

# ANNUAL REPORT

METEOROLOGICAL  
OFFICE  
EDINBURGH

19 NOV. 1921

M.O.7.

OF THE

## METEOROLOGICAL COMMITTEE

TO

### THE AIR COUNCIL

**For the Year ended 31st March, 1921**

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



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# CONTENTS.

	PAGE
LIST OF MEMBERS OF THE METEOROLOGICAL COMMITTEE .. ..	3
LIST OF MEMBERS OF THE COMMITTEE OF THE METEOROLOGICAL OFFICE, EDINBURGH .. .. .	4
LIST OF MEMBERS OF THE GASSIOT COMMITTEE .. .. .	4
LIST OF MEMBERS OF THE ADVISORY COMMITTEE ON ATMOSPHERIC POLLUTION .. .. .	5
THE STAFF OF THE METEOROLOGICAL OFFICE AND OF THE OBSERVA- TORIES OF THE METEOROLOGICAL COMMITTEE .. .. .	6
REPORT.	
COMMITTEE'S REPORT .. .. .	10
DIRECTOR'S REPORT—	
Meteorological Committee—Meetings .. .. .	12
Co-operation with the School of Meteorology .. .. .	12
Geophysical Observatory at Lerwick, Shetland .. .. .	12
Weather Telegraphy .. .. .	14
The Radio-telegraphic inquiry into the location of Thunderstorms	15
Meteorological Reports from ships at Sea by Wireless .. ..	16
Experimental Station at Porton .. .. .	17
Meteorological Office, Edinburgh .. .. .	17
Meteorological Committee for Scotland .. .. .	19
Conference at Bergen .. .. .	19
International Meteorology .. .. .	20
Publications .. .. .	20
Staff .. .. .	24
Rates of Pay for Women Professional Assistants .. .. .	25
Care of Meteorological Buildings .. .. .	25
Finance .. .. .	25
REPORTS FROM THE OFFICERS IN CHARGE OF THE FOLLOWING SERVICES—	
Marine Division .. .. .	27
Forecast Service, Headquarters Division .. .. .	35
Forecast Service, Local Centres Division .. .. .	39
Climatology Division .. .. .	43
Instruments Division .. .. .	47
Army Services Division .. .. .	49
Advisory Committee on Atmospheric Pollution .. .. .	50
British Rainfall Organization .. .. .	51
Meteorological Office, Edinburgh .. .. .	54
Kew Observatory .. .. .	57
Eskdalemuir Observatory .. .. .	62
Valencia Observatory .. .. .	66
Benson Observatory .. .. .	68
South Farnborough Branch Office .. .. .	68
Falmouth Observatory .. .. .	70
Armagh Observatory .. .. .	70
Southport Observatory .. .. .	70
APPENDIX. Agreement between the Meteorological Committee and the Scottish Meteorological Society .. .. .	71

# METEOROLOGICAL COMMITTEE.

OCTOBER, 1920 — MARCH, 1921.

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Appointed by the Air Council.

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

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

Lieut.-Colonel D. CLAPHAM, C.B.E., D.S.O. Superintendent of Experi-  
ments, Shoeburyness. Nominated by the  
War Office.

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

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

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

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

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

# COMMITTEE OF THE METEOROLOGICAL OFFICE, EDINBURGH.

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Appointed 1913.

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

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

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

DR. E. M. WEDDERBURN, W.S. Nominated by the Scottish Meteorological Society.

DR. C. G. KNOTT. Nominated by the Scottish Meteorological Society.  
MR. A. WATT (*Secretary*).

---

## THE GASSIOT COMMITTEE, 1921.

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

---

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

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

The Astronomer Royal.

Dr. C. Chree.

Mr. W. H. Dines.

Sir Richard Glazebrook.

Mr. J. H. Jeans.

Sir Joseph Larmor.

Professor H. F. Newall.

Sir Arthur Schuster.

Sir Napier Shaw.

Dr. G. C. Simpson.

Mr. G. I. Taylor.

Mr. G. W. Walker.

Mr. C. T. R. Wilson.



## ADVISORY COMMITTEE ON ATMOSPHERIC POLLUTION, 1920-21.

SIR NAPIER SHAW, F.R.S. (*Chairman*).

Professor H. B. Baker, C.B.E., F.R.S. (*Royal College of Science*).

Mr. J. G. Clark, F.I.C.

Professor J. B. Cohen, B.Sc., Ph.D., F.R.S., (*Professor of Organic Chemistry, Leeds University*).

Dr. H. A. Des Voeux (*Hon. Treasurer, Coal Smoke Abatement Society*).

Dr. J. S. Owens (*Coal Smoke Abatement Society*).

Dr. E. J. Russell (*Director of the Rothamsted Experimental Station, Harpenden*).

Bailie W. Smith (*Member of Departmental Committee on Smoke Abatement*).

Mr. F. J. W. Whipple (*Superintendent Climatology Division, Meteorological Office*).

Nominated by the  
Meteorological  
Committee.

Dr. John Robertson, nominated by the Corporation of Birmingham.

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.

Dr. J. B. Wilkinson, nominated by the Corporation of Oldham.

Dr. J. R. Ashworth, nominated by the Corporation of Rochdale.

Dr. Cates, nominated by the Corporation of St. Helens.

Mr. John Fyfe, nominated by the Corporation of Stirling.

Nominated  
by the Municipal  
Authorities  
contributing  
observations.

Mr. W. S. Curphey (*Chief Alkali Inspector of the Local Government Board*).

Nominated by the  
Advisory Council  
for Scientific and  
Industrial Research.

# THE STAFF OF THE METEOROLOGICAL OFFICE, AND OF THE OBSERVATORIES, CONTRIBU- TIVE, AND DISTRIBUTIVE STATIONS OF THE METEOROLOGICAL COMMITTEE, MARCH, 1921.

## HEADQUARTERS STAFF.

### DIRECTOR :

Dr. G. C. Simpson, C.B.E., F.R.S.

### DIRECTORATE AND GENERAL SERVICES DIVISION.

<i>Assistant Director</i> .. ..	R. G. K. Lempfert, C.B.E., M.A.
<i>Chief Clerk</i> .. ..	H. L. B. Tarrant.
<i>Principal Assistants</i> .. ..	L. H. Powers, B. Francis.
<i>Staff Assistants</i> .. ..	Misses D. G. Chambers, M. Coleman ; W. J. R. Pook.
<i>Clerk</i> .. ..	C. W. Heinemann.
<i>Clerk Assistants</i> .. ..	Misses H. G. Chivers, I. Cook, E. G. Picknett
<i>Junior Administrative Assistant</i> .. ..	Miss G. M. Hood.
<i>Clerk Computers</i> .. ..	Misses A. J. Clapham, R. M. Chambers ; C. S. Herbert.
<i>Clerks, Grade III</i> .. ..	Miss E. L. Beasley ; H. R. Sharpe, W. C. Curtis.
<i>Girl Clerks</i> .. ..	Misses M. L. Taylor and E. R. Andrews.
<i>Office and Storekeepers</i> .. ..	C. E. Goad, A. G. Goad, W. R. Chillman and F. W. Creek. 2 Messengers.

### FORECAST DIVISION.

<i>Assistant Director</i> .. ..	E. Gold, D.S.O., F.R.S.
<i>Superintendents</i> .. ..	J. S. Dines, M.A., A. H. R. Goldie, M.A.
<i>Assistant Superintendents</i> ..	E. G. Bilham, B.Sc., F. Entwistle, B.Sc., E. V. Newnham, B.Sc., R. Sargeant.
<i>Senior Professional Assistants</i>	C. K. M. Douglas, B.A., M. A. Giblett, B.Sc., W. C. Kaye, B.Sc., R. M. B. Mackenzie, M.A., J. J. Somerville, M. T. Spence, B.Sc., Misses L. F. Lewis, B.Sc., L. D. Sawyer, B.A., R. M. Stanhope, B.A.
<i>Junior Professional Assistants</i>	Miss G. L. Thorman, B.Sc. ; J. E. Cowper, R. H. Mathews, B.A., J. W. Wadsworth, B.A.
<i>Principal Assistants</i> .. ..	W. Hayes, R. Pyser.
<i>Staff Assistants</i> .. ..	W. G. Davies, J. F. Davison, A. A. Lovie, C. C. Newman, R. M. Poulter.
<i>Clerk</i> .. ..	W. J. Tomkins.
<i>Clerk Assistants</i> .. ..	Misses N. L. Despicht, D. G. Lee.
<i>Technical Assistants</i> .. ..	W. A. L. Marshall, W. R. Penfold, W. A. Kimber, H. W. Badger, E. L. Litton (Temp.).
<i>Clerk Computer</i> .. ..	F. C. Warmington.
<i>Draughtswomen</i> .. ..	Misses E. S. S. Andrews, M. K. Osborne.
<i>Clerks, Grade III</i> .. ..	Misses E. Gabriel, V. Stone, L. Williams ; F. J. Abbot, V. Bantock, R. W. Bradbury, W. G. Brown, R. G. Cocks, E. Coltman, S. W. Dustan, W. Hotten, A. L. Latchford, J. B. Mani, H. Pinkney, R. M. Rudlin.
<i>Clerk, Grade IV.</i> .. ..	J. Hayes.
<i>Typist</i> .. ..	Miss W. B. Hallett.
<i>Boy Clerks</i> .. ..	P. Powell, E. G. Ward.
<i>Boy Assistant</i> .. ..	J. C. Woods.
<i>Storekeeper</i> .. ..	J. L. Evans.
	4 Messengers.

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<i>Superintendent</i> .. ..	L. A. Brooke-Smith, Commander, R.N.R.
<i>Senior Professional Assistant</i> ..	C. S. Durst, B.A.
<i>Principal Assistant</i> ..	H. Keeton.
<i>Staff Assistants</i> .. ..	J. S. Williams, A. G. W. Howard.
<i>Clerk Assistants</i> .. ..	A. J. Tabor, H. T. Smith, W. T. Grieves, F. C. Levin.
<i>Technical Assistant</i> ..	W. G. Williams.
<i>Boy Clerks</i> .. ..	S. V. Upson, S. L. King, A. H. French.

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<i>Assistant Superintendent</i> ..	C. E. P. Brooks, M.Sc.
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<i>Junior Professional Assistants</i> ..	H. W. Braby, M.A., C. W. Lamb, B.Sc.
<i>Principal Assistant</i> ..	A. H. Bell.
<i>Staff Assistants</i> .. ..	C. A. Bracey, E. J. Hood, Miss R. E. Smith.
<i>Clerk</i> .. ..	A. E. Pycock.
<i>Clerk Assistants</i> .. ..	B. G. Brame, Misses M. Bigelstone, D. R. M. Figgins, H. W. Newsholme, W. Quennell, F. A. Shields.
<i>Clerk Computers</i> .. ..	Misses M. Enderby, T. M. Hunt.
<i>Draughtswoman</i> .. ..	Miss E. P. Davison.
<i>Probationers</i> .. ..	Misses E. V. Freeman, E. J. Johnson; G. T. Smith, R. J. Williams.
<i>Girl Clerk</i> .. ..	Miss A. W. C. Fitch.
<i>Boy Clerks</i> .. ..	R. Graham, W. G. Palmer, A. J. Wallis.

1 Messenger.

## INSTRUMENTS DIVISION.

<i>Superintendent</i> .. ..	R. Corless, O.B.E., M.A.
<i>Senior-Professional Assistant</i> ..	Miss E. H. Geake, M.Sc.
<i>Junior Professional Assistant</i> ..	N. H. Smith.
<i>Principal Assistants</i> .. ..	J. H. James, P. N. Skelton.
<i>Staff Assistants</i> .. ..	F. W. Snell, E. L. Clinch.
<i>Clerk</i> .. ..	C. H. Wood.
<i>Clerk Assistants</i> .. ..	Misses D. J. Taylor, K. Herbert, A. L. Sanford.
<i>Clerk Computer</i> .. ..	Miss W. Bulgin.
<i>Probationer</i> .. ..	H. J. Bigelstone *
<i>Storemen</i> .. ..	C. W. Atkins, G. E. Court.
<i>Packer</i> .. ..	G. J. Bassett.

1 Messenger.

\*On special leave.

## ARMY SERVICES DIVISION.

<i>Superintendent</i> .. ..	D. Brunt, M.A., B.Sc.
-----------------------------	-----------------------

## NAVY SERVICES DIVISION.

<i>Superintendent</i> .. ..	Vacant.
<i>Senior Professional Assistant</i> ..	Spencer C. Russell, L.L.B.

## BRITISH RAINFALL ORGANIZATION, 62, Camden Square, N.W.1.

<i>Superintendent</i> .. ..	M. de C. S. Salter.
<i>Senior Professional Assistant</i> ..	J. Glasspoole, B.Sc.
<i>Principal Assistant</i> .. ..	A. T. Bench.
<i>Staff Assistant</i> .. ..	H. E. Carter.
<i>Technical Assistant</i> .. ..	C. F. Martin.
<i>Clerk Computer</i> .. ..	Miss D. K. Lamport.
<i>Boy Clerk</i> .. ..	J. F. Oliver.

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

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

## METEOROLOGICAL OFFICE, EDINBURGH.

<i>Assistant Superintendent</i> ..	A. Watt, M.A., F.R.S.E.
<i>Senior Professional Assistant</i> ..	J. Crichton, M.A., B.Sc.
<i>Junior Professional Assistant</i> ..	J. E. Belasco, B.Sc.
<i>Clerk Assistant</i> .. ..	Miss M. Crawford.
<i>Probationers</i> .. ..	Misses I. H. Graham-Yooll, M. A. McKay, A. Murray, M. N. Wilson.
<i>Housekeeper</i> .. ..	Mrs. M. Moran.

## OBSERVATORIES AND CONTRIBUTIVE STATIONS.

### CENTRAL OBSERVATORY,

Kew Observatory, Old Deer Park, Richmond, Surrey.

<i>Assistant Director</i> .. ..	Dr. Charles Chree, F.R.S.
<i>Senior Professional Assistants</i>	R. E. Watson, B.Sc., E. Taylor, M.A., B.Sc.
<i>Junior Professional Assistant</i>	C. H. Kellett.
<i>Principal Assistant</i> .. ..	E. Boxall.
<i>Staff Assistant</i> .. ..	H. G. Harris.
<i>Clerk Assistant</i> .. ..	L. G. Hemens *
<i>Probationer</i> .. ..	H. E. Brooking.
<i>Boy Clerk</i> .. ..	L. Fletcher.
<i>Caretakers</i> .. ..	Mr. and Mrs. O. J. Lampard.
	2 Messengers.
	*On special leave.

### MAGNETIC OBSERVATORY, Eskdalemuir, Langholm, Dumfries-shire.

<i>Superintendent</i> .. ..	Dr. A. Crichton Mitchell, F.R.S.E.
<i>Senior Professional Assistant</i>	R. A. Watson, B.A.
<i>Technical Assistant</i> .. ..	P. F. Jarrold.
<i>Clerk Computer</i> .. ..	J. B. Beck.
<i>Probationer</i> .. ..	W. A. Grinstead.
<i>Caretaker</i> .. ..	Mrs. N. Stoddart.
	2 Messengers.

### WESTERN OBSERVATORY, Valencia Observatory, Cahirciveen, Co. Kerry.

<i>Superintendent</i> .. ..	L. H. G. Dines, M.A., A.M.I.C.E.
<i>Senior Professional Assistant</i>	P. J. Mulholland, B.Sc.
<i>Technical Assistant</i> .. ..	M. J. Morley.
<i>Supernumerary Clerk</i> .. ..	M. Sugrue.
<i>Boy Clerk</i> .. ..	J. B. Morley.
	1 Messenger.

### AEROLOGICAL OBSERVATORY, Benson, near Wallingford.

<i>Assistant Director</i> .. ..	W. H. Dines, F.R.S.
<i>Staff Assistant</i> .. ..	H. W. Baker.
<i>Mechanical Assistant</i> .. ..	B. C. Lewis.

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<i>Assistant Superintendent</i> ..	R. A. Watson Watt, B.Sc., A.M.I.E.E.
<i>Senior Professional Assistant</i>	F. J. Herd, A. M. I. Radio E.
<i>Technical Assistants</i> .. ..	A. J. Lander, H. D. K. Millar.
<i>Supernumerary Clerk</i> .. ..	Miss I. M. Brierley.

### WEATHER STATION, FALMOUTH OBSERVATORY.

<i>Assistant-in-Charge</i> .. ..	J. B. Phillips.
<i>Technical Assistant</i> .. ..	W. A. Toms.

### NORTHERN OBSERVATORY.

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

<i>Assistant</i> .. ..	G. A. Clarke.
<i>Boy Clerk</i> .. ..	G. M. Rattray.

### PORT METEOROLOGICAL OFFICE, LIVERPOOL.

<i>Senior Professional Assistant</i>	Lt.-Commander G. ff. Lloyd, R.N.R.
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### METEOROLOGICAL OFFICE, SHOEBURYNESSE.

<i>Senior Professional Assistant</i>	C. E. Britton.
<i>Staff Assistant</i> .. ..	A. W. Lloyd.
<i>Technical Assistants</i> .. ..	G. C. Baldwin, B. A. Copping, J. C. W. Heming, A. C. Lloyd, A. E. Mayers, R. G. Veryard, F. G. Whitaker, E. S. Wood, P. R. Zealley.

### METEOROLOGICAL OFFICE, LARKHILL.

<i>Senior Professional Assistant</i>	J. Durward, M.A.
<i>Clerk Assistant</i> .. ..	C. V. Ockenden *
<i>Technical Assistants</i> .. ..	R. E. Booth, H. W. Davis, P. W. Dingle, W. J. Fowler, R. L. Sims, F. B. Swain, W. T. Wilson.

\*On special leave.



## DISTRIBUTIVE STATIONS.

ANDOVER.		
<i>Senior Professional Assistant</i>	Guy Harris.	
<i>Technical Assistant</i>	.. H. G. Lacey.	
BALDONNELL.		
<i>Senior Professional Assistant</i>	A. Walters.	
<i>Junior Professional Assistant</i>	W. J. Grassick.	
<i>Staff Assistant</i>	.. J. D. Ashton.	
BIGGIN HILL.		
<i>Technical Assistants</i>	.. T. H. Applegate, W. H. Bigg.	
CALSHOT.		
<i>Senior Professional Assistants</i>	H. W. L. Absalom, B.Sc., A.R.C.S., R. P. Batty, B.A.	
<i>Staff Assistant</i>	.. C. F. J. Jestico.	
<i>Technical Assistants</i>	.. F. Davies, H. E. Forster, C. V. Starr.	
CATTEWATER.		
<i>Assistant Superintendent</i>	.. C. D. Stewart, B.Sc.	
<i>Staff Assistant</i>	.. T. F. Twist.	
<i>Technical Assistants</i>	.. G. L. Major, P. Gresswell, C. E. Jowitt, W. L. Andrews.	
CRANWELL.		
<i>Senior Professional Assistant</i>	W. H. Pick, B.Sc.	
<i>Staff Assistants</i>	.. R. Forbes-Bentley, G. A. Wright.	
<i>Technical Assistants</i>	.. W. H. Jupe, H. L. Pace, W. L. Lineham, J. H. Adams.	
CROYDON.		
<i>Senior Professional Assistant</i>	G. R. Hay, M.A.	
<i>Staff Assistant</i>	.. F. M. Dean.	
<i>Technical Assistants</i>	.. R. T. Andrews, C. J. G. Budd, S. N. Plumer.	
FELIXSTOWE.		
<i>Senior Professional Assistant</i>	S. T. A. Mirrlees, M.A.	
<i>Staff Assistant</i>	.. D. F. Bowering.	
<i>Technical Assistants</i>	.. J. S. Smith, H. I. Staveley, A. R. Ward.	
GRAIN.		
<i>Senior Professional Assistant</i>	W. Gillon, M.A., B.Sc.	
<i>Technical Assistants</i>	.. C. Smith, J. A. Sturch, E. V. Stone.	
HOLYHEAD.		
<i>Senior Professional Assistant</i>	S. F. Witcombe.	
<i>Technical Assistant</i>	.. C. A. Grant.	
HOWDEN.		
<i>Senior Professional Assistant</i>	H. F. Jackson, M.S.E.	
<i>Staff Assistant</i>	.. E. S. Tunstall.	
<i>Technical Assistant</i>	.. H. H. W. Champ, A. E. Geach.	
LYMPNE.		
<i>Senior Professional Assistant</i>	R. S. Read, M.A., B.Sc., A.R.C.Sc.	
<i>Staff Assistant</i>	.. J. G. Goodyear.	
<i>Technical Assistants</i>	.. P. J. Summerfield, E. S. Ward, C. Wilde.	
MANCHESTER.		
<i>Senior Professional Assistant</i>	G. L. H. Douglas-Lane, B.A.	
<i>Technical Assistant</i>	.. J. A. Watson.	
RENFREW.		
<i>Junior Professional Assistant</i>	H. St. G. Dyke-Marsh, B.A.	
<i>Technical Assistants</i>	.. W. Andrews, F. Husband.	
SECONDED FOR DUTY WITH OTHER BODIES.		
<i>Senior Professional Assistants</i>	Miss E. E. Austin ( <i>University of London</i> ). N. K. Johnson, B.Sc. ( <i>War Office, Porton Experimental Station</i> ).	
<i>Junior Professional Assistants</i>	F. J. Scrase, B.Sc. ( <i>War Office, Porton Experimental Station</i> ). O. T. F. Roberts ( <i>War Office, Porton Experimental Station</i> ).	

