

R E P O R T
OF THE
METEOROLOGICAL COUNCIL

TO THE
ROYAL SOCIETY,

For the Year ending 31st of March 1890.

Presented to both Houses of Parliament by Command of Her Majesty



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THE METEOROLOGICAL COUNCIL,

1889-90.

Lieutenant-General RICHARD STRACHEY, R.E., C.S.I., F.R.S.,
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the Admiralty.

R E P O R T
OF THE
METEOROLOGICAL COUNCIL
TO THE
ROYAL SOCIETY,
For the Year ending March 31, 1890.

THERE has been no change in the Council during the year. Introductory.
The executive officers are as in the last Report :—

Mr. R. H. Scott, M.A., F.R.S., Secretary.
Nav.-Lieut. C. W. Baillie, R.N., F.R.A.S., Marine Superintendent.

In the last Report it was mentioned that the Treasury had intimated to the Council that it was desirable to reduce the cost of printing for the Office; the action which has been taken to follow out this suggestion will lead to a considerable saving in the expense of the publications of the Office. The correspondence will be found in Appendix I. (p. 57).

The present Report is arranged under three headings :—

- I. Ocean Meteorology.
- II. Weather Telegraphy.
- III. Land Meteorology of the British Isles.

PART I.

OCEAN METEOROLOGY.

Collection of Information.—The practice followed by the Office with reference to observers at sea, as described in former Reports, remains unchanged. Collection of information.

Appendix II. (p. 60) contains a list of all the observers who during the past year have contributed logs classed as “excellent.” Several of these observers have regularly co-operated with the Recognition of “excellent” observers.

Recognition of "excellent" observers. Office for many years. The names which appear in the list for the first time are as follow:—

Captain's Name.	Ship.
Angus, T. S. - - -	S.S. "Canton."
Atkinson, G. W. - - -	S.S. "Kaisar-i-Hind."
Cameron, Sub-Lieut. A. C. L., R.N. -	H.M.S. "Stork."
De Horne, M. - - -	S.S. "Rohilla."
Docherty, H. - - -	"Baron Colonsay."
Drenning, W. B. - - -	S.S. "Mira."
Garnsworthy, T. - - -	S.S. "Ardanacorrach."
Gillies, W. - - -	S.S. "Medway."
Helby, Lieut. H. W. H., R.N. -	H.M.S. Myrmidon."
Mitchell, G. - - -	S.S. "Trinaeria."
Owen, O. - - -	S.S. "Cordelia."
Pasifull, E. J. - - -	"Rahane."
Pope, J. - - -	S.S. "Derwent."
Pullen, Commr. T. F., R.N. -	H.M.S. "Stork."
Saul, J. - - -	"Coronilla."
Sibery, H., R.N.R. - - -	S.S. "Clan Cameron."
Stewart, A. - - -	"County of Selkirk."
Thearle, J. - - -	S.S. "Lennox."
Thompson, Lieut. H., R.N. -	H.M.S. "Rambler."
Trevor-Roper, Dr. G. D., R.N. -	H.M.S. "Stork."
Worrall, W. A. - - -	"Camana."

Proportion of "excellent" to total number of logs received. The total number of logs received in the year ending March 31, 1890, is 172, of which 136, or 79 per cent., have been classed as "excellent," being nearly the same per-centage of "excellent" logs as in last year.

The average number of logs received annually during the five years, 1884-88, was 186, of which the per-centage of "excellent" logs was 75.

The Council take this opportunity of expressing their best thanks to the observers who have assisted them during the past year.

They regret to have to announce the deaths of four of their observers; Capt. Hugh Campbell, ship "Holkar," who had kept 7 "excellent" logs; Capt. A. Hart Dyke, S.S. "La Plata," who had kept 2; Capt. W. Hughes, ship "Bolan," who had kept 9; and Comr. T. F. Pullen, H.M.S. "Stork," who had recently begun to observe.

Appendix III. (p. 63) gives a list of meteorological logs and of meteorological reports from stations abroad, received at the Office during the year.

Districts from which observations are obtained. The following summary of the voyages of the ships observing for the Office shows the districts from which observations were received during the year:—

To Baffin's Bay or Greenland - - -	2
„ North America, East Coast - - -	28
„ „ „ West „ - - -	9
Off East Coast of North America - - -	1
To West Indies - - -	23

To South America, East Coast - - - -	13	Districts from which observations are obtained.
" " " West " - - - -	9	
" Australia and New Zealand, viâ Cape of Good Hope	23	
" " " " Suez - - - -	1	
At Australian stations - - - -	6	
To India, viâ Suez - - - -	11	
" India, viâ Cape of Good Hope - - - -	18	
" China, viâ Suez - - - -	6	
" Cape of Good Hope - - - -	10	
" West Coast of Africa - - - -	1	
" East " " - - - -	1	
Between British Ports - - - -	6	
To Mediterranean Ports - - - -	5	

Red Sea Charts.—The discussion of the Meteorology of the Red Sea, mentioned in last Report, has now been completed, and the charts are nearly ready for engraving.

Cape Guardafui Charts.—Numerous additions have been made to these charts, which illustrate the winds, sea temperature, and currents for the entire year, and they are now being prepared for the engraver.

The Aden Cyclone of June 1885.—The synchronous daily charts of two storms that occurred in this month have been completed, and will at once be engraved. They cover a period of six weeks, and are the first daily charts of this description that have been prepared for the Arabian Sea.

Cyclone Tracks in the Southern Indian Ocean.—These charts, which as stated in former reports have been compiled from the data furnished by Dr. Meldrum, showing the frequency and tracks of cyclones for nearly 20 years, arranged according to months, are now in the press, and will be issued immediately. Dr. Meldrum's original charts, showing the yearly tracks, will also be engraved and accompany those prepared in the Office.

The Charts of Barometrical Pressure for the Oceans.—The two charts mentioned in last Report, one exhibiting the mean barometrical pressure for the year, and the other indicating the extent of range in the barometrical readings taken in different districts, have been issued.

Current Charts for the Atlantic, Pacific, and Indian Oceans.—The whole of the data relating to currents contained in the Office logs have been entered on the charts, and the Remark Books of H.M. ships are now being dealt with. The currents recorded in the logs of H.M. ships between the years 1830 and 1862 will next be taken in hand. The information obtained from these sources is especially valuable as supplying currents near the land, and for parts of the sea seldom traversed by ships of the Mercantile Marine.

Southern Ocean.—The discussion of the meteorological information available for the region from the Cape of Good Hope to New Zealand, referred to in the last Report as the future marine work of the Office, has been commenced. The currents, winds, pressure, and temperature of the air and sea are dealt with, and the occurrence of ice and of whales is noted. The information contained in the Office logs will be supplemented by information

available from any extraneous sources which are likely to be serviceable.

Foreign
Stations.
Malden Island.

Supply of Instruments to Stations in the Pacific, &c.—The existing information as to the occurrence of cyclones or other storms in the Pacific is very incomplete, and the want of such information was felt on the occasion of the Samoa cyclone, March 20, 1889. With the view of obtaining further observations, instruments have been supplied on loan to Malden Island, lat. $4^{\circ} 2' S.$, long. $154^{\circ} 58' W.$, and others will be sent shortly to Port Moresby, in New Guinea. Besides these steps the co-operation of the French Meteorological Department has been solicited in the hope that data may be procured from New Caledonia and the Society Islands.

New Guinea.

Houtman's
Abrolhos
Islands.

A meteorological outfit has also been supplied to a station in the Houtman's Abrolhos Islands, in the South Indian Ocean, off Geraldton, in West Australia.

St. Domingo.

Observations at Sanchez, Samaná Bay, St. Domingo.—The observations made by the late Dr. W. Reid during the years 1886, 1887, and 1888, are now passing through the press, and the volume will appear shortly.

Stock of
Instruments
belonging to
the Office.

Supply and Stock of Instruments.—In Appendix IV. (p. 69) is given a list of the meteorological instruments supplied by the Office to ships in the Royal Navy during the year, with a statement for the 31st March 1890 of the stock and distribution of the instruments standing on the books to the account of the Admiralty.

Appendix V. (p. 70) gives similar information with regard to the disposal of the other instruments belonging to the Office, remaining in store, or which have been supplied to the Mercantile Marine, observatories, telegraph offices, &c.

PART II.

WEATHER TELEGRAPHY AND FORECASTS.

Administra-
tive.

There have been no serious interruptions of telegraphic communication during the year.

The following have been the changes in the reporting stations and staff:—The station at Barrow-in-Furness has been discontinued since the end of 1889; at Dungeness, Mr. Batton has succeeded Mr. P. Curnow; and at Scilly, Mr. A. Hicks has been appointed to replace Mr. W. Thomas, who died in March 1890.

A list of the telegraphic reporting stations, British and Foreign, is given in Appendix VI. (p. 71).

The work in this branch of the Office continues to increase. The Daily and Weekly Weather Reports, in particular, have been extended and improved.

Inspection of
the Stations.

Inspection of the Telegraphic Reporting Stations.—The telegraphic reporting stations have been inspected during the year, in England by Mr. Ley, in Scotland by Mr. Buchan, and in Ireland

and Wales by Mr. Scott. The reports submitted by the Inspectors to the Council, which are printed in Appendix VII. (p. 72), show that the efficiency of the service continues to be satisfactorily maintained.

Discussion and Publication of the Information received.—The practice of the Office in collecting, discussing, and disseminating the meteorological information received by telegraph is described in Appendix VIII. (p. 86). The Daily Weather Report has appeared regularly during the year; for details see Appendix VIII. It is distributed free of cost as follows:—To newspapers, seven copies; to seaports, for public exhibition, 71 copies; to Government offices and public institutions, 66 copies; to correspondents of the Office, 73 copies; and to foreign meteorological establishments, 46 copies. Nearly 200 copies are issued regularly to subscribers.

Discussion of the reports.

The Weekly Weather Report, with its Monthly Appendices, has also appeared regularly; for particulars of this publication see Part III., p. 17.

Public display at the Office of the State of the Weather on British Coasts.—With a view to the earliest possible supply to the public of the latest information as to the weather received from the principal points on the coast, the Council have arranged for the display in a conspicuous manner on the front of the Meteorological Office, 63, Victoria Street, of the substance of the reports received by telegraph at 9.30 a.m. and 3 p.m., every week day, of the state of the weather and sea at the following stations: Yarmouth, Dungeness, the Needles (Hurst Castle), Scilly, Holyhead, and Valencia.

Display of information in front of the Office.

Weather Forecasts.—Forecasts are, as heretofore, prepared three times a day, namely, at 11 a.m., at 3.30 p.m., and 8.30 p.m. The Forecasts prepared at 11 a.m., on the information derived from the 8 a.m. reports, refer to the probable weather between noon on the day of issue and noon on the following day. They are publicly exhibited in several places in London,* and are supplied to the afternoon editions of the newspapers. The 3.30 p.m. Forecasts are employed for storm warnings only, excepting in the hay harvest season, when they are issued as subsequently explained. The forecasts at 8.30 p.m. are specially prepared for publication in the morning newspapers, but all the forecasts are available for the information of anyone who applies for them at the Office.

Forecasts.

The inquiries received through the Post Office for special forecasts during the year amounted to 52, and the personal applications to 29. The rules of the Office relating to such inquiries are stated in Appendix VIII. (p. 91).

Inquiries at the Office.

The results of a comparison of the Forecasts issued at 8.30 p.m. during the year, with the weather actually experienced are given

Testing of the Forecasts.

* Viz., in the City, at the Mansion House, Lloyd's Rooms, Messrs. R. & J. Beck's, Cornhill, and Messrs. de la Rue & Co.'s, Bunhill Row; in the West End, in the Libraries of the House of Lords and House of Commons; at Messrs. Elliot's, St. Martin's Lane; Messrs. Stanford's, Charing Cross; Messrs. Negretti & Zambra's, Regent Street; and Messrs. Pastorelli's, New Bond Street.

Results of
Forecasts.

in Appendix X. (p. 94). The following summary shows the successes and failures over the whole United Kingdom, estimated as explained in that Appendix. The results were best, 87 per cent., for England South, and worst, 76 per cent., for Scotland West.

SUMMARY of RESULTS of 8.30 p.m. FORECASTS, 1889-90.

Districts.	Per-centages.				Total per-centage of Success.
	Complete Success.	Partial* Success.	Partial* Failure.	Total Failure.	
SCOTLAND, N. - -	50	31	12	7	81
„ E. - -	51	31	12	6	82
ENGLAND, N.E. - -	46	35	12	7	81
„ E. - -	51	32	11	6	83
MIDLAND COUNTIES -	51	29	15	5	80
ENGLAND, S. - -	54	33	10	3	87
SCOTLAND, W. - -	45	31	14	10	76
ENGLAND, N.W. - -	48	30	13	9	78
„ S.W. - -	51	31	10	8	82
IRELAND, N. - -	48	33	11	8	81
„ S. - -	46	32	12	10	78
Summary - -	49	32	12	7	81

* Note "partial" implies "more than half."

Testing of
Forecasts.

The following table shows for each year from 1881 to 1889, inclusive, the per-centages of complete and partial success of the Forecasts issued at 8.30 p.m. for the whole year. Without questioning that improvements may be hoped for as a result of further research, it is doubtful how far greater success is likely to be attained so long as, at present, no information can be obtained concerning atmospheric changes going on over the Atlantic beyond the west coast of Ireland.

PER-CENTAGES of RESULTS of FORECASTS for the whole of the
BRITISH ISLES.

Year.		Complete Success.	Partial, i.e., more than Half Success.	Total Success.
1881	- -	34	42	76
1882	- -	43	37	80
1883	- -	48	33	81
1884	- -	50	31	81
1885	- -	50	34	84
1886	- -	49	31	80
1887	- -	52	32	84
1888	- -	51	31	82
1889	- -	49	32	81
Average	- -	47	34	81

Hay Harvest Forecasts.—The Council renewed in 1889 the offer made in previous years to the Royal Agricultural Society, the Royal Dublin Society, and the Highland and Agricultural Society to send Daily Forecasts *gratis* during the haymaking season to a number of observers selected by those Societies, on two conditions, viz., that the information should be made known as widely as possible, and that a record of the weather actually experienced should be sent weekly to the Office. The Societies accepted the proposal, and the Forecasts were issued as shown in the following table:—

Hay Harvest
Forecasts.

LIST of those who received HAY HARVEST FORECASTS
in 1889.

Districts.	To whom sent.	Address.
0. SCOTLAND, N.	Rev. Dr. Joass - Major Smith -	Golspie. Munlochy, Inverness.
1. SCOTLAND, E.	J. Whitton - G. Murdoch - C. L. W. Forbes -	Glamis, by Forfar. Rothiemay, Huntly. Aberfeldy.
2. ENGLAND, N.E.	Sir J. Wilson - J. Turner -	Chillingham Barns, Chatton, Northumberland. The Grange, Ulceby.
3. ENGLAND, E.	W. Birkbeck - Sir J. B. Lawes, Bt., and J. H. Gilbert, Ph.D. J. Fergusson* -	High House, Thorpe, Norwich. Rothamsted, Harpenden. Brettenham Manor, Thetford.
4. MIDLAND COUNTIES	Royal Agricultural College. E. E. Harcourt-Vernon	Cirencester. Grove Hall, East Retford.
5. ENGLAND, S.	C. Whitehead - E. P. Squarey - G. M. Allender - M. J. Sutton -	Barming House, Maidstone. The Moot, Downton, Wilts. Stammerham, Horsham. Reading.
6. SCOTLAND, W.	W. Calder - M. J. Stewart, M.P. - J. S. R. Ballingal -	Castle Hill, Dalreoch, Dum- barton. Ardwell, Stranraer. Eallabus House, Islay.
7. ENGLAND, N.W.	G. W. Wray - The Earl of Derby, K.G.	Leyburn, Yorkshire. Knowsley Hall, Prescott.
8. ENGLAND, S.W.	Colonel J. B. Turbervill The Earl of Ducie - T. Dyke - R. Neville Grenville -	Ewenny Priory, Bridgend, Glamorganshire. Tortworth, Gloucestershire. Long Ashton, Clifton, Bristol. Butleigh Court, Glastonbury.
9. IRELAND, N.	E. F. Farrell -	Moynalty, Co. Meath.
10. IRELAND, S.	D. A. M'Cready - D. A. Milward - W. Talbot Crosbie, D.L.	Larchvale, Moneygall, King's Co. Lavistown, Kilkenny. Ardfert Abbey, Tralee, Co. Kerry.

* Mr. Fergusson is a subscriber for these Forecasts.

Hay Harvest
Forecasts.

The issue of the forecasts commenced on June 11th with those for the South and East of England, and were continued for about five weeks, ending on the 3rd of August over the greater part of Scotland, and a week later in Ireland.

The general result of the issue of these forecasts, shown by the subjoined table, has been prepared solely from the reports of the above-mentioned gentlemen, and is entirely independent of any estimate formed within the Office itself :—

SUMMARY of RESULTS.—HAY HARVEST FORECASTS, 1889.

Districts.	Names of Stations.	Percentages.				Total percentage of Success.
		Complete Success.	Partial Success.	Partial Failure.	Total Failure.	
SCOTLAND, N.	Munlochy and Golspie	57	33	10	—	90
" E.	Aberfeldy, Rothiemay, and Glamis	51	31	13	5	82
ENGLAND, N.E.	Chatton and Ulceby	67	26	7	—	93
" E.	Rothamsted, Thorpe, and Thetford	64	29	7	—	93
MIDLAND COUNTIES	Cirencester and East Retford	61	34	3	2	95
ENGLAND, S.	Downton, Horsham, Maidstone, and Reading.	60	30	10	—	90
SCOTLAND, W.	Stranraer, Islay, and Dumbarton	52	30	14	4	82
ENGLAND, N.W.	Leyburn and Prescot	53	30	12	5	83
" S.W.	Tortworth (Gloucestershire), Clifton, Bridgend (Glamorganshire), and Glastonbury.	50	40	9	1	90
IRELAND, N.	Moynalty	50	40	7	3	90
" S.	Moneygall, Kilkenny, and Tralee	56	29	10	5	85
Mean for all districts, 1889		57	32	9	2	89
" " 1888		49	35	11	5	84

These figures show that the forecasts for 1889 were five per cent. better than those for 1888, and indicate the highest proportion of success that has ever been reached.

The largest general per-centage (95) was attained in the Midland Counties, and the lowest (82) was in Scotland East and West.

Major Smith and Messrs. Birkbeck, Fergusson, Squarey, and Sutton all gave independent testimony to the correctness of the forecasts.

In addition to the above, telegrams were sent to several other gentlemen at their own cost.

The funds at the disposal of the Council will not admit of extensive gratuitous distribution of Hay Harvest Forecasts, but now that the Board of Agriculture has been organised, the Council propose in the course of the current year again to suggest the advisability of a wider distribution of these Forecasts, their former reference to the Privy Council on the subject having led to no result.

Supply of Forecasts to the Fleet during the Manœuvres.—At the request of the Admiralty daily forecasts were supplied to the Commander-in-Chief of the "A" Fleet during the continuance of the Manœuvres in 1888 and 1889.

Information as to Forecasts supplied to the United States.—In the month of April 1889 inquiries as to the practice of the Office

in the preparation and issue of forecasts were received from the Chief Signal Office, Washington, and the Council furnished replies. The correspondence will be found in Appendix IX., p. 92.

Storm Warnings for the Coasts of the United Kingdom.—In Appendix XI. (p. 95) are given the names of the stations furnished with signals for Storm Warnings, in accordance with Circular 717 of the Board of Trade issued in February 1874.

Storm warnings.

These stations were, at the end of March 1890, 153 in number, situated:—

72 in England, 16 in Wales, 44 in Scotland, 15 in Ireland, 3 in the Isle of Man, and 3 in the Channel Islands.

With a view of adding to the efficiency of these warnings a revision of the districts in which the stations are arranged has been made, and further measures will be taken to improve the record of storms on the coasts by means of which the utility of the warnings will be better checked.

A comparison has been made in the Office between the warnings issued in 1889 and the weather experienced on our coasts, the warnings being tested by the method explained in Appendix VIII. (p. 92). The results of this comparison are shown in the following tables:—

RETURN of the RESULT of the COMPARISON between the WARNINGS ISSUED and the WEATHER EXPERIENCED in 1889.

