sand were taken in constructing the new concrete hut which has been erected to accommodate the recording portion of the instrument.

New recording anemometers are being erected at Croydon and Lympne Aerodromes in connexion with the London-Paris Air Route.

Special Supplies to Observatories and Local Centres.—As a result of the experiments by Mr. R. A. Watson Watt on the use of light filters for following the course of pilot balloons by means of theodolites (see *Professional Notes*, No. 16) a number of mounted filters have been obtained for issue to Observatories and Local Centres.

A number of "wall-heads" or fittings to be attached permanently to the tops of fixed masonry pillars for supporting theodolites have been obtained. These will be issued to Observatories and Local Centres as the necessary pillars are erected. They should save time in setting up theodolites and will also prevent the accidents to theodolites which occasionally arise with the use of wooden tripods.

A Piché evaporimeter has been sent to Valencia Observatory for comparison with the evaporation tank which has been erected there.

Assmann psychrometers for the accurate determination of the temperature of ventilated dry and wet-bulb thermometers have been issued to observatories.

A quantity of electrical and laboratory apparatus has been obtained for use at observatories.

The special cards which are used for receiving the records of "bright sunshine" in Campbell-Stokes sunshine recorders are now provided by H.M. Stationery Office. The quality of the card, which had of necessity been changed during the war from the standard card previously in use, has again been changed. Experiments were made which showed that no difference could be detected between records obtained from the three kinds of card: the experiments showed further that slight variations in colour were unimportant.

The supply of fuel to the Observatories and Local Centres has been placed upon a standard basis.

A rangefinder by Goerz with a 4-metre base has been received from the Inter-Allied Aeronautical Commission of Control. It is hoped that this instrument, when repaired, will be useful for the determination of the heights of clouds.

Tests of Rain-gauges and Rain Measures.—During the year 36 rain-gauges and 94 rain measures were tested in the Office for instrument makers on request, and certificates of accuracy issued. Fees are charged for these tests.

Exhibitions.—Publications and diagrams were displayed at the Royal Agricultural Show which was held at Derby in June, 1921, and a complete climatological station was set up temporarily and maintained throughout the show. Representatives of the Office attended to take the observations and to answer inquiries.

Instruments were exhibited on November 2nd, 1921 at the Soirée which was held at the new rooms of the Royal Meteorological Society at 49, Cromwell Road, South Kensington.

Various instruments for the measurement of humidity were shown at the Royal College of Science on November 25th, 1921, in connexion with a meeting of the Physical Society at which a discussion on hygrometry took place.

Loan of Instruments.—Among the loans which were made during the year may be mentioned that of a quantity of meteorological apparatus to the Shackleton-Rowett Expedition to the South Seas in the ss. *Quest*, by means of which observations in the upper air as well as at the surface might be obtained.

ARMY SERVICES DIVISION.

The stations at Shoeburyness and Larkhill have been maintained. At the former station the experiments with a kite balloon have been continued, and some results of value obtained. Unfortunately the kite balloon was destroyed by lightning during the last week of March. The experiments will be continued with a new balloon whose construction has been completed at South Farnborough.

At Larkhill, pilot balloon observations have been carried out regularly with a view to supplying meteorological information to the School of Artillery. The Meteorologist-in-Charge has given lectures on the application of Meteorology to Gunnery, to the officers undergoing training at the School.

From April to September, 1921, a technical assistant was stationed at each of the Artillery practice camps at Buddon Ness, and Glen Imaal.

Three technical assistants have been loaned to the War Office Experimental Station (Chemical Warfare), Porton, for which station professional staff has been seconded from the Meteorological Office.

During the year the Superintendent has attended a number of meetings of the Chemical Warfare Committee. In addition a Meteorology Sub-Committee of the Chemical Warfare Committee, with the Superintendent of Army Services as Chairman, has been formed to advise on the meteorological work at Porton.

LOCAL CENTRES DIVISION.

General.—The functions of the Local Centres are as follows :—

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

b. To collect 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.

Stations have been in operation at the following places :—

CIVIL AVIATION AERODROMES.

Croydon	throughout the year
Lympne	,, ,, ,,
Renfrew	,, ,, ,,
Pulham (Airship Station)	,, ,, ,,
Manchester	to 20th October, 1921

ROYAL AIR FORCE ESTABLISHMENTS.

Cadet College, Cranwell	throughout the year
School of Aerial Navigation and Naval Co-operation, Calshot	,, ,, ,,
Royal Aircraft Establishment, South Farnborough	,, ,, ,,
No. 11 (Irish Group) Baldonnell	,, ,, ,,
Seaplane Station, Felixstowe	,, ,, ,,
Instrument Design Establishment, Biggin Hill	,, ,, ,,
Seaplane Station, Cattewater	,, ,, ,,
Marine and Armament Experimental Station, Isle of Grain	,, ,, ,,
Airship Base, Howden	to 22nd Dec., 1921.
No. 5 Flying Training School, Shotwick	since 24th Oct., 1921.
Royal Air Force Base, Leuchars	since 2nd Sept., 1921.
Royal Air Force, Andover	since 2nd Jan., 1922.

Unattached.

The Observatory, Falmouth	to 31st Dec., 1921.
Experimental Anemometrical Station, Holyhead	throughout the year.

Auxiliary Reporting Stations.

Goswick	to 30th Nov., 1921.
Flamborough Head	throughout the year.
Beachy Head	,, ,, ,,
Hythe	,, ,, ,,
Dungeness	,, ,, ,,

Most of these stations, being largely concerned with work of a distributive or advisory nature have been in charge of a professional meteorologist, assisted by technical staff. One or two have been manned by technical staff only. Those in the last list have no Meteorological Office staff but are Coastguard Stations or Lighthouses from which abbreviated reports are received by arrangement with the Admiralty or with Trinity House respectively. Further accounts of the nature and work of individual stations are given below.

South-East England.—An Assistant Superintendent, stationed at Headquarters, has been directly responsible for the preparation and issue of reports and forecasts in connection with flying to and from stations in south-east England. Whilst the general organization of this section has undergone little change, the system of special reports for the air routes between London and the Continent has been improved in detail from time to time.

In particular :—

(a) On the 14th July, 1921, an improved system of ground signals (as set out in *Notice to Airmen*, No. 57 of 1921) came into use at Lympne. The signals indicate to homeward bound machines the height of the lowest clouds, the visibility and the weather at Biggin Hill and Croydon.

(b) From 13th February, 1922, this system was extended by the addition—for the benefit of machines about to cross the Channel—of signals relating to conditions at St. Inglevert on the other side (*Notice to Airmen*, No. 18 of 1922).

(c) The new code adopted by the International Commission for Weather Telegraphy (London, September, 1921) was brought into use in this country and in Belgium as from 1st January, 1922, in Holland as from 2nd January, 1922, and in France as from 26th March, 1922.

The complete scheme of reports as now in operation is set out in Meteorological Office Publication 252 under the heading "Hourly Reports" pp. 10-12 and later amendments. Briefly it consists in the issue daily, Sundays included, of collective reports each hour from 7h 35m G.M.T. to 16h 35m G.M.T., the reports relating to the existing weather conditions 35 minutes earlier at Croydon, Lympne, Biggin Hill, Beachy Head, Dungeness and Botley Hill (North Downs); forecasts and information regarding the upper wind are included at certain hours. Similar issues are made by International agreement in France, Belgium and Holland. Arrangements have been made for the extension of the system in the coming summer to the early hours of the morning to provide for the earlier flying services between London and Paris.

The whole of the available information has been displayed regularly at Croydon and Lympne, as well as at the Air Ministry and advice has been given by the Meteorologists-in-Charge to pilots and others making inquiry. The number of such inquiries made personally at Croydon rose during the winter to about 200 per month. For the better display of route reports a large blackboard was erected at Croydon in October, 1921. A lightning recorder of the latest type was also installed there on the 16th September. Reports of observations made with this instrument are made daily to Headquarters and weekly to the Radio Research Board Station, Aldershot. Several trials have also been made at Croydon with an experimental instrument designed by Mr. W. H. Dines for measuring the height of fogs.

Other Districts.—A special feature of the work at Baldonnell has been the collection of the necessary information and the issue of reports and forecasts in connection with the flight of machines between England and Ireland and also with the military Aerial Mail Services in Ireland. With the changed political situation in Ireland, this work has practically ceased, and it is anticipated that the meteorological station will shortly be closed.