ANNUAL REPORT  
OF THE  
**METEOROLOGICAL COMMITTEE**  
TO  
**THE AIR COUNCIL.**

For the Year ended 31st March, 1921 (the Sixty-sixth Year of the Meteorological Office).

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THE year 1920-21 has been a time of transition and reorganization in the Meteorological Office. Of the changes which have taken place during the year the most outstanding is the retirement of Sir Napier Shaw from the Directorship.

Sir Napier Shaw became a member of the Meteorological Council in 1897 and accepted the appointment of Secretary to the Council in 1900, becoming its chief executive officer at a time when the Meteorological Service of the country was admittedly in a state of comparative stagnation. Sir Napier, with his clear insight into the scientific and practical possibilities of a public weather service, commenced to build up step by step an organization founded on scientific knowledge and research which most efficiently met the needs of the country in peace-time. The soundness of Sir Napier's work was proved when the war made such urgent and unexpected demands for weather information, for it was then found that the methods of observation, forecasting and upper air research which had been developed by the Office under his charge were capable of unlimited expansion to meet the new needs of the Navy, the Army, and the Royal Air Force.

The appreciation of the Meteorological Committee was expressed to Sir Napier on his retirement by the Chairman in the following letter :—

AIR MINISTRY,  
KINGSWAY, W.C. 2.  
5th November, 1920.

Dear Sir Napier Shaw,

The members of the Meteorological Committee at the last meeting at which you were present took the opportunity of bidding you farewell, but they also wish me to express to you in writing their high appreciation of your past services as Director of the Meteorological Office, and their good wishes for the future.

The Committee are deeply sensible of all they owe to you, for they realise that it is the unique position which your scientific abilities have gained for you in international meteorology, combined with your great administrative skill, which has placed this country in the van of meteorological progress.

While feeling great regret that your association with them has come to an end, they are very pleased to know that your services will not be lost to the science of meteorology, and they trust that your work at the School of Meteorology will be as markedly successful as your work in the past at the Meteorological Office.



May I add a personal note of thanks to you for the very successful way in which you carried through the amalgamation of the meteorological services and the incorporation of the Meteorological Office in the Civil Aviation Department of the Air Ministry.

Yours sincerely,  
F. H. SYKES.

Sir Napier Shaw, F.R.S.,  
10, Moreton Gardens,  
S.W. 5.

Sir Napier retired on 6th September, 1920, on which date Dr. G. C. Simpson, C.B.E., F.R.S., took over the duties of Director.

Last year's Report described the steps which had led up to the unification of the various meteorological organisations left by the war into one meteorological service attached to the Air Ministry.

On the 1st April, 1920, the attachment of the Meteorological Office to the Air Ministry had been completed, but there had been very little assimilation.

Before the transfer, the Meteorological Office had been a self-contained unit, and decisions on matters of policy, personnel and expenditure were made by the Meteorological Committee, which was directly responsible to the Lords Commissioners of His Majesty's Treasury for the administration of the Parliamentary Grant-in-Aid for Meteorology. The Office dealt directly with the meteorological services of foreign countries, the Stationery Office, the Treasury and other Government Departments.

As a part of the Air Ministry the conditions are entirely changed. As a consequence of attachment these independent functions no longer continue and the administration of the Meteorological Office is now definitely joined up with the administration of the Air Ministry: the financial control exercised by the Finance Branches of the Air Ministry is extended to include the expenditure, audit and store accounting of the Meteorological Office; the appointment of new staff and the rates of pay throughout the Office is examined by the Secretariat of the Air Ministry; the communications of the Office by telegraph, telephone and wireless are arranged through the Controller of Communications; and the demands of the Office on the Stationery Office are unified with those of the rest of the Air Ministry. These are only a few examples of the many consequences of attachment. Such changes have involved, on the part of the Meteorological Office, a large sacrifice of independence, and radical changes in procedure.

Throughout the year the necessary changes to carry out assimilation have been in progress. These changes in procedure have not been effected without some difficulty, but great advances have been made with a minimum of friction, although at the end of the year the assimilation is not entirely completed.

On behalf of the Meteorological Committee,

F. H. SYKES,

Sept. 14th, 1921.

(Chairman).

## REPORT BY THE DIRECTOR OF THE METEOROLOGICAL OFFICE.

**Meteorological Committee.**—The Committee met six times during the year: on 28th April, 23rd June, 28th July, 24th November, 26th January, and 16th March.

At the meeting on 28th April the Committee adopted the recommendation of the sub-committee appointed to consider the "Future Functions of the Meteorological Committee." The recommendations were subsequently slightly amended on the suggestion of the Royal Society, and finally approved by the Air Council. The "Constitution and Functions of the Meteorological Committee" as finally adopted were printed in Appendix II of last year's Report.

To meet the wishes of the Secretary of State for Scotland the Air Council decided on 18th February, 1921, to add a representative of the Scottish Office to the Meteorological Committee, but a nomination had not been received at the end of the year.

The only change in the membership of the Committee during the year was that Major D. Clapham, D.S.O., O.B.E., Royal Artillery, succeeded Lieut.-Colonel H. A. Lewis, C.B.E., as War Office representative on 30th November, 1920.

**Co-operation with the School of Meteorology.**—Arrangements were made during the year for the Air Ministry to co-operate with the Imperial College of Science and Technology in the establishment of a School of Meteorology in association with the School of Aeronautics which has been established to give effect to the Zaharoff benefaction.

The first appointment of Professor of Meteorology, which was made with the concurrence of the Air Ministry, was accepted by Sir Napier Shaw.

The Air Council authorised the Meteorological Office to second from year to year one or more members of its staff to act as full time lecturers or instructors. The salaries of officers so seconded for whole time duty are to be payable by the authority to whom they are seconded. Miss E. E. Austin, a senior Professional Assistant, was seconded for the 1920-21 Session. Capt. D. Brunt, Superintendent of Army Services, also gave a course of lectures on Dynamical Meteorology.

Arrangements were made for a room at the Meteorological Office at South Kensington to be placed at the disposal of the Professor of Meteorology and for lectures to be given in part of the library, and the roof was made available for practical instructions.

Facilities were given to the staff of the Office to attend the lectures at their own expense and it is gratifying to be able to report that twenty members entered their names for various courses of lectures.

**Geophysical Observatory at Lerwick, Shetland.**—In 1919 a request was received through the Foreign Office from the Norwegian Government for co-operation in a special study of the meteorological and magnetic conditions of the Northern Regions in connection with Roald Amundsen's expedition to the Arctic Ice Field.

The Royal Society, on the advice of the National Geophysical Council, approved the proposal and it was considered that the establishment of a station in the Shetlands equipped for making observations of the Aurora, Terrestrial Magnetism, Earth Currents, Atmospheric Electricity and Meteorology, would be the most practical method of meeting the wishes of the Norwegian Government.

The need for a magnetic observatory in the Shetlands had also made itself felt from another direction. The Meteorological Office is mainly responsible for magnetic data relating to the British Islands and for this purpose it has observatories at Kew, Valencia and Eskdalemuir. The electrification of the London railways has, however, seriously affected the records at Kew, which are now not suitable for many important investigations. At Valencia magnetic observations are taken only once a week. Eskdalemuir is the only observatory from which undisturbed hourly values of the magnetic elements are obtained and tabulated. For the closer study of magnetic disturbances one observatory can do very little and the establishment of additional observatories has become imperative. In order to get further within the region of increased disturbance and to link up observation of aurorae with magnetic work, it is considered that any new observatory should be to the North of Eskdalemuir. To meet these needs the establishment of a magnetic observatory in the Shetlands has long been under consideration.

The programme for the establishment of new meteorological observatories drawn up as part of the re-organisation of the Meteorological Office after the war had included a station in the Shetlands.

Dr. Crichton Mitchell visited the Shetlands to find a suitable site for an observatory and he reported that the wireless station near to Lerwick appeared to be eminently suitable for the purpose.

This wireless station, which has ample residential accommodation attached, had recently been transferred from the Admiralty to the Post Office but is only used by that Department in case of emergency, for example when there is a breakdown of the cable or a great press of telegraphic work due to the presence in Lerwick harbour of the fishing fleet. The Post Office did not intend to use the dwelling houses attached to the station. It proved possible to make an arrangement highly satisfactory to the Air Ministry and to the Post Office. The station has been transferred to the Air Ministry on condition that the wireless plant is maintained and kept available for use by the Post Office in case of any emergency, the Air Ministry having the use of the station for the establishment of an observatory and of the wireless plant for the transmission and receipt of meteorological observations, gale warnings and time messages.

The observatory will be run for three years on a temporary basis; if it justifies its existence by the work done in that time its continuance as a permanent institution will be considered.

At first the observatory will undertake the following work:—

- (a) *Meteorology.* The observatory will be a full reporting station, the observations from which will be quickly transmitted from the wireless station.



(b) *Terrestrial Magnetism.* Recording and absolute instruments will form the basis of the work.

(c) *Aurorae Parallax* (beginning in the autumn 1921).

(d) *Atmospheric Electricity.*

Other observations appertaining to geophysics will be undertaken if the observatory is placed on a permanent basis.

**Weather Telegraphy.**—Before the war the recognised, and practically the only method of exchange of meteorological information for weather forecasting, was by telegram. (The distances involved are usually too great to make the telephone practicable.) There was no National distribution nor International exchange by Wireless Telegraphy. A certain number of reports from ships in the Atlantic were collected by this means and a commencement had been made of issuing a daily message from the Eiffel Tower, which contained abbreviated reports for a relatively small number of stations in Western Europe. During the war, very little change was made owing to the need for secrecy, but as soon as the war was over steps were taken with a view to utilizing the natural advantages of Wireless Telegraphy and the advances in it made during the war for the collection, exchange and distribution of meteorological information.

In Great Britain, reports are now collected by Wireless Telegraphy from about eight stations, the remaining reports being collected by telegram and in certain cases, by telephone. Reports are distributed hourly from the Air Ministry by broadcast wireless during the hours of daylight in connection with aviation between London and the Continent. General inferences, indicating the meteorological distribution and its bearing on the weather prospects for the British Isles are issued twice daily, and collective messages giving the results of observations at about twenty British stations, four times daily, also from the Air Ministry.

Generally speaking, Wireless Telegraphy has not the same outstanding advantages for the distribution of forecasts for land areas, as these must necessarily refer to a restricted region and a single forecast issued from headquarters would not meet the requirements of the case. Accordingly up to the present, a general inference, which is indicative of the general changes anticipated in the meteorological situation over the British Isles, is the only forecast issued regularly by Wireless Telegraphy from the Air Ministry, apart from the special forecast for the Continental Flying Services. A similar general forecast for the Western Seaboard of the British Isles is issued by W/T from Poldhu.

Gale warnings issued for the use of Mariners are transmitted by W/T from eight Post Office Wireless Stations distributed round the coast. These are issued on the special wave length for merchant shipping, 600 metres. Gale warnings issued to stations on the coast where warning cones are hoisted, are transmitted by ordinary telegraphy.

Practically every European country now issues reports giving the results of observations at a selection of stations once or more daily.

The transmission and reception of these messages has not yet been made with sufficient accuracy and regularity to warrant cable messages being discontinued. The messages are transmitted in a figure code

and strict accuracy is essential because, in general, a mistake cannot be corrected by the context as it can be in the case of an erroneous letter in a plain language message.

One of the difficulties to be met arises from the fact that many meteorological services depend upon a single wireless receiving station, and consequently are unable to receive messages issued simultaneously. So long as this state of affairs exists, countries cannot issue their messages simultaneously or, if they do, only one of the messages will be available for the Meteorological Services of many other countries.

The International Convention for Aerial Navigation envisaged a scheme in which all National reports were collected and a selection from these reports issued in collective form from the Central National Office within  $1\frac{1}{2}$  hours of the time of observation. This celerity can be achieved, and probably surpassed, as more wireless receiving stations become available. If each meteorological service of the leading European Countries could command the services of four wireless receiving stations for one hour three times daily and of one issuing station for 20 minutes also three times daily, the principal meteorological maps and the forecasts based upon them, could be completed within two hours of the time of observation. But, at the present time, even if all countries worked to a pre-arranged scheme and those countries with only one receiving station available for meteorological purposes were willing to forego the reports of nearly half the countries in Europe, the earliest time by which their map could be completed would be  $2\frac{3}{4}$  hours after the time of observation. Such a scheme has been prepared and is gradually being brought into operation. It will be a great advance in most cases on the cable service and as Great Britain's issue comes in this scheme one hour after the time of observation, its reports will be available in good time for all countries. This should render cable messages unnecessary, except to those countries which require supplementary reports from a larger number of stations than that included in the wireless issue.

#### **The Radio-Telegraphic Inquiry into the Location of Thunderstorms.—**

This inquiry arose out of the success attained during the war by the direction-finding wireless stations of the Admiralty in locating the position of thunderstorms by determining the direction from which the radio disturbances created by a storm were received. The inquiry was directed by Mr. R. A. Watson Watt, Meteorologist-in-Charge, South Farnborough, who has made a special study of radio-telegraphy. Mr. Watt had devised a simple direction-finding instrument suitable for the purpose and a programme had been approved for installing five sets of these instruments at suitable localities.

The method, however, was not entirely satisfactory and in his report last year Mr. Watt wrote :

"The thunderstorm inquiry can only reach a satisfactory stage when it is prosecuted as a sub-section of a research into the origin, nature, and travel of radio-telegraphic strays in general, and this wider research must depend for success on a collateral study of the deviation and perturbations of the artificial wave trains emitted by radio-telegraphic transmitters."

About the same time the Radio Research Board of the Department of Scientific and Industrial Research had appointed a Sub-Committee

to investigate the subject of *Atmospherics*, which reported that in their opinion the work of the *South Farnborough Wireless Station* should not be limited to work on thunderstorm location, but should be extended to include investigations of all phenomena connected with *atmospherics*, so far as the apparatus and personnel at present at the Station would allow.

On 26th July, 1920, the Department of Scientific and Industrial Research inquired whether the Air Council would be prepared to extend the scope of the investigations in the manner suggested.

After full consideration of the position the Meteorological Committee advised the Air Council that the proposed extension could not be satisfactorily prosecuted by the Meteorological Office, because the methods to be employed needed specialised knowledge of the technique of radio research, which is outside the sphere of meteorology, and the expense involved was not justified in present circumstances from a purely meteorological point of view. They expressed, however, their great interest in the proposed researches, which ultimately may have important meteorological significance, and suggested that the radio station at South Farnborough should be transferred to the Radio Board for the investigations. The Air Council accepted this view and offered to second Mr. Watson Watt and his assistant, Mr. Herd, to the Radio Board, and to transfer with them the buildings at South Farnborough which had been used for the thunderstorm inquiry. This offer was accepted by the Scientific and Industrial Research Department and at the end of the year arrangements for the transfer had been made.

The instruments devised for the location of thunderstorms will be used for that purpose at the out stations of the Office as opportunity offers, but further research on the general problems presented by *atmospherics* will be conducted by the Radio Board instead of by the Meteorological Office.

**Meteorological Reports from Ships at Sea by Wireless.**—Before the war arrangements were in operation for the transmission of wireless reports from ships in the North Atlantic, but these naturally fell through as soon as war was declared. It was the desire of the Meteorological Office to recommence the service as soon as possible after the establishment of peace, but before doing so it appeared desirable to devise a new code for transmitting the reports, as the one in use before the war did not admit of the despatch of all the information now considered necessary.

A panel of the Marine Sub-Committee was appointed to consider the question and they recommended a simple code which incorporated a check system, which makes it possible not only to detect errors of transmission but to correct them if the message is not too badly mutilated.

Many nations are interested in wireless weather messages from ships at sea, and in spite of the delay entailed it was considered desirable to place the new code before the International Commission for Weather Telegraphy which met in London during September, 1920, before bringing it into use. The Commission proposed a few small alterations in the code, and resolved that, subject to the approval of the Commission for Marine Meteorology, it should be recommended to the International Meteorological Committee for adoption.



In the meantime, arrangements have been made for a number of British ships on the Atlantic route to use the modified code experimentally for a few months in order that practical experience may show any defects which could then be corrected before the code is finally submitted for adoption by the International Committee.

**Porton.**—In a letter dated 13th October, 1920, the Secretary to the War Office informed the Air Ministry that the Treasury had sanctioned a Civilian Scientific staff for the Experimental Station at Porton which included three meteorologists. The letter stated that the Army Council were of opinion that the best way to ensure the close liaison with the Meteorological Department which the work at Porton necessitated, could be obtained by the personnel for these appointments being members of the Meteorological Department seconded by the Air Council for a tour of duty at the Station.

Although this proposal was inconsistent with the policy of a unified Meteorological Service which should undertake and supervise all meteorological services for Government Departments, it was considered that as the War Office had already made financial provision for the personnel concerned, and were desirous of close co-operation with the Meteorological Office, the men required should be seconded as desired. Treasury sanction for the proposal was sought and obtained and three meteorologists were seconded for work at Porton.

The question of providing subordinate meteorological staff to carry on the work at Porton was under consideration at the end of the year under review.

**Meteorological Office, Edinburgh.**—As from the 1st April, 1920, a fundamental change was made in the relationship between the Meteorological Office, Edinburgh, and the Meteorological Office, London. Prior to that date the Edinburgh Office had been organised as part of the Scottish Meteorological Society and had been administered in accordance with a schedule of regulations dated April 30th, 1913, embodying an agreement between the Scottish Meteorological Society and the Meteorological Committee. This schedule of regulations is printed in the Minutes of the Meteorological Committee, Minute 393, 30th April, 1913, from which the following important clauses have been extracted.

*Extracts from "Regulations for Meteorological Office, Edinburgh."*

1. The objects of the Office are :—
  - i. The collection of trustworthy meteorological statistics from municipal and voluntary stations in Scotland and the preparation of summaries for the Meteorological reports issued by Government, and for the statistical reports of the Registrar of Births, Deaths, and Marriages for Scotland.
  - ii. The supply of meteorological information in reply to inquiries.
  - iii. The promotion by all available means of public technical instruction in meteorology and of the applications of meteorological science in the interests of the public health, of agriculture, fisheries, and other industries.
  - iv. The promotion of meteorological researches, including researches on an international basis, which depend on the organisation and compilation of observations.
2. £100 a year is now paid to the Society by H.M. Treasury on account of the Registrar-General for Scotland. In addition to the sum the Meteorological Committee will allocate from the grant placed at their disposal

by Parliament a sum of £350 for the service of the Edinburgh Office, which will be paid to the Society in quarterly instalments by the Meteorological Committee.