Coasts.	Total No. of Orders to hoist and repetitions.	Warnings justified by subsequent Gales. Force 8 and upwards.	Warnings justified by subsequent strong Winds. Forces 6 and 7.	Warnings not justified by subsequent Weather.	Warnings late. Force 9 reached at two Stations before issue.	Warnings partially late. Force 9 reached at one Station before issue.	Warnings in Error owing to telegraphic mistakes.	Storms for which no Warning was issued.
Ireland, South -	43	24	12	5	1	1	—	Feb. 2-3.
„ East -	44	13	20	11	—	—	—	Feb. 2-3.
Scotland, East -	39	25	9	5	—	—	—	Jan. 18, Feb. 2-3.
„ West -	39	16	15	8	—	—	—	Mar. 26*, Sept. 28.
England, North-west	42	25	11	6	—	—	—	Feb. 2-3.
„ West -	37	14	18	5	—	—	—	Feb. 2-3, Mar. 26,
„ South-west	36	18	14	2	1	1	—	Sept. 28, Nov. 15.
„ South -	30	19	8	2	—	1	—	Feb. 2-3, Nov. 25.
„ South-east	28	11	11	5	—	1	—	Nov. 25.
„ East -	35	13	7	14	—	1	—	Nov. 25.
Totals -	373	178	125	63	2	5	—	
Per-centages -	—	47.7	33.5	16.9	0.5	1.4	—	

* These gales were felt only to the northward of Aberdeen.

NOTES as to GALES in 1889 for which WARNINGS were not issued.

Jan. 18th.—A brief but severe gale from westward, felt in Caithness and the Shetlands. Apparently caused by a small depression of which we could have no knowledge, but secondary

Notes as to
gales for which
warnings were
not issued.

to a larger system situated over Lapland. Gale confined to extreme northern stations.

Feb. 2-3.—A severe and wide-spread gale from west to north-west, caused by a large and deep depression which on Feb. 1 appeared to be moving eastwards towards Norway. At 6 p.m., 1st, barometer had begun to rise in Ireland as though the worst was past, but in the following night the storm suddenly took a southerly course, and passing quickly down our eastern coast, caused the gales mentioned. At 8 a.m., 2nd, it was too late to hoist any signals.

March 26th.—Fresh to strong north-westerly gale in north and east of Scotland, caused by small depression advancing suddenly from north-westward early on 26th, in rear of, and secondary to, a larger system which had moved from the Shetlands towards Norway. By 8 a.m., 26th, it was too late to hoist any warning signals.

Sept. 28th.—North-westerly gale in north of Scotland and north-west England. At 8 a.m., 28th, a depression lay off the west of Norway, and appeared to be moving south-eastwards. Subsequently it took a much more southerly course, while pressure actually increased on our western coasts; a gale was thus produced, without being expected. At 8 a.m., 29th, centre of depression was over Holstein.

Nov. 25th.—Strong south-westerly gale on western, southern, and south-eastern coasts of Great Britain, caused by a depression which lay over Ireland at 6 p.m., 24th. Of the depth of this disturbance we had no knowledge owing to insufficient information, the 24th being a Sunday. Available reports showed only a "V"-shaped system of moderate intensity, but the Parsonstown report next morning showed that the "V" contained a well-formed disturbance which caused the gales referred to.

Comparison of
results for
1889 with
previous years.

The following table contains a comparative statement of the storm warnings and their results in 1889, and in the ten preceding years. It will be seen that the total per-centage of warnings justified is 81·2, being 2·7 less than that for the preceding year:—

Years.	Total No. of Warnings issued.	Warnings justified by subsequent Gales.	Warnings justified by subsequent strong Winds.	Total Warnings justified.	Warnings not justified by subsequent Weather.
		p.c.	p.c.	p.c.	p.c.
1879	509	50·5	25·1	75·6	20·6
1880	390	58·2	24·6	82·8	13·3
1881	454	58·6	23·3	81·9	14·8
1882	503	61·4	21·1	82·5	14·9
1883	610	56·2	21·6	77·8	20·8
1884	461	66·4	20·0	86·4	12·1
1885	591	55·3	24·0	79·3	19·5
1886	542	55·3	26·9	82·2	15·9
1887	472	55·5	26·1	81·6	16·4
1888	539	55·3	28·6	83·9	14·3
1889	373	47·7	33·5	81·2	16·9

The Washington Maritime Conference.—A proposal to introduce international uniformity in the existing systems of Storm Warnings in various countries was included in the Programme for this Conference, and in the month of November the Council were consulted by the Board of Trade as to the representation of this country at Washington by a special delegate with reference to this question. The reply of the Council was not favourable to the nomination of such a delegate. The correspondence will be found at Appendix XII., p. 97.

Washington
Maritime Con-
ference.

Proposal for a Meteorological Station at Bermuda.—In the month of July an inquiry was received from the Board of Trade, as to the probable cost of the maintenance of a telegraphic reporting station at Bermuda. The Council, in their reply, strongly supported the establishment of such a station, and stated that the cost of such stations in these islands was very moderate. The correspondence will be found at Appendix XIII., p. 99.

Proposed
station at
Bermuda.

Fishery Barometers.—To add to the means of obtaining warnings of stormy weather by the sea-going population, barometers were many years ago supplied by the Board of Trade on loan to fishing villages and other places on the coast, to be set up for public information. The whole number of stations supplied by the Office with these instruments is 177. Of these 59 are in England, 6 in Wales, 49 in Ireland, 59 in Scotland, 3 in the Isle of Man, and 1 in Jersey. The list is given in Appendix XIV., p. 102.

Fishery
barometers.

The inspection of the Fishery Barometers in England and Ireland has been continued during the past summer, the Hon. R. Abercromby taking the east of England, while Captain Toynbee visited the north of Ireland, from Donegal Bay round to Dundalk.

In almost all cases the instruments were found to be in good order, and they seemed to be valued by the fishermen in each locality. Whenever possible, the opportunity of the inspection was taken to impart instruction in the use of instruments in connexion with weather observations.

Simultaneous Observations.—The Office has continued its co-operation in the system of International simultaneous observations, taken at Greenwich mean noon, as explained in former Reports, which was organised in 1874, at the request of the Chief Signal Officer of the United States.

Simultaneous
observations.

The number of these observations which have been received during the year from the Royal Navy has been 3,880, and from the Mercantile Marine, 6,300.

PART III.

LAND METEOROLOGY OF THE BRITISH ISLES.

Observatories and Stations.—The observations of the climate of the British Isles, which are received by the Office from certain

stations, may be arranged in five classes, according to the degree of completeness with which they are made.

Self-recording
observatories.

1. The Observatories furnished with self-registering instruments by which all the principal meteorological phenomena are recorded continuously. These alone afford the materials necessary for the study of the periodic variations of the meteorological elements.

Anemographic
stations.

2. Anemographic stations furnished with instruments registering the wind only. The records from these stations relate rather to weather as distinguished from climate, and are especially important in connexion with storms. They are often useful in affording evidence available in courts of law with respect to collisions at sea, and damage done by wind.

Stations of
Second Order.

3. Stations of the Second Order furnishing climatological information from eye observations taken twice a day. The observers at these stations are all volunteers.

Telegraphic
Reporting
Stations.

4. The Telegraphic Reporting Stations, at which the observations are taken by eye, but supplemented in some cases by self-recording aneroids, &c., supply the material upon which the daily weather reports and forecasts are based. The hours of observation at these stations are determined by the requirements of the telegraphic system, as explained in Part II., but the data which they furnish are also utilized to afford climatological information for parts of the country where Stations of the Second Order do not exist.

Extra stations.

5. Extra stations furnishing returns with less completeness and detail than those of Class 3.

Sunshine
stations.

A continuous record of the amount of bright sunshine is received from 39 stations in the British Isles, of which some are first or second order stations, whilst from others the sunshine record is alone received. See Appendix XV., p. 103.

A fuller account of these several stations and of the methods employed by the Office in dealing with their records will be found in Appendix XVI., p. 104.

Documents
received.

Appendix XVII., p. 108, contains a list of all documents relating to the land meteorology of the British Isles received at the Office during the year.

Regulation of
Observatory
work.

Regulation of Work at principal Observatories.—The regulations for the management of the self-recording instruments have been carefully revised. They will be found in Note A., p. 24. The experience of nearly 20 years has shown that in all essentials the instruments are thoroughly satisfactory, and that very little alteration was required in the instructions originally issued for their use, which are contained in the Report of the Office for 1868.

Inspection of
Stations.

Inspection of the Stations.—The self-recording observatories and the anemographic stations (Classes 1 and 2), as well as the Telegraphic Reporting Stations (Class 4), are regularly visited each year by the Inspectors of the Office. The extra stations (Class 5) are inspected as opportunity offers. Of the Stations of the Second Order (Class 3), some belong to the Royal Meteorological Society; these are visited by an Inspector appointed by that Society, an allowance being made by the Office toward the cost of the

inspection, in accordance with the recommendation of the Treasury Committee (1877); and some belong to the Scottish Meteorological Society. The remaining Stations of the Second Order are visited at least once in every two years by the Inspectors of the Office. The Superintendent of the Kew Observatory, Mr. G. M. Whipple, and his chief assistant, Mr. T. W. Baker, are specially employed to inspect and report on the self-registering apparatus, and on the photographic processes at the observatories. Extracts from the Reports of the Inspectors are given in Appendix VII., p. 72.

Inspection of stations.

Information supplied to the General Register Office, Dublin.—Reports from eleven of the Irish stations of the Office have been regularly supplied to the Registrar General for Ireland, for his Weekly and Quarterly Returns.

Reports supplied to Registrar General for Ireland.

Quarterly Weather Report.—Part I. of the volume for 1880 has been issued, and Part II. is in the press. On the final completion of this volume the issue of the Quarterly Weather Report with the reproduction of the continuous records from the seven observatories, comes to an end.

Publications.

The following is a list of the volumes which have already appeared or are in process of issue, with the dates of their publication:—

Quarterly Weather Reports.

Year.				Published.				Year.				Published.			
1869	-	-	-	1871	1875	-	-	-	1879	1870	-	-	-	1884	1871
1870	-	-	-	1872	1876	-	-	-	1884	1872	-	-	-	1885	1872
1871	-	-	-	1874	1877	-	-	-	1885	1873	-	-	-	1887	1873
1872	-	-	-	1873	1878	-	-	-	1887	1874	-	-	-	1889	1874
1873	-	-	-	1875	1879	-	-	-	1889	1875	-	-	-	—	1875
1874	-	-	-	1877	1880*	-	-	-	—	1877	-	-	-	—	1877

* In progress, Parts III. and IV. still to appear.

In place of this publication there have been successively issued, first, the Monthly Weather Report, and subsequently, the Monthly Summary of the Weekly Weather Report.

Other Periodical Reports.

Monthly Weather Report, 1884–1887 (January to August), published; 1881–1883 and 1887 (September to December), still to appear.

This publication ceases with the year 1887, and the information it supplied is now given in the Monthly Summary of the Weekly Weather Report.

The Weekly Weather Report, which is prepared in the Telegraphic Branch of the Office (see Appendix VIII., p. 88), has been considerably modified in form, with a large saving of expense, and now supplies, by its synchronous charts, a very complete and instructive view of the chief meteorological changes, day by day, over the greater part of Europe, such as is not to be found in any of the similar publications issued by any other office.

Publications.

A Monthly Summary, replacing the former Monthly Weather Report, appears as a supplement to the Weekly Weather Report.

Appendix I. to the Weekly Weather Report for 1889 gives a summary for each quarter, and for the whole year, of the Rainfall and Temperature for each district, for the 24 years 1866-1889, and also the Monthly and Progressive values of Accumulated Heat, Rainfall, and Bright Sunshine for all the districts in each month of 1889. Appendix II. to the same Report gives the Weekly and Progressive values for the same elements during the year 1889 (in continuation of Appendix II. for the year 1888), and Appendix III. gives the Mean Weekly values for the following number of years:—

Accumulated Heat and Rainfall, 11 years, 1878 to 1889.

Bright Sunshine - - - 8 „ 1881 „ 1889.

Appendix IV. gives for each district, for the 12 years 1878 to 1889, the mean temperature for each week in the year.

Hourly Readings.—After full consideration the Council have resolved to make a very considerable alteration in the form of publication of the *Hourly Readings* obtained from the records of the self-registering instruments at the four principal observatories, and to commence the new series with the year 1887. The calculations for that year are in an advanced stage, and will shortly be ready for press. In future the publication will consist of a carefully arranged series of mean values, which it is believed will prove more generally useful than the publication of the hourly readings *in extenso*, which has hitherto taken place. The new series will comprise—

- (1.) *Hourly* means of pressure, temperature, the difference between the dry and wet bulbs, and of wind components, together with the amount and frequency of rain; these hourly means will be for periods of (a) five days, (b) calendar months, and (c) the year.

From these will be computed the harmonic components of the hourly and yearly mean variations of pressure and temperature for each month and for the year.

- (2) The daily, five-daily, monthly, and yearly means of pressure and temperature.
- (3.) The monthly and annual falls of rain will be given as heretofore.
- (4.) The wind results will be given in the form of mean components, referred to the four cardinal points, the Council considering this to afford upon the whole the best solution, although by no means an altogether satisfactory one, of the difficult problem of dealing with the mean direction of the wind.

The computation of mean hourly values of the temperature of the air and of barometrical pressure for the seven observatories and for each month of the year 1883 has been completed, and the Council has decided to extend the work to all those years preceding 1883 for which data exist and which have not already

been dealt with, and considerable progress has been made with Publications the work.

Observations at Stations of the Second Order.—The volume for 1885 has appeared, and that for 1886 is in an advanced state.

The number of stations, 32, from which the returns have been of late years published *in extenso* has been considerably in excess of the number, 15, proposed by the Congress of Rome in 1879, and the Council has therefore resolved to reduce the present number to 21, which they consider to be sufficient, while it will considerably diminish the cost of the publication. At the same time the number of stations from which monthly means and summaries only are published in a concise form, has been increased from 14 to 45.

The following is the list of stations for which returns will be published for 1886 and future years:—

STATIONS for PUBLICATION in DETAIL on Form A.,
21 in Number.

Stations.	In connexion with	Years already published in detail.	Remarks.
Glasgow -	M. O.	10	Formerly observatories. 10 years hourly readings already published. Continuous records of pressure, temperature, wind, and rainfall still available, except for Armagh, which furnishes wind and rain only. For Stonyhurst and Armagh the records for 1884 and 1885 have been published among the stations on Form A.
Stonyhurst -	M. O.	12	
Armagh -	M. O.	12	
Dunrobin Castle -	S. Met. Soc.	6	High-level station (1,113 feet).
Braemar -	S. Met. Soc.	6	
Dundee -	S. Met. Soc.	6	
Wolfelee -	S. Met. Soc.	—	Sutton Coldfield to be substituted for Churchstoke for 1889.
Scarborough -	R. Met. Soc.	5	
Hillington -	R. Met. Soc.	9	
Churchstoke -	R. Met. Soc.	10	High-level station, 1,395 feet. The only high-level station available in the south of England.
Carmarthen -	R. Met. Soc.	11	
Margate -	R. Met. Soc.	4	
Dartmoor (Princetown).	R. Met. Soc.	7	This is the most northern station available, and there is a continuous record of wind.
Swanbister -	M. O.	—	
Laudale -	M. O.	7	
Douglas (Isle of Man).	M. O.	8	At both of these stations there are long series of observations available taken by the officers of the Ordnance Survey.
Southampton -	M. O.	8	
Dublin (Mountjoy Observatory).	M. O.	—	
Markree Castle -	M. O.	11	
Parsonstown -	M. O.	13	
Londonderry -	M. O.	7	

LIST for PUBLICATION on Form B. (Monthly Means and Summaries).

Swanbister.	❧ Buxton.
❧ Lairg.	❧ Cheadle.
❧ Dunrobin Castle.	❧ Hillington (Norfolk).
❧ Gordon Castle.	Leicester.
❧ Glencarron.	Uppingham.
Aberdeen.	❧ Churchstoke (Montgomeryshire).
❧ Fort Augustus.	Geldeston (Beccles).
Braemar.	❧ Bennington.
❧ Fort William.	❧ Cheitenham.
❧ Lednathie.	St. David's.
Laudale (Argyleshire).	❧ Carmarthen.
❧ Dundee.	❧ Berkhamsted.
❧ Ochtertyre.	Kew.
❧ Callton Mor.	❧ Margate.
Glasgow.	Southampton (Ordnance Survey Office).
❧ Rosewell.	St. Leonard's.
❧ Rothesay (Isle of Bute).	❧ Southbourne.
❧ Marchmont.	❧ Rousdon.
❧ Wolfelee.	❧ Dartmoor.
❧ Pinmore (Ayrshire).	❧ Babbacombe (Torquay).
❧ Glenlee.	Falmouth.
❧ Cramlington.	Londonderry.
❧ Cargen.	❧ Lissan (Co. Tyrone).
❧ Scaleby (near Carlisle).	Armagh.
Durham.	Brookeborough (Colebrooke Park).
Newton Reigny.	Markree Castle (Sligo).
❧ Aysgarth (Yorkshire).	Dublin (Glasnevin).
❧ Scarborough.	Dublin (Mountjoy Observatory, Phoenix Park).
Cronkbourne (Douglas), Isle of Man.	Dublin (City).
York.	Parsonstown (Birr Castle).
Stonyhurst.	❧ Killarney.
❧ Wakefield.	Valencia.
❧ Prestwich.	
❧ Llandudno.	

The Stations marked ❧ belong to the Scottish, and those marked ❧ to the Royal Meteorological Society.

Observations
on Ben Nevis.

Observations on Ben Nevis.—The arrangements made with the Directors of the Observatory on the summit of Ben Nevis, at a height of 4,406 feet above the sea, and explained in the Report for 1885, remain in force, and the Council have continued the annual grant of 100*l.* towards the expenses of the Observatory, and have received MS. copies of all the meteorological observations taken.

The building of the new observatory at Fort William is now completed. It was explained in the last Report that the Council had agreed to subsidize this observatory to the extent of 250*l.* a year, and supply it with the necessary outfit of instruments. These will shortly be sent down and erected.

Sea Surface
Temperature.

Sea Surface Temperature on the Coasts of the British Isles.—These observations, which are obtained through the courteous assistance of the Admiral Superintendent of Naval Reserves, the Trinity House, and the Commissioners of Irish Lights, are still continued, and a large amount of valuable information is thereby collected.

Cloud Photo-
graphy.

Cloud Photography and Measurement.—This subject has continued to receive attention, but as yet satisfactory results have not been obtained.

The Bridled Anemometer.—The experiments with the bridled anemometer, an instrument intended to record strong gusts of wind, which have been undertaken by Mr. W. H. Dines, as intimated in the last Report, have been continued, and the result has been to show that the cups, placed in the same plane, at the ends of short arms, exercised appreciable interference on each other. The anemometer will be altered to remedy this defect. Further experiments have also been carried on by Mr. Dines at Hershams with respect to other questions relating to wind. An account of these will be found at Note B., p. 36.

The Bridled
Anemometer.

Electrical Anemometer.—This instrument has now been erected at Kew for the purpose of ascertaining whether its indications can be utilized. The results hitherto have not been satisfactory.

Electrical
Anemometer.

Violle's Actinometers.—At the request of the Solar Physics Committee the Council have undertaken to institute some experiments at Kew Observatory on Violle's apparatus for measuring solar radiation. (Note C., p. 46.)

Violle's
Actinometer.

The Harmonic Analyser.—The analysis by this instrument of the barograms from the seven observatories has now been completed for the 12 years 1871–1882 inclusive. The corresponding results obtained from the thermograms were published in 1886.

The Harmonic
Analyser.

In consequence of the resolution of the Council to undertake the calculation of the mean hourly values of pressure and temperature, the question arose whether the harmonic constants might not be obtained in a more complete and satisfactory manner by arithmetical computation than by the mechanical process. The Council therefore thought it advisable to ascertain as far as possible what was the degree of accuracy obtainable by the use of the machine, and what were the causes of error likely to arise.

For this purpose a series of experiments has been carried out, more complete than those before made, the result of which has been to show that, owing to certain difficulties which are experienced in passing the curves through the machine, and which could not be avoided without making a very considerable alteration in the mechanical details of one portion of the instrument, the results obtained by a mechanical analysis of the curves are liable to errors which, though small in themselves, are important in relation to the quantities being dealt with, which are themselves very small.

From this and other considerations, and from the character and results of the experiments upon the operation of the machine which will be found in fuller detail in Note D., p. 47, the Council have resolved to obtain the harmonic coefficients by arithmetical computation in preference to the use of the machine, though the machine may for certain purposes be found very useful.

Thermometers for Cotton Cloth Factories.—The Cotton Cloth Factories Act, 1880, states that in every such factory there shall be provided, maintained, and kept in correct working order two sets of "standardised" wet and dry-bulb thermometers. In the

Thermometers
for Cotton
Cloth Factories

Thermometers
for Cotton
Cloth Factories.

month of January the Council were requested by the Home Office to inform the Secretary of State how thermometers had best be "standardised" for the purposes of the Act. The Council replied that thermometers were at present being verified at the Kew Observatory of the Royal Society to the extent of several thousands annually, and that accordingly the testing of such instruments presented no difficulty.