South-East England.—An Assistant Superintendent, stationed at Headquarters, has been directly responsible for the preparation and issue of reports and forecasts in connection with flying to and from stations in south-east England. Whilst the general organization of this section has undergone little change, the system of special reports for the air routes between London and the Continent has been improved in detail from time to time.

In particular:—

(a) On the 14th July, 1921, an improved system of ground signals (as set out in *Notice to Airmen*, No. 57 of 1921) came into use at Lympne. The signals indicate to homeward bound machines the height of the lowest clouds, the visibility and the weather at Biggin Hill and Croydon.

(b) From 13th February, 1922, this system was extended by the addition—for the benefit of machines about to cross the Channel—of signals relating to conditions at St. Inglevert on the other side (*Notice to Airmen*, No. 18 of 1922).

(c) The new code adopted by the International Commission for Weather Telegraphy (London, September, 1921) was brought into use in this country and in Belguim as from 1st January, 1922, in Holland as from 2nd January, 1922, and in France as from 26th March, 1922.

The complete scheme of reports as now in operation is set out in Meteorological Office Publication 252 under the heading "Hourly Reports" pp. 10-12 and later amendments. Briefly it consists in the issue daily, Sundays included, of collective reports each hour from 7h 35m G.M.T. to 16h 35m G.M.T., the reports relating to the existing weather conditions 35 minutes earlier at Croydon, Lympne, Biggin Hill, Beachy Head, Dungeness and Botley Hill (North Downs); forecasts and information regarding the upper wind are included at certain hours. Similar issues are made by International agreement in France, Belgium and Holland. Arrangements have been made for the extension of the system in the coming summer to the early hours of the morning to provide for the earlier flying services between London and Paris.

The whole of the available information has been displayed regularly at Croydon and Lympne, as well as at the Air Ministry and advice has been given by the Meteorologists-in-Charge to pilots and others making inquiry. The number of such inquiries made personally at Croydon rose during the winter to about 200 per month. For the better display of route reports a large blackboard was erected at Croydon in October, 1921. A lightning recorder of the latest type was also installed there on the 16th September. Reports of observations made with this instrument are made daily to Headquarters and weekly to the Radio Research Board Station, Aldershot. Several trials have also been made at Croydon with an experimental instrument designed by Mr. W. H. Dines for measuring the height of fogs.

Other Districts.—A special feature of the work at Baldonnell has been the collection of the necessary information and the issue of reports and forecasts in connection with the flight of machines between England and Ireland and also with the military Aerial Mail Services in Ireland. With the changed political situation in Ireland, this work has practically ceased, and it is anticipated that the meteorological station will shortly be closed.

At Cranwell regular courses in Meteorology at the Cadet College have been continued by the Meteorologist-in-Charge; he has also acted as examiner. Many additional open lectures have been given in the college and at schools and institutions in the county. A class-book entitled *A Short Course in Elementary Meteorology* has been completed and published.

At Calshot lectures have been continued to officers attending the courses in Aerial Navigation and Naval Co-operation and examinations have been conducted in Meteorology. As far as possible, also, airmen applying for classification as meteorologist-airmen have been tested at this station.

Whilst Civil Aviation has made few demands on the station at Renfrew, its staff has been very fully occupied in other local distributive work. The *Local Daily Weather Report* (M.O.2375) issued by this station has a circulation of over 40 copies daily in Glasgow and neighbourhood—being distributed to the principal public libraries, railway stations and engineering departments, Harbour, University, &c.

The stations at Howden and Pulham have been associated with airship work. At Pulham special arrangements were made for obtaining data in connection with experiments in mooring airships. In the early summer of 1921 all meteorological arrangements were made for the proposed flight of the Airship R.38 from Howden to America. Advice had also been given by one of the professional staff during the initial trials at Bedford and he had proceeded in the ship to Howden; but no member of the staff was on board on the occasion of the final disaster. The station at Howden was closed on 22nd December, 1921, and that at Pulham on 31st March, 1922.

The development of civil aviation not having been such as to justify the continuance of the station at Manchester it was closed on 20th October, 1921; the personnel and instruments were transferred to a new station at Shotwick which is attached to No. 5 Flying Training School, Royal Air Force. Between Shotwick and Baldonnell, with Holyhead as an intermediate observing station, interchange of meteorological information has taken place from time to time for the benefit of machines flying between England and Ireland.

In consequence of changes in the requirements of the Royal Air Force, the station at Felixstowe was closed on 31st March, 1922, and the station at Cattewater was reduced during the year.

A new station was opened on 2nd September, 1921, at Leuchars, being attached to the Royal Air Force Base there.

A new station attached to the Royal Air Force (Staff College and School of Air Pilotage) was also opened on 2nd January, 1922, at Andover.

The previously existing stations at Falmouth, Farnborough and Holyhead were added to the Division. It was reluctantly decided that the Office could not continue after 1921 to maintain the Falmouth Observatory (which had been in operation since 1867), and as from 31st December, 1921, the Office therefore ceased to be responsible for its upkeep. Telegraphic reports from that district are, however, necessary, and arrangements were made with the Admiralty for these to be made by the Coastguard at Pendennis Castle. The Royal Cornwall Polytechnic Society, with local assistance, is endeavouring to maintain the Observatory, which now reports as a voluntary station.

At Cranwell regular courses in Meteorology at the Cadet College have been continued by the Meteorologist-in-Charge; he has also acted as examiner. Many additional open lectures have been given in the college and at schools and institutions in the county. A class-book entitled *A Short Course in Elementary Meteorology* has been completed and published.

At Calshot lectures have been continued to officers attending the courses in Aerial Navigation and Naval Co-operation and examinations have been conducted in Meteorology. As far as possible, also, airmen applying for classification as meteorologist-airmen have been tested at this station.

Whilst Civil Aviation has made few demands on the station at Renfrew, its staff has been very fully occupied in other local distributive work. The *Local Daily Weather Report* (M.O.2375) issued by this station has a circulation of over 40 copies daily in Glasgow and neighbourhood—being distributed to the principal public libraries, railway stations and engineering departments, Harbour, University, &c.

The stations at Howden and Pulham have been associated with airship work. At Pulham special arrangements were made for obtaining data in connection with experiments in mooring airships. In the early summer of 1921 all meteorological arrangements were made for the proposed flight of the Airship R.38 from Howden to America. Advice had also been given by one of the professional staff during the initial trials at Bedford and he had proceeded in the ship to Howden; but no member of the staff was on board on the occasion of the final disaster. The station at Howden was closed on 22nd December, 1921, and that at Pulham on 31st March, 1922.

The development of civil aviation not having been such as to justify the continuance of the station at Manchester it was closed on 20th October, 1921; the personnel and instruments were transferred to a new station at Shotwick which is attached to No. 5 Flying Training School, Royal Air Force. Between Shotwick and Baldonnell, with Holyhead as an intermediate observing station, interchange of meteorological information has taken place from time to time for the benefit of machines flying between England and Ireland.

In consequence of changes in the requirements of the Royal Air Force, the station at Felixstowe was closed on 31st March, 1922, and the station at Cattewater was reduced during the year.

A new station was opened on 2nd September, 1921, at Leuchars, being attached to the Royal Air Force Base there.

A new station attached to the Royal Air Force (Staff College and School of Air Pilotage) was also opened on 2nd January, 1922, at Andover.

The previously existing stations at Falmouth, Farnborough and Holyhead were added to the Division. It was reluctantly decided that the Office could not continue after 1921 to maintain the Falmouth Observatory (which had been in operation since 1867), and as from 31st December, 1921, the Office therefore ceased to be responsible for its upkeep. Telegraphic reports from that district are, however, necessary, and arrangements were made with the Admiralty for these to be made by the Coastguard at Pendennis Castle. The Royal Cornwall Polytechnic Society, with local assistance, is endeavouring to maintain the Observatory, which now reports as a voluntary station.

At Farnborough the researches in connection with atmospheric electrical disturbances were taken over by the Radio Research Board, the Office being now responsible only for the purely meteorological work for which the station was originally established in 1911 at the request of the Army Council. In particular, investigations on the subject of up and down currents in the atmosphere have been pursued; also investigations on the feasibility of obtaining very high pilot balloon ascents by having the balloon released from an aeroplane at a height of some five kilometres vertically above the observing station. So far, practical difficulties connected with this latter investigation have not been overcome.