3. The grants will be administered by a Committee consisting of :—

The Director of the Meteorological Office.

One member appointed by the Board of Agriculture for Scotland.

One member appointed by the Registrar-General for Scotland.

Three members appointed by the Scottish Meteorological Society.

The Director of the Meteorological Office will preside at meetings of the Committee which he attends, and the Society will appoint one of its representatives to be chairman in his absence.

5. Out of the grant of £450, not less than £250 shall be applied in payment of the salary of an officer who will act as Superintendent of the Office.

7. The staff of the Office will be appointed by, and be subject to dismissal by the Society.

15. These regulations may be modified as regards the arrangements for the administration of the Meteorological Office in Edinburgh and the co-operation of that Office with the Meteorological Office in London, by agreement between the Meteorological Committee and the Scottish Meteorological Society.

In 1920 there was considerable danger of the Meteorological Service of Scotland lapsing owing to the lack of funds of the Scottish Meteorological Society, and strong representations were made to London for further help. The whole position was discussed at a meeting of the Committee for the Meteorological Office, Edinburgh, held on 16th April, 1920, Sir Napier Shaw being in the chair. A new agreement between the Meteorological Committee and the Scottish Meteorological Society was drawn up which was subsequently confirmed by the Meteorological Committee at their meeting held on 28th April, 1920. The agreement is reprinted as an Appendix to this Report (page 71). It will be seen that under this agreement the Air Ministry assumed control of full financial responsibility for the Edinburgh Office as from 1st April, 1920, a purely advisory Committee being appointed to assist in directing the work.

At the same meeting of the Meteorological Committee the following Resolution was adopted : " Dr. A. Crichton Mitchell, Superintendent of Eskdalemuir, to be lent to act as Superintendent of the Edinburgh establishment for two years from 1st April, 1920, with special reference to the organisation of the work in Edinburgh and in Shetland in conjunction with that at Eskdalemuir."

Throughout the year under review the meteorological work in Scotland has been successfully carried out under these arrangements, and I would like to record my high appreciation of the work of Dr. Crichton Mitchell. Owing to heavy press of work in London consequent on the transitional state of the Meteorological Office, it has been impossible for the Director to give the same personal attention to the changes in Scotland as might have been possible in more normal times. Dr. Mitchell, almost unaided, has not only successfully carried on his duties as Superintendent of the Eskdalemuir Observatory, but has made all arrangements for establishing a geophysical observatory at Lerwick, and started the Meteorological Office, Edinburgh, on its new course to the entire satisfaction of the many interests concerned.

Almost immediately after the Air Ministry took over the control of the Edinburgh Office, the lease of the rooms occupied by the Scottish Meteorological Society at 122, George Street, Edinburgh, came to an end, and it was necessary to find a new home for the Office. The

Office of Works successfully accomplished this by providing 10, Rothesay Place, which, however, is only held on a yearly lease.

**Meteorological Committee for Scotland.**—While the Edinburgh Meteorological Office was under the Scottish Meteorological Society the grants were administered by a Committee consisting of:—

The Director of the Meteorological Office.

One member appointed by the Board of Agriculture for Scotland.

One member appointed by the Registrar-General for Scotland.

Three members appointed by the Scottish Meteorological Society.

When the complete control of the Office was taken over by the Air Ministry it was felt that this Committee should be enlarged and that its functions should become advisory. With this end in view, paragraphs 6 and 7 were included in the agreement between the Scottish Meteorological Society and the Meteorological Committee referred to above and printed in Appendix 1.

As the result of discussions in the Meteorological Committee and correspondence with the Scottish Office it was decided that two members representing the Scottish Universities should be added to the suggested Committee and the terms of reference slightly modified.

The constitution of the Committee and its terms of reference as finally decided upon are as follows; (*vide* Air Ministry letter to the Scottish Office No. B.11304 dated 24th June, 1920, and subsequent correspondence):—

1. There shall be an Advisory Committee for the Edinburgh Meteorological Office, of which the Director shall be Chairman, which shall include:—

1 member	nominated by the	Board of Agriculture for Scotland
1	"	" " Fishery Board for Scotland.
1	"	" " Scottish Board of Health.
1	"	" " Royal Society of Edinburgh.
1	"	" " Royal Society of London.
1	"	" " Scottish Meteorological Society.
2 members	"	" " Scottish Universities.

2. The Committee shall meet at least once a year and shall have power to submit to the Meteorological Committee any proposals for the development of meteorological science.

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

Nomination to the re-organised Committee had not been completed at the end of the year under review.

**Conference at Bergen.**—On the 13th May, 1920, Prof. V. Bjerknes, the Director of the Geophysical Institute, Bergen, wrote to Sir Napier Shaw inviting four or more British meteorologists to visit Bergen, to study a new method of forecasting recently developed by himself and his students. The Bergen Steamship Company, by way of marking its appreciation of the advantages accruing to shipping interests from the prosecution of such researches, promised to provide free passages both ways for the members of the visiting party. The invitation was accepted, and on July 17th, Sir Napier Shaw, Director Meteorological Office; Colonel Blandy, Controller of Communications;



Major Goldie, Superintendent of Distributive Stations; Captain Douglas, Professional Assistant Forecast Division and Mr. L. F. Richardson left England for Norway.

The delegation reached Bergen on the morning of July 19th, and various members left Bergen on dates between July 27th, and August 4th.

The results of the visit were of great importance, the discussions embracing both the theoretical and practical aspects of the new method of forecasting which has arisen out of the researches of Professor Bjerknes. From these it appears that the phenomena of the weather of the Northern Hemisphere are largely dependent upon the surface of junction of polar and equatorial air which can be detected at the earth's surface as a line of discontinuity in the conditions of pressure, temperature, wind direction and force, humidity and visibility. On the return of the delegation the proceedings of the conference were set out in a paper which is of great value to the forecasting staff of the Office.

**International Meteorology.**—The third meeting of the Commission for Weather Telegraphy under the Presidency of Lieut.-Colonel E. Gold, D.S.O., F.R.S., was held at the Air Ministry on November 22nd–27th, 1920. Many important questions, dealing chiefly with the form of the codes for the international exchange of weather messages, and with the times for the issue of broadcast synoptic messages by wireless telegraphy, were discussed.

The recommendations of the Commission will be considered by the International Meteorological Committee which meets in London during September, 1921.

The members of the Commission were entertained at lunch on Thursday, November 25th, by His Majesty's Government, the Marquis of Londonderry, the Under Secretary of State for Air, being in the chair.

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

Bergen, Geophysical Institute; Tromsø, Geofysiske Institut; Brussels, Société belge d'Astronomie; Dartmouth, R.N. College; London, Imperial College of Science and Technology; Bordeaux, Observatoire; Paris, Service Météorologique de la Navigation Aérienne, Service Météorologique Agricole, Service Météorologique Militaire; Rome, Ufficio Centrale Idrografico; Lausanne, Geophysical Institute; Ottawa, Department of Marine and Fisheries; Austin, Texas State Board of Health; New York, Public Library.

Exchange of publications has been arranged with:—

Prague, Institut für Kosmische Physik; Kobe, Imperial Marine Observatory.

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

Helsinki, Vattion Meteorologinen Keskuslaitos; Cracow, Astronomical Observatory; Lemberg, Technical High School; Varsovie, Institut Météorologique; Aachen, Meteorologisches Observatorium; Aachen, Erdbenstation; Berlin, Meteorologisches Institut, Institut für Meereskunde, Wetterbureau;

Bremen, Meteorologisches Observatorium ; Darmstadt, H. Landesamt für Wetter und Gewässerkunde, Physikalisches Institut ; Dresden, Landes Wetterwarte ; Friedrichshafen, Drachenstation am Bodensee ; Giessen, Physikalisches Institut ; Gotha, Petermann's Mitteilungen ; Göttingen, Geophysikalisches Institut ; Halle, Akademie der Naturforscher ; Jüchenheim, Erdbebenwarte ; Leipzig, Universitäts Bibliothek ; Lindenberg, Aeronautisches Observatorium ; Munich, Geophysikalisches Observatorium ; Potsdam, Meteorologisch-Magnetisches Observatorium, Centralbureau der Internat. Erdmessung ; Stuttgart, W. Statistisches Landesamt ; Wilhelmshaven, Marine Observatorium ; Strassbourg, Service Météorologique ; Pola, Ufficio Idrografico ; Trieste, R. Istituto Geofisico ; Innsbruck, Institut für Kosmische Physik ; Kremsmünster, Sternwarte ; Vienna, Ost. Gesellschaft für Meteorologie ; Budapest, M. Kir. Orszagos Meteorologiai es Foldmagnessegiz Intezet ; Kalocsa, Haynald Observatorium ; Brno, Meteorological Institution ; Prague, Universitäts Bibliothek, Meteorological Institute ; Sofia, Institut Météorologique Central ; Cernanti, Institutul de fizica cosmica ; Zagrebu, Kr. Zem. Zavod Za Meteorologiju i Geodinamiku ; Beirut, American University Observatory.

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

**PERIODICAL.**—**The Daily Weather Report** issued in three sections [to date].

1. The British Section.
  2. The International Section.
  3. The Upper Air Supplement.
- (For further particulars *see* page 37).

**Monthly Meteorological Charts of the North Atlantic Ocean** [to date] (*see* page 31).

**Monthly Meteorological Charts of the East India Seas** [to date] (*see* page 31).

**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 January, 1921].
- Part III. (2).—**Geophysical Journal**. Daily Readings in meteorology and terrestrial magnetism, and the results of observations in the upper air [to December 1919].
- Part IV.—**Hourly Values from Autographic Records**. Hourly values for terrestrial magnetism, atmospheric electricity and meteorology for five Observatories. [Volume for 1917 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. [Tables for 1916 issued.]

(For further particulars *see* page 45.)

**British Rainfall, 1919**. A report on the distribution of rain in space and time over the British Isles during the year 1919 as recorded by about 5,000 observers.

**Observer's Handbook**, 1921 edition.

**Calendar** with notes and diary of operations for the use of observers for 1921.

**The Meteorological Magazine** [to date]. (*See* pages 45, 52.)

**OCCASIONAL.—The Computer's Handbook.** Second edition. Introduction. C.G.S. Units of Measurement in Meteorology with their Abbreviations and Equivalents. Section II, Sub-Section 1. The Computation of Wind Components from Observations of Pilot Balloons and Shell Bursts.

**The Book of Normals of Meteorological Elements of the British Isles.** Section III. Maps of the Normal Distribution of Temperature, Rainfall and Sunshine.

**Meteorological Corrections for the Use of Gunners.** By D. Brunt, M.A., B.Sc. and J. Durward, M.A.

**Geophysical Memoirs :—**

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

**Professional Notes :—**

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

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

**Vol. II :—**

No. 11. Notes on the Ground Day Visibility at Cranwell, Lincolnshire during the period February 1—April 8, 1920. By W. H. Pick.

No. 12. An Analysis of the Rate of Ascent of Pilot Balloons. By R. P. Batty.

No. 13. A Report on two Pilot Balloon Ascents at Shoeburyness. By N. K. Johnson, B.Sc., A.R.C. Sc.

No. 14. Tables of Frequencies of Surface Wind Directions and Cloud Amounts at Metz, Mülhausen, Karlsruhe and Frankfurt. By D. Brunt, M.A., B.Sc.

No. 15. Diurnal Variation in Wind Velocity and Direction at different Heights. By J. Durward, M.A.

No. 16. The Use of Light Filters in the Observation of Pilot Balloons. By R. A. Watson Watt, B.Sc.

No. 17. Report on the Thunderstorm which caused the disastrous Flood at Louth, 29th May, 1920. By E. V. Newnham, B.Sc.

**Meteorological Charts of the Southern Ocean** between the Cape of Good Hope and New Zealand.

**Report of Proceedings of International Meteorological Conference at Paris, 1919.**

**Minutes of Third Meeting of the Commission for Weather Telegraphy.**

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.

**Marine Observer's Handbook,** Third edition.

**Meteorological Office Forecast Code.**

**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.

**Hurricanes and Tropical revolving Storms.** By Mrs. E. V. Newnham.



**Professional Notes.**

- 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 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 the Climatological Screen at Valencia Observatory and that in a Stevenson Screen exposed in an open field. 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.

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

By Sir Napier Shaw, F.R.S.—

Pioneers in the science of weather. Q.J., R. Met. Soc., 46, 1920, pp. 141–153.

By W. H. Dines, F.R.S.—

Atmospheric and Terrestrial Radiation. Q.J., R. Met. Soc., 46, 1920, pp. 163–171.

The Ether Differential Radiometer. Q.J., R. Met. Soc., 46, 1920, pp. 399–405.

By Dr. Charles Chree, F.R.S.—

A Comparison of Magnetic Declination Change at British Observatories. London, Proc. R. Soc., 98A, 1921, pp. 411–14.

Magnetic Observations at Kew, May, 28–30, 1919. Terr. Mag., 25, 1920, pp. 175–6.

By F. J. W. Whipple, M.A.—

Notes on the Robinson Anemometer. London. Rep. Adv. Comm. Aero., 669, 1920, pp. 10, 3 figs.

By C. E. P. Brooks, M.Sc. and H. W. Braby, M.A.

The Clash of the Trades in the Pacific. Q.J., R. Met. Soc., 47, 1921, pp. 1–11.

By C. E. P. Brooks, M.Sc.—

The Meteorology of Nassau, Bahamas, 1892–1919. Q.J., R. Met. Soc., 47, 1921, pp. 59–62.

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

By Harold Jeffreys, M.A., D.Sc.—

On Turbulence in the Ocean. Phil. Mag., 39, 1920, pp. 578–586.

Tidal Friction in Shallow Seas, London. Phil. Trans., R. Soc., 221A, 1920, pp. 239–264.

On the Relation between Wind and Distribution of Pressure, London, Proc. R. Soc., 96A, 1919, pp. 233–249.

By Lewis F. Richardson, B.A.—

Some Measurements of Atmospheric Turbulence, London. *Phil. Trans. R. Soc.*, 221A, 1920, pp. 582-610.

The Supply of Energy to and from Atmospheric Eddies, London. *Proc. R. Soc.*, 97A, 1920, pp. 354-373.

Sun-flash balloons for continuous signalling. *Q.J., R. Met. Soc.*, 46, 1920, pp. 293-294.

By Captain C. K. M. Douglas, B.A.—

Thunderstorms in Scotland and their probable explanation. *J. Scot. Met. Soc.*, 18, 1921, pp. 143-154.

Clouds as seen from an Aeroplane. *Q.J., R. Met. Soc.*, 46, 1920, pp. 233-242.

At the end of the year, arrangements were completed for passing all requisitions for printing, binding, etc., through the Stationery branch of the Air Ministry, instead of sending them direct to H.M. Stationery Office as previously, and the new procedure came into effect on 1st April, 1921.

**Staff.**—The Office has lost the services of Mr. L. F. Richardson, B.A., who resigned his appointment at Benson in September, 1920, in order to take up a teaching post at the Westminster Training College.

The results of the experimental work upon which Mr. Richardson was engaged while at Benson are being published in *Professional Notes*. Mr. Richardson is also about to publish through the Cambridge University Press, the results of his work on *Forecasting by Numerical Process*.

Miss E. F. Walker, M.Sc., Mrs. E. V. Newnham, M.Sc., and Mr. J. Logie, M.A., B.Sc., whose names appear in the staff list for last year among professional assistants have resigned their appointments. The retirement of Mr. H. Harries was referred to in the report for last year. Miss E. E. Austin has been seconded to the Imperial College of Science for duty under the Professor of Meteorology, and Mr. N. K. Johnson, B.Sc., to the War Office for duty at Porton.

The Professional staff has thus lost the services of seven members in the grades of Assistant Superintendent and Professional Assistant and thirteen new appointments have been made in these grades during the year, bringing the number of posts filled up to fifty-six out of a total of eighty posts for which sanction has been given.

Mr. J. A. Curtis who had retired in 1914 after completion of 45 years service with the Office, but rejoined the staff during the war in his old position as Cashier, retired in November, by which date arrangements had been completed for the Financial Branches of the Air Ministry to take over the administration of the Office Finances. Mr. Curtis's connection with the Office had thus covered a period of fifty-one years. His long experience of the Office was invaluable in settling the many intricate points of detail which had to be adjusted during the process of transfer, and I take this opportunity of putting on record the appreciation of Sir Napier Shaw, and myself, of his services.

The Office has lost the services of another old servant in Mr. A. R. Simpkins, who retired at the end of 1920 on attaining the age of 65 years. Mr. Simpkins joined the Office in September 1876, and served the greater part of his time in the Forecast Division. He was transferred to the Climatology Division in 1913 and was promoted to a Principal Clerkship upon the retirement of Mr. J. Shearman at the end of 1919.

It is with great regret that I chronicle the death of Mr. F. L. McCreary in June. Mr. McCreary joined the Office staff on 4th May, 1920, and was attached to the station at Renfrew. He lost his life through an accident while attempting the ascent of Ben Lomond while on leave.

Much difficulty has been experienced in securing technical staff possessing the required educational qualifications to carry on the work at out stations, as the restriction that candidates must be drawn from ex-service men severely limited the field of selection. The total number of clerical, technical and unclassified posts on the establishment is 278, of which only 182 were filled at the commencement of the financial year. By the end of the year the number had been brought up to 213, leaving 65 vacancies still to be filled. There has been a considerable number of voluntary retirements among the clerical and technical staffs—in most cases with a view to taking up more favourable appointments under other departments of the Government. It seems inevitable that such losses will continue to be incurred while the terms of appointment under this Office remain, as they are at present, distinctly less favourable than those which prevail in other departments of His Majesty's service where work requiring similar qualifications is done. The tendency is also unavoidable for the most capable members of the junior staff to be thus attracted elsewhere. This question has been under discussion with the Establishment Divisions of the Ministry and I trust that a satisfactory solution of the difficulty may be found at an early date.

**Rates of Pay for Women Professional Assistants.**—In a letter dated 31st August, 1920, the Treasury ruled that the rates of pay for new women entrants to the grades of Professional Assistants should be :

Senior Professional Assistants . . . . . £200—15—300

Junior Professional Assistants . . . . . £150—10—200

The corresponding rates for men are £250—15—350 and £175—15—235 respectively.

**Care of Meteorological Buildings.**—It was arranged during the year that the Director, Works and Buildings, Air Ministry, should assume charge of all the works and buildings appertaining to the Meteorological Office except those housing headquarters staff, which will remain with the Office of Works.

Under this arrangement, His Majesty's Office of Works has assumed responsibility for the premises occupied by the Meteorological Office at South Kensington, and at 62, Camden Square, and in future the rent and maintenance of these buildings will form a charge against the Vote of the First Commissioner of Works.

All remaining buildings, including Kew Observatory and the Edinburgh Meteorological Office, will be maintained by the Director of Works and Buildings, Air Ministry, but the cost of the maintenance and of any new buildings will be provided in the Meteorological Office Vote (Vote 8G).

**Finance.**—The year under review, 1920–21, is the first 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 approximate figures:—



**EXPENDITURE ON METEOROLOGICAL  
OFFICE 1920-21. (Approximate).**

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H.Q. STAFF (including South Kensington and British Rainfall Organization):—		
Salaries etc. . . . .	£53,780	
		<u>£53,780</u>
OUT STATIONS :—		
Salaries and Wages . .	31,920	
Rent, Fuel, & Incidentals	1,080	
Buildings . . . . .	825	
Kite Balloons { Cover . . £780		
{ Maintce. £460		
	1,240	
Aux. Met. Stns. Telegraphic	1,070	
Subventions . . . . .	400	
		<u>36,535</u>
MISCELLANEOUS :—		
Instruments and Stores	6,000	
Superannuation . . . .	1,555	
Transport and Subsistence	1,220	
Postage, Telephones, etc.	1,760	
Brit. Rain. Organization (Sundry Expenses) . .	30	
Atmospheric Pollution Expenses	400	
		<u>10,965</u>
		<u>£101,280</u>

**RECEIPTS FOR 1920-21. (Approximate).**

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Instruments and Carriage	£4,000	
Daily Weather Reports, Harvest forecasts, publications, information supplied, telegraphic and telephonic charges repaid . . . . .	2,000	
National Debt Office (Annuities) . . . . .	472	
Royal Society (Rosse and Gassiot Funds) . . . .	773	
		<u>£7,245</u>

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Separate Reports from the Officers-in-Charge of the following Services are given below :—

Marine Division ; Forecast Service, Headquarters Division ; Forecast Service, Local Centres Division ; Climatology Division ; Instruments Division ; Army Services Division ; Advisory Committee on Atmospheric Pollution ; British Rainfall Organization ; Meteorological Office, Edinburgh ; Kew Observatory ; Eskdalemuir Observatory ; Valencia Observatory ; Benson Observatory ; South Farnborough Station ; Falmouth Observatory ; Armagh Observatory ; Southport Observatory.