Records from
stations of the
Royal Engi-
neer and
Army Medical
Departments.

Observations from Military Stations.—The summaries of these observations, made under the direction of the Royal Engineer and Army Medical Departments, between 1852 and 1886, have been completed, and the volume has now been issued.

Trevandrum
Observations.

Trevandrum Observations.—On the death of Mr. J. Allan Broun, F.R.S., in 1879, the desirability of discussing and publishing the records of the observatory at Trevandrum, in Southern India, which had been carried on under his superintendence for over twelve years, was brought before the Royal Society of London by the Royal Society of Edinburgh. The whole of the records, 31 volumes, were subsequently (in 1880) deposited at the Meteorological Office, by Mrs. Broun, for safe keeping. The negotiations on the subject with the Indian Meteorological Department at that time led to no result. The Meteorological Council have now resolved to make another effort to induce the Indian Authorities to render the very valuable material contained in these MSS. accessible to scientific men, and have addressed the Royal Society on the subject.

LIBRARY.

Library.

The library contains standard works on Meteorology and the allied Sciences, and is, besides, particularly rich in Transactions, Proceedings, Reports, and other Publications which give a large mass of Meteorological observational data from all parts of the world, extending over many years. It consists at present of over 11,000 volumes and pamphlets, exclusive of charts and MS. records of observations. The books and other documents are accessible to scientific men for reference at the Office.

Appendix XVIII., p. 113, contains a list of the additions to the library during the year, which have been catalogued upon cards, and are entered in the reference catalogues under (1) Authors, and (2) Subjects.

EXPENDITURE.

Financial.

Appendix XIX., p. 138, shows the receipts and payments during the year ending 31st March 1890. The amount voted by Parliament was 15,300*l.*, as in the previous year.

The following abstract of expenditure shows the amount properly chargeable to the year in question, and its distribution under the

various heads, together with the increase or decrease in 1889-90, as compared with the previous year :—

NET EXPENDITURE.	1888-89.	1889-90.	Increase.	Decrease.
GENERAL ADMINISTRATION:	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Payment of Council -	1,000 0 0	955 18 4	—	44 1 8
Secretary -	800 0 0	800 0 0	—	—
Office -	798 8 0	801 4 2	2 16 2	—
Rent, fuel, and lighting -	709 17 11	701 14 3	—	8 3 8
Alterations to premises, attendance, and contingencies -	436 4 0	474 7 6	38 3 6	—
Expenses incidental to International Meteorological Congress -	22 2 3	5 2 0	—	17 0 3
Pensions -	138 16 4	186 16 4	48 0 0	—
SPECIAL RESEARCHES -	570 5 0	710 10 6	140 5 6	—
LAND METEOROLOGY -	3,353 7 1	3,544 9 11	191 2 10	—
WEATHER INFORMATION -	3,845 10 4	3,777 19 5	—	67 10 11
INSPECTIONS -	702 5 1	664 2 5	—	38 2 8
OCEAN METEOROLOGY -	2,795 3 3	2,736 9 4	—	58 13 11
Total - - £	15,171 19 3	15,358 14 2	420 8 0	233 11 3

In the year 1889-90 the sum of 1,606*l.* 9*s.* 5*d.* was paid to the Post Office on account of inland and foreign telegrams, allowances to clerks, and rental of private wires.

(Signed) R. STRACHEY,
Chairman.

NOTE A.

CODE of REGULATIONS, &c., &c., for conducting the WORK at the FIRST-CLASS OBSERVATORIES, and the EXAMINATION thereof.—1889.

THE errors to which the traces derived from self-recording meteorological instruments, and the numerical values obtained from them, are subject, are of three classes, viz. :—

- i. Errors in the traces themselves, including those due to faulty attachment of the paper upon which the curves are produced.
- ii. Errors of date and time-scale entered upon the papers.
- iii. Errors in tabulating from the traces.

Errors in the Traces themselves.

With a view of avoiding, as much as possible, errors included in the first category, the attention of observers in charge of instruments is directed to the following points :—

Care must be taken that the gas flames in the instruments are so adjusted, and the condensers and reflectors so fixed, that the barometer tube and two thermometer tubes with their attached shields are at all times well illuminated.

In the event of a very exceptional rise or fall of pressure or temperature, and when the observer has reason to fear that readings will otherwise be lost, the instrument should be temporarily raised or lowered by means of the screw, so that the record of extreme values may be secured.

But as any alteration of the positions of the instruments, especially of the barometer, throws out the zero of the scales, this measure should only be adopted with extreme caution.

In all cases when changes in the positions of the instruments are made, careful eye observations should be made before and after each change, to guard the records from the effects of erroneous index errors, or errors of zero lines.

In the case of the barometer the instrument should be carefully restored to its original position as soon as the occasion for the change has passed away.

The thermometers, however, must be regularly raised and lowered by the screw suspending them, in the course of every year, in order to secure sufficient illumination for the portion of the scale likely to be in use in summer and winter respectively : and care must be taken not to postpone this operation in spring and autumn until some of the readings have been lost.

Great care should be taken that all the parts of the instruments are working correctly, and are free from dust.

Before wrapping the photographic paper round the cylinders it should be carefully examined as to the freedom from blemishes or defective coating of the sensitive surface, and when fixed in its

place on the cylinder a second examination should be made to see that while it is everywhere in close contact with the cylinder, there is no bagging or bulging, and that its edge is parallel to the edge of the cylinder nearest to the trace. Care should also be taken in cutting off the superfluous paper, that no loose ends are left projecting, as they are liable to cause a stoppage of the clock.

The prepared papers for use with the anemograph and rain-gauge require similar precautions to be taken with regard to wrapping them upon the cylinders; but additional care is also required, so that the lines ruled upon these papers are made to coincide with certain points of the apparatus designed for the purpose of properly setting the instruments.

After placing a new sheet of prepared paper on the cylinder of the rain-gauge, the glass tabulating scale should be used to see that the printed scale on the paper is parallel with the edge of the cylinder. The height of the pencil is next adjusted so that, the bottle being empty, the trace runs along the zero line of the blank paper, when the cylinder is turned by hand.

The float is also to be depressed by the finger and allowed to rise again in order to see that it is free to act throughout its whole range.

Great care should be exercised to avoid interfering with the instruments or their positions, but when any alteration of position, or interference with, or interruption of, their action occurs, an explanatory note of the causes of all deficiencies should be made on the curves and tabulations.

Errors of Time and Date.

Observers should set their watches daily to correct G.M.T., either by reference to a standard clock, or to a chronometer corrected to the true time for the day by means of a table of going rates. The instrumental clocks should all be set to this correct time at the time of changing the papers, and comparisons should be made at every observation hour in order to see that no stoppage has occurred in the interval which has elapsed between the observations.

In the case of the photographic instruments, after changing the papers, the observer should, if possible, listen for the sounds produced by the closing and opening of the light shutter, which will show that it is duly performing its duty.

The error of the instrument clocks should never be allowed to exceed two minutes in the two days.

The instrumental clocks should all be wound daily between the hours of 10 and 11 a.m., fresh papers being placed daily on the cylinders of the anemograph and rain-gauge, and on alternate days on the barograph and thermograph. The observer should carefully note the exact time at which the clocks are stopped or the cylinders detached from the driving gear, and should also read the indications of the dials and time-scales, noting them down at

the time on the journals, and on the reverse sides of the anemograph sheets. Similar memoranda should also be jotted down of the time at which the instruments are again set in action. The photographic sheets to be marked with the initials B_1 , B_2 , and T_1 , T_2 , in addition to the date, as a guide to the photographer in his operations, the sheets marked B_1 T_1 being the outer.

As soon afterwards as time permits, the dates should be permanently and distinctly written up in ink, the time-scales, &c. stencilled on, and the clock times and check standard readings entered on the sheet in accordance with the regulation pattern.

The wet bulb thermogram should be examined for places where the damping was inefficiently performed, and remarks made accordingly.

Check observations of the standard thermometers and barometer should be made five times daily; those of the thermometers at the moment coincident with the shutting off the light from the curve at two minutes before the even hour, and those of the barometer when the light is restored at two minutes after the even hour.

General Instructions.

WET-BULBS:—At the times of reading the standard thermometers the state of the wet-bulbs of both the standard and self-recording instruments ought to receive attention. If both bulbs seem to be properly wetted, and sufficient water is in the cistern to maintain them in the same condition until the next visit of the observer, the sign \checkmark should follow the entry of the standard reading in the observation book and journal. If either of the bulbs is wholly or partially dry at the time of observation, a note should be made to call the attention of the tabulator to the unsatisfactory nature of the observation at that hour, and the observer should proceed to damp the thermometer at once.

In time of frost the bulbs should be kept covered, if possible, with a thin coating of ice by applying, at frequent intervals, a little cold water directly to the surface of the bulb. When the air is too moist to allow of this ice jacket evaporating or the temperature is at or about the freezing point, and the ice does not melt off the bulb quickly enough, it should be melted off by using a little warm water. This may also serve to thaw the ice in the supply tank, tubes, and threads, which might otherwise fail to act properly.

In hot and dry weather it is sometimes found that difficulty occurs in maintaining the wet-bulbs in a properly moistened condition. In such cases the tank should be refilled at more frequent intervals than usual, and also new threads and muslin should be fitted up. It is necessary to soak well, or boil in water, the threads and muslin before they are used, in order to remove from them any gum or starch, the presence of which seriously reduces the capillary actions.

The water supplied to the wet-bulb cistern should, if possible, be rain water, and always be taken from a vessel exposed to the

air, so that its temperature may be that of the air, this being of importance. The best plan is to save and use the water collected from the rain-gauge as being free from lime, which in the case of hard water forms an incrustation on the muslin; when this is observed the muslin should be changed.

Flooding from excess of water often occurs when the cistern is refilled, vitiating the record for a quarter of an hour or more after replenishing.

The water cistern should, as a rule, be filled after reading the thermometers; and it is advisable to restrain the flow of water so that no more runs over the bulb than is requisite to keep it completely moistened. The lowest points of the thread should always be somewhat lower than the *points of attachment* of the thread to the thermometer bulb, so that the water rises to the bulb by capillary attraction. Notes of the times of adding water must be made on the curves.

ANEMOGRAPH:—Once a month, on a calm day, the orientation of the anemograph should be tested in order to see that the direction of the wind is being properly recorded, and that no slipping has taken place in any of the joints of the shafting. Opportunity should also be taken of this, to oil the instrument thoroughly, and to see that the bearings are free from dirt.

Full details as to how this is to be performed are given in a special circular of instruction which was issued in March, 1882.

RAIN GAUGE:—As regards the rain-gauge, particular care must be taken to change the recording papers every day at about the hour of 10 a.m.; the observer must never assume absence of rain in the 24 hours, as a shower may fall unnoticed during the night.

At the time of changing the rain-gauge papers the observer should always empty the contents of the receiver into the measuring glass, and compare the amount so measured with that indicated at the time by the curve, recording on the sheet the sum of the discharges *plus* the quantity so measured.

The measurement of snow by this gauge does not give very satisfactory results. Probably the best method is to collect the snow contained in the receiver into a vessel, and having melted it, to pour the water through the gauge in order to show the trace. In such cases the measurement of the hourly values should not be attempted, but the total amount entered at the latest hour to which the trace extends.

A spare gauge of the 8-inch pattern should be kept in the close vicinity of the Beckley gauge, and its contents measured immediately after the latter has been seen to.

Any material discrepancy between the indications of the two instruments should be noted in the weather journal, and endeavours made to ascertain its cause.

SUNSHINE RECORDER:—The cards are to be changed if possible at sunset each day, or if this is inconvenient, at some

other fixed hour, which having been chosen, is to be adhered to as closely as possible.

The card is to be changed even if it has not been scored, and the identical card which was in the instrument returned to the Meteorological Office.

If the weather be windy it is advisable to insert a small wedge of paper so as to hold the card firmly in its groove.

In time of snow, when there is any chance of sunshine, the snow should be removed from the ball and from between the ball and the card. Hoar frost should also be removed from the ball as soon as possible, and the ball should occasionally be wiped to remove any dirt which may have become deposited upon it.

Every card should have clearly written upon it the name of the observatory, the date, and the time of insertion and withdrawal, using local apparent time; this is especially important if the cards are changed while the sun is shining. Should the instrument have been moved, or should anything have occurred to interfere with the accuracy of the score in any way, an explanatory note should always be written on the back of the card.

The cards are to be returned to the office as soon as possible after the close of each month. In packing them for transmission through the post they should always be kept flat and never be folded.

Further particulars as to the setting of the instrument, obtaining local apparent time, &c. will be found in a special circular issued January 1889, entitled "Directions for adjusting and using the Sunshine Recorder."

Tabulation of traces and discovery of Errors.

Tabulation forms are provided for the entry of the measurements made from the automatic traces. These have to be suitably prepared for use by having written upon each of them on every page the name of the observatory and a consecutive number corresponding with that given in the diary issued by the Meteorological Office for each year. The dates are next entered, care being taken that they accord with the entries in the diary and journals, and also that each month's work is kept totally distinct from any other. New forms throughout should be brought into use on the first day of every month.

Barograms.—The curve being duly written up and dated, is fixed in the tabulator frame and the scale fitted, the brass time-scale being adjusted so that the measuring bar-catch accords with the time gaps on the barograph curve indicating the even hours, in order that the reading glasses may be properly placed for the *odd* hours, not so indicated.

The reading glasses—the upper being set so that when the zero of the scale corresponds exactly to 30·0 ins. the distance between the cross lines on the two glasses shall agree with the scale value supplied by the Meteorological Office—are then moved until they stand tangential to the curve at both the upper

and the lower margins, and the corresponding barometric pressure is then read off, and entered in the line and column of the tabulation form for the corresponding hour and day. This is done for every hour of the week's series of curves, and in accordance with the notes on the tabulation.

The absolute highest and lowest points shown on the curve for each day should also be noted and recorded.

A second series of tabulations of a less degree of refinement (to be employed as a check) follows, the readings being made by means of an ivory scale, read to the nearest hundredth of an inch only, and the readings entered in a second blank form known as a Subsidiary Sheet. If possible the two sets of measurements should be taken by different persons.

The entries in the first form, in hundredths only, are then copied into the subsidiary sheet beside the other set. The differences are next taken, and when they exceed $\cdot 01$ inch from the normal, a re-examination of the corresponding point on the curve is made, the faulty reading crossed through (not erased or altered), and the corrected value entered above it.

Should any portion of the curves be too faint for measurement with the ordinary tabulating instrument, but not for the ivory scale, it ought to be so measured, such measurements to be indicated in the tabulations by the addition of the word "approximate." On no account should the curves be pencilled or inked in.

The barogram readings should next be compared with the check observations of the standard barometer.

The readings of the standard having been corrected for index error and for capillarity, and reduced to 32° , should be entered in the "S" column of the tabulation form *prior to the tabulation of the curve*. The values of the barograms, corresponding to the times at which the standards were read, should be measured and entered. The differences between each pair of these observations should then be taken for the period from 11 a.m. of one day to 11 a.m. of the next, and from the mean of all of these which do not vary as much as $0\cdot 008$ in. from the average of the whole, a mean difference or "residual correction" for the period under discussion is formed. Should less than three standards be available, if it is not the day on which the curves are changed, the *residual* is calculated for the whole curve, but if it be changing day, it is calculated up to midnight of the following day. In extreme cases great range of pressure might modify this rule.

If the resulting mean difference be less than $0\cdot 001$ in. it is considered that there is no residual correction, and the hourly values should be entered direct into the column headed "Tabulated value corrected." If a residual be formed they should be entered in the "H" column.

The residual correction is applied to all the tabulated values of the barogram, and the corrected values compared with the corresponding standard barometer readings. Where a difference exceeding $0\cdot 007$. in occurs, an examination of the accuracy of the

curve measurements is made, and if this is found correct, the standard reading is concluded to be erroneous, and is marked on the tabulation sheet by means of brackets as (30·050). If necessary, on account of this rejection, a second residual correction is computed, applied to the original readings, and comparison with standards made anew.

Thermograms.—The thermograms are virtually registers of two separate instruments on one sheet of paper, and are, in the question of tabulation, treated as perfectly independent traces; dry-bulb and wet-bulb thermometer readings.

A thermogram is laid on a flat table, and covered by a glass scale engraved with two sets of parallel lines crossing one another at right angles, arranged to represent degrees of temperature and hours of time; the zero line of the curve is then made to lie along a previously determined line of the degree scale of the glass, whilst the lines crossing are made to correspond with the left-hand margin of the gaps in the curve indicating time.

The observer then having set his scale, and noticed that the indications of stopping and starting the curve are in accordance with the times indicated by the graduations on the glass, proceeds to read the position of the upper margin of the photographic sinuous line as referred to the degree lines every hour, and enter the readings on the corresponding tabulation form. This done for the whole week, the curves are again taken, and re-measured at each hour with an ivory scale, graduated to correspond with the glass scale. The readings of this scale are entered in a subsidiary sheet, as in the case of the barograms, and are compared with the corresponding readings already made by the glass scale, copied from the original tabulation into this sheet. When the difference between the two sets of measurements amounts to $0^{\circ}\cdot3$, the curve is again read off at the point in question, the faulty reading struck through, and the correct one entered above it.

Next, the check observations of the standards, duly corrected for index error, are copied from the journals, and entered into the proper columns in the tabulations.

These are compared with the tabulated values, and if differences exceeding $0^{\circ}\cdot5$ are found, those readings are examined, and, if necessary, the eye observations are struck out by being bracketed.

Finally, the points of maximum and minimum temperature each day are selected on the curves, and their values and times of occurrence noted and recorded.

A similar method of tabulation is pursued with regard to the trace of the wet-bulb thermometer, but with the difference that the observer has to carefully guard against entry of observations for those hours when the curve is marked, indicating that the instrument has been acting improperly.

In the case of the wet-bulb instrument, maxima and minima are not recorded.

Faint curves are to be treated as prescribed for the barograms.

Anemograph.—In this apparatus both velocity and direction of the wind are recorded mechanically on the same sheet of paper.

As the clock moving the recording cylinder is not provided with an automatic time-marker, the only guides as to correct timing of the traces are the positions of the two ends of the curves on the printed sheet, the observer should note that these correspond with the two small pin-boles made by a pricker attached to the instrument, which is depressed momentarily at the times of putting on and taking the sheet off the cylinder. If these do not accord within 10 minutes, with the times indicated by the ends of the traces, a fresh time scale must be ruled to agree with them, and the curves tabulated from the new scale.

The hourly wind velocity is measured with a glass scale, which gives the run of the Robinson cups from 30 minutes before to 30 minutes after each hour.

These values are entered in the tabulation sheet, and a correction for friction theoretically computed by Dr. Robinson applied to all velocities below 11 miles as follows:—

0 m.	- corr.	=	1·5 miles.
1 m. to 3 m.	„	=	1·0 „
4 m. to 10 m.	„	=	0·5 „

No subsidiary measurement is made for each hourly result, it being considered sufficient if the aggregate of the 24 uncorrected hourly velocities agrees within 5 miles with the whole distance run by the wind on the curve.

The wind's direction for every hour is deduced from the position of the centre of the trace, which constantly varies in width owing to the oscillations of the wind. For this purpose another scale is used, engraved to accord with the scale printed upon the paper; should this slightly differ from that determined for each instrument by the operation of orientation performed monthly, due allowance must be made in setting the scale.

The subsidiary measurements in direction are made by inspection of the anemograms and entering on a form the special position of the traces marked thereon for each hour. The results are entered on a special form and compared with the readings obtained by the glass scale.

An examination should be made in all cases where there is a difference of two points between the two readings.

Beckley Rain-Gauge.—This registers the time of fall of rain and the amount deposited in a funnel of 100 square inches area, placed 21 inches above the surface of the ground.

The rain from the funnel runs into a copper bottle floating on mercury, and, by its weight, depresses it. A pencil attached to the bottle is drawn by its descent down the paper wrapped round the drum.

When 20 cubic inches of water, corresponding to a rainfall of two-tenths of an inch, have been collected, a siphon causes the

bottle to discharge, and the float rises to its first position again, carrying the pencil up to the zero of the curve ready to make another trace.

The pencil should be adjusted to press on the paper with such force that it may have sufficient power to make a good trace, but not such as to prevent its rising to the top of the form on the paper, after a discharge assisted by a Stonyhurst lifter.

Measurements of the rain which has fallen during every hour are made from the curves by means of a glass scale. The hourly quantities should be entered in the tabulation form opposite the hour which indicates the end of the period to which the measurement refers, and the sum of the readings for the 24 hours should agree with the quantity gauged at the time of changing of the papers.

General.—The documents and curves should be forwarded to the Meteorological Office every Thursday as directed by the "Diary of Operations."