Holyhead was established in 1862 as an experimental anemometrical station. The Harbour Engineer was formerly responsible to the Office for its management, but it is now in charge of Meteorological Office personnel. An anemobiagraph has been erected for comparison with the other types of anemometer there, and pilot balloon ascents are now made twice daily.

Upper Air Observations.—The total number of single-theodolite ascents made at the stations during the year was 8,950.

The number of flights made by pilots of the Royal Air Force for the determination of upper air temperature and humidity was 456, mostly to heights of 10,000 to 16,000 feet. Most of these were made at Baldonnell, Andover and Leuchars by pilots detailed specially for this work. The remainder were made at Farnborough and Grain. The observations at Baldonnell came to an end in January, 1922. Those at Leuchars commenced in October, 1921.

The number of kite ascents made at Pulham for the same purpose was 57.

By May, 1921, Besson Comb Nephoscopes had been erected at most stations and observations by them made part of the regular routine.

Miscellaneous.—In April, 1921, arrangements were made by the Controller of Communications, Air Ministry, for the more extensive use of wireless telegraphy in the collection of reports from Local Centres to Headquarters.

A large number of visitors from the Meteorological and Aviation Departments of foreign countries have visited the Division, being mostly interested in the question of weather services for aerial routes.

Special magnetic observations were made at Lympne, Calshot, Howden, and Holyhead at the time of the solar eclipse of the 8th April, 1921.

A syllabus of examination in Meteorology for civilian air pilots was prepared in June, 1921.

For a few days at the beginning of April, 1921, a station was maintained on a temporary basis at Inchinnan in connection with the trials of the Airship R. 36.

Similarly, the old Bedford station was opened from 14th to 19th August, 1921, for the flight of the Airship R. 33 from Pulham to Bedford.

From 14th to 21st February, 1921, a meteorologist was attached to a Squadron at Bircham Newton to give instruction in a method of measuring upper wind for a special purpose. A Hill's mirror being employed on the ground, an aeroplane at heights for which data were required emitted smoke clouds by means of a special device. From observations of the motion of these clouds the wind was calculated.

In the early summer of 1921, a Professional Assistant was specially detailed to collate all available meteorological information and to work out all arrangements that would require to be made in the event of airship flights taking place from England to Egypt. This was duly completed.

Inquiries.—A complete record has not been kept at all stations of the number of inquiries in person or by telephone for information additional to that contained in the regular *Local Daily Weather Reports* (M.O. Form 2375) or *Aerial Route Reports* (M.O. Form 2322). The recorded numbers, however, amount to 2,631 for the year; it is estimated that the actual total number dealt with would be about one thousand more.

In the great majority of these the advice was wanted in connection with aviation. Agricultural and Press inquiries came next in frequency. The remaining inquiries were for meteorological information or advice in connection with a wide variety of purposes, as, for instance, railway goods traffic arrangements, launching or towing of vessels, harbour extension works, boom defence experiments, cinematograph films, medical researches, herring fishing, &c.

Buildings.—The new meteorological hut at Croydon was completed in June, 1921.

A second wooden hut was erected at Calshot to supplement the previously existing accommodation.

The new hut at Holyhead was completed in November, 1921.

Slight structural alterations were made in the Office at Lympne.

Staff.—Considerable difficulty has been experienced by the staffs in finding reasonable housing accommodation at certain aerodromes in isolated districts. In some cases service quarters have been provided, but, as a rule, these are available only for single men, and the allocation of personnel to stations has occasionally had to be governed by this consideration.

Changes of staff between different stations have again been numerous. Towards the close of the year in particular considerable re-arrangements have been necessary in consequence of the extension of flying hours on the London-Continental air routes.

BRITISH RAINFALL ORGANIZATION.

Changes in Procedure.—The merging of the routine work of the British Rainfall Organization into the general scheme of the Meteorological Office has been practically completed during the year ended March 31st, 1922. It is now possible to state definitely that the incorporation of the voluntary system of rainfall observing into the official organization has been successfully carried out.

The Headquarters of the Organization were transferred on March 20th, 1922, from 62, Camden Square, N.W.1., to Exhibition Road, S.W.7, and much of the re-organization has naturally centred round the change of premises.

The method of dealing with the correspondence of the Division has been brought into line with Air Ministry practice; and the accounting system, after being remodelled in April, 1921, has now been taken over entirely by the Finance Department of the Ministry. The

practice of accepting subscriptions over and above the cost of publications from Observers and others interested in the Rainfall work has been discontinued.

The sale of publications has been transferred to H.M. Stationery Office, and the issue of official copies to the Publications Department of the Air Ministry. All stocks hitherto held by the Division have been taken over by these Departments. The Superintendent continues to carry on all communications with the rainfall Observers.

On the removal to South Kensington the library at Camden Square was amalgamated with the Meteorological Office library, surplus volumes being distributed to various out-stations. This work was largely carried out by the library staff. At the same time a considerable amount of miscellaneous meteorological records, hithereto housed by the British Rainfall Organization, was passed to the appropriate Divisions of the Office.

A scheme has been drawn up, in consultation with the Superintendent of the Meteorological Office, Edinburgh, for the transfer of the work of collecting and checking rainfall returns for Scottish stations to Edinburgh, the Superintendent of the British Rainfall Organization retaining full responsibility.

This scheme comes into effective operation in respect of the returns for 1922; and those for 1921, sent in at the end of that year, although collected in Edinburgh, were checked in London. It is hoped that the new arrangement will enable a greater amount of personal attention to be devoted to the encouragement of rainfall observing in Scotland. This is highly desirable on account of the peculiar physical problems which the rainfall of Scotland presents, and in view of the increased attention which is now being given to hydro-electric development in Scotland, for which purpose a knowledge of local rainfall is essential.

Observations and Stations.—On the transfer of the Organization to South Kensington the Superintendent took an active part in an unofficial capacity in securing the continuation of the series of meteorological observations at Camden Square, commenced in 1858 by the late Mr. G. J. Symons, F.R.S. In this connection a comparison of the rainfall and temperature records at Camden Square, Greenwich, and Kew was carried out. Sanction has been given for the loan of the instruments, and the Royal Meteorological Society has accepted responsibility for the future upkeep of the observations. It is believed that the arrangements now made will result in the station being put on a practically permanent basis. The observations have been slightly modified, and the old Glaisher thermometer screen has been replaced by a Stevenson screen.

The number of rainfall observers reporting to the Organization in 1921 showed an increase over the previous year for the first time since the commencement of the War, and there is reason to think that a normal growth in the observing staff has now been resumed. The very unusual meteorological conditions prevailing in 1921, especially in the south-east of England, where the drought was unprecedently severe, have resulted in the Organization getting into touch with a number of new observers and others who had not hitherto sent returns.

The improvement in the distribution of stations has been maintained. In particular, the erection of several groups of mountain gauges in central Scotland supplies a long felt want.

practice of accepting subscriptions over and above the cost of publications from Observers and others interested in the Rainfall work has been discontinued.

The sale of publications has been transferred to H.M. Stationery Office, and the issue of official copies to the Publications Department of the Air Ministry. All stocks hitherto held by the Division have been taken over by these Departments. The Superintendent continues to carry on all communications with the rainfall Observers.

On the removal to South Kensington the library at Camden Square was amalgamated with the Meteorological Office library, surplus volumes being distributed to various out-stations. This work was largely carried out by the library staff. At the same time a considerable amount of miscellaneous meteorological records, hithereto housed by the British Rainfall Organization, was passed to the appropriate Divisions of the Office.

A scheme has been drawn up, in consultation with the Superintendent of the Meteorological Office, Edinburgh, for the transfer of the work of collecting and checking rainfall returns for Scottish stations to Edinburgh, the Superintendent of the British Rainfall Organization retaining full responsibility.

This scheme comes into effective operation in respect of the returns for 1922; and those for 1921, sent in at the end of that year, although collected in Edinburgh, were checked in London. It is hoped that the new arrangement will enable a greater amount of personal attention to be devoted to the encouragement of rainfall observing in Scotland. This is highly desirable on account of the peculiar physical problems which the rainfall of Scotland presents, and in view of the increased attention which is now being given to hydro-electric development in Scotland, for which purpose a knowledge of local rainfall is essential.