## MARINE DIVISION.

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

On April 1st, 1920, the staff of the Marine Division was increased, and by 8th June it was brought up to the full sanctioned strength.

On April 1st the Division was re-organised, and much time has been taken in building up and perfecting the new organisation to meet modern requirements.

The personnel was sub-divided into three sections, viz :

Section A.—Administration.

Section B.—Data Extraction and Research.

Section C.—Charting and Codes.

**Voluntary Observing Fleet and Observers.**—At the commencement of the year there were 104 ships equipped with full sets of office instruments, of which 19 had not contributed logs for 12 months or more ; and 117 ships were observing with the ships' instruments, and returning Forms 121, 122, and 121A (Ocean Meteorological Reports).

Active steps were taken during the first half of the year to enlist the voluntary co-operation of the Mercantile Marine in keeping four-hourly meteorological logs ; these met with such response that it was necessary to decline many offers in order to spread the available instruments amongst ships working on the most suitable routes.

By the end of October, 133 British merchant ships were equipped with sets of instruments, and nine H.M. Ships with Admiralty instruments had undertaken to keep logs.

It was then found that the number of logs these yielded was as many as the Division could cope with under the new system of data extraction ; in fact it may be necessary to slightly reduce this number.

In order to obtain information of weather in all parts of the navigable seas, and to encourage interest in Marine Meteorology in its bearing on navigation, the use of the Ocean Forms (121A) is being steadily increased, and in this connection the postcard method of obtaining barometer corrections has been worked up.

We now have, on 31st March, 1921, 133 ships equipped with instruments keeping logs, and 216 keeping Forms 121A with ships' instruments ; these include twenty-four ships under foreign ensigns, there being U.S.A., Dutch, and Japanese. Owing to depression of freights recently, many ships have been laid up. There are only two ships remaining in the observing fleet who have not returned a log within a reasonable period.

Since 1st May, 1920, from 21 to 24 cross-channel and coastal steamers have been equipped with thermometers, and are making regular telegraphic reports.

The observation of sea and air temperatures round the British coasts had necessarily been largely discontinued during the war. This service has been re-organised, and at forty-two stations, carefully geographically selected, manned by Coastguardsmen, Lighthouse-Keepers, and others, observations are being made twice daily of air and sea temperatures, wind, weather, fog and visibility.

Observations at six West Indian Light Stations, and at Falkland Island Light Station, have been continued.

With a view to training marine observers, the Cadet Training Ships "Conway" and "Worcester" and the Nautical College, Pangbourne, are keeping the Cadets' Meteorological Log.

A tabular statement of the observing fleet and the various documents received during the past year is given on page 33, also the corresponding figures of previous years for comparison.

The experience of the past year has shown that there is a keen desire on the part of the Captains and Officers of the Mercantile Marine to co-operate in the work on practical and seaman-like lines; and when the staff to deal with more observations at Headquarters can be allowed, the number of the observing fleet and the collection of data can be extended indefinitely. We receive much encouragement from sailors, and the notes on applied marine meteorology on the charts appear to be a cause of attraction.

**Obituary.**—It is noted with regret that the following deaths of old observers to the Office have occurred during the year:

Captain James Watt	..	..	Cunard Steamship Company.
Captain J. Pope	..	..	Royal Mail Steam Packet Co.
Captain C. H. Bell	..	..	S.S. "Highland Piper."
Captain R. McKillop	..	..	S.S. "Dunbridge."
Captain F. H. M. Custance,	..	..	S.S. "Araguaya."
D.S.O., R.N.R.			

**Long Service Observers.**—Many of the voluntary observers to the Office have kept a large number of logs, and amongst these should be mentioned: Commander A. J. Coad, R.N.R., Commodore of the Orient Line, S.S. "Osterley," 36 logs; Lt.-Commr. W. S. Shelford, R.N.R., S.S. "Orvieto," 36 logs; Captain W. Stanley, S.S. "Oxfordshire," 26 logs; Captain C. J. Higgins, S.S. "Clan Macgillivray," 24 logs; and Captain F. A. Hemming, S.S. "Rimutaka," 23 logs.

**Excellent Observers.**—A list is appended (page 34) of Captains and Officers, with the names of their ships, who have been awarded "excellent." These awards are now made annually; the presentations being made as before for logs below the character of "excellent" as the logs are received.

Generally the logs received show an improvement in the manner they are kept, and in the interest taken in observation; and notwithstanding the fact that classification has been stiffened, 34 per cent. of the logs have been classed "excellent."

The publications which have been chiefly used for excellent awards are:

Bound volumes of the monthly Meteorological Charts of the North Atlantic Ocean and East Indian Seas for 1920; and Meteorological Charts for the Ocean District adjacent to Cape of Good Hope.

The publications which have been chiefly used for ordinary presentations are:

Monthly Wind Charts of the South Atlantic;  
Monthly Wind Charts for the Coastal Regions of South America;  
Meteorological Charts of the Southern Ocean between the Cape of Good Hope and New Zealand;



Meteorological Charts of the Red Sea ;  
 Charts showing the Surface Temperature of the Atlantic,  
 Indian and Pacific Oceans ;  
 Monthly Current Charts for the Atlantic Ocean ;  
 Monthly Current Charts for the Indian Ocean ;  
 Quarterly Current Charts for the Pacific Ocean ;  
 Meteorological Charts of the Mediterranean ;  
 The Barometer Manual ;  
 The Seaman's Handbook of Meteorology ;  
 The Marine Observer's Handbook ;  
 The Meteorological Glossary ;  
 The Weather Map ;  
 Weather of the British Coasts.

**Marine Agencies and Port Meteorological Officers.**—Owing to the very heavy press of work of certain Board of Trade Examiners, due largely to an accumulation of candidates over the war period, these gentlemen have been in some cases unable to give the necessary attention to the work of the Office. Meanwhile, however, the Marine Department of the Board of Trade have permitted nautical surveyors to relieve these gentlemen. Captain F. W. Bate, O.B.E., R.D., R.N.R., Nautical Surveyor, has taken over the Agency at Southampton (April 1920) ; Captain G. A. Williamson, Nautical Surveyor, has similarly taken over the Agency at Hull, August, 1920, and Captain A. H. Raymer, Nautical Surveyor, at Sunderland in November, 1920.

Lieut.-Commr. G. ff. H. Lloyd, R.N.R., late Chief Officer, R.M.S. "Trent," who served during the war in command of H.M. Destroyers "Cynthia" and "Roebuck," and who kept meteorological logs before the war as an officer in the Royal Mail Steam Packet Company's and Messrs. Elder, Dempster & Company's services, has been appointed Senior Professional Assistant and Port Meteorological Officer. Lt.-Commr. Lloyd will take up his duties at the Port of Liverpool at the commencement of the next financial year, relieving Commr. F. M. Sergeant, R.D., R.N.R., Senior Examiner of Masters & Mates, who has acted as Marine Agent at Liverpool since 1909 with great zeal and success.

By arrangement with the Admiralty, Lt.-Commr. S. Robinson, R.N., Superintendent of Admiralty Chart and Chronometer Depôt, Hong Kong, has been appointed marine agent at that port.

By arrangement, through the High Commissioners in London, with the Director of the Canadian Meteorological Service, T. S. H. Shearman, Esq., has been appointed marine agent at Vancouver, B.C., and the Commonwealth Meteorologist at Melbourne has undertaken the direction of a marine agency in Australia.

**Classification of Logs, Data Extraction and Research.**—The Sub-Committee on Marine Meteorology on which the Admiralty, Board of Trade, Meteorological Office, and Royal Society are represented, have considered the work of the voluntary observing fleet and the Marine Division ; and the following represents the more important results :

The large number of logs stored in the Division, which had not been used in the preparation of Charts and Publications, gave ample proof that it was of little use, and at the same time extravagant, indiscriminately to collect observations made with tested instruments.

Therefore, commencing from 1st April, 1920, a new system of data extraction has been in operation. At the same time the observing fleet for this particular purpose has been kept within manageable limits, thus reducing expenditure on instrumental equipment.

As each log is received, it is carefully examined and classed; logs classed "very good" or above have their barometer, wind, temperature, weather, and surface current values extracted into the data books; and at the same time an index is made of all specially interesting phenomena. The number of logs received during the past year was 204 (see table on page 33); and they have been classed as follows:

Excellent.....	69
Very Good.....	130
Good.....	5

This work of data extraction requires great care and technical knowledge of navigation and observation at sea; and as the future work of the Division depends upon this foundation, much time has been spent in working up the system.

Record of the set and drift of ocean currents experienced has of recent years not been recorded in meteorological logs as fully as is desired. Active steps have been taken to obtain these observations and there is already a marked improvement in the logs; and special attention has been paid to the extraction of these observations, which with the more general use of stellar navigation can be obtained regularly.

From logs received since April 1st, 1920, 72,134 sets of observations have been extracted, which gives an average of 51 sets of observations per man per day, including Sundays and holidays.

Meanwhile the extraction of *old* logs has been continued as far as possible, and 12,198 sets of observations referring to the North Atlantic and the Ocean District adjacent to Cape Guardafui and Sokotra have been extracted.

This system enables the distribution of observational activity to be regulated to some extent.

The Panama Canal has greatly altered shipping tracks, and with a view to obtaining more observations from the Pacific, agencies have been established at Vancouver, Hong Kong and Melbourne.

Much useful data has been received from the Hydrographer of the Navy, and the Division has been able to supply him with some information for Admiralty Charts and Sailing Directions.

In the extraction of data from logs prior to 1st April 1920, Squares 31 and 67, for the month of September, the Hollerith Electrical Sorting and Tabulating Machine has been used as a trial with success. It is hoped that by this means we may be enabled to improve and increase data extraction; as this will relieve the technical assistants of much purely clerical work, and at the same time increase the general output of the Division both with regard to the information for the practical use of navigators and airmen and for the more scientific uses of the meteorologist.

In addition to the data obtained from logs of which the instrumental values are official, much useful data are obtained from Ocean Forms 121A, and are used in connection with the research for providing the articles on the backs of the monthly charts. The data from these forms have also enabled us to answer many enquiries concerning missing ships, etc.

The following are the more important matters of research work that have been undertaken during the year :

*Swell on the Gold Coast.*

*Abnormal Currents*, reported in June 1920, near the Newfoundland Banks.

*Cyclone in the Arabian Sea*, June 7th to 13th, 1920.

*Indraft of Wind* in cyclone, February 1904, in South Indian Ocean.

*Fog in the North Atlantic*, and other weather, in order to prove the utility to navigators of Wireless Weather Reports and Weather Charts at Sea.

*The winds and currents* in the ocean district adjacent to Cape Guardafui, latitude  $7^{\circ}$ — $13^{\circ}$  N., Longitude  $50^{\circ}$ — $57^{\circ}$  E; also the conditions of obscurity of the atmosphere, cloud, sea, and swell, which has enabled us to amend the recommended tracks for steamers from the East, bound homeward, via Suez, during the height of the S.W. Monsoon season.

**Exchange of Data.**—Information regarding ice and derelicts reported in the North Atlantic has been forwarded as received to Lloyds' List for publication.

Information regarding all ice reported in the North Atlantic has been forwarded monthly to the Danish Meteorological Institute.

Ocean current data for selected squares in the North Atlantic for the months of March, April and May 1914 to 1919, have been forwarded to the Dutch Meteorological Institute; also data concerning tropical cyclones in the Indian Ocean.

As the new system of data extraction is developed, it is hoped to materially increase the exchange of data with Dominion and Foreign Services, and to contribute to the Réseau Mondial.

**Information to Navigators, and others interested in weather and climate at Sea, and Ocean Currents.**

Revision of the Monthly Meteorological Charts of the North Atlantic and East Indian Seas has been continued, and these charts are being steadily improved. Articles have been published monthly on applied marine meteorology, particularly with reference to the practical application of weather reports and synoptic charts constructed by navigators at sea; amongst these articles were :

*Wireless Telegraphy and Weather at Sea.*—Weather Charts and how they may be constructed by Navigators and used for forecasting,—Commr. L. A. Brooke Smith, R.N.R.

*Ocean Waves.*—Mr. H. Keeton.

*Local Winds near the Coast.*—Mr. C. S. Durst.

*North Atlantic Weather, July 18th to 20th, 1920.* Some possibilities of W/T weather reports and the synoptic method.—Commr. L. A. Brooke Smith, R.N.R.

*The Ice in the North Atlantic.*—Mr. A. G. W. Howard.

*Currents on the Newfoundland Banks—Ice and Fog.*—Mr. A. G. W. Howard.

*Notes on the Barometer.*—Mr. C. S. Durst.

*The Ice of the Southern Hemisphere.*—Mr. A. G. W. Howard.

*South Pacific Hurricanes.*—Mr. H. Keeton.

*Report on a Cyclone in the Arabian Sea, June 7th to 13th, 1920.* Received from Lieut. A. Taylor, Commanding S.S. "Rotenfels."



*The Laws of Tropical Cyclones, abbreviated, and rules for handling ships in or near them.*—Commr. L. A. Brooke Smith, R.N.R.

The Marine Observers' Handbook has been re-written as a 3rd edition, with the exception of the chapter on optical phenomena, and is now in the hands of the printer. Endeavour has been made to give all the information necessary for observation and log-keeping at sea, concisely and clearly.

The Atlas of Meteorological Charts of the Cape of Good Hope to New Zealand has been revised and published as a 3rd edition.

**Information Required in Connection with the Investigation of Disappearance of Missing Ships, and other Maritime Casualties.**—Considerable time has been devoted to the compilation of data from logs and Forms 121A for the Inquiries Section for the above purpose. It has already been found that the system of data extraction is of material assistance in this connection in reducing the work.

**W/T Reports from Ships at Sea.**—Much time has been devoted to the discussion of codes and instructions for the use of ships in reporting weather to the Office by W/T, and for the exchange of synchronised data between ships at sea.

The code approved by the International Conference on Weather Telegraphy, London, November 1920, which is a modification of that drawn up by Dr. G. C. Simpson, Director of this Office, has been adopted for trial in the North Atlantic, and a register and instructions for its use have been drawn up in the Marine Division. These have been forwarded to the owners of certain Atlantic Liners fitted with long range W/T installations, and they have kindly given facilities; and a trial of the reports is now in operation. The first report was received from R.M.S. "Mauretania," Captain A. H. Rostron, C.B.E., R.D., R.N.R., on March 27th.

It is intended that if this code is found suitable for reporting to the Office, it should be circulated to all ships observing for the Office, to enable them to exchange weather messages, whereby, with little trouble navigators can, if they wish, construct simple but effective weather charts from which they may be able:

1. To forecast weather, which will be valuable, particularly with regard to the avoidance of the dangerous area of the storm field of tropical cyclones.
2. To be prepared for bad weather.
3. To foretell possible spells of settled fine weather and so regulate speed to maintain schedule with economy of fuel.

The importance of the latter will be seen when it is realised that with reciprocating engines the coal consumption varies as the cube of the speed, at the same displacement.

Briefly the ultimate aims are:

1. To collect synchronous data for the Forecast Service.
2. To promote the exchange of synchronous data at sea, whereby navigators may use the synoptic method.
3. When 1 and 2 have been attained, to extend the official forecasts along the trade routes, by exchange of W/T reports between ship and shore, ship and ship, and ship and aircraft.

## Details of Voluntary Observing Fleet and Coast Stations.

	At 31st March.								
	1921	1920	1919	1918	1917	1916	1915	1914	1913
Number of Ships equipped with sets of instruments	133	104	—	—	—	—	192	209	192
No. of H.M. Ships observing ...	9	2	2	—	—	1	3	4	6
No. of ships contributing Ocean Forms, using Ship's Instruments	216	117	7	—	—	—	—	—	—
No. of ships equipped specially for W/T Weather Reports ...	1	—	—	—	—	—	9	11	12
No. of Coast Stations equipped with Instruments for Form 129A.	42	53	52	49	49	58	59	62	61
No. of ships equipped with Instruments for Home Waters Telegraphic Reports. ...	24	—	—	—	—	—	—	—	—
No. of ships with Instruments on board									
No logs for 12 months ...	2	19	—	—	—	—	—	—	—
Number of Barometer (Ships) Errors ascertained ...	365	—	—	—	—	—	—	—	—

## Receipts for the year ended 31st March.

	1921	1920	1919	1918	1917	1916	1915	1914	1913
Meteorological logs ...	204	67	22	59	115	147	224	279	290
Ocean Forms	1068	503	21	144	670	882	1064	1597	1628
Forms 129A	437	381	334	324	340	351	510	682	680
Lighthouse Registers ...	16	12	16	15	14	15	14	15	17
Ocean W/T Reports ...	—	—	—	—	—	20	410	858	783
Home Waters Telegraphic Reports ...	1898	—	—	—	—	—	—	—	—
Cadets									
Meteorological Log ...	6	—	—	—	—	—	—	—	—
New Data Extraction.									
Logs extracted Old Data Extraction.	169	—	—	—	—	—	—	—	—
Logs extracted: N. Atlantic	53	—	—	—	—	—	—	—	—
Ocean District Adjacent to C. Guardafui	411	—	—	—	—	—	—	—	—

*List of Captains and Officers who have been awarded "Excellent."*

Captain	Chief Observing Officer.	Ship
* Allen, Wm.	Hersee, C.	"Port Augusta"
* Boyd, R. L.	Dillon, W. C.	C. S. "Britannia"
Byers, G.	Dowler, J.	"Hunan"
Campos, V., O.B.E., Lt.-Commr., R.N.R.	Muir, A. S.	C. S. "Colonia"
* Cattnach, J. C.	Ratcliffe, L.	"Chindwin"
Chambers, F. W., D.S.C.	Pascoe, J.	"Digby"
* Chave, Sir B., K.B.E.	Roach, W. D.	"Cawdor Castle"
* Coad, A. J., Commr., R.N.R.	Douton, A. R. C.	"Osterley"
* Collyer, R. M. M., Commr., R.N.R., R.D.	Edwards, L. J.	"Nore"
* Cornish, N. P.	Fox Russell, T.	"Matheran"
* Cottell, S. C.	Catchpole, E.	"Port Victor"
Dale, S. G.	—	"Trewidden"
* Diggle, E. G., Commr., R.N.R., R.D.	Thelwell, R. G.	"Caronia"
* Fishwick, A. T.	Roberts, W. G.	"Port Albany"
* Gandy, G. K., O.B.E., Commr. R.N.R., R.D.	—	"Edinburgh Castle"
* Glazebrook, R. C., Lt.-Commr., R.N.R.	St. John, C.	"Orontes"
Glennie, R. W., C.M.G., Captain, R.N.	Sollas, G. W.	"H.M.S. Mutine"
* Griffiths, J. N.	Lt., R.N.	"Bosworth"
* Hall, J.	Campbell, A. F.	"Pretorian"
Hayes, I. J., Commr., R.N.R., R.D.	Leicester, R.	"Orontes"
Hemming, F. A.	St. John, C.	"Rimutaka"
* Henderson, W.	Dee, T.	"Bosworth"
* Higgs, W. G.	Bisley, F. T.	"Batsford"
* Hoad, A. C.	Campbell, A. F.	"Port Macquarie"
* Hodge, W. C.	Leicester, R.	"Port Caroline"
* Horscroft, A.	Lawrey, E. T.	"Conway"
* Hoskins, D. H.	Harris, G. T. C.	"Wangaratta"
	Roberts, W. H.	"Kinfauns Castle"
	Williams, C. H.	"Polglass Castle"
* Hughes, E. G.	Bratt, H. H.	"Trewidden"
* Kemp, T. H.	—	"Lexington"
* Ledsome, J. S.	Church, A. T.	"Hypatia"
Lockyer, H. R. C.	Sitwell, G.	
Matheson, C. G., D.S.O., Commr., R.N.R., R.D.	Robinson, W. N.	"Orvieto"
McKellar, A. W., Commr., R.N.R., R.D.	Burton Davies, J.	"Ruapehu"
Moodie, J.	Scott, R. G.	"Kybfels"
* Parry, H.	Davies, H. H.	"Melita"
Roberts, J., C.B.E., D.S.O., Capt., R.N.R., R.D.	Shaw, R. H.	"Runic"
Schlanbusch, O. V.	Farmer, L. G. A.	"Canopic"
Taylor, A., O.B.E., Lt., R.N.R.	David, H.	"Somme"
* Tingey, W. G. T.	Burton, E. A.	"Rotenfels"
Wallace, W. K.	—	"Frankenfels"
Warrington, A. F. G., F.R.G.S.	Berry, E. J.	"Krasnoiarsk"
Williamson, J. N.	McBride, H. J.	"Teucer"
	Hetherington, H.P.	"Elpenor"
	Cave, L. J.	"Hatarana"
	Beswick, A.	"Atreus"
	Cowperthwaite, W.	