REGULATIONS AS TO THE EXAMINATION OF THE TABULATIONS AT THE METEOROLOGICAL OFFICE:

Assistant's Instructions.

General.

- (1.) Examine each curve in order to see if there is any want of light, bagging, finger-marks, or bad photography.
- (2.) See that the clock and shutter have been in good action throughout the curve.
- (3.) That the instrumental clock does not differ more than two minutes from the chronometer time as recorded on the curve.
- (4.) That the date written on the back of the sheet agrees with that on the face, and that the days of the week and month at the top of the curve are correct.
- (5.) That the sheet is properly written upon after the pattern.
- (6.) That in the journals the proper day of the month is placed alongside of Sunday, and that the others follow consecutively.
- (7.) That the times of starting and stopping the instrument as recorded on the journal have been properly entered on the curve.
- (8.) Finally, ascertain, by inspection of the curve, that its times of beginning and ending are the same as those inscribed on the face of the sheet, and that no slipping of the cylinder has taken place.

Barograms.

- (9.) See that the journal readings of the standard barometer have been correctly reduced to 32°, and are entered under their proper dates into the barograph tabulation sheets, differences of .003 in. and upwards being noted as errors of reduction.

- (10.) Compute the differences ($S-T$), (with their proper signs), between the standard reading (S) and the corresponding corrected hourly value of the barograph (T). In all cases of differences exceeding $\cdot 007$ in. the hourly value should be checked, and if, on repetition, found to be correct, the standard reading should be rejected as probably faulty. The mean monthly differences should be recorded.
- (11.) See that the tabulated hourly values have been correctly copied into column "A" of subsidiary sheets, and check the accuracy of the subtractions made in the tables occasionally.
- (12.) Investigate all cases where $A-B$ is $\cdot 02$ in. greater than the normal difference; if an error be revealed in the tabulations, it ought to be corrected and noted at once.
- (13.) By means of the ivory scale examine all cases where the differences between two consecutive hourly values amount to or exceed $\cdot 05$ in. The values are to be corrected for errors of $\cdot 01$ in. and upwards, a note thereof being made on the "Notes of Errors" Sheet. These corrections ought to be made before the next step in the process is commenced.
- (14.) Ascertain the correctness of the computed residual correction, and whenever it is necessary to alter it, the last column of the tabulations should be corrected to correspond.
- (15.) Check the accuracy with which the residual corrections have been applied, and correct any errors.
- (16.) Make 40 re-measurements in every month's work for each observatory, selecting those parts of the curves most favourable for accurate measurements.

Thermograms.

- (17.) See that the journal readings of the standard thermometers are entered under their proper dates into the thermograph tabulation sheets; and that they have been properly corrected for index error.
- (18.) See that the tabulated hourly values have been correctly copied into column "A" of subsidiary sheets, and check the accuracy of the subtractions made in the tables occasionally.
- (19.) Investigate all cases in which $A-B$ is $0^{\circ} \cdot 5$ Fah. or more above the normal difference, and correct any errors.
- (20.) Compute the differences ($S-T$), (with their proper signs), between the standard reading (S) and the corresponding hourly value of the thermogram (T).
- (21.) In all cases of differences between "S" and "T" exceeding $0^{\circ} \cdot 5$, the hourly value should be checked, and if, on repetition, it be found to be correct, the standard reading should be rejected. The monthly mean differences between the simultaneous standard and thermograph readings should be recorded.
- (22.) By means of the ivory scale, examine all cases where the difference between two consecutive hourly values amounts to, or exceeds, $5^{\circ} \cdot 0$. The values are to be corrected for errors

- of $0^{\circ} \cdot 3$, and when they amount to $0^{\circ} \cdot 5$ a note thereof is to be sent to the observatory.
- (23.) Compare the dry-bulb readings with the corresponding wet ones, marking and examining all those cases in which the latter appear higher than the former.
 - (24.) Check the accuracy of the times and values of the maximum and minimum temperatures.
 - (25.) Make 40 re-measurements in every month's tabulations of both the dry and wet bulb traces for each observatory, selecting parts most favourable for accurate measurement.
 - (26.) Measurements for the purpose of checking the values of the zero lines are to be taken when the mean monthly difference amounts to $\pm 0^{\circ} \cdot 25$, the said difference not being caused by errors in measurement, or reading of the standards.

Anemograms.

- (27.) Examine each curve in order to see that both pencils work well and freely, that the paper has been accurately attached to the cylinder, and the cylinder has not slipped.
- (28.) See that the times of starting and stopping the instrument as recorded by the pricker and traces, do not differ more than five minutes from the chronometer time, inscribed on the sheet.
- (29.) Inspect the direction and velocity wind curves in connexion with the tabulated results, in order to ascertain that each curve is tabulated under its proper date.
- (30.) Examine all cases in which A—B is *two points* and upwards, and correct when necessary.
- (31.) Examine all differences between two consecutive hourly values of velocity amounting to 10 miles.
- (32.) Make 40 re-measurements in every month's work for each observatory, both for direction and velocity.

Rain Curves.

- (33.) See that the clock has been in proper action; that the pencil has worked well and freely; that the paper has been properly attached to the cylinder; and that the cylinder has not slipped.
- (34.) That the curve is properly written upon, and that the times of putting on and taking off, as shown by the trace, do not differ more than five minutes from the recorded times.
- (35.) See that the total rainfall entered upon the curves agrees with that shown by the trace, and also with the record of the spare gauge.
- (36.) That the trace had been tabulated from hour to hour, and make a general examination of the hourly values.
- (37.) See that in tabulating, a proper allowance has been made for retardation of the pencil (through friction), bad attachment, bagging, &c.

GENERAL NOTE.

Whenever any error of time amounting to 10 minutes (and which has not been allowed for in tabulating) is discovered in a curve, re-tabulation will be necessary.

Curves erroneously tabulated should be returned to the observatories for re-tabulation.

Meteorological Office (Secretary).

The assistant shall report upon all curves and tabulations that are deficient from any cause, and the Secretary shall make the necessary communications to the Meteorological Council on the one hand, and to the director of the observatory where the failure occurred on the other, with any remarks that may tend in his estimation to obviate in future the causes of failure.

The Secretary shall also cause a tabulated report of the results of the examination of each month's work to be made to the Meteorological Council, and a copy of the "Notes of Errors" to be forwarded to each observatory concerned.

The foregoing regulations apply to the examination of the traces of self-recording instruments, and the tabulation of the numerical values intended for final record and publication. But a general inspection of all the traces should be made immediately on their receipt, so that any defects apparent, on such an examination as can be made without instrumental appliances, may at once be brought to notice.

NOTE B.

NOTE ON EXPERIMENTS ON PRESSURE OF WIND made by
Mr. W. H. DINES.

MR. DINES first took up this subject at the instance of the Wind Force Committee of the Royal Meteorological Society, and his experiments were directed to a re-determination of the factor of the Robinson cup-anemometer, the exact value of which was still involved in some doubt.

The experiments were made with a whirling machine of 29 ft. radius, driven by steam, erected in a level and somewhat sheltered field at Hersham, Walton-on-Thames. The results of the experiments were published in the Quarterly Journal of the Society, Vol. XIV., p. 253, and Vol. XVI., p. 26. Mr. Dines found the factor to be about 2·2, and thus practically confirmed the conclusion of Sir G. G. Stokes, who deduced (*Proc. Roy. Soc.* 1881, p. 170) the value 2·3, in place of 3 as found by Dr. Robinson.

As Mr. Dines had shown great skill in devising and carrying out these experiments, and had expressed his willingness to continue his researches with his whirling machine, the Council considered it desirable that the opportunity thus presented should be utilised for further experiments in certain branches of aërodynamics.

A grant was accordingly made, and Mr. Dines proceeded to investigate the connexion between the velocity of the wind and the pressure on obstacles of various kinds. A full description of the experiments and of the results was submitted to the Council in May 1889, and has since been published in the Quarterly Journal of the Royal Meteorological Society, Vol. XV., p. 1; it will therefore here suffice to give a summary.

The natural wind is not available for experiments on wind pressure, because it is usually gusty and variable in direction, and because it is not easy to measure its velocity with accuracy. It thus becomes practically necessary to have recourse to a whirling machine. But if such a machine be made on so small a scale that it can be sheltered from the natural wind, then, unless the pressure plate be small, the circularity of the motion introduces a large error, and besides the possibility of the persistence of eddies in the air may be a cause of uncertainty in the results. A whirling machine should be therefore on a large scale and must accordingly be erected in the open air. Under these conditions, the natural wind, which always exists to a greater or less extent, is superposed on the artificial wind, and the total wind, to which the pressure is due, oscillates about a mean value in the course of each revolution of the whirler.

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These various difficulties have, however, been obviated by Mr. Dines by means of an ingenious device.

It has long been known that, to a close degree of approximation, wind pressure varies as the square of the velocity of the wind. Now if a weight be swung round in a circle the restraint required to keep it in its course varies as the square of its velocity. It therefore occurred to him to balance the pressure on the experimental plate, when carried round by the arm of the whirler, by the centrifugal force, or tendency to fly outwards, of a weight swung round by the same arm. This plan was found to answer admirably, for when the right amount of centrifugal force for balancing the pressure of the artificial wind was found for any one speed of the whirler, the balance was maintained at all other speeds.

It thus became unnecessary to make any accurate measurements of the rate of revolution of the whirling machine.

Mr. Dines also devised an ingenious arrangement by which the amount of centrifugal force opposing the wind pressure varied automatically, until a true balance was attained. Also since the automatic adjustment did not take place instantaneously, but only by degrees, the disturbance due to natural wind was almost entirely eliminated, and thus experiments were made possible, excepting on days when there was a very high wind.

This is not the place for a full description of the apparatus by which the mechanical principle, explained above, was utilized, but a few words of general explanation are advisable.

The pressure plate was rigidly attached to a short arm, which lay in the same plane as the plate. The other end of the short arm could turn about a pivot which was attached to the long arm of the whirler. When the plate was in position for an experiment, the short arm was in line with the long arm, and the wind pressure tended of course to make the plate turn about the pivot.

The centrifugal force was due to the weight of a horizontal metal bar, at right angles to the long arm of the whirler. This bar could slide through a slot, and when the middle of the bar was at one side of the slot the centrifugal force, due to the revolution of the machine, tended to make the slot turn. The slot was geared to the short arm of the pressure plate by mechanism, which need not be described, so that the centrifugal force reacted against wind pressure. By an automatic action the bar slid through the slot, until, when the weight of the bar was winged out to a certain distance, there was a balance between wind pressure and centrifugal force. Measurement of the distance between the centre of the bar and the slot then gave the amount of force which had been called into play. The tendency of the pressure plate to turn was arrested by two stops, so near together that the plate could only turn through about 1° ; it bore on one stop, when the centrifugal force was insufficient for a balance, and on the other when too great. An electrical indicator was devised for detecting on which of the two stops the plate was bearing. An experiment was made by giving a few turns to the machine, and continuing the revolu-

tion until the indicator showed that the plate was bearing on neither stop, or more commonly until it sometimes bore on one stop and sometimes on the other.

For the smaller plates the maximum velocity of which the machine was capable was about 70 miles an hour, but most of the experiments were made at speeds between 20 and 30 miles an hour.

A number of plates and cups of different sizes and shapes were used, and the values given in the following table are the mean of all the experiments made with each particular plate, the number of experiments made with each being given in the last column of the table. Each experiment consisted of about three observations taken in immediate succession. As a rule no plate was tried twice on the same day. With the larger plates a single value seldom differed from the mean by more than 5 per cent., and on the whole the different values were fairly consistent. There were, however, two cases of exception to this statement, and they were the cylindrical surface and the sharp cone when placed in front of the plate. The results of five experiments out of the series of about 150 were rejected.

The particular value of 20·86 miles per hour for the velocity given in the table was chosen for the following reason:—The centre of the pivot about which the pressure plates could turn was 28 ft. 1 in. from the axis of rotation of the whirling machine, and the centre of the plate 28 ft. 7 ins. Taking the numerical value of the acceleration due to gravity as 32·19, these figures give 20·86 miles per hour as the velocity of the centre of the plates at which the centrifugal force acting upon the bar is equal to its weight.

TABLE showing the PRESSURE upon various PLATES at a VELOCITY of 20·86 MILES per HOUR. The Values are reduced to the Standard Temperature and Pressure. The Flat Plates were cut out of Hard Wood $\frac{3}{8}$ in. thick. Allowance has been made for the arm which carried them:—

Plates.	Actual Pressure, in lbs.	Pressure, in lbs. per Square Foot.	No. of Experiments.
A square, each side 4 ins. - - -	·17	1·51	4
A circle, 4·51 ins. diameter, same area - -	·17	1·51	9
A rectangle, 16 × 1 ins. - - -	·19	1·70	7
A circle, 6 ins. diameter - - -	·29	1·47	7
A square, each side 8 ins. - - -	·66	1·48	8
A circle, 9·03 ins. diameter, same area -	·67	1·50	12
A rectangle, 16 × 4 ins. - - -	·70	1·58	4
A square, each side 12 ins. - - -	1·57	1·57	7
A circle, 13·54 ins. diameter, same area -	1·55	1·55	14
A rectangle, 24 × 6 ins. - - -	1·56	1·59	6
A square, each side 16 ins. - - -	2·70	1·52	6
A plate, 6 ins. diameter, and $4\frac{3}{4}$ ins. thick -	·28	1·45	5
A cylinder, 6 ins. diameter, and $4\frac{3}{4}$ ins. long -	·18	0·92	4
A sphere, 6 ins. diameter - - -	·13	0·67	8
A plate, 6 ins. diameter, with a blunt corner angle 90°, at the back - - -	·29	1·49	4

Plates.	Actual Pressure, in lbs.	Pressure, in lbs. per Square Foot.	No. of Experiments.
The same, with cone in front - - -	·19	0·98	4
A plate, 6 ins. diameter, with a sharp cone, angle 30°, at the back - - -	·30	1·54	4
The same, with cone in front - - -	·12	0·60	4
A 5-inch Robinson cup, mounted on 8½ ins. of ½-in. rod - - -	·28	1·68	8
The same, with its back to the wind - - -	·12	0·73	4
A 9-in. cup, mounted on 6½ ins. of ½-in. rod - - -	·82	1·75	3
The same, with its back to the wind - - -	·28	0·60	3
A 2½-in. cup, mounted on 9¾ ins. of ¼ in. rod - - -	·13	2·60	3
The same, with its back to the wind - - -	·05	1·04	3
One foot of ⅝ in. circular rod - - -	·09	1·71	9

The results of the table may be roughly summarized as follows: The pressure upon a plane area of fairly compact form is about 1½ lb. per square foot at a velocity of 21 miles per hour, or in other words, a pressure of 1 lb. per square foot is caused by a wind of a little more than 17 miles per hour.

Experiments were also made with two kinds of plates made of perforated zinc. The pressure on the first kind, which contained about 77 holes of ·08 in. diameter per square inch, was 9 per cent. less than on a solid plate, but gave the high value of 2·43 lbs. pressure per square foot of actual surface. The values for the second kind, having 11 to 12 holes of ·22 in. diameter per square inch, were 20 per cent. less than on a solid plate, and gave about 2 lbs. per square foot of actual surface.

It was necessary to stiffen these plates by turning up the edges, and it was found that this edge when presented to the wind increased the pressure by about 6 per cent.

A cone and a projecting rim, when put at the back of the foot circular plate, caused no appreciable alteration in the pressure, but when the rim projected in front the results were:—

An increase of 6 per cent. with a projection of $\frac{1}{8}$ in.

10	10	10	10	10
14	14	14	14	14

The effect of cutting holes in the foot square plates was also tried—eight circular holes, each of one square inch area, being made, four as near the centre as possible, and one close to each corner. No difference in the pressure could be detected, whether any or all of the holes were covered or open. The eight holes together take away more than 5 per cent. of the plate, yet a difference of 1 per cent. in the pressure, had it existed, would certainly have been apparent.

The pressure upon the same area is increased by increasing the perimeter. The pressure upon any surface is but slightly altered by a cone or rim projecting at the back, a cone seeming to cause a slight increase, but a rim having apparently no effect. This result

is of importance, since a pressure plate for permanent use should be of some material which will not warp, and if thin metal be used a rim is necessary to obtain the requisite stiffness. As might be expected, a cone in front greatly reduces the pressure.

Mr. Dines next determined the moment of pressure upon a 5-in. Robinson cup when placed at different angles to the wind from 0° to 180° . The cup was mounted upon an arm 1 foot in length.

The moment varied as the square of the velocity, so that the same mechanical device as before was again applicable.

The following table gives the moment in feet and pounds when the velocity of the wind is 20·94 miles an hour. The angles are measured, so that when the wind blew straight into the concavity of the cup its incidence is 0° ; when it blew across the mouth of the cup it is 90° , and when it blew at the back it is 180°

At angle of	0°	moment =	·284
„	12°	„ =	·292
„	24°	„ =	·303
„	36°	„ =	·303
„	48°	„ =	·317
„	60°	„ =	·246
„	72°	„ =	·127
„	84°	„ =	·048
„	96°	„ =	— ·014
„	108°	„ =	— ·050
„	120°	„ =	— ·046
„	132°	„ =	— ·073
„	144°	„ =	— ·110
„	156°	„ =	— ·116
„	168°	„ =	— ·124
„	180°	„ =	— ·127

In Sir G. Stokes's bridled anemometer the rotation of the cups is not free as in the ordinary instrument, but is restrained by the action of a spring or weight. The amount of torsion of the spindle which bears the cups is the datum from which the velocity of the wind is deduced. One of these anemometers is under trial at Holyhead.

The instrument ought of course to give constant results from whatever quarter the wind blows, and thus the torsional force required to hold the spindle bearing the cups ought to be independent of the orientation of the wind with respect to the cups. Sir G. Stokes has used Mr. Dines's results with respect to a single cup to determine the inequality, according to orientation, of the action of the wind on a bridled anemometer, consisting of any number of cups from one to six. In Mr. Dines's table, given above, the semi-circumference is divided into 15 equal parts, and accordingly there are materials for computing the action of the wind on an anemometer of one or several cups in 30 different azimuths. It is obvious that if there are several cups, the same

torsional couple is repeated several times over ; if, for example, there are two cups, there will be 15 different azimuths, if three, 10 different ones, and so on.

The mean of Mr. Dines's numbers, when repeated so as to go round the whole circumference, is 80, hence the mean couple due to a single cup may be taken as 80. Sir G. Stokes then computed the couple due to pressure on a single cup for the 30 azimuths, with such repetitions as correspond to an anemometer with 1, 2, 3, 4, 5, 6 cups, and subtracted from each the mean couple 80.

For example, when there are six cups, the excess above or defect below 80 is + 12, + 1, - 5, - 12, + 1, repeated six times in all. The sum of these five numbers, regardless of sign, is 31, and their fifth part is 6·2. Hence the average inequality with six cups is represented by 6·2, the mean couple being represented by 8·0. In this way he found that, still taking the mean couple as 80, the average inequality is as follows:—

With 1 cup,	161·5.
With 2 cups,	28·2.
With 3 cups,	19·3.
With 4 cups,	17·2.
With 5 cups,	4·8.
With 6 cups,	6·2.