Observations and Stations.—On the transfer of the Organization to South Kensington the Superintendent took an active part in an unofficial capacity in securing the continuation of the series of meteorological observations at Camden Square, commenced in 1858 by the late Mr. G. J. Symons, F.R.S. In this connection a comparison of the rainfall and temperature records at Camden Square, Greenwich, and Kew was carried out. Sanction has been given for the loan of the instruments, and the Royal Meteorological Society has accepted responsibility for the future upkeep of the observations. It is believed that the arrangements now made will result in the station being put on a practically permanent basis. The observations have been slightly modified, and the old Glaisher thermometer screen has been replaced by a Stevenson screen.

The number of rainfall observers reporting to the Organization in 1921 showed an increase over the previous year for the first time since the commencement of the War, and there is reason to think that a normal growth in the observing staff has now been resumed. The very unusual meteorological conditions prevailing in 1921, especially in the south-east of England, where the drought was unprecedently severe, have resulted in the Organization getting into touch with a number of new observers and others who had not hitherto sent returns.

The improvement in the distribution of stations has been maintained. In particular, the erection of several groups of mountain gauges in central Scotland supplies a long felt want.

The number of rainfall stations inspected during the year by the staff of the Organization was 134, in addition to 24 sites for rain-gauges. The most important work is this connection was done in Perthshire, Inverness-shire, Radnorshire and Montgomeryshire, where considerable improvements in the exposure of mountain and moorland gauges were effected. Practically all the stations in Guernsey were also visited. Special reports on inspections were supplied to the Corporations of Birmingham and Liverpool and to the Metropolitan Water Board. A note-book and revised instructions, together with appropriate equipment, have been designed for the use of inspectors.

The number of rain-gauges on loan during the year was 42. Several defective gauges were replaced. A mountain gauge was established on Lank Rigg in Cumberland at an elevation of 1,750 feet.

Tests were carried out at Camden Square of two new patterns of self-recording rain-gauge, and also of a recently designed rainfall rate recorder.

State of Work.—*British Rainfall*, 1920, was published on 7th December, 1921. The statistical material included :—

Records of	Percolation	at	8 stations
,,	,, Evaporation	,,	13 ,,
,,	,, Monthly Rainfall	,,	395 ,,
,,	,, Annual Rainfall (Total Fall)	,,	4,952 ,,

The 4,952 records in the General Tables were made up as follows :

	Records.	Change from 1919.
England	3,460 ..	+41
Wales and Islands ..	453 ..	+17
Scotland	758 ..	− 8
Ireland	281 ..	+ 4
British Isles	4,952 ..	+54

The Obituary List contained the names of 77 Observers.

Reprints of Part III of *British Rainfall*, 1920, were issued gratis to 645 Observers in January, 1922.

The whole of the records of Rainfall, Duration of Rainfall, Evaporation and Percolation for 1920 were entered in the permanent registers, a new series of decennial sheets being opened.

The preliminary work on the compilation of *British Rainfall*, 1921, has been somewhat hampered by the necessity of withdrawing part of the time of the staff for duties in connection with the change of premises. The checking of about 4,200 returns, received in response to the application sent out at the end of December, was completed with some difficulty about one month later than the normal date. The first six sub-sections of the annual volume were prepared for printing by the end of March.

The issue of the *Meteorological Magazine* was continued regularly in collaboration with the Climatology Division.

Special Work.—Considerable attention has been given during the year to the standardization of rainfall records. In this connection specifications of the standard rain-gauge were drawn up and published in the *Meteorological Magazine* (July, 1921) and in *British Rainfall*, 1920. It has been decided to discontinue accepting advertisements of unapproved instruments for the official publications in charge of the Division.

The number of rainfall stations inspected during the year by the staff of the Organization was 134, in addition to 24 sites for rain-gauges. The most important work is this connection was done in Perthshire, Inverness-shire, Radnorshire and Montgomeryshire, where considerable improvements in the exposure of mountain and moorland gauges were effected. Practically all the stations in Guernsey were also visited. Special reports on inspections were supplied to the Corporations of Birmingham and Liverpool and to the Metropolitan Water Board. A note-book and revised instructions, together with appropriate equipment, have been designed for the use of inspectors.

The number of rain-gauges on loan during the year was 42. Several defective gauges were replaced. A mountain gauge was established on Lank Rigg in Cumberland at an elevation of 1,750 feet.

Tests were carried out at Camden Square of two new patterns of self-recording rain-gauge, and also of a recently designed rainfall rate recorder.

State of Work.—*British Rainfall*, 1920, was published on 7th December, 1921. The statistical material included :—

Records of	Percolation	at	8 stations
,,	,, Evaporation	,,	13 ,,
,,	,, Monthly Rainfall	,,	395 ,,
,,	,, Annual Rainfall (Total Fall)	,,	4,952 ,,

The 4,952 records in the General Tables were made up as follows :

	Records.	Change from 1919.
England	3,460 ..	+41
Wales and Islands ..	453 ..	+17
Scotland	758 ..	− 8
Ireland	281 ..	+ 4
British Isles	4,952 ..	+54

The Obituary List contained the names of 77 Observers.

Reprints of Part III of *British Rainfall*, 1920, were issued gratis to 645 Observers in January, 1922.

The whole of the records of Rainfall, Duration of Rainfall, Evaporation and Percolation for 1920 were entered in the permanent registers, a new series of decennial sheets being opened.

The preliminary work on the compilation of *British Rainfall*, 1921, has been somewhat hampered by the necessity of withdrawing part of the time of the staff for duties in connection with the change of premises. The checking of about 4,200 returns, received in response to the application sent out at the end of December, was completed with some difficulty about one month later than the normal date. The first six sub-sections of the annual volume were prepared for printing by the end of March.

The issue of the *Meteorological Magazine* was continued regularly in collaboration with the Climatology Division.

Special Work.—Considerable attention has been given during the year to the standardization of rainfall records. In this connection specifications of the standard rain-gauge were drawn up and published in the *Meteorological Magazine* (July, 1921) and in *British Rainfall*, 1920. It has been decided to discontinue accepting advertisements of unapproved instruments for the official publications in charge of the Division.

A standardized method of measuring rainfall duration has been introduced and is being brought into general use in 1922.

The standardization of rain-gauge tests has been discussed with the National Physical Laboratory and a uniform practice introduced.

An experimental design for an improved Nipher rain-gauge shield has been made and observations have been commenced at Eskdalemuir.

In connection with the anticipated demand for the completion of the Rainfall Survey Map of the British Isles, emphasized in the Final Report of the Water Power Resources Committee of the Board of Trade, an investigation has been commenced into the variation of the 35 years' annual average rainfall in the British Isles. This investigation is not yet complete.

The work of preparing a new section of the *Book of Normals of Meteorological Elements for the British Isles*, incorporating the monthly average rainfall data for about 600 stations, has been commenced.

The Superintendent has given expert advice in connection with rainfall to the Promoters of the Grampians Hydro-electric Scheme, to the Corporations of Birmingham and Birkenhead, the Padiham Urban District Council, Sir Armstrong Whitworth & Co. (Water-power schemes in Scotland and elsewhere), and the Metropolitan Water Board. He attended before the Local Legislation Committee of the House of Commons in connection with the Padiham Urban District Council Bill of 1922.

A memorandum on the professional work of the Organization was prepared, and the first meeting of a special committee for the purpose of drawing up a revised scheme in connection with this work was held on March 13th.

Inquiries.—The number of inquiries by the public for rainfall data and similar information has been exceptionally large.

Maps of the distribution of average rainfall for Scotland were supplied to the Scottish Board of Health and to Captain W. N. McClean, and maps for certain other localities to the Don Valley River's Board the Forestry Commission, Messrs Martin and Fenwick, C.E., Mr. M. Kellow, Mr. J. Phillips and Miss G. Dear. Data were supplied for research purposes to the National Institute of Medical Research, the Marine Biological Association and numerous others.

Arrangements were made for the supply of supplementary statistics of rainfall to the Registrar-General of England and Wales.

Exhibits were prepared for the Royal Agricultural Society's Show at Derby and the soirée of the Royal Meteorological Society on November 2nd, 1921.

ADVISORY COMMITTEE ON ATMOSPHERIC POLLUTION.