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



## FORECAST SERVICE.—HEADQUARTERS DIVISION.

*Report by Mr. J. S. Dines, M.A., Superintendent.*

**General.**—The final step in the co-ordination of meteorological work at the central office was taken on August 14th when the Naval Meteorological Service was transferred to the Meteorological Office.

On the 23rd April, 1920, a method of making current meteorological information available to the general public by means of a large scale map in one of the ground floor windows of Empire House was introduced. On May 10th a blackboard was added giving latest reports of wind and weather over South-East England and North-East France. A replica of the map was shewn daily at the Aero Exhibition at Olympia in July.

After the disastrous flood at Louth on May 29th a representative of the Forecast Service was despatched to obtain first hand information, and a full report of the occurrence and the accompanying weather phenomena has been issued. (*Professional Notes No. 17.*)

During the summer months special meteorological demonstrations were given at the Crystal Palace War Museum. A fully equipped observing hut was borrowed and pilot balloon ascents made twice a week when conditions permitted.

From the 25th of January, 1921, incoming telegrams have been received by telephone direct from the Central Telegraph Office instead of coming via East Strand Post Office, and a decided saving in time has resulted. The same applies to outgoing messages.

On the 1st March, 1921, the New Code for weather messages, drawn up by the International Commission for Weather Telegraphy at its meeting in London in November 1920, was adopted for British Reports. This has entailed an increase in the observing work at all telegraphic reporting stations, information now being given for visibility, cloud form and height, and humidity.

**Observations Received.**—Surface observations have been received throughout the year from the regular telegraphic reporting stations with the exception of a few occasions when telegraphic communication with Malin Head, Blacksod Point or Stornoway was interrupted. Communication with Castlebay was restored on 18th May, after having been interrupted since 15th December, 1919.

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

Renfrew	Plymouth	Castle Bromwich
Manchester	Shoeburyness	Flamborough Head
	Grain	Berwick

Ross-on-Wye became a contributing station on 1st July, 1920.

Upper wind reports are now being received from all local centres and observatories (19 in all) and observations of upper air temperatures are taken whenever conditions permit at

Baldonnell	Duxford	S. Farnborough
Grain		Andover

From 1st May. reports giving wind, sea and air temperature and weather from mid-channel have been received from cross channel and coasting steamers at different points round the coasts of the British Isles.

**Reports from Foreign Countries.**—The use of wireless for the transmission of synoptic data has increased during the year. Messages were sent out by the following European countries by the close of the year :—

Algeria	France	Poland
Austria	Germany	Roumania
Belgium	Holland	Serbia
Czecho-Slovakia	Hungary	Spain
Denmark	Italy	Sweden
Esthonia	Norway	Turkey

The reports from the nearer Continental countries are received by the Air Ministry regularly, but the more distant ones are less reliable. It has therefore not yet proved possible to dispense with reports transmitted by cable. Foreign countries still find it necessary to receive British Reports in the same way.

**Night Service.**—With the exception of two nights at Christmas the night service has been maintained throughout the year. A chart of the 1h. observations has been prepared and forecasts and duplicated reports based upon it have been issued regularly.

**Distribution of Information.**—The supply of data from Great Britain by wireless has been augmented during the year. Synoptic messages are now issued four times daily from the Air Ministry, picked up by Aberdeen and retransmitted. Information in the synoptic messages has included temperature, humidity and visibility observations since 1st September, 1920, and since the 1st March, 1921, the new Code of M.O. 242 (*Report of the Third Meeting of the Commission for Weather Telegraphy*) has been used.

From the 1st June, 1920, general inferences based upon 7h. and 18h. observations have been issued by wireless from the Air Ministry at 0915 and 2000.

An evening message at 2130 has been issued from Poldhu since 3rd November, 1920, in addition to that at 0930, giving a forecast of conditions over the western seaboard of the United Kingdom.

Many of the reports prepared by the Naval Meteorological Service and issued by wireless telegraphy ceased from 2nd December, 1920 and all meteorological reports issued from Cleethorpes ceased from 11th January, 1921.

Synoptic messages have been transmitted by cable to the following countries :—

Denmark	Italy	Portugal
France	Norway	Sweden
Holland		Switzerland

Upon the unification of the French Meteorological Services the supply of information to Paris was considerably reduced on 1st March, 1921.

Airship weather warnings are now issued by wireless from the Air Ministry instead of via the Admiralty.

Special forecasts and synoptic data have been supplied to aerodromes in connexion with airship flights on several occasions. In particular the trials of the R. 80 at Barrow and of the R. 36 at Inchinnan may be mentioned.

From the 7th March, 1921, a synoptic report containing observations from 22 stations in North-West Europe has been prepared and despatched daily to the Meteorological Office, Toronto.

**Lithographed and Duplicated Reports.**—The Daily Weather Report has been issued throughout the year together with the duplicated A, BB, C, and D Reports.

The Monthly Supplement, previously a four page octavo duplicated report became a two page lithographed publication in August, and in January was enlarged to four pages with a full page chart of pressure-time isopleths for the line Iceland to Gulf of Lyons, as suggested and developed by Professor D'Arcy Thompson.

A small chart of Isallobars was added to the second page of the B report on 1st August.

Correction sheets to the Daily Weather Report for each month of 1920 and for January, 1921, have been prepared and issued, and title pages for each quarter of 1920.

**Gale Warnings.**—During April, 1920, the system of gale warnings was revised. The cones are now lowered only upon direct instructions by wire from the Meteorological Office, instead of being lowered automatically at sunset on the day following that of issue.

On the 1st May all Coastguard stations, hitherto warned via the District Intelligence Officers of the Admiralty, were transferred to the Office list of stations and are now warned direct from the Office. During the year thirteen new stations were added to the list and five taken off.

An examination of the returns from the signal stations showed a steady reduction in the time taken in transmission of the messages during the winter months. In November, 1920, 65 per cent. of the messages issued in the daytime were transmitted and delivered to the recipients in less than 2 hours: in March, 1921, the percentage of such rapid warnings had increased to 90 per cent. For night delivery, the percentage rose from 21 per cent. to 46 per cent.

By arrangement with the Post Office, gale warning messages are now delivered up to 10 p.m. to practically all stations.

The warnings for 1920 have been checked, and the results for the year show that for all districts 77 per cent. were justified by subsequent gales and strong winds. The district results ranged from 58 per cent. in the Southern Part of District I (Scotland North) to 95 per cent. in the Irish Sea.

During the year all warnings of strong winds and gales were sent to the contractors of the Clover Graving Dock Extension at Birkenhead, who found the information of great service.

**Harvest Forecasts.**—The summer of 1920 was on the whole a cool and changeable one with practically no spells of dry weather of very long duration. During the summer Harvest Forecasts were issued daily and were sent to twenty-five subscribers for varying lengths of time, ranging from a few days to three months.

In the summer of 1920 a spell notification was issued whenever conditions appeared favourable for two or three days of fair weather.

Such notifications were issued on twelve occasions to fifty-seven subscribers. Of these subscribers three wished to have notifications during the whole summer, four for three months, and the remainder for shorter periods.



The first spell notification was issued on 2nd June to the subscribers in the South-West and East of England. Apart from slight showers on the East Coast during the night of the 3rd to 4th the weather was fair and the notification justified.

On 7th June a second issue was sent to the Midlands and East of England and Scotland, and fine weather held over the whole area until the 12th when rain fell in all but the Eastern districts.

A notification was sent to all subscribers on 22nd June, but slight rain fell in the East of Scotland on the 24th, and on the following day over England except the South-West districts. The weather, however, did not completely break up and there was considerable sunshine, though accompanied by some rain, for several further days.

One notification only was issued in July and even then the fair weather was only of brief duration. The notification was issued on the 19th, but slight showers were experienced in the Western districts by evening of the 20th and rain generally on the 21st.

The next was issued on 9th August to all districts. Late on the 9th there was rain in the Eastern Counties followed by fairer weather which held until the 15th. In the Midlands there was slight rain on the 12th, but otherwise the weather was dry until the 15th. Unsettled weather with rain at times continued throughout in the North of Ireland.

A spell notification of the 19th August was followed by fair weather on the 20th, but rain fell in the Midlands and Eastern Counties on the 21st, and in Ireland on the 22nd.

On the 25th August a notification was followed by fine weather until the 27th, when a further notification that the fair weather would still continue for some days was issued: the fair dry weather held to the end of the month.

Four days fine weather prevailed after the issue of a notification on the 9th September.

On the 22nd of the same month another was sent to Ireland and the South-West of England, and on the 23rd to the remainder of England. Generally fair dry weather followed in Great Britain until the 30th except that slight rain or drizzle fell locally on the 24th. In Ireland the weather became unsettled by the 24th.

During October two notifications were issued to the South and East of England. One on the 8th was followed by four fine days, and one on the 19th by fair or fine weather to the end of the month, except that rain occurred on the 21st in the South-West.

**Regular Supply of Information to the Press.**—Weather forecasts for issue to the Press have been prepared three times each day with the exceptions of Bank Holidays and Sundays, when the morning forecasts are not issued.

Remarks on the weather of the day over North-Western Europe and a tabular statement of weather experienced at a number of health resorts have been issued each evening. A mid-day issue of the last named report was prepared each week-day from 26th July to 30th September.

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

Inquiries were received by telegram or telephone on 929 occasions and there were 299 personal inquiries at the Press Room.

*Inquiries.*

1919-20			1920-21	
Month	By Telephone and Tele- graph	Per- sonal	By Telephone and Tele- graph	Per- sonal
April	—	—	37	8
May	—	—	83	32
June	—	—	73	17
July	—	—	166	36
Aug.	—	—	86	20
Sept.	—	—	54	13
Oct.	—	—	53	23
Nov.	—	—	72	23
Dec.	24	8	87	42
Jan.	39	10	85	32
Feb.	48	27	66	23
Mar.	43	18	67	30
			929	299

## FORECAST SERVICE—LOCAL CENTRES DIVISION.

*Report by Major A. H. R. Goldie, M.A. (Superintendent).*

The organisation of a system of Local Meteorological Centres has continued and these now number thirteen, most of them in charge of a trained professional meteorologist, assisted by technical staff. The duties of the staff are :—

- To make all the necessary local observations, especially of upper wind, visibility and cloud.
- To collect simple meteorological reports from other places in the area.
- To receive by wireless telegraphy or by ordinary telegram, the necessary collective reports for the preparation of synoptic charts.
- 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	..	..	..	..	..	" " "
MANCHESTER	..	..	..	..	..	" " "
RENFREW	..	..	..	..	..	since 19th May, 1920
PULHAM (Airship Station)	..	..	..	..	..	since 2nd Dec., 1920

*Royal Air Force Establishments.*

Cadet College, CRANWELL .. .. .	throughout the year
School of Aerial Navigation and Naval Co-operation, CALSHOT .. .. .	" " "
Airship Base, HOWDEN .. .. .	" " "
No. 11 (Irish) Group, BALDONNELL .. .. .	" " "
Seaplane Station, FELIXSTOWE .. .. .	" " "
Instrument Design Establishment, BIGGIN HILL .. .. .	" " "
Seaplane Station, CATTEWATER .. .. .	since 11th Aug., 1920
Marine and Armament Experimental Station, ISLE OF GRAIN .. .. .	since 4th Oct., 1920
Airship Station, PULHAM .. .. .	from 31st May to 14th July, 1920

**South-East England.**—An Assistant Superintendent, stationed at Headquarters, has been directly responsible for the preparation and issue of reports in connection with flying in South-East England. During the year the system of special reports for the Air Routes between London and the Continent has been gradually extended and improved. It soon became possible to render these more complete by reason of:—

- a. The issue of hourly collective weather reports by W/T from LE BOURGET for stations in Northern France and from BRUSSELS for Belgian stations, which (on the lines of the British Reports) commenced on 12th and 22nd April, 1920, respectively.
- b. The receipt of the reports by W/T from SOESTERBERG giving conditions on the Dutch coast and at UTRECHT. These commenced on 17th May, 1920, and were revised and increased as from 12th July, 1920. On 1st November, 1920, they ceased again for the winter.

Arrangements were also made for the stations at CROYDON, LYPNE and BIGGIN HILL to measure, by means of small pilot balloons, the height of the cloud in cases where the cloud was lower than 1,000 feet.

Since 12th August, 1920, Ground Signals have been laid out at LYPNE Aerodrome for the benefit of machines arriving in this country; the signals indicate the height of the clouds and the visibility at BIGGIN HILL and CROYDON respectively.

Modifications in the code used for the collective hourly reports took place on 2nd August, 1920, and again on 1st March, 1921. The code now in use is that recommended by the International Commission for Weather Telegraphy (London, November, 1920). The complete scheme of reports is set out in M.O. 2622 (Collective Weather Reports for London and S.E. England) (Revised January, 1921). Briefly, it consists in the issue daily, Sundays included, of collective reports each hour from 07.35 G.M.T. to 16.35 G.M.T., the reports relating to the existing weather conditions 35 minutes earlier, at FELIXSTOWE, CROYDON, LYPNE, 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.



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.

By arrangements with the Admiralty regular reports of an abbreviated nature have been received from the Coastguard Stations at BEACHY HEAD and HYPHE; and by arrangement with Trinity House, reports of Channel visibility have been sent in by the Light Keeper, DUNGENESS.

**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 Aerial Mail Services in Ireland.

The Meteorologist in Charge at CRANWELL has continued to give the regular courses of Instruction in Meteorology at the Cadet College and to act as examiner. Many additional open lectures have been given in the College and at Schools and Institutions in the County. The manuscript of a Class-Book of Meteorology has also been completed.

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

A Distributive Station was opened at RENFREW on 19th April, 1920. This station replaces Springburn Park, Glasgow, as a contributing station and is the terminal station for the Aerial Route London-Glasgow, along which a number of experimental flights were made during 1920. Later on, in order to secure a representative series of reports for this route arrangements were made with the Admiral Commanding Coastguards and Reserves for the staff of the Admiralty W/T Station at GOSWICK to transmit abbreviated weather reports to RENFREW. After some preliminary instruction had been given, the reports commenced on 15th October, 1920.

The stations at HOWDEN and PULHAM have been closely associated with Airship work. The former has been in operation throughout the year, and since July has assisted in the training of the American personnel stationed there. The latter station was open from 31st May to 14th July, 1920, in connection with the taking over of certain Airships from Germany. Again, on 2nd December, the meteorological station was opened when PULHAM became an aerodrome for Civil Airships, and, in addition to the usual advisory work for airship flights, has co-operated in the experiments at the Mooring Mast. In connection with the trials of the Airship R. 80, the Meteorological Station at BARROW-IN-FURNESS was maintained in operation from 6th July to 6th November, 1920, and again from 2nd to 13th February, 1921. From 11th March, 1921, a meteorologist was also specially detailed for work at INCHINNAN, near RENFREW, in connection with the trial of Airship R.36. The stations at MANCHESTER and FELIXSTOWE have continued in operation throughout the year.

On 12th August, 1920, a new station was opened at CATTEWATER Seaplane Station on Plymouth Sound and on 4th October a station was opened at ISLE OF GRAIN (Marine and Armament Experimental Station).

At CATTEWATER, MANCHESTER and RENFREW arrangements have been made for the display of meteorological information to the general public.

**Upper Air Observations.**—The total number of single-theodolite ascents made at the stations during the year was 6,989.

The pilots detailed by the Royal Air Force to make regular flights at BALDONNELL and ANDOVER (UPAVON until 8th April, 1920) for the measurement of temperature and humidity in the Upper Air have during the year made 379 such flights, mostly to heights of 10,000 to 16,000 feet.

**Local Daily Weather Report.**—A special form of chart (M.O. 2375) for a Local Daily Weather Report was prepared and issued in March for use at Distributive Stations. The Report makes provision for the latest synoptic chart, general inference and local forecast, together with latest reports of weather, cloud, visibility and upper wind at neighbouring stations or along aerial routes.

**Miscellaneous.**—Meteorological reports and advice, additional to the normal issues have been given as required at all stations; the greater part, but not all, of this information has been demanded in connection with flying.

Reports on the local weather conditions have been submitted in connection with aviation accidents.

An exhibit and special reports were prepared for the Aero Exhibition at Olympia from 9th to 20th July, 1920, and for the Imperial War Museum at the Crystal Palace.

The Superintendent, as one of the British representatives, attended a Conference with Scandinavian Meteorologists at BERGEN in July, 1920, with a view to studying the special methods recently introduced by Prof. Bjerknes in the Geofysisk Institut there. A detailed report of the proceedings was prepared and duplicated for circulation to all Office Establishments.

Special preparations and investigations have been made in connection with the projected experimental flights of Civil Airships to the Mediterranean.

Col. Scott, a representative of Civil Aviation in Canada, and Lieut. Schiebel, of the Danish Naval Service, were given an insight into the organization of the Division.

**Buildings.**—The new meteorological hut at CROYDON is almost complete. The building at ANDOVER has been ready for occupation since August, 1920.

It has proved impossible to find reasonable housing accommodation at certain Aerodromes in isolated districts, in particular at BALDONNELL, CALSHOT, CRANWELL, HOWDEN and GRAIN. These stations, as far as possible, have been staffed by single men, but cannot be maintained indefinitely unless houses are provided.

**Staff.**—The majority of the staff required have now been provided and trained.

A sad event was the loss of Mr. F. L. McCreary on 9th June, 1920. On that date, having been granted a day's leave, Mr. McCreary set out alone to climb Beñ Lomond. He failed to return and despite diligent search no clue to his disappearance could be obtained until on 4th September his remains were found at the foot of a small precipice.

## CLIMATOLOGY DIVISION.

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

**Organisation.**—The normal work of the Climatology Division is the collection of meteorological observations and of autographic records, the preparation of the several parts of the *British Meteorological and Magnetic Year Book*, and the discussion of all information bearing on climate.

From July 10th, 1920, the Library and Inquiries Section has been incorporated in the Division.

From the beginning of November the name "Climatology Division" has been adopted in place of the former "Statistics Division."

Mr. A. R. Simpkins, Principal Clerk from January, 1920, retired at the end of the year and was succeeded by Mr. A. H. Bell. Mr. Simpkins, who had been in the Office since 1876, had been responsible for the preparation of the *Weekly Weather Report* and, in part, of the *Monthly Weather Report*, since he joined the Statistics Division in 1913.