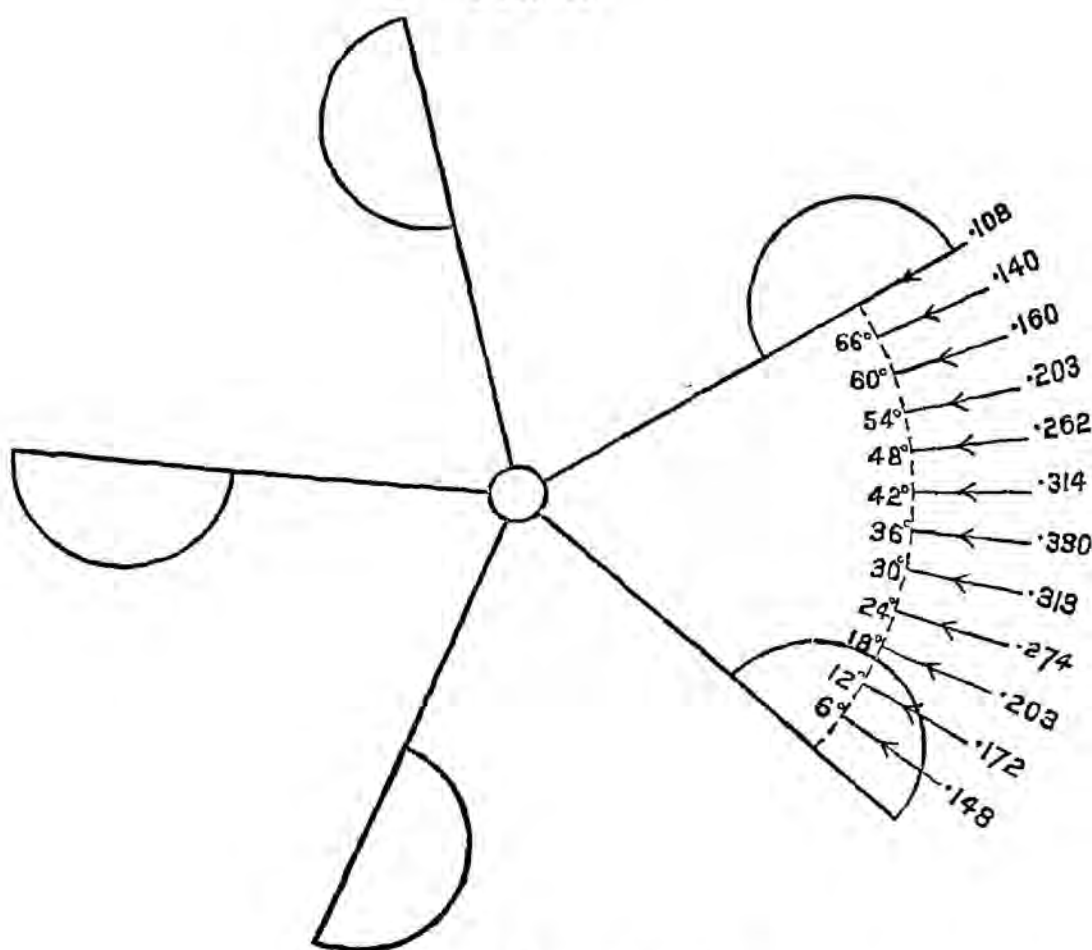
It is obvious that the smallness of these numbers is a measure of the goodness of the instrument as a wind measurer. In designing the instrument, Sir G. Stokes had had an impression that an odd number of cups would be better than an even number, and this appears to be borne out by the numbers. There is naturally a diminution in the inequality with the increase in the number of cups, but this appears to be blended with a superiority of odd to even. Thus 3 cups come out nearly as good as 4, and 5 rather better than 6.

If 6 cups be taken as a superior limit to the number desirable, 5 appears to be the best number to choose.

Sir G. Stokes had been induced to undertake this investigation (which was communicated to the Council in the form of a letter) by some further experiments by Mr. Dines, to which we now return.

Mr. Dines, then, tested an anemometer of five cups, exactly like that at Holyhead, by the same method as that by which he had previously treated the pressure plates. He found that the magnitude of the moment due to the wind was greatly influenced by orientation. The values for positions at intervals of 6° are shown in the annexed diagram, each value being the mean of several observations. The results of the experiments were fairly consistent with one another, the observation for each angle seldom differing by more than three or four per cent. from the mean value.

FIG. 1.



BRIDLED ANEMOMETER.

The figures show the moment, expressed in lbs. and feet, exerted by a wind of 21 miles per hour. The direction of the wind relatively to the cups is shown by the line against which the figures are placed. In all cases the moment varies as the square of the velocity.

It was obvious from the consideration of these numbers that the great inequality in the torsional force is not due to the causes considered by Sir G. Stokes, but arises from the interference of each cup with the one partially behind it.

In consequence of these investigations, it was therefore decided to reconstruct the anemometer, retaining five cups in accordance with Sir G. Stokes's views, but re-arranging them spirally on their spindle, so that the interference detected by Mr. Dines should be obviated.

Mr. Dines was then requested to undertake a new series of experiments on the bridled anemometer in its modified form. On the completion of his experiments he submitted the following report to the Meteorological Council :—

“ DETERMINATION of the MOMENT of the WIND FORCE upon the
“ new arrangement of CUPS of the BRIDLED ANEMOMETER.

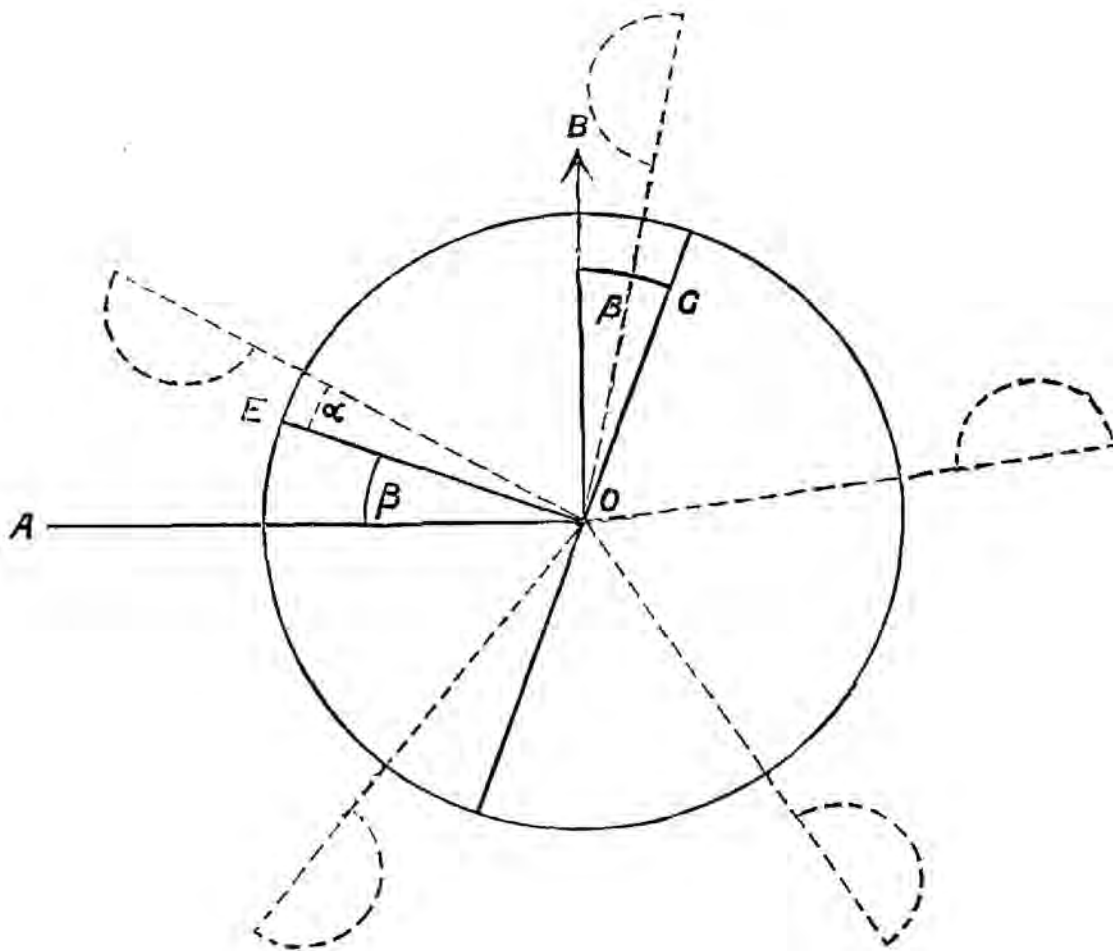
“ The instrument consists of five cups, each 5 ins. diameter
“ mounted with their centres $7\frac{1}{2}$ ins. from the axis. The cups are

“ not in one plane, but are arranged so that there is 1 in. clear
 “ vertical space between the rims of two consecutive cups, and a
 “ difference of 144° azimuth.

“ Since the length of the axis rendered it impossible to use the
 “ method which was adopted with the old instrument, the follow-
 “ ing plan was adopted.

“ A thin metal disc graduated in degrees round part of its
 “ circumference was made to fit loosely on the bottom of the shaft
 “ of the anemometer, and was provided with a screw by which it
 “ could be clamped in any position. A brass weight was attached
 “ to the disc at 3 ins. from the centre, and at the same distance on
 “ the opposite side of the centre an exactly equal piece of wood
 “ was placed to neutralize the wind pressure upon the brass. The
 “ whole was fitted in a light iron frame so that it could turn freely
 “ about its axis. The frame could be attached to the long arm
 “ of the whirler, so that the axis of the instrument was vertical,
 “ and consequently the disc horizontal.

FIG. 2.



“ Suppose O to be the centre of the disc, OA the direction of
 “ the line joining O with the centre of the whirling machine. OB
 “ the direction of motion, G the position of the weight, and E the
 “ zero mark of the graduations, OG being at right angles to OE .

“ Let the angle between $O E$ and the vertical plane through one of the cup arms be α , and the angle $A O E$, or $B O G$ be β .

“ It is clear that if a sufficient weight be placed at G , the centrifugal force upon the weight will prevent the complete rotation of the cups, and that there will be some value of β lying between 0° and 90° which will be in a position of equilibrium.

“ The experiments were made thus:—The disc was clamped so that α had a certain value, the whirling machine was then rotated, and soon after a steady velocity had been obtained, a brake was applied to the disc by a string running from the centre of the whirling machine, in order that no change of position should be possible until the reading had been obtained. The machine was then stopped and the value of B read off to the nearest degree. The value of $\alpha + \beta$ gave the direction of the wind relatively to the cups, the moment of the force exerted by the wind at the instant of applying the brake being proportional to $\cos \beta$.

“ In order that the scale might be an open one, a weight was chosen which gave the position of equilibrium with a small value of β . If W be this weight the moment due to the centrifugal

“ force is $\frac{W v^2}{g (r + O G \sin \beta)} O G \cos \beta$.

“ As has been explained in my account of the experiments with pressure plates, the actual velocity v need not be measured, and is immaterial to the result, but in these experiments a high velocity of about 60 miles per hour has been employed to eliminate as far as possible the troublesome error due to the natural wind. Assuming that the position of equilibrium is taken up immediately, it will be seen that the natural wind may either raise or lower the moment as determined by this method. If the brake be applied when the instrument is moving with the wind the apparent moment is lowered, and conversely. On the whole, however, the tendency is to increase the moment, so that the error cannot be eliminated by taking the mean of a large number of observations.

“ Care has been taken that the brake should not be applied in any one part of the circle more than in another, and no experiment has been entered which was made at any time when there was the smallest perceptible wind. Still a wind of two miles per hour is barely perceptible in the open air, and such a wind might alter the moment in the ratio of $58^2 : 60^2$, that is, cause an error of from 6 to 7 per cent.

“ About 80 experiments have been made and worked up thus:—A row of figures from 1 to 72 being prepared, the value of $\cos \beta$ was taken from a table and placed opposite to the figure indicating the value of $\alpha + \beta$ for the same experiment. In the first experiments the value of α was chosen at random, but in subsequent experiments it was chosen so as to fill in the blanks left in the list as far as possible.

“ When the whole set of experiments had been thus tabulated it was found that the mean value of $\cos \beta$ was .965, the lowest value

“ .900, and that there was no very marked variation in the value of
“ $\cos \beta$ in different parts of the list. The figures were pretty
“ evenly distributed, there being no case of four consecutive
“ numbers, without at least one value opposite to them.

“ The difference in weight of the brass and the facsimile piece of
“ wood was found to be 6,259 grains, and the distance of the axis
“ of the instrument from the axis of the whirling machine 28 feet
“ 11 inches.

“ Taking these values for a first approximation we obtain
“ .000510 V^2 for the value of the moment expressed in feet and
“ lbs., V being in miles per hour.

“ The experiments were made at temperatures ranging from
“ 60° — 70° F. and mostly between 60° and 65° ; and at a pressure
“ ranging from 29.80 ins. to 30.00 ins.

“ One more correction is necessary; the cup which was concave
“ to the wind was inside, and hence the above value is rather too
“ low. Reference to the table of wind moments for a single cup
“ in various positions, given in a preceding report, will show that
“ this correction should be about 1.5 per cent., and hence that
“ .0005523 V^2 is the value of the moment due to the wind
“ pressure upon the instrument. This result is in close agree-
“ ment with that deduced from the experiments upon a single
“ cup, and may, I think, be taken as very nearly correct. I
“ think also that no greater departure than 3 per cent. from
“ the mean value occurs in any relative position of the wind
“ direction and the cups.

“ W. H. DINES.”

Upon the conclusion of these experiments the instrument at Holyhead was dismantled, and it is being reconstructed with the cups arranged spirally on the spindle, as explained above.

The foregoing experiments of Mr. Dines have given such valuable results that the Council have requested him to continue his investigations, with the aid of a further grant of money. This series of experiments was to be on the resistance of plates of various forms at oblique incidences of the wind, and a memorandum of suggestions, as to the line which the experiments should take, was drawn up by Professor Darwin. The account of this work will fall into the annual report of an ensuing year, and it must here suffice to say that the results have proved of the highest interest, and are to be communicated to the Royal Society.*

* A paper containing an account of the experiments was read before the Royal Society on June 19th, 1890.

NOTE C.

EXPERIMENTS with VIOLLE'S ACTINOMETER APPARATUS.

THE *Boules conjuguées* of M. Violle are an instrument for readily measuring the solar radiation. Like the sun thermometer, as ordinarily used, it gives a relative measurement of the total radiation effect of the sun and sky, in excess of the air temperature, but according to the theory of its action as described by the inventor, with proper precautions, it may be made to furnish that of the solar intensity alone in terms of absolute units. Its principle is the same as that of the blackened and uncoated sun thermometers, used in conjunction, the theory of which has been given by Ferrell, and it is used in the same manner, viz., by exposure to the sun until its temperature has become constant.

It consists of two thin hollow copper spheres, the one coated with lamp black, the other gilt, which surround the bulbs of two thermometers precisely similar in all respects. The interior of the copper spheres and the bulbs of the enclosed thermometers are coated with lamp black. They are exposed to the sun, side by side, and when the temperatures have become constant readings of the two thermometers are taken, and at the same time the temperature of the air is observed with a sling thermometer. From these three observations the radiation coefficient is computed by a simple formula or taken from a table.

Theoretically the excess temperatures of the blackened and gilt spheres above that of the air should bear a constant proportion to each other, both varying directly with the quantity of heat received in the unit of time by radiation. The object of the tests now being applied at Kew is to ascertain whether this condition is fulfilled in practice, or whether such small variations in the coating of the spheres and the enclosed bulbs, in the circumstances of exposure, &c., as are unavoidable with different instruments, or with the same instruments at different times, seriously impair the constancy and comparability of the registers. For this purpose two pairs of spheres are now under trial, and the readings of the four thermometers will be compared with each other to see if their relative values are sensibly constant; whether, in short, the instrument is one that can be placed in the hands of meteorological observers, who have had no special training in a physical laboratory, in the expectation that the results will be more satisfactory than those yielded by the ordinary sun thermometer.

NOTE D.

On the WORK done with the HARMONIC ANALYSER at the
METEOROLOGICAL OFFICE.

THE Harmonic Analyser was designed by Sir William Thomson in 1878. Full details of the principle of the instrument will be found in the Proceedings of the Royal Society, Vols. XXIV., p. 262, and XXVII., p. 371; while a description of the machine as constructed for this Office, and also of the method of its employment, is given in Vol. XL., p. 382. Reports as to the method of employing the machine will be found in the Reports of the Meteorological Council for the years 1880, 1881, 1883, and 1885.

The hope was at first entertained that the machine would admit of the labour involved in making the hourly measurements of the photographic traces being dispensed with, and that the harmonic constants could by means of the machine be derived directly from the curves.

For some time after the machine had been delivered at the Office only experimental work was carried on with it, for the double purpose of determining the constants of the machine and the reliability of its results, and also of familiarizing the operator with its use.

The analysis of the thermograms for the year 1876 was first taken in hand, because for that year the mean hourly values of temperature had been calculated, from the published hourly values for the seven observatories, and the data were thus supplied from which the results obtained by the use of the machine could be compared with results obtained by computation. As this was the first operation in which the machine was brought into continuous use, the results were submitted to an examination by Professor Stokes, who instituted "a more searching comparison between the " results obtained by the machine and those got by calculation " than had previously been possible from the available data," with the object of ascertaining whether there was in them any indication of systematic errors, and to what extent they might be relied upon as correct.

The conclusions arrived at, together with the figures upon which they are based, were published by the Meteorological Office in 1884 as an Appendix to the Quarterly Weather Report for 1876, p. [39], the concluding paragraphs of which are as follows:—

"Disregarding now the systematic character of some of the errors, and treating them as purely casual, we get as the average difference between the constants as got by the machine and by calculation from the 24-hourly means 0·065. It may be noticed, however, that the numbers are unusually large (and at the same time very decidedly systematic) in the case of the second cylinder of the first order, for which the average is as much as 0·125, the eighth of a degree. If b_1 be omitted, the average for the remaining cylinders of the machine is reduced to 0·047.

“ We see, therefore, that with the exception perhaps of b_1 , the constants got by the machine for the mean of the days constituting a month are as accurate as those got by calculation which requires considerably more time, inasmuch as the hourly lines have to be drawn on the photograms, then measured, then meaned, and the constants deduced from the means by a numerical process by no means very short.”

While these preliminary trials had been going on it had not been thought expedient to discontinue making the hourly measurements of the curves and publishing the hourly values thus obtained, but hourly means were not computed. At the same time General Strachey, F.R.S., had been occupied in computing the harmonic constants of the entire series of barometric and thermometric observations made at Greenwich for the 20 years between 1849 and 1868, and as he was desirous of obtaining as complete data as possible for comparison with those he had obtained, it was considered that the satisfactory results of the treatment of the photograms of 1876 justified the extension of the use of the machine to the whole series of records of the seven observatories, which in the absence of computed hourly mean values could not otherwise be dealt with.

The analysis of the temperature records for the 12 years 1871–1882 was therefore carried out, and the results were published in 1886 as an appendix to the volume of “Hourly Readings” for the year 1883, in which the harmonic constants of the diurnal march of temperature at each of the seven observatories are given for every month and year of the period.

Subsequently the barograms for the same period were similarly dealt with, but the results have not yet been published.

With a view of obtaining as complete a knowledge as possible of the reliance that can be put on the results derived from the machine, a further set of trials has been carried out by Mr. R. Curtis, which are described in the supplementary note which is annexed.

After careful consideration of the results of this further examination of the operation of the machine, the Council have been induced to modify their former opinions regarding its practical application. For since they have decided to publish the hourly numerical mean values, which are necessarily derived from the measurements of the curves, there is no room to doubt that the harmonic constants can be obtained from these mean values arithmetically with less labour and with greater accuracy than by the use of the machine, while the results can be far more readily and completely checked.

The Council being of opinion that the harmonic analysis of the chief meteorological phenomena should invariably follow the computation of the requisite mean values, they have, for the reasons above stated, resolved that the analysis shall be made by arithmetical computation, while the use of the machine will be reserved for special occasions when its use may be found desirable.

MEMORANDUM by Mr. R. CURTIS.

THE object of these experiments has been to find out how far the actual readings obtained from the harmonic analyser may be relied upon as correct, and to ascertain something of the nature and magnitude of the errors which may be expected to exist in them.

It should be said that at present the only available check upon this portion of the work is to compare the monthly results obtained from cylinder 7 (the mean) with the arithmetical means already obtained from the hourly measurements of the curves. But it is obvious that for the readings of the other six cylinders this test can only be one of the most general character; while as applied to cylinder 7 itself it is by no means so satisfactory as one could wish, since, as these experiments show, the differences between the increments yielded by two tracings of the same curves are often greater than the increments themselves.

The insufficiency of this test has been further shown by these experiments, in having disclosed two important errors in the original operation which the comparison failed to reveal, and which nothing short of re-analysing the curves could be expected to show.

In both instances a temperature curve for one day was passed twice through the machine, and necessarily on both occasions another curve must have been omitted altogether, otherwise the error would have been detected; yet although the error extended in each instance over several days, both escaped detection on comparison with the monthly mean. It is perfectly easy to account for the occurrence of such accidents as these, and bearing in mind the many ways in which they could happen, I think it by no means unlikely that in so large a piece of work as the analysis of the thermograms and barograms, which extends over 12 years records, and involves dealing with an aggregate of upwards of 61,300 days' traces, many of them may exist. It is therefore important to remember that for their detection the comparison of the mechanically and arithmetically derived means is not likely to be of much use.

In the present experiments the thermograms and barograms for Valencia for the year 1877 were again passed through the machine, using the same data for the setting of the machine as on the first occasion, but, in order to guard against the possibility of bias in any direction, not allowing the operator to see any of the original results during the progress of the work. The year 1877 was selected for no other reason than that it was about the middle of the series of years dealt with, and therefore likely to represent a fair average of the work; but it was a

good year to select for the purpose in view for this further reason that it embraced very few cases of defective photography, and those only for short intervals, and therefore the chance that differences would arise from this cause, in the way alluded to later on, was very small.

THERMOGRAMS.