The investigation of atmospheric pollution has been continued under the direction of the Advisory Committee on Atmospheric Pollution, of which Sir Napier Shaw is chairman and Dr. J. S. Owens honorary secretary. Three additions have been made to the Committee, making the list of members as given on page 5.

The work of collection, tabulation and classification of monthly analyses of rain and other matter deposited in standard gauges at about 30 stations, in various parts of the country, has been continued on lines described in the Committee's Annual Reports, the Seventh of which has now been issued by H.M. Stationery Office.

A new form of standard gauge has been evolved, and several new stations are commencing work.

Seven automatic instruments, by which continuous records of suspended impurity in the atmosphere are obtained, have been in operation in different localities, and from the classified records of four stations curves have been prepared from which deductions have been made as to the source of the impurities.

Other experimental work has been carried out on the following lines :

(*a*) Microscopic examination of fog nuclei, with reference to size, rate of settlement, carriage by wind, nature of soluble salts contained, etc.

(*b*) Dust in expired air.

(*c*) Methods of measuring acidity of the air and salts in suspended material.

The microscopic work has largely been made possible by the portable instrument described in the *Proceedings of the Royal Society*, A, 101, 1922.

Ultra-microscopic counts of particles suspended in still air have also been made for comparison.

The acidity research has not been followed up completely owing to temporary lack of laboratory accommodation, but a well-equipped laboratory has now been placed at the disposal of the Committee.

Other work, including research upon the relationship between visibility and suspended matter, is in hand.

Exhibits have been prepared and shown at the Royal Society soirées and other exhibitions, and several papers dealing with the work have been read.

NAVAL SERVICES DIVISION.

The Superintendent took up duties on 11th April, 1921.

These duties have chiefly consisted in acting as Liaison Officer between the Meteorological Office and the Admiralty, mainly the Hydrographic Department and that of the Admiral Commanding Coast Guard and Reserves.

Numerous requests for special information have been received in this Division from the Admiralty, and arrangements have been made for the supply of the required information.

Thirty-three storm-warning stations on the east and south coasts of England have been visited and their positions fixed for insertion on the Admiralty Charts.

METEOROLOGICAL OFFICE, EDINBURGH.

Organization of Work.—Details were given in last year's *Annual Report* of the general plan of the work of the Office. The system was continued during the year now under report, with one important addition. From January, 1922, the work of collecting all rainfall measurements made in Scotland was transferred from the British Rainfall Organization to the Edinburgh Office. The number of stations contributing monthly statements of daily rainfall is at present 230. These are critically examined, checked, and summarised or extracted for the purpose of the *Monthly Weather Report*, the *Meteorological Magazine* and the Monthly Rainfall Map. In addition to monthly returns, annual returns will also have to be dealt with from about 530 stations. On the other hand a slight diminution in the volume of tabulation and computation has been effected by the retransfer to Eskdalemuir of the work of tabulation of meteorological hourly values.

The number of inquiries received during the year was 78, as compared with 52 in the previous year. Most of the inquiries related to marine insurance risks. One dealt with the speed of wind gusts in Edinburgh as bearing on the question of erecting unusually long span wires for electric tramways in the city. Library facilities and general assistance were given to two Forestry students, an irrigation engineer from India and to a cotton growing expert from the Soudan.

The tabulation of Eskdalemuir magnetic hourly values, and the heavy computing work involved therein, were kept well up to date during the year. Two years ago, owing to shortage of staff during the war, this work had fallen behind by 14 months. It is now only 9 months behind date, and it is expected that further progress will be made during the current year. During the visit of the British Association to Edinburgh in September, 1921, a demonstration was given in the Natural Philosophy Department of the University of the method of preparing weather maps and issuing forecasts, based on the synoptic wireless messages issued from different stations in Europe. A wireless receiving set was erected and a *Daily Weather Report* was prepared, duplicated, and exhibited at the different sectional meeting places and at various points in the city. The wireless telegraphy arrangements were supervised by Mr. D. Sinclair of the Communications Department, while Mr. M. A. Giblett was in charge of the *Daily Weather Report* and had the assistance of three members of the Edinburgh Office staff.

The Office co-operated in connection with an exhibition of diagrams, records, and photographs of meteorological and geophysical interest, promoted by the Royal Meteorological Society at a meeting held in Edinburgh on 6th September.

The Superintendent gave a short account of the new geophysical observatory at Lerwick to Section A of the British Association, and contributed a paper on the diurnal variation of pressure at Eskdalemuir Observatory (1911-1920).

Meteorological Stations.—The number of observing stations in Scotland at work during the year is shewn below :—

	Observatories.	Climatological Stations	Telegraphic Stations	Health Resorts
No. at beginning of year	2	56	7	4
No. closed during year	—	3	—	—
No. opened during year	1	—	1	—
No. at end of year	3	53	8	4

Lerwick Observatory.—The additional observatory opened during the year was that at Lerwick. Last year's report gave details of the preliminary steps which were taken towards the establishment of this Observatory, and these were so far advanced that the Observatory was opened on 7th June, 1921. Mr. J. Crichton, M.A, B.Sc., Senior Professional Assistant, was placed in charge, and two probationers and a caretaker appointed. The first instalment of the instrumental equipment arrived at the same time. Later on, the construction of a magnetograph house, and of huts for absolute magnetic and auroral observation, was undertaken, The latter were completed by the end of the year, but it will be several months yet before the thick concrete walls and roof of the magnetograph house can be thoroughly dried and instruments placed in position. A considerable amount of work was done during the year in preparing for the regular observational routine which, it is expected, will begin during the current year.

The instruments installed by the end of the year included barometers, barograph, hygrograph, Assmann's psychrometer, nephoscope, rain-gauge (ordinary and self-recording), sunshine recorder, thermometers, weekly and daily thermographs, electric anemometer, dip circle. The geographical co-ordinates of each instrument were determined with precision. A line of twin cable was laid in an approximately horizontal plane round Loch Trebister, in order to obtain a record of changes in the vertical component of terrestrial magnetic force. Meanwhile, meteorological observations were restricted to those at normal hours. Aurorae were observed and noted whenever visible. In October, 1921, Lord Rayleigh, F.R.S., visited the Observatory in order to make observations on the auroral spectrum line, and these have been continued systematically since.

Climatological Stations.—The reduction in number of the climatological stations was due to Kirkwall, Dalkeith, and Glasgow University stations having closed. The first station was closed on account of the death of the Rev. J. S. Begg. It is hoped, however, that it will be reopened during the current year. The second was not a station which, in any systematic re-distribution, would have been continued. The question of opening another station in Glasgow under municipal management was under discussion at the end of the year.

In last year's report reference was made to the condition, distribution, and general efficiency of the climatological stations in Scotland, and to the fact that proposals towards the introduction of an improved system had been submitted. Although no final decision was passed on these proposals, continued efforts were made during the year towards a better state of things. In three cases, it has been possible to effect or to pave the way for effecting very considerable improvement. These relate to the stations at Arbroath, North Berwick and Inverness. At Arbroath, the Town Council have taken over the responsibility for the maintenance of the station formerly in existence there, have established a new station with modern instrumental equipment, and have secured the services of an observer who has undergone a period of training at Eskdalemuir Observatory. At North Berwick, similar arrangements are now practically complete, and the observer is undergoing training at Aberdeen Observatory. At Inverness, the Town Council have also been induced to take action on similar lines and have agreed to open a well-equipped climatological station under municipal management. With these changes, the number of stations under municipal management has been raised to nine. It is intended during the current year to continue efforts in the same direction and to improve existing stations of this kind as far as possible.

Telegraphic Stations.—The telegraphic station maintained at Leith for many years was closed on 21st June, 1921, and in its place another station was opened on the island of Inchkeith. The new station has the advantage of providing a practically continuous watch on the weather, and is now sending telegraphic reports at 1h., 7h., 13h., and 18h., instead of the 7h., and 18h. reports from Leith.

Rainfall Stations.—The number of stations in Scotland from which rainfall measurements are now forwarded to the Edinburgh Office is approximately 750. The distribution of these stations leaves much to be desired, inasmuch as there are considerable areas for which information is very scanty. Proposals were made towards the end of the year towards the partial filling up of the largest of these, Rossshire and Sutherlandshire.

Inspection of Stations.—Twenty-five stations were inspected during the year.