**Climatology of the British Isles. Distribution of Stations.**—A list of stations in connection with this Office, in which particulars are given of the official publications for which returns have been prepared is issued as a separate circular, Circular 001(J), but for economical reasons this list has not been reprinted since 1919. An alphabetical list of the stations accompanies the Introduction to the *Monthly Weather Report*.

The following table gives the distribution by districts of the stations of different types and also indicates where autographic records are being kept. The list refers to March, 1921 :—

Stations.					Autographic Records.					
	Observatories.	Distributive Stations.	Other Tele-graphic Stns.	Climatological Stations.	Sunshine.	Rainfall.	Wind.	Pressure.	Temperature.	Humidity.
0. Scotland, N...	0	0	4	14	6	0	1	6	0	0
1. " E...	1	0	2	29	11	1	5	2	2	2
2. England, N.E.	0	2	2	17	13	2	4	4	2	2
3. " E...	0	3	2	21	19	3	4	5	3	2
4. " Midlands	0	0	3	36	22	0	0	2	0	1
5. " S.E.	0	7	1	40	31	3	4	6	6	5
London District	1	0	0	8	8	4	2	2	2	1
6. Scotland, W., and Isle of Man	1	1	0	22	13	2	2	3	2	2
7. England, N.W., and N. Wales	0	1	3	34	22	2	3	4	2	1
8. England, S.W., and S. Wales	0	1	2	28	27	2	3	3	2	2
9. Ireland, N. ...	0	0	3	6	4	1	1	3	0	0
10. " S. ...	1	1	2	16	9	2	4	6	2	2
11. Scilly and Channel Isles	0	0	2	2	4	0	1	3	0	0
	4	16	26	273	189	22	34	49	23	20



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, Glasgow 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 Flixton (Suffolk), Lenton Fields (Nottingham), Long Ashton (Somerset), Mursley (Bucks), and Oakwood St. Albans, (Herts.).

Observations at Aberdovey and Walton-on-the-Naze were resumed during the year.

The following stations have been given up during the year :—Dover, New Malden, Reading (Leighton Park), Walton-on-the-Hill, Wilton House (Salisbury), St. Louis Observatory (Jersey), Rousdon (Devon). The station at Wilton House had been maintained by the Earls of Pembroke since about 1866. The Observatory at St. Louis was established by the Society of Jesus in 1894 and had been under the superintendence of the Rev. M. Dechrevrens since its foundation. The Observatory at Rousdon was established by the late Sir C. E. Peek, Bart.; the observer, Mr. Charles Grover, died on February 16th, 1921, in his 79th year and the observations are not being continued.

**Climatology of the Globe.**—A list of the foreign and colonial stations from which documents are received is given in Circular 001.J. In most cases these returns have been examined and summarised month by month. From several stations in Rhodesia, and from Sandakan in British North Borneo, returns have been received for the first time during the year under review.

With the retirement at the close of 1920 of Mr. Edwin C. Hathaway, in charge of Lloyd's Signal Station at Cape Spartel in Morocco, the useful series of meteorological observations which he has maintained there since May, 1893 comes to an end.

For climatological information with regard to most countries the Office depends on publications received in the Library. For many purposes this information has to be worked up, long term averages or frequencies being derived from the daily or monthly values found in the publications. The policy of utilising as far as possible the normal values of the meteorological elements accepted by the official meteorological services directly concerned is now being adopted, however, both as an economy of labour and as tending to consistency.

A Bibliography of climatological data has been undertaken. It includes several thousand entries and is approaching completion. A bibliography of upper air data is in hand.

**Publications.**—The Climatology Division is responsible for the preparation of the periodical publications grouped under the title "The British Meteorological and Magnetic Year Book" and in part for the *Meteorological Magazine*.

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

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

*Part I. Weekly Weather Report.*—Observations at Wilton House, Salisbury, having been discontinued at the end of 1920, the readings at Porton are now utilised for the computation of District Values.

*Part II. Monthly Weather Report.*—The number of stations contributing to the Monthly Weather Report has been increased by the inclusion of the Distributive Stations at aerodromes.

From May, 1920, the measurements of the time during which stars in the neighbourhood of the pole can be photographed, have been supplied by the Royal Observatory, Greenwich, and the results, together with other data, have been incorporated in a new table, Table IVa.

*Part III. (1) Daily Readings at Meteorological Stations of the First and Second Orders. (2) Geophysical Journal.*—No alteration has been made in the form of these publications.

*Part IV. Hourly Values from Autographic Records.*—For the years 1911 to 1913, "Hourly Values from Autographic Records" appeared in two sections. The issue of the first section, which contained hourly values of the meteorological elements, was interrupted by the war, and has not yet been resumed, so that meteorology is only represented by the averages for the months for the several hours. The magnetic tables are still published in full.

The 1917 volume was published in the year under review. For the 1918 volume now in the press a new form is being adopted for the meteorological summaries.

*Part V. Réseau Mondial.*—The first four parts of the Year Book are devoted to British Meteorology. In the fifth part observations from selected stations covering the whole globe in a "Réseau Mondial" are tabulated, material from the library being supplemented when necessary by manuscript returns. The volume of tables for 1910 was issued during the year under review, those for 1911, 1912 and 1913 having appeared previously. The maps for 1910 and the tables for 1914 are now in the press.

*Part VI.*—The issue of a sixth part of the Year Book to include summaries of observations in the Crown Colonies has been approved. The 1920 volume will be the first of the series.

**The Meteorological Magazine.**—The Meteorological Magazine, which incorporates Symons's Meteorological Magazine, the organ of the British Rainfall Organization, and the Meteorological Office Circular contains official notices and other matter likely to be of interest to observers. The magazine is now printed by Messrs. Eyre and Spottiswoode for H.M. Stationery Office and is published on the 16th day of the month.

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

**The Book of Normals.**—Statistics representing the normal climatology of the British Isles have been scattered in various publications hitherto. In the Book of Normals of Meteorological Elements which is now being prepared in Sections the data will be more readily accessible. Section II, containing normals for Rainfall, Temperature and Sunshine for Districts and Section III, containing maps showing the distribution of these elements month by month, have been issued during the year.

**Returns of 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 to the Irish Registrar-General.

**Admiralty Pilots.**—The handbooks issued by the Admiralty for the use of navigators are provided with climatological tables prepared in the Meteorological Office. The text of eleven "Pilots" was revised during the year and tables for 32 stations were prepared in the Division. Tables for sixteen other stations were received from meteorological services abroad and forwarded to the Hydrographer.

**Information for Aeronauts.**—Several special memoranda have been prepared for aeronautical purposes. Among these may be mentioned:—

Aeronautical Gazetteer for British Isles—Meteorological Section—Text and Tables.

Chapter on Meteorology for the Aeronautical Handbook.

Memorandum on the Meteorology of Western Europe and the Mediterranean, for the Airship route, London to Cairo.

Memorandum on the Direction and Force of Strong Winds, at proposed aerodromes between Cairo and Karachi.

A memorandum on the climate of the West Indies (including upper air data) was prepared in answer to several inquiries.

**Training of Observers.**—A party of Naval Ratings detailed for meteorological work on the site of a proposed hill sanatorium in the Straits Settlements attended the Office for training. In this connection a memorandum on the Probable Climate of a Mountain Station in the Straits Settlements was prepared for their use.

**Royal Agricultural Show.**—The Royal Agricultural Show was held at Darlington in 1920. The Office was represented by Messrs. N. H. Smith and C. W. Lamb. A climatological station was established and ascents of pilot balloons were observed regularly. Diagrams representing the correlation between weather and crops in N.E. England were prepared for the exhibition.

**Library.**—Miss E. F. Walker left the Office on July 10th, 1920, and Dr. H. Jeffreys took over the duties of Librarian. At the same time the Inquiries Section was combined with the Library for administrative purposes.

The additions to the Library during the past year include 390 new books and pamphlets. The number of periodicals received has risen to about 200. 4,000 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: the preparation of the cards for books received before 1905 has been continued and the work is now carried as far as "Ross."

A shelf catalogue, for convenience in stocktaking, was commenced in January, 1921. Most of the books in the library have been labelled and the compilation of the catalogue is proceeding.

Arrangements have been made by which members of the staffs of out-stations may borrow books from the library. Previously this privilege had been restricted to Lending Library copies.

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

Wind und Wetter in den Europäischen Gewässern, by W. Koppen; Preparation Météorologique des voyages aériens, by J. Rouch; Meteorology, by R. G. K. Lempfert; Meteorology, by A. E. M. Geddes; The Dynamical Theory of Gases, by J. H. Jeans; A Course of Modern Analysis, by E. T. Whittaker and G. N. Watson; Higher Mechanics, by Horace Lamb.

The last three were presented by Dr. J. E. Crombie. Among those acquired by purchase have been:—

The Oxford Survey of the British Empire, by A. J. Herbertson and O. J. R. Howarth. Vol. I, British Isles, and Vol. III, Africa; The Depths of the Ocean, by Sir John Murray and Johan Hjort; Australian Meteorology, by Griffith Taylor.

**Inquiries.**—The inquiries dealt with during the year were 964 (exclusive of those dealt with by the Forecast Service), of which 742 were by letter and 222 personal. These figures compare with a total of 842 for the previous year, of which 550 were by letter and 292 personal. Those requiring information for legal purposes numbered 211, as against 194 in 1919–20. The total charges made for inquiries amounted to £115 15s. 1d. 491 requisitions for office publications were dealt with.

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## INSTRUMENTS DIVISION.

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

**General.**—This division is responsible for the supply of and accounting for instruments and stores of all kinds issued free to the observatories, local centres and stations maintained by the Office, and to a number of stations and ships of the mercantile marine which forward observations to the Office, either as a voluntary act or in return for a small retainer. Meteorological instruments and stores are also issued on repayment, on demand, to H.M. Ships and Dockyards, to the Army and the Royal Air Force, to Colonial and foreign governments, and also to municipal and private observers in connexion with the Office. In addition the division is at present responsible for the sub-editing of all Office publications and forms as they pass through the press, and the work connected therewith.

**Store Accounts.**—The number of store accounts now kept, each of which details the equipment belonging to the Office at a single station or on board a ship, is 526. The store accounts in connexion with the British Rainfall Organization, have recently been added to those already kept in the division. Each store account has been verified either 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 Finance Department of the Air Ministry where necessary.

**Store at South Kensington.**—The division is housed in the Office building at South Kensington, but the accommodation there is insufficient to receive the whole of the stores held. A number of Stevenson Screens are stored in the new Science Museum building, contiguous to the Office, by the courtesy of the Director of the Science Museum, and a few heavy iron masts and stands for self-recording anemometers are stored at the R.A.F. store depôt at Kidbrooke by arrangement with the Director of Equipment, Air Ministry.

**Accounting Procedure.**—At the request of the Stores Audit division of the Finance Department, Air Ministry, the system of accounting for movements of stores which had been in use since 1917, and had been developed out of previous Office practice, was discontinued on the evening of 30th September, 1920, and replaced by the system which had lately been evolved in the Air Ministry for the use of the Royal Air Force. Owing to the fact that the Sections of Air Votes, under which funds for the provision of stores for the Royal Air Force and the Meteorological Office, are distinct from one another, the use by the Office of the R.A.F. forms and vouchers relating to the new system has occasionally given rise to peculiar difficulties, especially when stores are transferred on repayment from the Office to the R.A.F. or *vice-versâ*. These difficulties have been adjusted as they arose, and on the whole the new system is working satisfactorily.

The new system is well adapted to Store Audit, for which the previous system had not been designed.

**Store Audit and Stocktaking.**—Air Ministry auditors visited the division from 15th to 19th November, 1920, to audit the store-accounts from 1st April, 1920, to date. In connexion with this, a stocktaking was put in hand, and a comparison was made between the actual stock and the ledger balances, the differences being subsequently adjusted with the concurrence with the Store Audit branch. Several improvements in detail in the new method of accounting were suggested by the Audit branch which have in all cases been adopted with advantage.

**Surplus Stores.**—Considerable quantities of the surplus instruments referred to in last year's report have been disposed of by sale to Foreign countries, British dominions and colonies. There are still available large quantities of certain types of instruments, *e.g.*, aneroid barometers, barographs, nephoscopes, sunshine recorders, which are available for sale at prices which compare very favourably with those now ruling.

It has been decided by the Treasury that the instruments and stores deposited at the Office by the Army Meteorological Section at the conclusion of the war should be paid for at the valuation prices assigned in the Office, and a sum of £2,837 6s. 6d. is now due to the War Office on that account.

**Purchase of Instruments and Stores.**—It has been arranged to pass all requisitions for new purchases required for the Meteorological Service to the Director of Contracts, Air Ministry, except in the case of small items, which may be purchased locally. Purchase from contractors is not arranged if the stores required are available in R.A.F. Store Depôts. In that case a system of indent on the appropriate depôt is adopted, and a "vote adjustment," whereby the cost of such supplies is credited to the R.A.F. vote and debited to M.O. vote, is subsequently made in the Finance Department.

Formal specifications have been drawn up where necessary for all instruments and stores ordered through the Director of Contracts.

**Departmental Expenses.**—The basis of the charge for departmental expenses in connexion with the supply of instruments on repayment has been changed to bring it into line with other departments of the Air Ministry.

**Noteworthy Supplies.**—Equipment is being issued to the R.A.F. in Egypt for the establishment of meteorological stations on the Cairo-Karachi Air Route.

Equipment has been issued to a new geophysical observatory to be maintained by the Office at Lerwick, Shetland Islands.

Direction-recording pressure-tube anemometers have now been installed at Gorleston, Inchinnan and Holyhead, and arrangements are in hand for further similar installations at Aberdeen, Spurn Head, Lympne and Croydon.

Equipment has been re-issued to the local centre at the Isle of Grain.

A large consignment of meteorological instruments has been issued to the Federated Malay States, on repayment, for a special survey, and the training of four yeomen of signals in the use and manipulation of them was undertaken.

**Demands.**—The total number of demands dealt with during the year was 1,408.

**Exhibitions.**—Exhibits of meteorological instruments were prepared for a conversazione of the Royal Society on 12th May, 1920; for the Imperial War Museum, Crystal Palace, in connexion with the R.A.F. exhibit there, as from 7th June, 1920; for the aeronautical exhibition at Olympia in June, 1920; and for the Royal Agricultural Society's annual show at Darlington in June, 1920.

**Tests of Rain Gauges and Rain Measures.**—The testing of rain gauges and rain measures for instrument-makers and the general public which had been carried on by the British Rainfall Organization for many years, was transferred to the Instruments Division as from 8th October, 1920. At the same time the fees were increased to 1s. per rain gauge and 2s. per measure. The B.R.O. mark is still used in connexion with these tests. During the year ended 31st March, 1921, 21 rain gauges and 41 measures were certified.

## ARMY SERVICES DIVISION.

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

The work of the station at Shoeburyness has been continued on the lines of the preceding year. In connexion with the measurement



of temperatures and winds in the upper air, a new Kite Balloon has been designed by the Director of Research department, and installed at Shoeburyness. With the new balloon it is anticipated that observations up to 10,000 feet can be obtained regularly. The construction of the balloon shed has been completed. A new Scammell winch with Williams Janney variable gear has been installed, and arrangements have been made for laying down mechanical handling gear, so as to reduce the number of personnel required for handling the balloon to a minimum.

During the year meteorological reports have been prepared as required for the reduction of Range and Accuracy Trials at Shoeburyness, and considerable progress has been made with the computation of weighting factors for different trajectories.

The station at West Lavington was removed to Larkhill in October, 1920, to a position near the Headquarters of the School of Artillery. Married quarters have been provided for the married staff by the School of Artillery, and the unmarried technical assistants are accommodated in the Sergeants' Mess. Meteorological reports have been prepared as required, for use in connexion with artillery practice. The Meteorologist-in-Charge has delivered lectures on Meteorology to officers in training at the School.

Arrangements have been made for opening a station at each of five Artillery practice camps during the summer of 1921.

By arrangement with the War Office, three members of the Professional Staff have been seconded for duty at Porton, in connexion with research in Chemical Warfare. The meteorological station was opened in January, 1921, Mr. N. K. Johnson, Professional Assistant, being in charge.

**Special Investigations.**—A detailed investigation has been made by Captain J. Durward of the vectorial changes of wind with place in connexion with the area of applicability of meteorological reports to Artillery corrections, and also in connexion with questions of aerial navigation.

**Publications.**—Notes on Meteorological Corrections for the Use of Gunners, by Captain D. Brunt and Captain J. Durward; Professional Note No. 12. An Analysis of the Rate of Ascent of Pilot Balloons, R. P. Batty; Professional Note No. 13. A Report on Two Pilot Balloon Ascents at Shoeburyness, N. K. Johnson; Professional Note No. 14. Tables of Frequency of Surface Wind Directions and Cloud Amounts at Metz, Mülhausen, Karlsruhe and Frankfurt, by Captain D. Brunt; Professional Note No. 15. Diurnal Variations in Wind Velocity and Direction at Different Heights, Captain J. Durward.

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#### ADVISORY COMMITTEE ON ATMOSPHERIC POLLUTION.

*Report by J. S. Owens, M.D., Superintendent.*

**The Study of Atmospheric Pollution.**—From 1912 the study of Atmospheric Pollution has been carried on by a Committee with Sir Napier Shaw as Chairman. The expenses of the investigation are now charged against the votes of the Air Ministry. A list of members

of the Advisory Committee on Atmospheric Pollution with the authorities by whom they are nominated is printed on p. 5. At the request of the Meteorological Committee, Sir Napier Shaw has remained Chairman of the Advisory Committee though no longer holding that position *ex officio* as Director of the Meteorological Office. Dr. J. S. Owens is responsible for the organization of the investigation. Mr. Watson, Junior Professional Assistant in the Meteorological Office, has devoted his whole time to research for the Committee.

The discussion of measurements of the amount of solid matter deposited from the air month by month, is the principal routine work of the Committee.

An automatic instrument by which continuous records of the suspended impurity in the atmosphere can be obtained, has now been developed and valuable results are being obtained.

Special research during the year has been devoted to methods of measuring the acidity of the air.

Six annual reports have been published by the Committee and the seventh, dealing with the year ending March 31st, 1921, is now in preparation.

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## BRITISH RAINFALL ORGANIZATION.

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

**Organization.**—The year ended March 31st, 1921, was the first complete administrative year since the transfer of the Organization to the Meteorological Office. A large amount of time has necessarily been spent on matters arising out of re-organization, and this has been rendered difficult by the delay in bringing the staff up to its full complement.

Mr. W. A. Bion, who was appointed temporary cartographical assistant in February, 1920, carried on this work until October when Mr. A. T. Bench was transferred to the Department as Cartographer. From this date, Mr. Bion worked exclusively on the rainfall maps for the Climatological Atlas. Mr. C. F. Martin was appointed on August 9th, and has been employed on routine computing.

The methods of account-keeping have been re-modelled during the year, and the transfer of printing and block-making to H.M. Stationery Office has been effected. Free postage both for incoming and outgoing correspondence was brought into operation on February 1st.

The original manuscripts containing daily rainfall records from 1865 to date have been removed from the office at the bottom of the garden where they were suffering from damp, and re-stored in labelled boxes in the house, their accessibility being greatly improved. The whole of the draft rainfall maps and the stock of ordnance and other maps in the office have been rearranged and indexed.

**Advisory Committee.**—In May, 1920, the Meteorological Committee appointed a special sub-committee to advise on rainfall work. This committee has met on three occasions. The Superintendent was appointed Secretary on October 27th, 1920.