Cylinder 7 (mean).—The readings on this cylinder all through the operation were higher than on the first occasion, and the final reading at the close of the year was $+53.685$ instead of $+48.358$, a difference of 5.327 turns of the cylinder. As, however, we deal with *daily* means, these numbers have to be divided by the number of days in the period, and doing this we get a difference of $0^{\circ}.11$ in the mean daily temperature for the year.

In the mean daily temperature obtained from the *monthly* increments we find larger differences between the two operations:—

January = $+0^{\circ}.3$; February, $+0^{\circ}.25$; March, $+0^{\circ}.21$;
 April, $+0^{\circ}.04$; May, $+0^{\circ}.02$; June, $+0^{\circ}.02$; July,
 $+0^{\circ}.02$; August, $-0^{\circ}.005$; September, $+0^{\circ}.07$;
 October, $+0^{\circ}.06$; November, $+0^{\circ}.12$; December,
 $+0^{\circ}.18$.

It is worth noting here that the differences are large only in the winter months, from April to October they are insignificant, and in August the very trifling difference shown has a minus instead of a plus sign.

The largest differences are of course found between the readings for single days, and the largest of these amounts to $0^{\circ}.65$; the extreme *range* of the differences (from largest $+$ to largest $-$) amounted to $1^{\circ}.2$.

I think these differences are entirely due to the way in which the curves were traced by the operator on the two occasions, and not to any error in the "setting" of the instrument. Every care was taken to set the ball correctly upon the disc, and if any error had been made here it would have been the same thing as taking an incorrect value for the centre of the disc, which would have given an error constant in sign and amount throughout, which is not what we get.

But to test this point the month of January was passed through the machine a third time, after I had myself examined it to see that the adjustments were good, the zero pointers being then shifted so that an entirely fresh start should be made, as before. In this case the increments were nearly all smaller than in the second operation, though still larger than in the first, the mean daily temperature being $0^{\circ}.13$ lower than the one and

$0^{\circ}\cdot 17$ higher than the other, a result which I think bears out my suggestion; as I explain further on, the exigencies of the machine make it a difficult task to pass a curve such as a thermogram twice through with exactly the same result.

Cylinders 1 and 2.—In the case of these cylinders the differences were small, the increments being themselves usually very slight; but relatively to the latter they were sometimes considerable, and occasionally as large as the increment itself. The final reading at the close of the operation gave a difference in the daily mean for the year of only $- 0^{\circ}\cdot 03$ in a_1 and of $+ 0^{\circ}\cdot 04$ in b_1 but as will be seen from the table appended, the daily differences for the months were larger. It is to be noted, however, that the differences varied a good deal in sign, and so tended to cancel each other in the mean.

Some very large differences were found upon examination to be due to the accidental omission of a curve, as already explained.

Cylinders 3, 4, 5, and 6.—Here again the differences are only considerable when they are compared with the size of the increments themselves. The mean daily differences for the year are, in the case of each cylinder, insignificant, but for the month they are sometimes larger. These cylinders were only read at the end of each five days, and it is of course with those readings that the largest differences occur, as, for example, at the close of the first five-day period, when we have—

—		Cylinder 3.	Cylinder 4.	Cylinder 5.	Cylinder 6.
Reading	- -	$\cdot 020$	$\cdot 065$	$\cdot 016$	$\cdot 100$
Difference	- -	$\cdot 015$	$\cdot 022$	$\cdot 018$	$\cdot 010$

the difference on cylinder 4 being equal to $0^{\circ}\cdot 13$.

BAROGRAMS.

Cylinder 7 (mean).—The difference between the mean daily pressure for the year, obtained from the final readings of the two operations, is insignificant, but in the daily means for the months the differences are larger, and vary from $+ \cdot 002$ to $- \cdot 004$ inch. The largest difference between the two readings for any one day is equal to $\cdot 026$ inch, and these daily differences range from $+ \cdot 026$ to $- \cdot 017$ inch. Taking the daily readings of this cylinder as a whole, the differences appear large relatively to the size of the increments, but owing to their constant change of sign they tend to cancel each other as the period over which the mean is taken is lengthened.

Cylinders 1 to 6.—The results here seem to be very similar to those obtained from the re-analysis of the thermograms, and although the differences are all small, yet they frequently bear a considerable proportion to the increments themselves. It is noticeable that there is no indication of any bias on the part of the operator in any one direction, and from this I conclude that the differences indicate fairly the limits within which a set of barograms may be expected upon re-analysis to yield the same results.

In passing a curve through the machine two things have to be attended to: first, the zero line of the curve has to be made to conform to a *fixed* pointer at one end of the cylinder over which the curve is fed; and secondly, a *movable* pointer has to be made to travel over the edge of the trace itself.

In the case of a thermogram the zero is supposed to be a straight line, but practically it is seldom so, owing to an unequal shrinking which occurs in the sheets in drying after completing the photographic process, and which causes a certain amount of curvature in the line known as "bagging." The amount of bagging varies a good deal, sometimes it is very trifling and sometimes considerable.

The zero line of a barogram is the "temperature edge" of the curve, and is not supposed to be straight but to vary with the temperature, owing to the action of the temperature compensation-arrangement of the barograph. In addition to this the curves "bag," as do the thermograms.

The difficulty in dealing with the curves in the harmonic analyser lies in having to keep the two pointers correctly placed at one and the same time. If the zero pointer gets off the line it can only be set right by shifting the sheet, and this has to be done so that it shall then be fed into the machine in such a way that the line shall keep under the pointer for as much of the curve as possible. In doing this there is no room for previous trial as to the effect of the shift before actual working, and although with practice the operator is able to manipulate the sheets in the machine with a good deal of skill, yet it is clear that he cannot always be right, and in any case if the bagging is great the changes have to be frequently made. Besides this there is the risk of his getting considerably off the line before noticing it when his attention is mainly given to following the deviations of the trace with the movable pointer.

It seems to me that here is the weak spot in the machine as we use it. The machine itself leaves little to be desired as regards accuracy of working, as was sufficiently proved long since by the zigzag curves suggested by Prof. Stokes, in which with ordinary care there was no room for error on the part of the operator. The errors now dealt with arise almost solely from the difficulty of following with the necessary accuracy the

edges of the traces, and in the difficulty, almost an impossibility, of ensuring that *both* pointers shall fulfil their functions correctly and continuously lies the chief cause of the differences obtained in passing the same curve twice through the machine.

Another cause of error operating in a similar way is bad photography, since when the curve is very indistinct, it is sometimes impossible to ensure that it shall be followed twice in exactly the same way, and there is always more or less guessing as to what the curve really is.

In addition to this there is the danger of mistake in putting the curves into the machine, the wrong curve may be taken up, or a sheet already in the machine may be used a second time.

And finally, there is the danger of error arising from incorrect reading of the cylinders, or of error in recording the readings upon the sheets.

For errors arising from any of these causes the only checks available, without re-working, are the comparison of the results obtained from cylinder 7 with the arithmetical means, and such check as may be applied by an examination of the readings *inter se*.

VALENCIA, 1877.

BAROMETER.

Month.	Trial.	First Order.		Second Order.		Third Order.		Mean.
		a_1 .	b_1 .	a_2 .	b_2 .	a_3 .	b_3 .	
JANUARY	1st	+0.0047	-0.0377	+0.0055	-0.0101	-0.0006	-0.0007	29.635
	2nd	+0.0048	-0.0369	+0.0064	-0.0101	-0.0008	-0.0008	29.631
FEBRUARY	1st	-0.0047	-0.0068	+0.0052	-0.0036	-0.0018	-0.0006	29.992
	2nd	-0.0044	-0.0078	+0.0057	-0.0032	-0.0020	-0.0003	29.991
MARCH	1st	+0.0086	-0.0109	+0.0074	-0.0033	-0.0010	+0.0011	29.794
	2nd	+0.0078	-0.0096	+0.0082	-0.0039	-0.0022	+0.0015	29.793
APRIL	1st	-0.0008	-0.0042	+0.0056	-0.0017	0.0000	-0.0017	29.608
	2nd	-0.0018	-0.0044	+0.0059	-0.0022	-0.0001	-0.0015	29.610
MAY	1st	-0.0010	+0.0031	+0.0055	+0.0038	+0.0013	+0.0021	29.810
	2nd	-0.0008	+0.0026	+0.0062	+0.0031	+0.0003	+0.0019	29.808
JUNE	1st	-0.0075	-0.0153	+0.0073	-0.0096	+0.0020	-0.0059	29.913
	2nd	-0.0078	-0.0153	+0.0079	-0.0099	+0.0012	-0.0055	29.911
JULY	1st	+0.0016	-0.0068	+0.0048	-0.0020	+0.0018	-0.0011	29.913
	2nd	+0.0016	-0.0068	+0.0059	-0.0025	+0.0013	-0.0012	29.912
AUGUST	1st	-0.0091	-0.0091	+0.0057	-0.0027	+0.0018	-0.0016	29.784
	2nd	-0.0094	-0.0091	+0.0055	-0.0029	+0.0009	-0.0009	29.786
SEPTEMBER	1st	+0.0008	+0.0070	+0.0098	-0.0034	+0.0019	+0.0011	30.048
	2nd	+0.0008	+0.0058	+0.0098	-0.0043	+0.0013	+0.0014	30.049
OCTOBER	1st	-0.0018	-0.0060	+0.0073	-0.0098	-0.0010	+0.0028	29.895
	2nd	-0.0023	-0.0065	+0.0063	-0.0095	-0.0009	+0.0023	29.897
NOVEMBER	1st	+0.0117	+0.0289	+0.0092	-0.0022	0.0000	+0.0073	29.546
	2nd	+0.0117	+0.0286	+0.0091	-0.0018	-0.0006	+0.0073	29.548
DECEMBER	1st	-0.0014	-0.0188	+0.0048	-0.0090	-0.0022	+0.0008	30.010
	2nd	-0.0013	-0.0153	+0.0054	-0.0092	-0.0028	+0.0001	30.009

TEMPERATURE.

Month.	Trial.	First Order.		Second Order.		Third Order.		Mean.
		$a_1.$	$b_1.$	$a_2.$	$b_2.$	$a_3.$	$b_3.$	
JANUARY	1st	-0'88	-0'12	+0'34	+0'42	-0'08	-0'15	48'63
	2nd	-0'86	-0'08	+0'38	+0'40	-0'07	-0'13	48'92
	3rd	-0'89	-0'07	+0'38	+0'39	-0'07	-0'14	48'79
FEBRUARY	1st	-0'71	-0'48	+0'29	+0'32	0'00	-0'13	47'50
	2nd	-0'76	-0'47	+0'31	+0'29	+0'01	-0'13	47'74
MARCH	1st	-1'82	-1'26	+0'39	+0'65	+0'01	+0'20	45'41
	2nd	-1'85	-1'30	+0'41	+0'66	+0'01	+0'18	45'62
APRIL	1st	-1'85	-1'72	+0'42	+0'50	+0'08	+0'18	48'59
	2nd	-1'94	-1'77	+0'45	+0'51	+0'11	+0'18	48'64
MAY	1st	-2'14	-2'51	+0'17	+0'11	+0'24	+0'49	51'12
	2nd	-2'02	-2'46	+0'19	+0'12	+0'27	+0'47	51'15
JUNE	1st	-2'74	-1'69	+0'20	+0'22	+0'10	+0'20	57'34
	2nd	-2'74	-1'81	+0'20	+0'25	+0'10	+0'16	57'37
JULY	1st	-2'06	-1'23	+0'16	+0'28	+0'15	+0'15	57'59
	2nd	-2'10	-1'31	+0'18	+0'29	+0'17	+0'13	57'61
AUGUST	1st	-2'22	-1'27	+0'27	+0'41	+0'11	+0'30	58'47
	2nd	-2'26	-1'43	+0'29	+0'41	+0'08	+0'29	58'47
SEPTEMBER	1st	-2'77	-2'22	+0'48	+0'86	+0'13	+0'23	54'95
	2nd	-2'80	-2'32	+0'48	+0'86	+0'12	+0'22	55'02
OCTOBER	1st	-1'52	-0'56	+0'67	+0'59	-0'08	+0'02	53'78
	2nd	-1'57	-0'89	+0'68	+0'51	-0'06	+0'02	53'82
NOVEMBER	1st	-0'82	-0'38	+0'45	+0'46	-0'12	+0'08	48'52
	2nd	-0'83	-0'40	+0'47	+0'45	-0'13	+0'07	48'64
DECEMBER	1st	-0'70	-0'44	+0'50	+0'36	-0'10	-0'30	47'07
	2nd	-0'65	-0'42	+0'45	+0'33	-0'10	-0'29	47'25

APPENDIX.

APPENDIX.

APPENDIX I.

CORRESPONDENCE with H.M. TREASURY about COST of PUBLICATIONS.

(M.O. 480.)

SIR, Treasury Chambers, March 11, 1889.

THE Lords Commissioners of Her Majesty's Treasury have before them a letter from the Controller of the Stationery Office, asking for directions as to the limits within which the demands of the Council for printing, &c., are to be complied with by the Stationery Office without special sanction of this Board.

On reference to the figures given in the annual Estimates, and putting aside the cost of printing the Report, which is about covered by the proceeds of its sale, my Lords find that the average printing expenditure during the last ten years is about 2,400*l.* per annum; the average of the first three years being 1,250*l.*, and that of the last seven 2,850*l.* a year.

The great increase in the expenditure appears to have taken place in 1881-2 and in 1882-3, of the cause of which their Lordships have at present no explanation.

Except in 1884-5, when, as my Lords understand, a special work was issued, the expenditure in each of the last six years appears to have remained without material change.

The expense of this service is so considerable that, before giving instructions as to its supply my Lords will be glad to have before them such observations as the Council may desire to offer as to the probable nature and extent of the future demands for printing, &c. My Lords think it right to state that, if it were contemplated that the annual outlay would further increase, they would have to consider as an alternative, whether it would not be possible to fix a maximum limit for work to be done by the Stationery Office within the year; or to allow to the Council a fixed sum in lieu of the free printing at present enjoyed by them.

In connexion with this subject the Controller of the Stationery Office has called the attention of this Board to an alteration which has recently been made in the size of the Weekly Weather Reports and Charts issued by the Council, whereby the cost of the publication will be raised from 273*l.* to 546*l.*

My Lords will be glad to be favoured with the opinion of the Council as to whether this very considerable increase of cost will be justified by a corresponding advantage to the public.

I am, &c.

(Signed) FRANK MOWATT.

The Secretary of the
Meteorological Council,
116, Victoria Street, S.W.

(P.C. 1511.)

SIR, Meteorological Office, August 6, 1889.

ON receipt of your letter dated the 11th March last, No. 4164, relative to the cost of printing and other work performed by the Stationery Office for the Meteorological Office, the Meteorological

Council took immediate steps for inquiry into the matters specially referred to in that letter.

To enable them to reply to the inquiries of the Lords Commissioners of Her Majesty's Treasury, the Council desired if possible to obtain from the Stationery Office information somewhat in detail as to the cost of the various publications issued from this Office during the years to which special reference is made in your letter. This necessarily occupied some time, and the results have not been such as to admit of any very precise reply being given as to the cause of the increase of expense in printing which is noticed as having taken place in 1881-2 and 1882-3.

The Council have no doubt, however, that the increase of charge after the first three years to which allusion is made was, speaking generally, due to the increased activity at the Office after its re-organisation in 1877. The application of the increased funds placed at the disposal of the Office necessarily involved some expansion of its operations, to meet which those funds were specially assigned; and from the nature of the duties that devolve on the Office, the performance of more work involves an increase in the volume of its publications.

In 1881-2 a change was made in the form of one of the publications of the Office (the Quarterly Weather Report), which involved a large increase to the copper-plate engraving, and was doubtless a cause of increased expenditure; this has now been discontinued. In 1882-3 a special publication was issued relating to the sea off the Cape of Good Hope, which was accompanied by plates, which also must have led to additional charge. In this year, however, the principal increase appears to have been due to the issue during it of publications appertaining to former years, which had fallen into arrear. It is not possible to distinguish properly the yearly cost of the various publications, which in some cases extended over two or more years, and, in the absence of the actual figures, which the Council has not been able to obtain, the best way of judging of this charge will probably be to take as a guide the number of publications issued in the successive years, and their aggregate selling price as fixed by the Stationery Office, which will, no doubt, be some measure of their cost. A statement of this description is annexed, which also indicates the publications which were the most costly.

With reference to the inquiry as to the increased size and cost of the Weekly Weather Report, the Council desire to state that the changes last made were adopted with a view of bringing it more completely up to the standard of information that the present requirements of students of meteorology demand, in relation to the various practical objects and occupations in which the conditions of the weather are important or influential. Among these Agriculture holds a very prominent place, and the reports have been specially framed in communication with persons conversant with the bearing of meteorology on agriculture in view of meeting their wishes.

The attention of the Council having been more particularly directed to this portion of your letter, they have adopted the conclusion that any less full illustration of the conditions of weather over the British Isles and the adjacent countries which influence it, than is now supplied in the Weekly Weather Report, could not be regarded as satisfactory or sufficient, and they deprecate any economy in this direction.

At the same time the Council is fully impressed with the duty imposed upon them of reducing the cost of printing as far as practicable, and they have undertaken a careful revision of their periodical publications, which they have every reason to believe will result in a sub-

Council took immediate steps for inquiry into the matters specially referred to in that letter.

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At the same time the Council is fully impressed with the duty imposed upon them of reducing the cost of printing as far as practicable, and they have undertaken a careful revision of their periodical publications, which they have every reason to believe will result in a sub-

stantial reduction of the charge incurred in their behalf at the Stationery Office. The subject will continue to have their attention, and they desire to assure My Lords that every effort will be made on their part to prevent any printing which is not really requisite for the due discharge of the service entrusted to them.

As to the future, the Council have no reason to anticipate any increased demand for printing, but as already mentioned they look to sensible reduction. In modifying the forms of their publications, however, caution is very necessary, and when the revision now proceeding has been completed, they will report its results, and endeavour to supply a standard such as My Lords appear to desire. It may be added that it would assist the Council in controlling this element of expenditure if the Stationery Office from time to time communicated to the Meteorological Office the cost of the work done for it, of which at present it has no means of obtaining any knowledge.

I am, &c.

(Signed) R. STRACHEY,
Chairman of the Meteorological Council.

F. Mowatt, Esq., C.B.,
Assistant Secretary, Treasury.

NUMBER and SELLING PRICE of PUBLICATIONS of the METEOROLOGICAL
OFFICE from 1877 to 1887.

	Year.	Number.	Aggregate Price.		
			£	s.	d.
	1877	3	3	5	0
	1878	2	0	4	6
	1879	2	1	1	0
	1880	—	—	—	—
	1881	5	3	8	6
	1882	9	19	14	0
	1883	5	6	16	6
	1884	2	2	13	0
	1885	4	8	8	6
	1886	2	3	14	6
	1887	3	2	8	6

SPECIAL PUBLICATIONS.

	£	s.	d.
1877. Meteorology of Arctic Regions, 5 Parts -	-	1	9 0
1877. Do. North Atlantic, 31 Charts -	-	0	15 0
1877. Quarterly Weather Report, 4 Parts -	-	1	1 0
1882. Do. (3 years) 13 Parts and Appendices -	-	9	9 0*
1881. Observations at Stations of Second Order	-	1	0 0
1882. Do. do.	-	1	14 6
1884. Do. do.	-	1	15 0
1885. Do. do.	-	1	15 0
1886. Do. do.	-	1	10 0
1887. Do. do.	-	1	12 0

* This charge is spread over several years.

			£	s.	d.
1882. Hourly Readings of Observations	}	1881, 4 Parts	3	12	6
at Special Observatories					
1882. Do. do.		1882, 4 Parts	4	8	6
1883. Do. do.		1883, 4 Parts	4	13	0
1885. Do. do.		1884, 4 Parts	2	7	6
1886. Do. do.		1885, 4 Parts	2	4	6
1885. Weather Charts of Atlantic Ocean,		4 Parts, 33			
sheets, each	-	-	-	3	8 0
1883. Sea Temperature Charts	-	-	-	1	1 0
1887. Barometric Pressure over Oceans	-	-	-	0	10 6
1882. Meteorological Atlas—British Isles	-	-	-	0	5 6
1881. Rainfall Tables—British Isles	-	-	-	0	7 6

APPENDIX II.

LIST of CAPTAINS (and Officers) who have sent in Logs classed as "Excellent" during the year ending March 31, 1890. The figures opposite to each show the total number of such Logs which they have returned to the Office during the period that they have been observing.