Office Library.—The library consists chiefly of scientific serials, and there is a great mass of unbound material, much of it disposed of in tied-up parcels. A working catalogue is kept up to date, but until a considerable amount of binding can be done, and further shelving facilities provided, it will not be possible to have everything arranged for purposes of rapid reference. The more important publications are, however, readily accessible. About 750 items (bound volumes or parts of serial publications) were received from the library at 62, Camden Square, London. Many of these are being retained to supplement the library at Edinburgh. The remainder are available for Eskdalemuir or Lerwick.

Advisory Committee.—An Advisory Committee for the Meteorological Office, Edinburgh, was constituted; it held its first meeting on 4th November, 1921, in Edinburgh, the Director acting as chairman.

CENTRAL OBSERVATORY, KEW OBSERVATORY, RICHMOND, SURREY.

Instruments and Instrumental Comparisons.—A new tube was fitted to the photographic thermograph to serve as a wet bulb, the old wet bulb tube which had remained intact being converted into a dry bulb. The position of the water tank was shifted in the screen to suit the altered arrangements.

A new cord has been fitted to the "nilometer," the one previously in use having broken.

An Assmann psychrometer has been provided and a position prepared for its use conveniently adjacent to the thermograph screen.

A great deal of work has been done in connexion with the magnetograph intended for Shetland, including the trial of electric lamps. Much attention has also been given to Krogness magnetographs made by Mr. P. Adie, a variety of modifications having been suggested as the results of experience.

A magnetometer intended for Shetland has been supplied by the Cambridge and Paul Instrument Company, and a number of special observations have been made on it which have shown the necessity for various alterations.

A second comparison has been commenced between the standard Jones magnetometer and the new coil magnetometer designed by Sir Arthur Schuster and Mr. F. E. Smith. To this end special observations have been made with the Dover magnetometer No. 140 at the National Physical Laboratory by the Superintendent and Mr. E. Taylor, and a large number of observations with the Dover magnetometer have also been made at the Observatory. In view partly of this comparison, a redetermination is being made of the moment of inertia of the Jones collimator magnet; twelve complete sets of swings have already been made.

Three inertia bars purchased from the executors of the late Professor Watson, which Professor Watson had lent to Potsdam Observatory before the war, have now been received *viâ* De Bilt Observatory, where they had been swung. Intercomparison of these with the other inertia bars at the Observatory is contemplated.

The magnetic comparison by Messrs. de Azpiazu and Gil, referred to in last year's report, lasted over several weeks, and a very large number of curve measurements were necessary to supply the information required by those gentlemen after the comparison was completed. No information has yet been received as to the results of the comparison.

Eye Observations and Observational Data.—The ordinary eye readings of the meteorological instruments have been made daily as usual at the statutory hours, and reports have been made to the Office by telephone. Pilot balloons have been sent up under suitable weather conditions.

Regular cloud observations have been made with the Fineman nephoscope in connexion with the investigation of the upper air. On days of bright sunshine the Ångström pyrheliometer has been used to measure the intensity of solar radiation within half an hour of noon.

Observations of a series of distant objects have been made as in past years ; observations have also been made on more distant objects in accordance with the scale of visibility now recognised at the Office.

The magnetic elements, declination, inclination and horizontal force have been observed regularly with the Jones magnetometer and the Barrow dip circle, usually once a week.

Absolute observations have been made of potential gradient in the garden on most fine days, to standardize the electrograph. Observations of the air-earth electrical 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 two Ebert apparatus. The Wilson and Ebert observations have been taken on most fine afternoons between 14h.30m. and 15h.30m.

Reduction and Utilisation of the Photographic Records and Observations.—All the meteorological records obtained, except those from the float barograph, the microbarograph and the Callendar thermograph, have been tabulated for each hour. The tabulations during 1921 were transmitted weekly to the Office. Commencing with January, 1922, the further treatment of the records and the preparation of the results for press are intended to be done at the Observatory.

Tables of two-hourly mean values of magnetic declination have been prepared and sent weekly to the Geographical Section of the War Office, the Institution of Mining Engineers, the Secretary of the Institute of Mine Surveyors of Great Britain and to two Mining Journals. Information is supplied at the same time 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 extracted of the mean diurnal inequality from all days with the exception of the disturbed days of " character " 2. The most recent information on this point, with the corresponding information for the previous year, appears on the weekly sheet issued. Magnetic " character " figures after the international scale are assigned to each day, and the results are communicated every three months to De Bilt. The list for the first quarter of 1922 has been sent. Diurnal inequalities for magnetic declination and horizontal force from the international quiet days have been prepared for the first six months of 1921.

The electrograms from the Kelvin Water-dropper have been measured at 3h., 9h., 15h., and 21h. each day, and the daily electrical character has been assigned up to the end of February, 1922. The electrograms for the selected days—ten a month— have been measured to the end of 1921.

The seismograms have been studied up to the end of March, 1921. A list of earthquakes has been transmitted monthly to the Office, and also to Professor Turner at Oxford for the information of the British Association.

The water-level curves from the " nilometer " in the basement have been studied up to the end of February, 1922. Until the end of 1921 the results were sent monthly to the office.

Special Reports.—A comparison of magnetic declination changes at British Observatories made by the Superintendent has appeared as *Geophysical Memoir, No.* 17.

The discussion of the Antarctic observations of the last Scott Expedition, referred to in last year's Report, has appeared in a volume entitled *British Antarctic Expedition*, 1910-1913, *Terrestrial Magnetism*.

Two manuscripts have been prepared: one by the Superintendent, discussing magnetic and electrical observations made in connexion with the Solar Eclipse in April, 1921; the other by Mr. R. E. Watson, discussing solar radiation results observed with various pyrheliometers.

Verification Work.—Reference has already been made to the magnetographs of the Krogness pattern and the magnetic outfit for Shetland. In addition there has been a considerable amount of testing work done for instrument makers and others. A collimator magnet and magnetograph deflection magnets and other apparatus were tested for Mauritius Observatory, and a collimator magnet and inertia bar for Manila. Three complete unifilar magnetometers with their magnets have been tested, also two dip circles and twenty-one needles. Five prismatic compasses were tested for the Instruments Division of the Office.

Miscellaneous.—The Royal Society Shelton clock, long at the Observatory, has been selected for use at the new Shetland Observatory. The same remark applies to a chronometer (originally sidereal) which was originally intended for pendulum work in connexion with an Antarctic Expedition.

One of the dip circles originally intended for the Russian Meteorological Service, purchased by the Office during the war, has been sent to Shetland for the use of the Observatory.

ESKDALEMUIR OBSERVATORY.

Buildings, etc.—The felt roofing of the east absolute magnetic hut was renewed. The general condition of the underground magnet house was more satisfactory after the repairs referred to in last year's report. Slight leakage through the floor still occurs at one or two places. The water supply was again deficient during the drought of 1921. Gas supply was satisfactorily maintained during the year, but the generators required overhaul and renewal in parts. This was arranged for, but not actually completed before the end of the year. The drainage system was kept in order, but the tank outside the Observatory grounds requires overhaul and repair.

The buildings have been frequently inspected by Officers of the Works and Buildings Department, but beyond the two items mentioned, nothing has been done by way of repairs and maintenance during the year.

Terrestrial Magnetism.—This is the principal subject of work at the Observatory. It includes photographic registration of the three geographical components of terrestrial magnetic force, and the absolute observations of declination, horizontal force, and inclination which are used for the purpose of standardising the readings of the curves obtained photographically. The reduction of the readings so obtained in order to arrive at hourly values, the deduction of mean values, diurnal inequalities, and their expression in harmonic series, absolute daily ranges, hourly ranges, etc., has been carried out in the manner

detailed in last year's report. The arrangement by which the curves are read at Eskdalemuir and the remainder of the computing is done in the Edinburgh Office was continued and worked satisfactorily. The delay in publication of results occasioned by the war was further reduced by about four months during the year, by the end of which the 1920 results had been completed. A beginning has been made at the somewhat heavy reduction of all magnetic results since 1911, upon one uniform plan.

The direct reading declination instrument referred to in last year's report was continued in use, daily readings being taken at a fixed hour, together with special readings during the time over which the absolute determination of declination is being made. The new cable, referred to in the last report, was completed in February, but about the close of the year, and before it could be brought into operation, it was seriously damaged by a grass fire. A large portion of it will have to be relaid. During the year, a Watson quartz thread vertical force instrument was transferred from Greenwich Observatory, but records could not be obtained from it owing to lack of a suitable recording drum. This, it is hoped, will be made good during the current year, not only for the purpose named but for others which are in view.