**Publications. "British Rainfall 1919."**—The issue was delayed until December 23rd on account of the change of printer. The arrangement of the volume was slightly modified. The statistical material included :—

Records of Percolation .. .. .	at	8	stations
" " Evaporation .. .. .	"	13	"
" " daily rainfall frequency .. .. .	"	100	"
Lists of Droughts and "Dry Spells" .. .. .	"	100	"
" " "Rain Spells" and "Wet Spells" .. .. .	"	100	"
Duration of Rainfall .. .. .	"	60	"
Heavy Rains in Short Periods .. .. .			
Heavy Daily Rains .. .. .			
Monthly Rainfall .. .. .	"	348	"
" " (percentage of average) .. .. .	"	106	"
Seasonal Rainfall (percentage of average) .. .. .	"	106	"
Annual Rainfall (percentage of average) .. .. .	"	209	"
" " total fall .. .. .	"	4,896	"

The number of complete records in each country was :—

England	Wales & Islands	Scotland	Ireland	British Isles
3,418	435	766	277	4,896

The number in England was 114 fewer than in 1918, that in the other countries was practically unchanged. On the whole the distribution of stations was improved. In all 391 records dropped out and 288 new records appeared.

The deaths of 93 observers were recorded, including two out of the five survivors of *English Rainfall* 1860, viz., Dr. W. C. Lake and Lord Peckover of Wisbech.

Reprints of Part III were issued gratis in January, 1921, to 591 observers.

**Meteorological Magazine.**—This publication has been continued on the lines set out in the report of last year, the size being slightly increased.

**Monthly Weather Report.**—Maps and tables of rainfall have been contributed each month.

**Meteorological Observations.**—The sunshine recorder was dismantled on June 1st, the official record being transferred to the Royal Botanic Gardens, Regents Park. The 4-foot earth thermometer was under repair from February 22nd to March 22nd. Otherwise there was no break in the observations which had been continued for 63 years up to December 31st, 1920.

**Permanent Files.**—All returns of Rainfall, Evaporation and Percolation up to those for 1919 have been entered. A new series of decennial sheets will be opened with 1920.

**Returns for 1920.**—The number of returns received to date is somewhat larger than usual, many of the records interrupted during the war having been recommenced. The preparation of *British Rainfall*, 1920, is in a satisfactorily advanced stage. An advance account of the rainfall of 1920 was published in *The Times* of January 28th.



**Rain Gauges on Loan.**—The number of rain gauges on loan up to March 31st, 1921, was 39. A gauge was established on the summit of Ben More in Mull, and the old gauge at the Styel, Cumberland, was replaced.

**Inspection of Rain Gauges.**—The number of gauges inspected during the year was :—

London .. ..	2	Gloucestershire ..	1
Surrey .. ..	1	Warwickshire ..	4
Sussex .. ..	10	Lancashire ..	14
Hampshire ..	5	Cumberland ..	15
Middlesex ..	3	Westmorland ..	8
Hertfordshire ..	4	Carnarvonshire ..	19
Essex .. ..	2	Perthshire ..	16
Cornwall ..	2	Inverness-shire ..	8

Rain gauge sites were inspected as follows :—

London .. ..	1	Perthshire ....	1
Lancashire ..	5	Inverness-shire ..	3

**Testing of Rain Gauges.**—Up to September four gauges and fourteen measures were certified and one gauge rejected. In September the work was transferred to the Instruments Division. Two new self-recording gauges and one rainfall intensity recorder have been under test. Fees received £2 7s. 6d.

**Inquiries.**—The number of inquiries for information has been exceptionally large, and the data have been in every case supplied. Among the more important items under this head were an average rainfall map of the Dee Basin (North Wales) and explanatory memoir prepared for the Water Resources Committee of the Board of Trade ; a copy of the recently completed average annual rainfall map of England and Wales supplied to the Board of Agriculture for their forthcoming Atlas of Crops ; and a report on the rainfall of the Thames Valley sent to the Marine Biological Laboratory, Plymouth, in connection with the Oyster Mortality inquiry. Information for scientific purposes or involving no appreciable expenditure of the time of the staff has been supplied free of charge.

**Professional Work.**—The Superintendent has given expert advice in connection with rainfall to the Hydro-Electric Syndicate (Grampian Electricity Order, 1921) ; the British Aluminium Company (Lochaber Power Bill, 1921) ; the Promoters of the South East Essex Water Bill ; the Corporations of Birmingham, Birkenhead, Warrington, Rugby and Batley ; the Urban District Council of Padiham ; and the Sunderland and South Shields Water Company. Evidence was given in *Smith v. Croydon Gravel Co.* ; and was prepared in *Sitwell v. Wells*.

Regular monthly reports on the rainfall of the Thames and Lea Valleys have been supplied to the Metropolitan Water Board.

**Climatological Atlas of the British Isles.**—A scheme for the preparation of a new series of average monthly rainfall maps of the British Isles was approved by the joint-committee of the Meteorological Office and the Royal Meteorological Society, and was carried out during the year. Mr. W. A. Bion was specially detailed for this work.

An account of the method was submitted to the Royal Meteorological Society in February, 1921. The data specially extracted for the purpose included 550 monthly averages for the period 1881–1915, and these are being brought into use as standards in *British Rainfall* and the *Meteorological Magazine*. Tracings of the final maps were prepared and are available for reproduction.

**Rainfall Survey Map.**—About one-half of the area of the British Isles has been mapped on the scale of two miles to one inch. A proposal for the completion of the map has been submitted and approved. During the past year the map has been extended or revised in parts of Northamptonshire, Cornwall, Shropshire, Warwickshire, Leicestershire, Lancashire, Yorkshire, Montgomeryshire, Denbighshire, Merioneth and central Scotland.

## METEOROLOGICAL OFFICE, EDINBURGH.

*Report by A. Crichton Mitchell, D.Sc., F.R.S.E., Superintendent.*

**Office Accommodation.**—During the first three months of the year the office was housed in the rooms at 122, George Street, Edinburgh, which had been occupied for many years by the Scottish Meteorological Society. In July, 1920, it was removed to more commodious, though possibly less centrally situated, premises at 10, Rothesay Place, Edinburgh.

**Staff and Organisation.**—At the beginning of the year, the position of the Edinburgh Office was that detailed in the agreement made with the Scottish Meteorological Society in 1913. In April, 1920, this was altered, the arrangement adopted being that detailed in the Minutes of the Fifth Meeting of the Committee for the Meteorological Office, Edinburgh, held on 16th April, 1920 (see Appendix). Under this arrangement, Dr. A. Crichton Mitchell, Superintendent, Eskdalemuir Observatory, was appointed Superintendent of the Edinburgh Office, but was instructed to continue in supervision of Eskdalemuir in so far as that was necessary. Mr. A. Watt, Miss M. Crawford, and Miss A. E. Murray, who were on the staff of the Society were given posts in the new organisation, while Mr. J. Crichton, who had been attached to the Office as Senior Professional Assistant, continued in that capacity. To these were subsequently added :—

Mr. J. E. Belasco, Junior Professional Assistant.

Miss I. H. Graham-Yooll, Probationer } transferred from

Miss M. N. Wilson, Probationer     .. } Eskdalemuir.

Miss M. A. F. Mackay, Probationer.

Mrs. M. Moran, Caretaker.

In practice, the Superintendent spends the greater part of his time at Eskdalemuir Observatory and only comes into Edinburgh for about a week once a month. In fact, the original plan has been reversed, for the Superintendent remains in full charge of Eskdalemuir Observatory and, in addition, supervises the work of the Edinburgh Office.

The double charge thus placed on the Superintendent involves heavy work. This is not mentioned as being a matter of personal

complaint, but as an explanation of the fact that the progress made in the reorganisation and development of meteorological work in Scotland was slower during the past year under report than may have been expected or desired. Closer acquaintance with the present conditions shews that much remains to be done to place matters on a satisfactory footing and that, without aiming at ideals unrealisable in times of financial stringency, much can be done in the direction of improvement in the near future. But for this, time and energy are required and the present arrangement scarcely provides a sufficiency of either for the purpose.

**Arrangement of Work.**—As this report is the first which has been submitted since the above changes were introduced, it may be well to give in some detail an account of the work of the Office in so far as it had been organised before the close of year.

- (i). *Climatological Work.*—Monthly returns are received from climatological stations in Scotland. These are duly checked and where necessary completed, and are finally put in form for publication in the *Monthly Weather Report*.

Daily Readings for two Scottish Stations are also prepared for publication in the appropriate section of the *Year Book*.

Descriptive notes on the weather of each month are also prepared and forwarded for use in compiling the first page of the *Monthly Weather Report*.

Returns of daily rainfall are received monthly from 70 stations. These are used to supplement the information obtained from the climatological returns.

Monthly Reports are prepared for the use of the Registrar-General. A consolidated Annual Report is also supplied to him.

- (ii). *Inquiries.*—The Office serves as a bureau of information regarding the weather in Scotland. In all, 52 inquiries were dealt with by correspondence, most of them being connected with marine insurance risks. Fees amounting to £14 9s. 3d. were received on account of 36 of these inquiries. A considerable number of inquiries were made by persons engaged in educational work, forestry, or purely scientific investigation.

- (iii). *Forecasts issued to Newspapers.*—The morning forecast is received here daily by telegram from London, and is at once communicated for publication in early editions of two evening newspapers in Glasgow and Edinburgh.

- (iv). *Eskdalemuir Computing.*—Two probationers on the staff of Eskdalemuir Observatory were transferred to the Office in August, 1920, and have been engaged in tabulation and computing of Eskdalemuir magnetic and meteorological results. In addition to current work, which is kept well up to date, considerable arrears in this direction have been overtaken.



- (v). *Special investigations.*—During the year several questions, which promised to yield interesting results when closely investigated, were taken up for inquiry. These included tabulations of hourly magnetic values at Eskdalemuir on days of high and low barometric pressure, normals of diurnal temperature range at Eskdalemuir, frequency distribution of hours of lowest pressure during passage of depressions at different stations. Many other subjects of the kind are calling for inquiry and it is hoped that the Office will be of distinct use in this direction.

The above provides some idea of the normal routine of the Office during the latter half of the year.

Beyond this, certain matters of a general kind were taken up with a view to their being remitted for consideration by the Director. One of the most important of these concerned the present condition of the climatological stations in Scotland, a question which calls for very early—and very drastic—treatment. A report on the subject was forwarded during the year. It dealt with the present distribution of these stations, their condition in respect of equipment, etc., and proposals were made for an entirely new scheme with regard to their establishment and maintenance. While it is conceded at once that reform and improvement in this matter will be difficult and perhaps slow, there are indications that something may perhaps be done without the introduction of a formal, generally applicable scheme. For example, the Town Councils of Arbroath and North Berwick have recently been induced to take up the question, and have agreed to establish climatological stations on a satisfactory scale in respect of equipment, to maintain them at their own cost, and to furnish returns to the Meteorological Office. It is hoped that other municipalities will follow the example thus set, and the Edinburgh Office is giving every encouragement and assistance possible in this direction. At the same time, due regard is and will be paid to the necessity for a proper distribution of such stations.

In addition to these matters, mention has to be made of the steps taken during the year towards the establishment of a Geophysical Observatory in Shetland. The Superintendent visited Shetland in June, 1920, in order to inspect different possible positions for the Observatory, and for the proposed out-station for auroral work. A detailed report was submitted, in which the final recommendation made was that application should be made to the Post Office for the transfer to the Air Ministry of the Wireless Station at Lerwick (which had been erected by the Admiralty, and handed over to the Post Office last year) and that if this could be secured steps should then be taken towards the equipment of the Observatory for a variety of geophysical purposes.

The Director visited Shetland in November, 1920, in order to decide a number of points which required attention, and to obtain information necessary to the formulation of a definite scheme. Sanction was finally given to the general plan involving the transfer of the Wireless Station and the establishment of the Observatory.

Steps were then taken towards the carrying out of the scheme. These involved questions relating to equipment, furnishing, the erection of a magnetograph house, huts for absolute and other observations,







Several old declinometers, regarded as museum objects, have been looked out by Messrs. Watson and Kellett, and brought, it is hoped, into a working state.

The Watson multi-needle vertical force magnet recently purchased from the executors of the late Professor W. Watson, F.R.S., has been tried under a variety of conditions and apparently satisfactory records have been obtained.

The set of magnetographs originally in Falmouth and then at Eskdalemuir, and now destined for Shetland, was brought to the Observatory by Mr. Crichton. It is being tried and examined with a view to deciding on the necessary alterations and repairs.

Two Krogness magnetographs, made by Mr. P. Adie, have been received from the Meteorological Office, for examination.

During the year a number of moment of inertia experiments have been made with the quartz fibre apparatus designed by the late Professor W. Watson, F.R.S., and recently purchased from his executors. In particular, the moment of inertia of an inertia bar belonging to the Eskdalemuir Magnetometer was determined in terms of the two Kew standard bars.

On the initiative of Sir Arthur Schuster, F.R.S., and Mr. F. E. Smith, F.R.S., a comparison was made between the Kew standard unifilar magnetometer by Jones, and a new coil magnetometer designed by Sir Arthur Schuster, and made at the National Physical Laboratory, under the supervision of Mr. F. E. Smith. This entailed two days' observations with Dover Magnetometer No. 140 by the Superintendent at the National Physical Laboratory, with supplementary observations at Kew Observatory.

By the instructions of the Director, an instrument designed by Mr. E. A. Reeves, Map Curator and Instructor in Surveying, Royal Geographical Society, has been under observation under a variety of conditions for some time.

Two Spanish gentlemen, Messrs. de Azpiazu and Gil have commenced an inter-comparison of magnetic instruments used in a magnetic survey of Spain with the Observatory instruments. Facilities for a comparison had been promised them by the late Director in 1920.

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

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

The observations of a series of distant objects have been continued as in previous years, as well as observations in accordance with the general scheme now recognised at the Office.

The magnetic elements declination, inclination and horizontal force, have been observed regularly, usually once a week.

Observations of the air-earth vertical electric current have been made with the Wilson apparatus, and observations of the positive

and negative charges per cubic centimetre associated with the more mobile ions in the atmosphere have been taken with the Ebert apparatus. These electrical observations have been taken on most fine afternoons between 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 micro-barograph and the Callendar thermograph, have been tabulated for each hour. The tabulations are transmitted weekly to the Office.

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 got out of the mean diurnal inequality from all days, with the exception of the highly disturbed days of "character" 2, and the most recent information on this point, with corresponding information for the previous year, appears on the weekly sheet issued.

Magnetic "character" figures after the international scale, based on all the magnetic elements, have been got out and sent to De Bilt at the end of each quarter.

Diurnal inequalities for magnetic declination and horizontal force from the international quiet days have been prepared up to the end of September, 1920.

The electrograms (from the Kelvin Water-dropper) have been measured each day at 3h., 9h., 15h., and 21h., and the daily electrical "character" has been assigned up to the end of February, 1921. The electrograms for the selected days—ten a month—have been measured up to the end of February, 1921, but the diurnal inequalities have still to be calculated for the whole of 1920.

The seismograms have been studied up to the end of March, 1920. A list of earthquakes has been transmitted monthly to the Office; particulars have also been sent 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, 1921, and the results have been sent monthly to the Office.

**Publication of the Results.** The *Geophysical Journal* (*British Meteorological and Magnetic Year Book*, Part III, Section 2), gives month by month particulars of barometric pressure, air temperature, humidity, wind direction and velocity, amount of cloud and weather at two fixed hours daily, also the daily totals of rainfall and duration of bright sunshine. It further includes for each day the minimum temperature on the grass, earth temperature at two depths, level of underground water, values of the electric potential gradient at 3h., 9h., 15h., and 21h., and the electric and magnetic "characters." The results are also given of the absolute magnetic observations, the solar radiation observations with the Ångström pyrheliometer, the electrical observations made near 15 h. with the Ebert and the Wilson apparatus, and the seismic movements.

**Hourly Values. Geophysical Section** (Part IV, Section 2, of the same publication), contains particulars of the diurnal and seasonal variation of magnetic declination and horizontal force, as derived from the international quiet days, and of the electric potential of the atmosphere derived from selected days. It also contains mean monthly values of magnetic inclination, total force, and north and west components, along with a table giving recent mean values of the magnetic elements at the observatories whose publications are received at Kew Observatory.

The following paper by the Superintendent relating to the work of the Observatory has appeared during the year: "A Comparison of Magnetic Declination Changes at British Observatories," Royal Society Proc. A., Vol. 98, p. 411. The paper is only a summary of a comparison, fuller details of which will appear in the Office publication—*Geophysical Memoirs No. 17*.

**Instruction of Magnetic Observers.**—Mr. L. C. Araujo, Instituto Astronomico, Brazil, who had come to England in connection with instruments ordered by the Brazilian Government, attended the Observatory during part of December, 1920, to receive instruction in the use of the dip circle. Mr. J. Crichton, during his attendance at the Observatory, received instruction in the use of the Unifilar magnetometer and dip circle, and in the determination of base values and scale values for magnetograms.

**Verification Work.**—A dip circle with five needles, belonging to Prof. Palazzo of Rome, was tested after the execution of repairs by Messrs. Casella & Co. The dip circle which Mr. Araujo was taking out to Brazil was also verified with two needles. Owing to the retirement and death of Mr. A. W. Dover, who had for a considerable time before the war almost a monopoly in the construction of dip circles and needles, the construction of magnetic instruments in this country has received a blow from which it will take some time to recover. Meantime as much assistance as possible is being given to makers who show any desire to fill the gap.

**Carpenter's Shop.**—During the year the carpenter has been principally engaged in the construction of marine screens for thermometers, of which 56 have been constructed. He has also made 38 thermometer boxes and 25 hygrometer boards. He has also done various repairs, including the replacement of a number of broken pales in the fence by new pales, supplied by the Mid-Surrey Golf Club in recognition of the part played by golf balls in the breakages.

**Antarctic Magnetic Observations.**—All the work in connection with the magnetic curves obtained in 1911-12 by the Scott Antarctic Expedition has been completed, and the volume including the results is expected to appear shortly.

The preparation of diurnal inequalities from the measurements made of the magnetic curves of the Australasian Antarctic Expedition, 1912-13, has been completed. The curves themselves, with term hour curves from co-operating stations, have been received, but no consideration has yet been given to separate magnetic disturbances.



**Library.**—The arrangement and classification of the books has proceeded as usual. A list of the institutions and societies whose publications are received has been prepared and sent to the Office. The possible usefulness of the library would be much increased if the shelving and arrangement of the books and the cataloguing could be considered by an expert having adequate time at his disposal.

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

To whom lent.	Articles.	Date of loan
New Zealand Government.	Dip circle, by Barrow, with one pair of needles and bar magnets, and a tripod stand .. ..	1899
“ “	Unifilar Magnetometer, by Jones, marked N.A.B.C. ..	1909
Board of Education Science Museum, S. Kensington.	Articles specified in the list given in the Annual Report of the Kew Committee for 1893 ..	1876
“ “	Articles specified on p. 52 of the 10th Annual Report of the Meteorological Committee to the Lords Commissioners of His Majesty's Treasury for the year ended 31st March, 1915.. ..	1914 and 1915
Messrs. S. & J. Bailey, Birmingham.	Two tripod stands for declino-meters .. .. .	1920

### ESKDALEMUIR OBSERVATORY.

*Report by A. Crichton Mitchell, D.Sc., F.R.S.E., Superintendent.*

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

- Miss M. N. Wilson, Temporary Clerk, } transferred to
- Miss I. H. Graham-Yooll, Temporary Clerk, } Edinburgh.
- B. G. Brame, Technical Assistant, transferred to Climatology Division, South Kensington.
- Mrs. Murray, Housekeeper, resigned.
- W. A. Grinstead, Probationer, appointed.
- P. F. Jarrold, Technical Assistant, transferred from South Farnborough.
- Mrs. Stoddart, Housekeeper, appointed.

The staff was not up to its sanctioned strength during the year but the difficulty has been to find accomodation.

**Buildings.**—Last year's Report referred to the Office of Works having undertaken the repairs necessary to stop the extensive leakage at different points in the main building and the Superintendent's house. These repairs were completed during the year and, as far as can be ascertained, have been done most satisfactorily.

The underground Magnet House also received attention. Leaks at the ventilating shafts which have caused a good deal of trouble during recent years were successfully closed. The cracks in the channel along the west wall still remain, however. Attempts to close these were only partially successful, but it is hoped that they will be completely closed as soon as a spell of dry weather allows of the work being done.