Captain's Name.	Number of "Ex- cellent" Logs.	Ship.
Angus, T. S. - - -	1	S.S. "Canton."
Atkinson, G. W. - - -	1	S.S. "Kaisar-i-Hind."
Barker, D. Wilson, F.R.Met. Soc.	12	S.S. "Buccancer."
Baxter, A. S. - - -	4	"City of York."
Belding, R. - - -	2	"Atlantic."
Bennett, E. C. - - -	14	"Thessalus."
Blackburn, Mr. H. S. - - -	7	S.S. "Rohilla."
Bolton, S. H. - - -	9	S.S. "Baidar."
Briscoe, R. F. - - -	3	S.S. "Kaisar-i-Hind."
Cameron, J. G., R.N.R. - - -	5	S.S. "Adriatic."
Cameron, Sub-Lieut. A. C. L., R.N.	1	H.M.S. "York."
Campbell, H. - - -	9	S.S. "Ardangorm."
Campbell, J. - - -	7	"Glengarry."
Campbell, R. - - -	3	S.S. "Elton."
Clapp, Staff Comr. E. S., R.N.	10	L.H. Tender "Richmond."
Conper, William - - -	2	"Clackmannanshire."
Crichton, A. T. - - -	5	SS. "Circe."
Cromarty, D. S. - - -	3	"Cassandra."
Crotty, F. H. - - -	4	"Evesham Abbey."
Crowley, C. - - -	3	"Alexander Lawrence."
Crutchley, W. C., R.N.R. - - -	19	S.S. "Kaikoura."
Dark, S. - - -	3	"Blairgowrie."
Dart, L. C. - - -	10	"Semantha."
Dawson, Comr. L. S., R.N. - - -	8	H.M.S. "Rambler."
De Horne, M. - - -	1	S.S. "Rohilla."
Docherty, H. - - -	1	"Baron Colonsay."
Drenning, W. B. - - -	1	S.S. "Mira."

Captain's Name.	Number of "Ex- cellent" Logs.	Ship.
Dunbar, J. I. - - -	17	S.S. "Arracan."
Dyke, A. H. - - -	3	S.S. "Don."
Dyke, H. W. - - -	8	"Accrington."
England, T. - - -	8	"Jane."
Exham, T. K., F.R.A.S.	6	S.S. "Esk."
Field, Lieut. and Comr. A. M., R.N.	4	H.M.S. "Dart."
Fraser, W. D. - - -	4	"Thomas S. Stowe."
Fullarton, D. - - -	5	"Timaru."
Garnsworthy, T. - - -	1	S.S. "Ardancorrach."
Gillies, W. - - -	1	S.S. "Medway."
Gray, J. - - -	13	S.S. "Hope."
Halley, E. - - -	4	"City of Madras."
Helby, Lieut. H. W. H., R.N.	1	H.M.S. "Myrmidon."
Hicks, G. M. - - -	2	S.S. "Nile" and S.S. "Neva."
Hird, W. - - -	5	"Marlborough."
Irving, P. J., R.N.R.	8	S.S. "Celtic" and S.S. "Germanic."
Jennings, R. C. - - -	3	S.S. "Colina."
Jones, S. Griff - - -	8	"Hermine."
Kemp, A. H. - - -	3	"Hudson."
Kiddle, Sub-Lieut. E. W., R.N.	5	H.M.S. "Egeria."
King, J. W. - - -	4	"Philomene."
Leportier, T. - - -	9	S.S. "Mira."
Long, Mr. J. C. - - -	6	S.S. "Kaisar-i-Hind."
McFee, J. R. - - -	3	"Great Victoria."
McLean, A. - - -	8	S.S. "Concordia."
Marshall, F. - - -	5	"Berkshire."
Mesnard, T. - - -	8	"Sierra Miranda."
Millican, J. W. - - -	4	"Myrtle Holme."
Milne, W. F. - - -	7	S.S. "Esquimaux."
Milner, W. H. - - -	8	S.S. "Avon" and S.S. "Neva."
Mitchell, G. - - -	1	S.S. "Trinacria."
Moignard, P. - - -	4	"Astoria."
Molony, E. J. - - -	8	"British Merchant."
Munn, L. A. - - -	2	S.S. "Durban."
Murdoch, P. - - -	10	"Sierra Lucena."
Newton, Mr. T. C., F.R.Met. Soc.	8	S.S. "Minia."
Norman, F. - - -	7	"John O'Gaunt."
North, W. G. - - -	12	S.S. "Tiger" and S.S. "Plato."
Oldham, C. F., R.N. - - -	9	H.M.S. "Egeria."
Owen, O. - - -	1	S.S. "Cordelia."
Parry, Moses, F.R.Met.Soc.	15	S.S. "Prydain."
Parsell, H. - - -	12	S.S. "Britannic."
Parson, G. F. - - -	9	"Earnock."
Pasifull, E. J. - - -	1	"Rahane."
Pearson, C. W. - - -	29	S.S. "Strathleven."
Pope, J. - - -	2	S.S. "Derwent."
Powles, F. W. - - -	6	S.S. "Essequibo."
Price, J. H. - - -	4	"Viola."
Pullen, Commr. T. F., R.N.	1	H.M.S. "Stork."

Captain's Name.	Number of "Ex- cellent" Logs.	Ship.
Dunbar, J. I. - - -	17	S.S. "Arracan."
Dyke, A. H. - - -	3	S.S. "Don."
Dyke, H. W. - - -	8	"Accerington."
England, T. - - -	8	"Jane."
Exham, T. K., F.R.A.S. -	6	S.S. "Esk."
Field, Lieut. and Comr. A. M., R.N.	4	H.M.S. "Dart."
Fraser, W. D. - - -	4	"Thomas S. Stowe."
Fullarton, D. - - -	5	"Timaru."
Garnsworthy, T. - - -	1	S.S. "Ardanecorrach."
Gillies, W. - - -	1	S.S. "Medway."
Gray, J. - - -	13	S.S. "Hope."
Halley, E. - - -	4	"City of Madras."
Helby, Lieut. H. W. H., R.N. -	1	H.M.S. "Myrmidon."
Hicks, G. M. - - -	2	S.S. "Nile" and S.S. "Neva,"
Hird, W. - - -	5	"Marlborough."
Irving, P. J., R.N.R. - -	8	S.S. "Celtic" and S.S. "Germanic."
Jennings, R. C. - - -	3	S.S. "Colina."
Jones, S. Griff - - -	8	"Hermine."
Kemp, A. H. - - -	3	"Hudson."
Kiddle, Sub-Lieut. E. W., R.N.	5	H.M.S. "Egeria."
King, J. W. - - -	4	"Philomene."
Leportier, T. - - -	9	S.S. "Mira."
Long, Mr. J. C. - - -	6	S.S. "Kaisar-i-Hind."
McFee, J. R. - - -	3	"Great Victoria."
McLean, A. - - -	8	S.S. "Concordia."
Marshall, F. - - -	5	"Berkshire."
Mesnard, T. - - -	8	"Sierra Miranda."
Millican, J. W. - - -	4	"Myrtle Holme."
Milne, W. F. - - -	7	S.S. "Esquimaux."
Milner, W. H. - - -	8	S.S. "Avon" and S.S. "Neva."
Mitchell, G. - - -	1	S.S. "Trinaeria."
Moignard, P. - - -	4	"Astoria."
Molony, E. J. - - -	8	"British Merchant."
Munn, L. A. - - -	2	S.S. "Durban."
Murdoch, P. - - -	10	"Sierra Lucena."
Newton, Mr. T. C., F.R.Met. Soc. - - -	8	S.S. "Minia."
Norman, F. - - -	7	"John O'Gaunt."
North, W. G. - - -	12	S.S. "Tiger and S.S. "Plato."
Oldham, C. F., R.N. - - -	9	H.M.S. "Egeria."
Owen, O. - - -	1	S.S. "Cordelia."
Parry, Moses, F.R.Met.Soc. -	15	S.S. "Prydain."
Parsell, H. - - -	12	S.S. "Britannic."
Parson, G. F. - - -	9	"Earnock."
Pasifull, E. J. - - -	1	"Rahane."
Pearson, C. W. - - -	29	S.S. "Strathleven."
Pope, J. - - -	2	S.S. "Derwent."
Powles, F. W. - - -	6	S.S. "Essequibo."
Price, J. H. - - -	4	"Viola."
Pullen, Commr. T. F., R.N. -	1	H.M.S. "Stork."

Captain's Name.	Number of "Ex- cellent" Logs.	Ship.
Randall, W. - - -	11	"Laomene."
Read, G. W., F.R.G.S. -	5	S.S. "Auretta."
Richardson, Mr. W. H. -	4	S.S. "Auretta."
Rigaud, H. C. - - -	2	S.S. "Derwent."
Ritchie, A. - - -	2	"Four Winds."
Rosseter, W. L. - - -	11	"Columba."
Russell, C. J. - - -	10	"Belfast" and "Holkar."
Saul, J. - - -	1	"Coronilla."
Scott, W. - - -	20	"Winifred."
Shearer, G. - - -	10	"Thetis."
Sibery, H., R.N.R. - -	2	S.S. "Clan Cameron."
Simpson, A. - - -	11	S.S. "Australasian."
Simpson, A. - - -	19	S.S. "Traveller."
Smith, W. C. - - -	11	"John R. Worcester."
Spooner, I. D. - - -	3	S.S. "La Plata."
Spratly, W. - - -	14	S.S. "Mozart."
Stewart, A. - - -	1	"County of Selkirk."
Sturdee, H. K. - - -	12	L.H. Tender "Richmond."
Thearle, J. - - -	1	S.S. "Lennox."
Thompson, J. E. - - -	2	S.S. "Monarch."
Thompson, Lieut. H., R.N. -	2	H.M.S. "Rambler."
Thomson, A. S. - - -	10	S.S. "Silvertown."
Tizard, Staff-Capt. T. H., R.N.	9	H.M.S. "Triton."
Travers, H. C. - - -	7	S.S. "Tartar."
Trevor-Roper, Dr. G. D., R.N.	1	H.M.S. "Stork."
Trott, S., F.R.Met.Soc. -	16	S.S. "Minia."
Trunks, H. - - -	4	"Aldbrough."
Vereker, Hon. F. C. P., R.N. -	9	H.M.S. "Myrmidon" and H.M.S. "Rambler."
Wait, A. M. - - -	4	S.S. "Spartan."
Walker, H. - - -	11	S.S. "Servia."
Wheaton, N. J. - - -	10	"Eliza."
Wilson, J., R.N.R. - - -	4	S.S. "Ethiopia."
Woolward, R. - - -	5	S. S. "Nile."
Worrall, W. A. - - -	1	"Camana."

Names of deceased observers printed in italics.

APPENDIX III.—SHIPS supplied and DOCUMENTS returned during the year ending 31st March 1890.

The number of merchant ships supplied with standard instruments and meteorological logs during the above period was 114.

The number of meteorological logs, and documents from Foreign Stations, received during the same period, and registered in the Office, amounted altogether to 353, of which 216 were returned from ships, and the remainder from land stations, outside the British Isles.

List of DOCUMENTS received from FOREIGN LAND STATIONS.

Place.	Observer.	No. of Documents.	Nature of Observations.
Abaco (Bahamas)	T. R. Thompson, Lightkeeper	1	" Lighthouse " Register, 1889, January to June.
Akassa, Nun River, Niger Delta	Frank Russell, F.R.G.S.	5	Two observations daily, 1889, May to November.
Bathurst (Gambia)	I. M. Harrison, E. J. Burt, and E. Allen.	1	" " " " October 1887 to September 1888.
Beyrout (Lee Observatory)	R. H. West, M.A.	12	" " " " February 1889 to February 1890.
Cape Juby (N. W. Africa)	Hubert Bray	3	" " " " October 1889 to January 1890.
Cape Pembroke (Falkland Islands)	G. K. Broom, Lightkeeper	2	" Lighthouse " Register 1889, January to December.
Cay Lobos (Bahamas)	N. H. E. Garner and J. G. Maura, Lightkeepers.	2	" " " " 1889, January to December.
Cay Sal (Bahamas)	T. R. Thompson, Lightkeeper	3	" " " " 1888, July to December. 1889, January to December.
Famagusta (Cyprus)	G. Eliades	2	Two observations daily, 1888, January to December.
George Town (British Guiana)	Robert Ward	11	" " " " 1889, March to December; 1890, January.
Gibraltar	Staff-Sergeant H. Spuckman, Med. Staff Corps.	12	" " " " February 1889 to January 1890.

LIST OF DOCUMENTS—continued.

Place.	Observer.	No. of Documents.	Nature of Observations.
Grand Bassam -	A. Jouve and G. Baillan, West African Tel. Co.	3	Two observations daily, 1888, April to September; 1889, February; 1890, February.
Heligoland -	J. J. Friederichs, Lightkeeper	12	" " March 1889 to February 1890.
Inagua (Bahamas) -	B. N. Jones and R. A. A. Espie, Lightkeepers.	2	" " Lighthouse" Register, 1889, January to December.
Kapalama (Hondolulu) -	Henry Cobb Adams	11	Two observations daily, 1889, February to December.
Kyrenia (Cyprus) -	M. Futeilham	2	" " 1888, January to December.
Larnaca (Cyprus) -	G. P. Voudiziano	2	" " " "
Limassol (Cyprus) -	Luigi Béraud	2	" " " "
Nicosia (Cyprus) -	G. Stephen and C. Carletti	2	" " " "
Papho (Cyprus) -	E. A. Malliotis	2	" " " "
Principe Island (West Africa) -	E. Hurdus	2	" " August 1889 to January 1890.
São Thomé (West Africa) -	E. Hurdus	2	" " 1888, December; 1889, January and February.
Suva (Fiji) -	J. D. W. Vaughan, F.R.Met. Soc.	8	One observation daily, 1887, July; 1888, April to December; 1889, January to December.
Teneriffe (San Antonio) -	W. L. Boreham (the late), and A. F. Perry.	10	Two observations daily, March 1889 to January 1890.
Tobago -	J. P. Tulloch, M.A., M.B.	10	" " 1889, March to December.
Trinidad -	J. H. Hart, Supt. Botanic Gardens.	11	" " January 1889 to January 1890.
Watling Island (Bahamas) -	S. W. Hall, Lightkeeper	2	" " Lighthouse" Register, 1889, January to December.

LIST of DOCUMENTS received from SHIPS.

Captain's Name.	Ship.	Voyage.	Year.
Anderson, Charles	S.S. Achilles	China, via Suez	1886-87
¹ Angus, T. S.	S.S. Canton	Bombay, via Suez	1889-90
² Armstrong, B. G.	S.S. Elbe	Brazil	1889
Asquith, W.	S.S. Deucalion	China, via Suez	1886-88
³ Atkinson, G. W.	S.S. Kaisar-i-Hind	Calcutta, via Suez	1889
Barker, D. W., F.R. Met. Soc.	S.S. Buccaneer	Pernambuco	1889
" R. J. M.	Earl of Aberdeen	Calcutta	1888-89
Batt, H.	S.S. Hector	China, via Suez	1886-88
Baxter, A. S.	City of York	Sydney, Sourabaya (Java)	1889-89
Belding, Rawstin	Barque Atlantic	River Plate	1889
Bennett, E. C.	Thessalus	San Francisco	1888-89
Bennet, J. T.	Alcester	Calcutta	1888-89
Bigley, W. B.	S.S. Diomed	China, via Suez	1886-88
Bolton, S. H.	S.S. Baidar	Ports in the Baltic, France, Spain	1889
"	"	Spanish Ports	1889-90
Bragg, I. T.	S.S. Antenor	China, via Suez	1886
³ Briscoe, R. F.	S.S. Kaisar-i-Hind	Bombay, China, via Suez	1889
Brown, R. J.	S.S. Titan	China, via Suez	1886-88
Buckler, J. H.	S.S. Dee	West Indies	1888-89
"	S.S. Solent	"	1889
Butler, S. H.	S.S. Priam	China, via Suez	1886
Cameron, Hugh	S.S. Ardangorm	Havana, Baltimore	1889
"	"	Havana, New Orleans	1889-90
" John	S.S. Thetis	Odessa, Antwerp	1888
⁴ " J. G.	S.S. Adriatic	New York	1888-89
R.N.R.	"	"	1889
⁵ " "	"	"	1889-90
Campbell, James	Glengarry	Calcutta	1889
⁶ Campbell, Robert	S.S. Elton	Rangoon, via Suez, Spezzia	1888
Carse, James	Barque Firth of Solway	Sydney	1886-88
Chrimes, Henry	S.S. Sarpedon	China, via Suez	1889
⁷ Clapp, Staff-Comr. E. S., R.N.	Schooner Richmond	Bahamas	1889-90
⁸ " "	"	"	1889-90
⁹ Conby, H. B.	Garfield	New York, Calcutta	1888
¹⁰ " "	Gilcrux	Calcutta, New York	1888-89
Couper, William	Clackmannanshire	New Caledonia	1888-89
Crichton, A. T.	S.S. Circe	Baltimore	1889
¹¹ " "	"	Montreal	1888-89
Cromarty, D. S.	Barque Cassandra	Autofagasta, New York	1886-89
Crotty, F. H.	Evesham Abbey	Mauritius, Calcutta, New York	1889
Crowley, C.	Barque Alexander Lawrence.	Rio Janeiro, New York	1888-89
¹² Crutchley, W. C., R.N.R.	S.S. Kaikoura	Cape Town, New Zealand, Rio Janeiro	1888-89
¹² " " "	"	Wellington, N.Z.	1889
¹² " " "	"	Wellington, via Cape Town, Rio Janeiro	1889-90
Dark, S.	Blairgowrie	Sydney, San Francisco	1888-89
Dart, L. C.	Barque Semantha	San Francisco	1888-89
Davies, David	Andora	Albany (W.A.), Calcutta, San Francisco, Sydney (N.S.W.)	1888-89
¹³ Dawson, L. S., R.N.	H.M.S. Rambler	China Sea, Port Darwin	1889
¹³ " "	"	N.W. Coast of Australia	1889
¹⁴ De Horne, M.	S.S. Rohilla	Bombay, via Suez, Hong-Kong	1889-90
¹⁵ " "	"	Calcutta, via Suez	1889-90
¹⁶ Dickinson, L. R.	S.S. Atrato	East Coast of South America	1888-89
Docherty, Hugh	Baron Colonsay	Singapore	1889
¹⁰ Drenning, W. B.	S.S. Mira	Calcutta, via Suez	1889
Dunbar, J. I.	S.S. Arracan	Rangoon, via Suez	1889
" "	"	"	1889

Captain's Name.	Ship.	Voyage.	Year.
Dunbar, J. I.	S.S. Arracan	Rangoon, viâ Suez	1889-90
¹⁷ Dyke, A. Hart	S.S. Don	Monte Video	1889
" H. W.	Accrington	New York, Calcutta	1888-89
"	"	New York	1889
Edwards, T. T.	S.S. Stentor	China, viâ Suez	1886-87
England, Thomas	Barque Jane	Quebec, Buenos Ayres	1888-89
¹⁰ Exham, T. K.	S.S. Esk	West Indies	1888-89
¹⁰ "	"	"	1889
¹⁰ "	"	"	1889
¹⁸ Field, Lieut. and Comr. A. M., R.N.	H.M.S. Dart	Sydney	1889
¹⁷ Ford, H. W.	S.S. Don	Monte Video	1889
Fraser, W. D.	Barque Thomas S. Stowe	Victoria (B.C.)	1888-89
Freeman, T. W.	S.S. Antenor	China, viâ Suez	1886
Fullarton, D.	Timaru	Brisbane	1888-89
Garnsworthy, Thomas	S.S. Ardancorrach	West Indies, Charleston	1889
"	"	Havana, New Orleans	1889-90
¹⁹ Gillies, W.	R.M.S. Medway	West Indies	1889
¹⁰ "	"	"	1889
Gould, H. W.	S.S. Ocean King	New Orleans	1889
"	"	Montreal, Norfolk (Va.), Bremen	1889-90
Gray, John	S.S. Hope	Greenland	1889
Grier, J. K.	S.S. Antenor	China, viâ Suez	1887-88
²⁰ Griffin, E. J., R.N.R.	S.S. Moor	Cape Town	1889
²⁰ "	"	"	1889
Guthrie, W. E.	S.S. Bellerophon	China, viâ Suez	1886
Halley, E.	City of Madras	Sydney, San Pedro (Cal.), Jacoma (Washington Ter.).	1888-89
Hannah, W. T.	S.S. Glaucus	China, viâ Suez	1886-88
²¹ Harris, James	S.S. Circassia	New York	1889
²¹ "	"	"	1889
²² Hicks, G. M.	R.M.S. Neva	West Coast of South America	1889
Hird, W.	Marlborough	Lyttleton	1888-89
Hutchinson, J.	S.S. Orestes	China, viâ Suez	1886-88
Huxtable, R. G.	Barque Lanarkshire	Adelaide	1889
²³ Irving, P. J., R.N.R.	S.S. Celtic	New York	1888-89
²⁴ "	S.S. Germanic	"	1889
Jackson, Charles	S.S. Palamed	China, viâ Suez	1886-88
" E. T.	S.S. Ajax	"	1887
" M. H. F.	S.S. Telamon	"	1886-88
" T. S.	S.S. Palinurus	"	1887-88
²⁵ Jennings, R. C.	S.S. Colina	Montreal, Monte Video	1888-89
"	"	Montreal	1889
Johansen, Augustus	Glenburn	New York, Calcutta	1887-89
Jones, Henry	S.S. Telemachus	China, viâ Suez	1886-88
Jones, Richard	Thomas Hilyard	Calcutta	1888-89
²⁶ Jones, S. Griff.	Barque Hermine	Esquimault, Valparaiso	1886-88
Kemp, A. H.	Barque Hudson	New Zealand	1888-89
King, J. W.	Philomene	Monte Video	1889-90
Lapage, W. P.	S.S. Anchises	China, viâ Suez	1886-88
Leportier, T.	S.S. Mira	Calcutta, viâ Suez	1889
Lourison, G. M.	Eaton Hall	San Francisco	1889-90
McFee, J. R.	Great Victoria	San Francisco	1885-86
"	"	Newcastle (N.S.W.), San Francisco	1887
McGonnell, James	Barque Matilda C. Smith	Ensenada, Apalachicola	1889
MacHugh, R. H.	S.S. Ching Wo	China, viâ Suez	1889
"	"	"	1889-90
McLean, A.	S.S. Concordia	Montreal, Monte Video	1888-89
"	"	Montreal	1889
Marshall, Frederick	Barque Berkshire	Chittagong	1888-89
Mesnard, T.	Sierra Miranda	Calcutta	1888-89
Milburn, W. J.	S.S. Ocean Prince	New York, &c.	1888-89
"	"	Porto Rico, Cape Breton	1889
²⁷ Miller, A. T.	H.M.S. Conway	Off Birkenhead	1889
Millican, J. W.	Barque Myrtle Holme	Adelaide	1889-90
Milligan, John	S.S. Jason	China, viâ Suez	1888