With regard to the absolute observations of terrestrial magnetic force, these are now (since January, 1922), carried out twice instead of once weekly.

The inquiry referred to in last year's report into the diurnal inequality on days of high and low barometric pressure, was completed as far as the two horizontal components are concerned. The results are again inconclusive. It is being completed for the vertical force inequality.

Meteorology.—The system of meteorological observation includes (1) autographic records of pressure (photographic barograph, Dines' float barograph, pen barograph, microbarograph), temperature (wet and dry bulb photographic thermographs, pen thermograph, pen hygrograph), wind speed and direction, rainfall and sunshine; (2) eye observations made for control purposes, including humidity by the Assmann hygrometer, at 9h., 15h., and 21h.; (3) observations for purposes of telegraphic weather reports at 7h., 13h., 18h.; (4) pilot balloon ascents when conditions permit; (5) nephoscope observations; and (6) a general watch on weather phenomena.

The information thus obtained is employed in the tabulation of hourly values, in summaries for the *Weekly* and *Monthly Weather Reports*, and for telegraphic weather reports.

The arrangement for tabulation of hourly values was altered during the year in view of the publication, as from 1st January, 1922, of all the Observatory results in one volume, which will be prepared here—a most decided improvement upon the system hitherto followed. Towards this end all meteorological hourly value tabulations were well up to date at the end of the year.

The number of telegraphic weather reports despatched during the year was 1,277, being about 500 less than in 1920-21. The reduction was due to the stoppage of the 1h. report and to the smaller number of pilot balloon messages sent separately. The arrangements for transmission by telephone worked fairly well during the year, there being fewer cases of failure or breakdown of the telephone lines.

The number of pilot balloon ascents during the year was 181, a lower number than usual in recent years, due to difficulties experienced in obtaining a regular supply of compressed hydrogen.

The investigation of the diurnal inequality of pressure on days of different character, which was begun last year, is still in hand. It has proved to be a rather heavy piece of work, but progress is being made with it, and the current year should see its completion.

The reduction of ten years' temperature records, 1911-1920, was completed.

Atmospheric Electricity.—Observations of potential gradient by means of a water-dropper and photographic record of a Dolazalek electrometer were continued as before. Factors for conversion of the readings into volts per metre above ground level in the open were obtained from separate observations made weekly. Values of the potential gradient have thus been obtained for four fixed hours every day, and for all hours on certain selected quiet days.

The mean diurnal inequality on quiet days for each month taken over the past ten years has been recently worked out and will be published separately.

Seismology.—The installation of Galitzin seismographs continued in regular operation, except for interruptions caused by irregularities in the clockwork which drives the recording drums. A new recording drum which will avoid the necessity for two components being shown on one sheet was under construction at the end of the year.

The usual details regarding earthquakes recorded were prepared for publication in the *Geophysical Journal.*

VALENCIA OBSERVATORY, CAHIRCIVEEN, Co. KERRY.

The year as a whole was somewhat eventful. The political state of the country during the spring was more disturbed than it had ever been, and from causes arising out of this the local railway was closed for some ten weeks, the nearest railway station during that period being about 40 miles away. Telegraphic communication was not, however, interrupted, and in time various devious routes were found by which a delayed postal communication with London was maintained.

The work of the Observatory was able to be continued in a normal manner, being one of the few local industries which were able to carry on as usual. An armed raid in June resulted in the loss of a valuable theodolite and the telephone, but with the aid of the telephone linesman the difficulty caused by the latter was got over, and no serious permanent inconvenience was caused.

Buildings.—A few small repairs to the fabric of the buildings have been undertaken either by the staff or by local contractors under the authority of Works and Buildings, Baldonnel.

The water supply failed for a time in June owing to drought and a stoppage of pipes; the latter defect was put right by the staff.

Works and Buildings, Baldonnell, went into the question of an improved rain water supply for the Observatory early in the year, but the scheme proposed was not proceeded with on the ground of expense.

As shortage and bad quality of water in dry weather have long given trouble a much cheaper scheme was designed by the Superintendent, approved by the Air Ministry, and carried out locally. It is now complete, and three or four times the former amount of rain water is now available, with double the storage capacity. This will greatly reduce the number of occasions when pumping from the polluted well supply has to be resorted to.

That portion of the Observatory property not immediately required has been let as before on short terms for grazing or cultivation.

Meteorological Routine.—The Observatory has been maintained as a first order meteorological station, keeping as far as possible a continuous record of the weather. Regular eye observations, including weather and sky, have been made eight times daily between 7h. and 21h. Telegraphic reports to the Forecast Division have been made five times daily on week days and four times on Sundays. Cloud observations with the Besson Comb Nephoscope have been regularly made in conjunction with the telegraphic reports throughout the year.

A daily forecast for the south-west of Ireland telegraphed from London each week-day was, after editing, exhibited in the Post Office in Cahirciveen. It was not made much use of by the general public and was discontinued in March, 1922.

The records of the mountain rain-gauge at Cahirciveen waterworks have been obtained without serious interruption, which is the more satisfactory as the site is a good deal frequented by the public.

The self-recording equipment has been maintained in full operation save for a few short stoppages, and on such occasions by using alternative instruments it has always been possible to compute the hourly values of the elements concerned.

Tabulation has been kept up to date, and the hourly values of temperature, humidity, pressure, wind (two anemometers), rain and sunshine have been computed and checked. Copies have been retained at the Observatory up to the end of 1921. Since that date all tabulations and original curves have been retained.

The arrangement of working hours of the staff has been such as to provide for observers on duty, or readily available, between 6h. 30m. and 18h. The Superintendent has acted as resident observer as before.

Instruments and Instrumental Investigations.—The evaporation tank continued to leak a little in the early part of the year. In the summer it was again taken in hand, treated with pitch and, it is believed, finally cured.

The measurements of rainfall and evaporation have occupied a good deal of attention. The Observatory standard 8-inch rain-gauge is situated in a rather open position and there is a possibility of the recorded falls being too low in consequence. Its readings have been compared during the year with those of another gauge placed in a more sheltered position. The comparison ought to be continued, since the hourly values of rainfall are now entirely based on the 8-inch gauge as a standard; provisionally the following main conclusions have been arrived at in connection with the measurement of rainfall and evaporation at the Observatory.

First. The standard 8-inch gauge is not seriously over-exposed, but the available data are not sufficient to base any final statement upon them.

Second. The evaporation tank, which is in a very open site, is very seriously affected by insplashing of rain in windy weather. As there is, therefore, no means of determining the exact amount of rain water falling into it, its records are quite valueless on occasions when rain has fallen.

Third. An 8-inch gauge placed in a conical pit, 5 ft. in diameter and 1 ft. deep, and having its rim level with the surrounding ground, catches far too much rain in windy weather and is not a solution of the difficulty of exposure in a windy site. The excess occurs from splashing from the surrounding ground surface.

Records from a Piché evaporimeter have been compared with the tank, and using only fine intervals traces of an annual variation in the ratio between them have been found. Relatively to the tank the evaporation from the Piché instrument is only about half as much in summer as in winter, a subject which requires further investigation.

A Nipher shield has been fitted to the Dines tipping bucket gauge for comparison with the standard gauge.

A Dines float barograph has been installed during the year. From such tests as have been made of it there is reason to believe that its accuracy is equal to that of the photographic barograph.

Several additions have been made to the general laboratory equipment of the Observatory in the shape of a few simple electrical instruments.

During the year steady progress was made with a system of synchronous electrical time-marking, and the anemograph, barograph, microbarograph and rain-gauge have been included therein. There being no precedent to follow, a certain amount of experiment was necessary, but no great difficulties were experienced, and a simple reliable system has been evolved and the component parts constructed in the workshop. The principal aimed at has been to avoid the use of additional pens, the actual recording pens of the several instruments being themselves depressed once an hour by means of suitable electro-magnets.

Pilot Balloons.—Ascents with one theodolite have been made once or twice daily when the weather conditions allowed, and telegraphed to the Forecast Division immediately; 351 ascents were made in all during the year. The ascensional velocity employed has been reduced in general to 140 metres per minute on account of the frequent leakage of balloons and consequent fictitious results obtained at great heights when working with a velocity of 152m/min. One two-theodolite ascent was made in which the balloon was followed by both till it burst at $12\frac{1}{2}$ kilometres height.