Gas and water supplies were satisfactorily maintained during the year. The main drain between the Observatory and the sewage tank outside was choked on one or two occasions, but since it was cleared a few months ago no further trouble has ensued.

**Terrestrial Magnetism.**—This department of the Observatory work was carried on along the usual lines. These were fully detailed in the Report for 1918-19, and no change has been made in the system. There have, however, been additions made to it. These include readings of a direct reading declination instrument and the record from a declination magnetograph, obtained during several months.

The Report of two years ago gave some details of observations made on pulsations of vertical force, observed by means of a cable laid in a horizontal plane, and enclosing an area of about 0·8 square kilometre. Work in this direction had to be stopped on account of damage done to the cable. Part of the cable runs near a public road and is liable to the attentions of mischievous persons; cattle on the hill chewed up considerable lengths of it and another portion was destroyed during a grass fire. Recently, however, preparations towards a resumption of the work have been made, by laying a cable on the moor to the west of the Observatory, where it is less liable to damage. In order to enclose a sufficient area, three turns of cable have been laid out, and it is intended to lay out a fourth very shortly.

The magnetograph set which was transferred here from Falmouth was dismantled and sent to London for general overhaul, preparatory to its being re-erected at Lerwick.

The reduction of the magnetic observations was carried out during the year in the same manner as hitherto. This involves the preparation for the Year Book of tables of (1) hourly values of each element, throughout the year; (2) diurnal inequalities of the components, N, W, V, H, D, I, for each month, on "all" days, international "quiet" days and selected "disturbed" days; (3) tables of harmonic coefficients for each month of the geographical components on the three classes of days; (4) mean monthly values of N, W, V, H, D, I, and T; (5) monthly tables of diurnal inequality range and non-cyclic change; and (6) a general review of the year's results, including a list of principal magnetic disturbances recorded. There is also prepared a monthly table of magnetic results (maxima and minima, with time of occurrence, range, etc.) for inclusion in the *Geophysical Journal*.

The published data have increased considerably during the past four years, and now involve a considerable amount of work. I am

not at all anxious that this should be reduced, for the Eskdalemuir results are now published more fully than those of any other magnetic observatory in the world, and this position should not be abandoned. There remains, however, a good deal to be done towards bringing up the earlier years' publications to the standard now reached. This involves the re-calculation of the principal results for the years 1911-16, and their publication in a special appendix to some future issue of the Year Book. I hope to see a beginning made to this most necessary work during the current year.

The arrangements for computing the magnetic results were altered somewhat during the year. The curves are now read here and the readings checked. These readings are entered upon weekly sheets which are then sent to the Edinburgh Office, where the remaining tabulation work is carried out. This allows us to keep our staff here mainly for observational duties and avoids the difficulty of having to find accommodation for computers, who can do their work at any place where they can be supervised. This arrangement came into effect in August, 1920, when all the 1920 computing work was removed to Edinburgh. The 1919 computing which remained here was practically finished by the end of the year under review, and we have thus made up about two months in arrears of time during the past year. The current year will, I fully expect, shew a still greater improvement.

The usual returns of magnetic character have been made to De Bilt during the year. We also exchange information with De Bilt as to the absolute daily range for each day of the year.

The following special inquiries were begun during the year :—

- a. Diurnal inequality on days of high and low barometric pressure.
- b. Diurnal variation of hourly magnetic activity during 1918.

The first of these was not completed by the end of the year. The subject was mentioned in last year's report as having been investigated with inconclusive results. The present is, however, a fresh attempt, based on more carefully selected data, and may be expected to settle the question at issue. The second was completed, but the results shew such great irregularity at times of disturbance that it is proposed to limit the results (which it is intended to publish shortly) to quiet days.

There are also in course of preparation some minor inquiries which will probably find a place in the Annual Review of Magnetic Results.

Preparations were made for special observations at the time of the solar eclipse on 8th April, 1921. The results do not fall within the year now under report.

**Meteorology.**—As stated in last year's Report, the system of meteorological observation includes (1) autographic records of pressure, temperature (photographic wet and dry bulb thermograph, and three pen thermographs), wind speed and direction, rainfall, sunshine, and microbaric change; (2) eye observations made for control purposes at 9h., 15h., and 21h.; (3) observations for purposes of telegraphic weather reports at 1h., 7h., 13h., and 18h.; (4) pilot balloon ascents when conditions permit; and (5) a practically continuous watch on the weather except between 1h. and 7h.



The information thus collected is employed in telegraphic weather reports at 1h., 7h., 13h., and 18h., in summaries for the Weekly and Monthly Weather Reports, and for tabulation of Hourly Values.

The number of telegraphic weather reports despatched during the year was 1776. This is a considerable increase in the number sent in pre-war years. For example, the number sent in 1914 was only 724. This increase, together with a very greatly increased volume of tabulated matter connected with meteorology, gives some indication of the extent to which the staff of the Observatory is taken up with this part of the work.

The number of pilot balloon ascents during the year was 387, the same number as in the previous year.

The telephone service shewed considerable improvement during the year.

The tabulation of values from autographic records is now carried out at Edinburgh in much the same way as has been explained above in connection with magnetic work.

During the year, the ten years records of atmospheric pressure from 1911-20 were finally reduced and the coefficients in the harmonic analysis obtained for each year and month. It is doubtful whether this, as it stands, is worthy of separate publication, but the matter will be referred for decision shortly. Meanwhile, the results have been compared with those for Castle O'er, published in the Quarterly Journal of the Royal Meteorological Society, by Dr. Chree, and it is proposed to communicate the results of this comparison to the Royal Meteorological Society.

The reduction of ten years' temperature records, 1911-20, was also undertaken during the year, but was not completed.

An attempt is being made to ascertain whether the Eskdalemuir pressure records would yield any results shewing the lunar diurnal variation in pressure. The method adopted is slightly different from that generally employed, but I have no great hopes of success.

Another inquiry, which is also proceeding slowly, concerns the diurnal variation of pressure on days of different character.

**Atmospheric Electricity.**—The photographic record of the electric potential of a point near the building has been continuous except for breaks of a few hours when insulation became faulty or light failed. Factors for converting the readings of these records into potential gradient in the open have been obtained from eye readings made about once a week. Values of the potential gradient have thus been obtained for four hours every day and for all hours on certain selected quiet days. Diurnal inequalities are being made out, as in past years, for the selected days for each month.

With a view to assisting in the interpretation of the record of disturbed days, various instrumental factors have been measured, viz. : the rate of leak, the rate of charging, the electrical capacity of various parts of the instrument, the period and logarithmic decrement of the needle of the electrometer.

The Ebert apparatus was repaired and brought into use again in May, 1920. About twenty observations have been made with it when weather conditions and Observatory routine work would permit.

Tabulations have been prepared as in previous years for the *Geophysical Journal*. In addition, tables and diagrams were prepared showing the relation of the potential gradient to wind strength at different periods of the year and day.

**Seismology.**—A considerable amount of trouble was experienced during the year with the driving clocks connected with the recording arrangements of the Galitzin seismographs. Ultimately, it was ascertained that the bearings at some parts had worn unequally after ten years' continuous work, and required overhaul. This having been carried out, the clocks have since behaved satisfactorily. The usual details of earthquakes recorded were prepared for publication in the *Geophysical Journal*.

Last year's report referred to the difficulty experienced in reading the seismograms of large earthquakes, owing to the records of two components of the motion being recorded on one sheet and becoming inextricably confused. This matter has again to be brought to notice, in the hope that funds will permit of the construction and installation of an additional recording drum and its connected mechanism.

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

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

There have been no changes in the Observatory staff since the preceding year. Mr. J. J. Somerville acted as an additional Professional Assistant for six weeks in the summer of 1920, taking charge of the Observatory during the absence of the Superintendent on leave in August.

Considering the very disturbed conditions of the S.W. of Ireland throughout the year it is satisfactory to be able to state that the Observatory work has not been adversely affected to any appreciable extent, though some inconvenience has been caused by the frequent dislocation of the postal and railway services. Telegraphic communication with London has been maintained without interruption.

The Observatory work has proceeded on lines similar to those followed in previous years and some small increases in the equipment have been made.

Necessary repairs were carried out to the roof of the main building and some internal decorating done in the Superintendent's house.

The arrangement of working hours of the staff has been such as to provide in general for observers on duty between 7 a.m. and 6 p.m., the Superintendent acting as resident observer as usual.

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

The Observatory has been maintained as a first order meteorological station, keeping as far as possible a continuous record of the weather. Regular observations have been made eight times daily between 7 a.m. and 9 p.m. Cloud observations with a nephoscope have been made on the prescribed days whenever the conditions were suitable, in connection with the International investigation of the upper air. The records of the mountain raingauge have been obtained

without interruption of any kind. A classified file has been drawn up setting out in detail all the current Observatory routine work with a view to minimising discontinuities when staff changes occur, and also to provide for future use a record of past methods of procedure.

A concrete tank, 6 feet square by 2 feet deep, for the measurement of evaporation, was made in an open site in the grounds during the year. A great deal of time was consumed over this work, which proved very troublesome. The tank was, however, at last made water-tight and records were commenced in February, 1921.

The self-recording equipment has been maintained in full operation, and except in the case of the pressure tube anemometer, and occasional unavoidable freezing of the wet bulb thermometer, the losses of record have been negligible. Several different patterns of self-recording raingauges have been under trial during the whole or part of the year. The heavy annual rainfall at Cahirciveen makes the place particularly suitable for such work.

A clock providing an hourly electric contact to an accuracy of a few seconds has been fitted up in a permanent manner as the first stage of a system of synchronous time marking, which it is hoped ultimately to install for the more important self-recording instruments.

Several of the instruments have been repaired in the workshop during the year.

Hourly values of temperature, humidity, pressure, wind and rain have been tabulated and checked at the Observatory and copies retained.

Telegraphic reports to the Forecast Division have been made regularly five times per day on week-days and four times on Sundays. A daily forecast telegraphed from London each week-day has, after editing, been exhibited in the Post Office in Cahirciveen.

The Wireless Station in Valencia Island has rendered assistance as before by being responsible for the 1h. report.

Pilot Balloon ascents with one theodolite have been made once or twice daily whenever the weather conditions allowed, and telegraphed to the Forecast Division immediately; 334 were so made during the year. All ascents which exceeded 2 kilometres will be published in the *Geophysical Journal*; owing chiefly to improved equipment, the mean height of the latter ascents shows a slight improvement on the previous year. One successful ascent was obtained using two theodolites when a height of 16 kilometres was reached.

Absolute magnetic observations of Declination, Horizontal Force and Dip have been taken, in general about three of each per month. These observations are taken at fixed times of day, and only those made at times reasonably free from magnetic disturbance have been utilised. They will be published in the *Geophysical Journal*.

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

A section hut 10 ft. by 20 ft. has been provided and erected in a substantial manner for use as a workshop. It has further been equipped with tools and is proving of great value in cases of repairs and experimental work, and in the making of new equipment.

The library has been sorted and reshelfed and a complete catalogue prepared.



An investigation has been made into the extent to which an ordinary wet bulb thermometer exposed near the sea is affected by salt, and notes on this and several other meteorological subjects have been prepared, or are at present in hand.

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### AEROLOGICAL OBSERVATORY AT BENSON.

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

The work in connection with the upper air with which the Observatory is specially concerned was continued during the year. There was still a difficulty in obtaining satisfactory balloons, but the quality was better than that obtainable during 1919. In all eighteen registering balloons were sent up and nine recovered, all of which gave satisfactory records, reaching the stratosphere in nearly every case.

A radiometer, designed to measure the radiation coming from the atmosphere and also the diffuse solar radiation, was erected during the summer. Observations were made with it and the results are shortly to be published.

Sundry instruments for use at other stations or in the Colonies have been made in the workshop during the year.

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### BRANCH METEOROLOGICAL OFFICE AT SOUTH FARNBOROUGH.

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

**Observations, Issue of Forecasts, Data and Time Signals.**—The range of work under these heads continues as in previous years, and involves the daily issue of eighteen copies of forecasts, six copies of upper air reports, eight summaries of meteorological elements, two climatological summaries; weekly issue of a rainfall return and mean pressure report, annual issue of a climatological summary. Telegraph reporting at 7h., 13h., and 18h. was continued, with special reports at other times when required. Casual inquiries were again numerous, though fewer than in the preceeding year.

Time signals were sent daily to Aldershot Command, to Bordon Camp, and (from December, 1920) to Royal Aircraft Establishment, from M.O. Radio Station.

**The Upper Air Work** of the year included 215 one theodolite ascents passing the 1k. level, the mean height sounded in these ascents being 2,980m., the maximum 14k., and the longest observed trajectory 43k. In 56 ascents the balloon was not observed beyond the 1k. level.

The use of light filters has been made part of the routine of pilot balloon observation.

A diagram showing the continuous improvement in heights sounded at South Farnborough in the past few years was exhibited at the Royal Society Soirée. This progress has not been maintained in the year under review, partly because of unfavourable weather, but mainly because increasing claims of other work diverted attention from pilot balloon work.

The collection of upper air temperatures from Royal Aircraft Establishment observers was continued. Efforts were made to arrange for regular observations, but machines and personnel could not be made available. A few special ascents with aeroplane psychrometers were made, in these Royal Air Force officers attached to Branch Office for instruction acted as observers.

**Minor Experimental Work** included a few tailed balloon ascents, the use of rangefinders in cloud and pilot balloon work, the downward extension of the scale of the two-metre Height and Range-finder by an external attachment, a comparison of Assmann and screen psychrometers, and a series of wind channel tests on the performance of aeroplane psychrometers at flying speeds. A preliminary report on the latter subject has been submitted.

A **Subsidiary Climatological Station** was brought into operation at M.O. Radio Station, Smallshot, on May, 16th, 1920, for the double purpose of providing data directly applicable to Aldershot Camp, and of providing a good exposure to check the effects of the apparently unsatisfactory exposure at Branch Office. The comparison shows that the Branch Office exposure is still sufficiently good for all ordinary purposes. The Golf Course anemometer was transferred to Smallshot Hill on September, 1920.

As part of an *Instructional Course* for Royal Air Force meteorological personnel for the Middle East, two flying officers were posted to Branch Office for successive three-week periods, during which they acted as Meteorologists-in-Charge. Two warrant officers were also attached for instruction.

**Staff Changes** were again somewhat numerous in the technical grades. The Branch Office continued without a Professional Assistant until August 28th, 1920, on which date Mr. J. F. Herd was transferred from Royal Air Force to act as Senior Professional Assistant at M.O. Radio Station.

**The Radiotelegraphic Inquiry into the Location of Thunderstorms** was continued. The routine observation of direction of arrival of atmospherics, suspended under pressure of work and staff shortage in 1919, was resumed and observations on a 20,000 metre wave-length are now made daily at 7h., 13h., and 16h. The measurement on an arbitrary scale of strength of disturbances is included in the observations.

Improvements have been introduced in the standard direction-finding sets. The troublesome problem of anode current supply to amplifiers is believed to have been satisfactorily solved by the introduction of small wet leclanché cells. A variety of experimental tests have been made, including work on discriminating recorders, cathode ray tubes, effect of site on direction-finders, screening and special frames for elimination of errors, measurements of voltages produced by atmospherics, &c.

A re-examination of the data already accumulated in the inquiry is in progress.

A direction-finding set was installed at Meteorological Office, Croydon in October, 1920.

On the formation of the Sub-committee of the Radio Research Board; the Meteorologist-in-Charge became a member of the committee on Atmospherics.

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### FALMOUTH OBSERVATORY.

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

The ordinary work of the Observatory has been carried on during the year. Telegraphic reports have been sent to the Meteorological Office at 1h., 7h., 13h. and 18h. Since 20th September the 7h. report has also been sent to Cattewater, Plymouth. In accordance with the arrangement made with the Falmouth Corporation, the 18 h. observation has usually been made by the Corporation Observer, Mr. R. H. Brenton. The self-recording instruments at the Observatory have been kept in continuous operation throughout the year. Oversight has also been given to the working of the Dines Pressure Tube Anemometer at Pendennis Castle. The records of the Robinson Anemograph and the Beckley Rain Gauge have been tabulated for each hour. Analysis of the Pendennis Castle Dines Pressure Tube Anemograms have also been made. Tabulation and analysis of Dines Pressure Tube Anemograms at Plymouth, tabulations of the Robinson Anemograms, and analysis of the Dines Pressure Tube Anemograms at Scilly, were made up to 30th September. This work was then transferred to Cattewater, Plymouth. The forecast based on the 7h. observations with remarks on Pressure Distribution, together with climatological data from the Observatory, have been exhibited daily at the Customs House and at the Municipal Buildings. The 7h. forecasts have been checked at the Observatory and the results forwarded to London. The Pendennis Castle Anemograms have also been exhibited at the Customs House.

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### ARMAGH.

The normal meteorological work of the Observatory, which includes that of a Second Order station together with maintenance of autographic records of wind and rainfall, has been carried on as usual.

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### SOUTHPORT.

At the Fernley Observatory, Southport, a meteorological station of the First Order is maintained under a trust administered by the Corporation. A subvention to ensure the publication of the report for the year 1919, was made by the Office in 1920.

G. C. SIMPSON  
(Director).

22nd June, 1921.



## APPENDIX.

### AGREEMENT BETWEEN THE METEOROLOGICAL COMMITTEE AND THE SCOTTISH METEOROLOGICAL SOCIETY.

1. The duties of the Meteorological Office, Edinburgh, as set out in No. 1 of the regulations of Minute 393, 30th April, 1913 (M.O. Circular 006), namely :—

- (i.) The collection of trustworthy meteorological statistics from municipal and voluntary stations in Scotland, and the preparation of summaries for the meteorological reports issued by Government, and for the statistical reports of the Registrar of Births, Deaths and Marriages for Scotland ;
- (ii.) The supply of meteorological information in reply to inquiries ;
- (iii.) The promotion by all available means of public technical instruction in meteorology, and of the application of meteorological science in the interests of the public health, of agriculture, fisheries and other industries ;
- (iv.) The promotion of meteorological researches, including researches on an international basis which depend on the organisation and compilation of observations ;

will be taken over by the Meteorological Office, Air Ministry, as from 1st April, 1920.

2. The staff which is at present employed for those duties by the Scottish Meteorological Society in accordance with No. 7 of the regulations, is as follows :—

- (i.) *Andrew Watt, M.A.*, Assistant to the Secretary 1900—1907, Secretary 1907—present time. Salary £550, corresponding with that of an Assistant Superintendent with one year's seniority ;
- (ii.) *Miss Madge Crawford*, seven years on the staff. Salary £140, corresponding with the initial salary of Clerk Computer ;
- (iii.) *Miss Alison E. Murray*, six months on the staff. Salary £80 with £10 a year increase, corresponding with that of a probationer.

Captain J. Crichton, Senior Professional Assistant, has been attached to the Office since his appointment on 1st January, 1920.

3. The work will form part of the duty of the Meteorological Office, Air Ministry, and the staff employed will be part of the staff of the Office, subject to the regulations of the Meteorological Committee.

4. The Meteorological Committee of the Air Ministry will maintain an Office in Scotland for the discharge of the duties hitherto assigned to the Meteorological Office, Edinburgh, and such other duties as may be approved by the Committee.

5. The Scottish Meteorological Society will agree to hand over its collection of books, maps, etc., to the Meteorological Office in trust for the maintenance of a meteorological library at the Office in Scotland with freedom of access to members of the Society and the general public, to consult the books, etc., under suitable conditions.

6. There shall be an advisory committee, of which the Director shall be Chairman ; which shall include :—

One member nominated by the Board of Agriculture for Scotland.

"	"	"	"	"	Fisheries Board for Scotland.
"	"	"	"	"	Scottish Board of Health.
"	"	"	"	"	Royal Society of Edinburgh.
"	"	"	"	"	Royal Society of London.
"	"	"	"	"	Scottish Meteorological Society.

7. The Committee shall meet at least once a year, and shall have power to submit to the Meteorological Committee any proposals for the development of meteorological science.

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