Terrestrial Magnetism.—Absolute observations of declination, horizontal force and inclination have been taken in general about two or three times per month. They have been taken at fixed hours in each case, and those made at times reasonably free from magnetic disturbance will be published in the *Geophysical Journal.*

Workshop.—The equipping of the workshop with tools has proceeded steadily, and it is now nearly complete for all purposes for which it is likely to be required. A large amount of both new work and repairs has been undertaken in it during the year.

Meteorological Research, Etc.—A note on visibility at Cahirciveen and the relation between wind direction and cloud amount was prepared.

Work has proceeded on a comparison between the wind at the surface and the geostrophic wind at Cahirciveen.

An analysis of all pilot balloon ascents made at the Observatory during the four years 1918-1921, which reached at least 2,000 metres, has been prepared and the mean results expressed graphically.

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

AEROLOGICAL OBSERVATORY AT BENSON.

During the year eighteen registering balloons were sent up, of which eleven were found and the instruments returned. In every case a satisfactory and legible trace was obtained, but the heights reached by the balloons were lower than in any previous year since observations were first commenced. This unsatisfactory state of affairs is due to the bad quality of the balloons, since the instruments and methods employed are just the same as formerly, and although balloons have been obtained from several firms, the quality has steadily deteriorated.

The observations on radiation from the sky, commenced in 1919, have been continued ; some of the results obtained have been published in a *Geophysical Memoir* (M.O. 220h) and also in the *Meteorological Magazine*.

The routine work of the station, the sending of the daily telegrams and the obtaining of continuous automatic records, has gone on without a break, and a considerable amount of mechanical work for other stations, beside that necessary for the special object of the Observatory, viz. : the upper air observations, has been done in the workshop.

PUBLICATIONS.

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

PERIODICAL.—**The Daily Weather Report** issued in three sections (to date).
1. The British Section.
2. The International Section.
3. The Upper Air Supplement.

Monthly Meteorological Charts of the North Atlantic Ocean (to date).

Monthly Meteorological Charts of the East Indian Seas (to date).

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, 1921).

Part III (2) **Geophysical Journal.** Daily Readings in meteorology and terrestrial magnetism and the results of observations in the upper air (to January, 1921).

Part IV **Hourly Values from Autographic Records.** Hourly Values for terrestrial magnetism, atmospheric electricity and meteorology for five observatories (none 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. (Charts for 1910 and Tables for 1914 issued).

British Rainfall, 1920. A report on the distribution of rain in space and time over the British Isles during the year 1920, as recorded by about 5,000 observers.

The Meteorological Magazine (to date).

Seventh Report of the Committee for the Investigation of Atmospheric Pollution. Report on observations for year ending 31st March, 1921.

Southport Auxiliary Observatory. Annual Report and results of meteorological observations for the year 1920. By Joseph Baxendell.

OCCASIONAL.—**The Marine Observer's Handbook.** 3rd Edition (also supplement No. 1 to 3rd Edition).

Weather Forecasting in Eastern North Atlantic and Home Waters for Seamen. By Commander L. A. Brooke-Smith, R.D., R.N.R.

Cloud Forms according to the International Classification. 2nd Edition.

The Weather Map. An Introduction to Modern Meteorology. By Sir Napier Shaw, F.R.S. 5th issue.

A Short Course in Elementary Meteorology. By W. H. Pick, B.Sc.

Professional Notes :—

Vol. I. Title Page.

Vol. II. Title Page.

No. 18. Lizard Balloons for signalling the Ratio of Pressure to Temperature. By L. F. Richardson.

No. 19. Cracker Balloons for signalling Temperature. By L. F. Richardson.

No. 20. The Relation of Bumpiness to Lapse of Temperature at El Khanka near Cairo from July 27th to August 3rd, 1920.

No. 21. The Structure of the Atmosphere over Benson (Oxon) on 3rd March, 1920. By E. G. Bilham, B.Sc.

No. 22. A Comparison of Minimum Temperatures for for the Periods 17h. to 9h. and 17h. to 17h. By M. A. Giblett, M.A.

No. 23. A Comparison between the Dry Bulb Temperature in a Climatological Screen at Valencia Observatory and that in a Stevenson Screen exposed in an Open Field adjoining. By L. H. G. Dines, M.A.
No. 24. The Variation of Wind with Place. By Captain J. Durward, M.A.
No. 25. A Minor Line Squall. By Captain M. T. Spence. B.Sc.
No. 26. The Relation between Haze and Relative Humidity in the Surface Air. By J. Wadsworth, M.A.
No. 27 A Gazetteer of Meteorological Stations of the First, Second and Third Orders. (Introduction and Specimen Pages). H. N. Dickson, C.B.E., M.A., D.Sc.

Geophysical Memoirs :—
No. 17. Simultaneous Values of Magnetic Declination at different British Stations. By C. Chree, Sc.D., LL.D., F.R.S.
No. 18. Observations on Radiation from the Sky and an Attempt to Determine the Atmospheric Constant of Radiation. By W. H. Dines, F.R.S.

Forecast Code for the abbreviation of Weather Forecasts transmitted by Telegraphy or Radiotelegraphy.

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

The Book of Normals of Meteorological Elements for the British Isles.
Section IVa. The Range of Variation of Temperature and Rainfall.
Section IVb. Frequency Tables of Hail, Thunder, Snow, Ground Frost, Snow lying and Fog.

Report of the Eleventh Ordinary Meeting of the International Meteorological Committee, London 1921.

Report of the Fourth Meeting of the Commission for Weather Telegraphy.

Particulars of Meteorological Reports issued by Wireless Telegraphy in Great Britain and by the Countries of Europe and North Africa.

The (New) International Code for Meteorological Messages.

Geophysical Memoirs :—
No. 19. Hurricanes and Tropical Revolving Storms. By Mrs. E. V. Newnham, M.Sc.
The Climatology of Glasgow. By Prof. L. Becker.

Professional Notes :—
Vol. III :—
No. 28. A Comparison of the Anemometer Records for Shoeburyness and the Maplin Lighthouse. By N. K. Johnson, B. Sc. and S. N. Sen, M.Sc.
No. 29. On the Formation of Thunderstorms over the British Isles in Winter. By E. V. Newnham, B.Sc.
No. 30. The Variations of Temperature with Wind Velocity and Cloudiness. By Capt. J. Durward, M.A.
Vol. IV :—
No. 31. The Relation between the Height reached by a Pilot Balloon and its ascending Velocity. By J. Wadsworth, M.A.

The publication of the following papers, etc., may also be mentioned :

By Dr. G. C. Simpson, F.R.S.—
The South West Monsoon. Q. J., R. Met. Soc. 47, 1921, pp. 151—172.
The Origin of the South West Monsoon. Nature, 107, 1921, p. 154.

By Dr. Charles Chree, F.R.S.—
An Electro Culture Problem. Proc. Phys. Sci., London, 33, 1921, pp. 377—385.

By F. J. W. Whipple, M.A., F. Inst. P.—
The Theory of the Hair Hygrometer. London, Proc. Phys. Soc., 34. 1922, pp. 50–55.
The Rationale of Glaisher's System of Hygrometry. London, Proc. Phys. Soc., 34, pp. 56–59.

By M. de Carle S. Salter.—

A New Method of Constructing Average Rainfall Maps. Q. J., R. Met. Soc., 47, 1921, pp. 101–116.

The Rainfall of the British Isles. London University Press.

By C. E. P. Brooks, M. Sc.—

The Evolution of Climate in North West Europe. Q. J., R. Met. Soc., Vol. 47, 1921, pp. 173–194.

Meteorology of British North Borneo. Q. J., R. Met. Soc., Vol. 47, 1921, pp. 294–297.

By E. G. Bilham, B. Sc.

Isallobars of Moving Circular Depression. Geog. Ann. III, 1921, pp. 336–357.

By Harold Jeffreys, M.A., D.Sc.—

On the Dynamics of Wind. Q. J., R. Met. Soc., 48, 1922, pp. 29–46.

By M. A. Giblett, M.A.—

Some Problems Connected with Evaporation from large Expanses of Water. Proc. R. Soc. Vol. 99, 1921, pp. 472–490.