Captain's Name.	Ship.	Voyage.	Year.
Milligan, Samuel	S.S. Jason	China, viâ Suez	1886
"	S.S. Stentor	"	1887-88
²⁸ Milne, W. F.	S.S. Esquimaux	St. John's (Newfoundland)	1889
Milner, W. H.	R.M.S. Avon	West Indies	1889
"	"	"	1889
"	S.S. Neva	Brazil	1889-90
Mitchell, George	S.S. Trinacria	Mediterranean Ports, New York	1888-89
"	"	New York, Palermo, New Orleans	1889
Moignard, P.	Barque Astoria	Sydney, San Francisco	1888-89
Molony, E. J.	British Merchant	Calcutta	1889
²⁹ Munn, L. A.	S.S. Durban	Cape Town	1889
Murdoch, Peter	Sierra Lucena	Bombay	1888-89
Nelson, R.	S.S. Menelaus	China, viâ Suez	1886-88
Nish, H.	S.S. Cyclops	"	1886-88
Norman, Francis	Barque John O'Gaunt	Hobart, Valparaiso	1888-89
North, W. G.	S.S. Plato	Hamburg	1889
"	S.S. Tiger	"	1889
³⁰ Oldham, Comr. C. F., R.N.	H.M.S. Egeria	Australian Station	1889
³⁰ " " "	"	"	1889
³¹ Owen, Owen	Barque Cordelia	Callao, Havana	1888-90
Parry, Moses	S.S. Prydain	Mediterranean Ports	1888-89
"	"	Constantinople, Rio Janeiro, Santos, New Orleans	1889-90
³² Parsell, H.	S.S. Britannic	New York	1888-89
¹⁰ Parson, G. F.	Earnock	Melbourne	1882-89
Pasifull, E. J.	Rahane	San Francisco	1889-90
Pattman, R.	Loch Torridon	New York, Calcutta	1888-89
Paul, John	Barque Glenogle	Callao	1889
³³ Pearson, C. W.	S.S. Strathleven	New York, China, viâ Suez	1888-89
Pike, A.	Walrus sloop Siggen	Spitzbergen	1888-89
³⁴ Pope, James	S.S. Derwent	West Indies	1889
³⁴ " "	"	Barbados	1889
Powles, F. W.	S.S. Essequibo	West Indies	1889
"	"	"	1889
¹⁰ " " "	"	"	1889
Price, J. H.	Barque Viola	Vancouver Island	1888-89
Pulford, J.	S.S. Patroclus	China, viâ Suez	1888
³⁵ Pullen, Comr. T. E., R.N.	H.M.S. Stork	Zanzibar, viâ Suez, Simon's Bay	1888-89
Purdy, T.	S.S. Dardanus	China, viâ Suez	1886-88
Randall, W.	Laomene	New York, Batavia	1888-89
³⁶ Read, G. W., F.R.G.S.	S.S. Aurette	Colombo, viâ Suez	1889
³⁷ Reynolds, Robert	S.S. German	Cape Town	1888-89
³⁷ " " "	"	"	1889
³⁴ Rigaud, H. C.	S.S. Derwent	West Indies	1888-89
³⁸ " " "	S.S. Tamar	Brazil	1889
Riley, J.	S.S. Ajax	China, viâ Suez	1886-88
Ritchie, Alexander	Four Winds	Melbourne, Calcutta	1888-89
Rosseter, W. L.	Columba	Calcutta	1888-89
Russell, C. J.	Belfast	"	1889
"	Holkar	"	1889
¹⁰ " " "	Glenlora	Nelson, N.Z.	1889
Sargent, A. H.	Barque Coronilla	Valparaiso, Hamburg	1888-89
Saul, John	S.S. Laertes	China, viâ Suez	1886-88
Scale, R. F.	Barquentine Winifred	Trinidad	1889
Scott, William	Barque Thetis	Buenos Ayres	1888-89
Shearer, George	S.S. Clan Cameron	Cape Town, Madras, Port Said	1889
Sibery, Harry, R.N.R.	"	Cape Town, Madras, home, viâ Suez	1889-90
³⁹ " " "	S.S. Australasian	Melbourne, via Cape, home, viâ Suez	1889
" " "	"	Melbourne, viâ Cape, Singapore, home, viâ Suez	1889
Simpson, Alexander	S.S. Traveller	Greenland	1889
²⁷ Smith, J. H.	H.M.S. Worcester	Off Greenhithe	1889
Smith, W. C.	Barque John Worcester.	Brisbane, San Francisco, Sydney	1887-89

Captain's Name.	Ship.	Voyage.	Year.
⁴⁰ Spooner, J. D. -	S.S. La Plata -	Brazil - - - -	1889
⁴¹ " -	" -	" - - - -	1889
Spratly, W. -	S.S. Mozart -	Rio Janeiro, New York, Monte Video - - - -	1888-89
⁴² " -	" -	Monte Video - - - -	1889-90
Storm, A. -	Barque Seiriol Wyn -	Sydney, San Francisco, Melbourne -	1887-89
Stewart, Alexander -	County of Selkirk -	Calcutta - - - -	1889-90
Streater, Rowland -	Barque Lutterworth -	New Zealand, Portland (Oregon) -	1888-89
²⁰ Symons, F. J., R.N.R. -	S.S. Moor -	Cape Town - - - -	1888-89
Thearle, J. -	S.S. Lennox -	China, via Suez, New York -	1888-89
Thompson, A. -	S.S. Patroclus -	China, via Suez - - - -	1886
⁴³ " J. E. -	S.S. Monarch -	Coast of British Isles - - - -	1889
" J. S. -	S.S. Nestor -	China, via Suez - - - -	1886-88
Thomson, A. S. -	S.S. Silvertown -	S.W. Coast of Africa - - - -	1889
Tizard, Staff-Capt. -	H.M.S. Triton -	Coasts of British Isles - - - -	1886-89
T. H., R.N. -	" -	" - - - -	" -
⁴⁴ Travers, H. de la Cour -	S.S. Tartar -	Cape Town - - - -	1888-89
⁴⁴ " -	" -	Cape of Good Hope - - - -	1889
⁴⁵ Trott, Samuel -	S.S. Minia -	North Atlantic - - - -	1889
⁴⁵ " -	" -	Halifax - - - -	1889
⁴⁵ " -	" -	" - - - -	1889-90
Trunks, H. -	Barque Aldborough -	Singapore, Bassein - - - -	1889
⁴⁶ Vereker, Hon. F. C. P., R.N. -	H.M.S. Myrmidon -	Sydney, Manila - - - -	1888
¹³ " -	H.M.S. Rambler -	China Sea, Port Darwin - - - -	1889
⁴⁷ Wait, A. McLean -	R.M.S. Spartan -	Cape Town - - - -	1889
¹⁷ " -	" -	" - - - -	1889
Walker, Henry -	S.S. Servia -	New York - - - -	1889
Webster, J. K. -	S.S. Prometheus -	China, via Suez - - - -	1886-87
Wheaton, N. J. -	Barque Eliza -	St. Domingo - - - -	1888-89
" -	" -	Mexico - - - -	1889
Wilding, J. -	S.S. Agamemnon -	China, via Suez - - - -	1886-88
Wilson, John, R.N.R. -	S.S. Ethiopia -	New York - - - -	1889
⁴⁸ Woolward, Robert -	R.M.S. Nile -	West Indies - - - -	1889
⁴⁸ " -	" -	" - - - -	1889-90
Worrall, W. A. -	Barque Canana -	Buenos Aires, Taltal (Chili) -	1889-90
⁴⁹ Young, H. -	S.S. Circassia -	New York - - - -	1888-89

In cases distinguished by marginal numbers the Meteorological Registers were kept chiefly by Officers, as follows:—

- ¹ Kept by W. W. Cooke, 2nd Officer, W. C. Pickering, 3rd Officer, Percy Gibson, 4th Officer.
- ² Kept by W. Fish, 2nd Officer, J. Murray, 3rd Officer, and J. Bloy, 4th Officer.
- ³ Kept by J. C. Long, Chief Officer.
- ⁴ Kept by H. I. Haddock, R.N.R., and E. W. Burnett.
- ⁵ Kept by E. W. Burnett, L. Scott, and J. T. Shenton.
- ⁶ Assisted by G. W. Planc and G. Burt.
- ⁷ Kept by H. K. Sturdee and F. W. Holden.
- ⁸ Kept by F. W. Holden.
- ⁹ Kept by 3rd Mate.
- ¹⁰ Assisted by Officers.
- ¹¹ Assisted by John Dickie, 2nd Officer.
- ¹² Kept by J. L. Berryman, 4th Mate.
- ¹³ Kept by Lieut. H. Thompson, R.N.
- ¹⁴ Kept by H. S. Blackburn, 1st Officer, and C. C. Talbot, 2nd Officer.
- ¹⁵ Kept by 4th and 5th Officers.
- ¹⁶ Kept by W. E. Moses, 4th Officer.
- ¹⁷ Kept by H. C. Miles, 3rd Officer.
- ¹⁸ Kept by W. H. Jones, Signaller.
- ¹⁹ Kept by H. Lament, 2nd Officer.
- ²⁰ Kept by J. V. Williams, 4th Officer.
- ²¹ Kept by James Adams, 2nd Officer.
- ²² Kept by Arthur Clarke, 3rd Officer.
- ²³ Kept by L. J. Lassins.
- ²⁴ Kept by T. B. O'Brien, R.N.R., H. J. Haddock, R.N.R., and J. C. Carr, R.N.R.

- ²⁵ Assisted by J. E. Browne, Chief Officer.
- ²⁶ Assisted by Messrs. Belson, Hutchinson, and Peterson.
- ²⁷ Kept by the Cadets.
- ²⁸ Assisted by J. Brown.
- ²⁹ Kept by R. H. Sach, 3rd Officer.
- ³⁰ Kept by Lieut. E. B. Kiddle, R.N.
- ³¹ Assisted by M. N. Anderton, Mate.
- ³² Kept by J. Christie.
- ³³ Assisted by G. R. Berwick, 2nd Mate.
- ³⁴ Kept by H. W. Beal, 2nd Officer.
- ³⁵ Kept by Sub-Lieut. A. C. L. Cameron and G. D. Trevor-Roper, Surgeon.
- ³⁶ Kept by W. H. Richardson, 1st Mate.
- ³⁷ Kept by A. H. Rhodes.
- ³⁸ Kept by C. E. Down, 2nd Officer.
- ³⁹ Assisted by Robert Stirling, 2nd Officer.
- ⁴⁰ Kept by George Adams and C. P. Langmaid.
- ⁴¹ Kept by George Adams, 4th Officer.
- ⁴² Assisted by T. Lloyd.
- ⁴³ Kept by A. F. Halpin, 3rd Officer, assisted by F. Alford and C. J. Hall, 2nd Officers.
- ⁴⁴ Kept by J. Bowyer, 2nd Officer.
- ⁴⁵ Kept by T. G. Newton, 1st Officer.
- ⁴⁶ Kept by Lieut. H. W. H. Helby, R.N.
- ⁴⁷ Kept by R. G. Jackson.
- ⁴⁸ Kept by P. S. Newton, 2nd Officer.
- ⁴⁹ Kept by J. Adams, 2nd Officer.

Captain's Name.	Ship.	Voyage.	Year.
⁴⁰ Spooner, J. D.	S.S. La Plata -	Brazil - - - -	1889
⁴¹ " "	" "	" " " " " "	1889
Spratly, W. -	S.S. Mozart -	Rio Janeiro, New York, Monte Video - - - -	1888-89
⁴² " "	" "	Monte Video - - - -	1889-90
Storm, A. -	Barque Seiriol Wyn -	Sydney, San Francisco, Melbourne -	1887-89
Stewart, Alexander -	County of Selkirk -	Calcutta - - - -	1889-90
Streater, Rowland -	Barque Lutterworth -	New Zealand, Portland (Oregon) -	1888-89
²⁰ Symons, F. J., R.N.R.	S.S. Moor -	Cape Town - - - -	1888-89
Thearle, J. -	S.S. Lennox -	China, via Suez, New York -	1888-89
Thompson, A. -	S.S. Patroclus -	China, via Suez - - - -	1886
⁴³ " J. E. -	S.S. Monarch -	Coast of British Isles - - - -	1889
" J. S. -	S.S. Nestor -	China, via Suez - - - -	1886-88
Thomson, A. S. -	S.S. Silvertown -	S.W. Coast of Africa - - - -	1889
Tizard, Staff-Capt. T. H., R.N.	H.M.S. Triton -	Coasts of British Isles - - - -	1886-89
⁴⁴ Travers, H. de la Cour	S.S. Tartar -	Cape Town - - - -	1888-89
⁴⁴ " "	" "	Cape of Good Hope - - - -	1889
⁴⁵ Trott, Samuel -	S.S. Minia -	North Atlantic - - - -	1889
⁴⁵ " "	" "	Halifax - - - -	1889
⁴⁵ " "	" "	" " " " " "	1889-90
Trunks, H. -	Barque Aldborough -	Singapore, Bassein - - - -	1889
⁴⁶ Vereker, Hon. F. C. P., R.N.	H.M.S. Myrmidon -	Sydney, Manila - - - -	1888
¹³ " "	H.M.S. Rambler -	China Sea, Port Darwin - - - -	1889
⁴⁷ Wait, A. McLean -	R.M.S. Spartan -	Cape Town - - - -	1889
⁴⁷ " "	" "	" " " " " "	1889
Walker, Henry -	S.S. Servia -	New York - - - -	1889
Webster, J. K. -	S.S. Prometheus -	China, via Suez - - - -	1886-87
Wheaton, N. J. -	Barque Eliza -	St. Domingo - - - -	1888-89
" "	" "	Mexico - - - -	1889
Wilding, J. -	S.S. Agamemnon -	China, via Suez - - - -	1886-88
Wilson, John, R.N.R.	S.S. Ethiopia -	New York - - - -	1889
⁴⁸ Woolward, Robert -	R.M.S. Nile -	West Indies - - - -	1889
⁴⁸ " "	" "	" " " " " "	1889-90
Worrall, W. A. -	Barque Camana -	Buenos Aires, Taltal (Chili) -	1889-90
⁴⁹ Young, H. -	S.S. Circassia -	New York - - - -	1888-89

In cases distinguished by marginal numbers the Meteorological Registers were kept chiefly by Officers, as follows:—

- ¹ Kept by W. W. Cooke, 2nd Officer, W. C. Pickering, 3rd Officer, Percy Gibson, 4th Officer.
- ² Kept by W. Fish, 2nd Officer, J. Murray, 3rd Officer, and J. Bloy, 4th Officer.
- ³ Kept by J. C. Long, Chief Officer.
- ⁴ Kept by H. I. Haddock, R.N.R., and E. W. Burnett.
- ⁵ Kept by E. W. Burnett, L. Scott, and J. T. Shenton.
- ⁶ Assisted by G. W. Plane and G. Burt.
- ⁷ Kept by H. K. Sturdee and F. W. Holden.
- ⁸ Kept by F. W. Holden.
- ⁹ Kept by 3rd Mate.
- ¹⁰ Assisted by Officers.
- ¹¹ Assisted by John Dickie, 2nd Officer.
- ¹² Kept by J. L. Berryman, 4th Mate.
- ¹³ Kept by Lieut. H. Thompson, R.N.
- ¹⁴ Kept by H. S. Blackburn, 1st Officer, and O. C. Talbot, 2nd Officer.
- ¹⁵ Kept by 4th and 5th Officers.
- ¹⁶ Kept by W. E. Moses, 4th Officer.
- ¹⁷ Kept by H. C. Miles, 3rd Officer.
- ¹⁸ Kept by W. H. Jones, Signalmann.
- ¹⁹ Kept by H. Lamont, 2nd Officer.
- ²⁰ Kept by J. V. Williams, 4th Officer.
- ²¹ Kept by James Adams, 2nd Officer.
- ²² Kept by Arthur Clarke, 3rd Officer.
- ²³ Kept by J. J. Lossius.
- ²⁴ Kept by T. B. O'Brien, R.N.R., H. J. Haddock, R.N.R., and J. C. Carr, R.N.R.

- ²⁵ Assisted by J. E. Browne, Chief Officer.
- ²⁶ Assisted by Messrs. Belson, Hutchinson, and Peterson.
- ²⁷ Kept by the Cadets.
- ²⁸ Assisted by J. Brown.
- ²⁹ Kept by R. H. Saeh, 3rd Officer.
- ³⁰ Kept by Lieut. E. B. Kiddle, R.N.
- ³¹ Assisted by M. N. Anderton, Mate.
- ³² Kept by J. Christie.
- ³³ Assisted by G. R. Berwick, 2nd Mate.
- ³⁴ Kept by H. W. Beal, 2nd Officer.
- ³⁵ Kept by Sub-Lieut. A. C. L. Cameron and G. D. Trevor-Roper, Surgeon.
- ³⁶ Kept by W. H. Richardson, 1st Mate.
- ³⁷ Kept by A. H. Rhodes.
- ³⁸ Kept by C. E. Down, 2nd Officer.
- ³⁹ Assisted by Robert Stirling, 2nd Officer.
- ⁴⁰ Kept by George Adams and C. P. Laugmaid.
- ⁴¹ Kept by George Adams, 4th Officer.
- ⁴² Assisted by T. Lloyd.
- ⁴³ Kept by A. F. Halpin, 3rd Officer, assisted by F. Alford and C. J. Hall, 2nd Officers.
- ⁴⁴ Kept by J. Bowyer, 2nd Officer.
- ⁴⁵ Kept by T. C. Newton, 1st Officer.
- ⁴⁶ Kept by Lieut. H. W. H. Helby, R.N.
- ⁴⁷ Kept by R. G. Jackson.
- ⁴⁸ Kept by F. S. Newton, 2nd Officer.
- ⁴⁹ Kept by J. Adams, 2nd Officer.

APPENDIX IV.

INSTRUMENTS supplied, &c. to the Royal Navy.

Per Account.		Baro- meters.	Ane- roids.	Thermometers.				Hydro- meters.
				Ordinary.	Max.	Min.	Screens.	
April 1st, 1889, afloat -	-	190	455	1,255	262	227	142	78
Issued since -	-	98	165	397	70	65	40	26
		288	620	1,652	332	292	182	104
Returned since -	-	77	140	324	43	34	15	51
April 1st, 1890, afloat -	-	211	480	1,328	289	258	167	53

INSTRUMENTS supplied, &c. for use at Naval Stations.

April 1st, 1889, in use -	-	59	64	192	17	18	3	12
Issued since -	-	2	5	52	6	4	8	1
		61	69	244	23	22	11	13
Returned since -	-	—	6	36	2	1	8	2
April 1st, 1890, in use -	-	61	63	208	21	21	3	11

DISPOSITION of ADMIRALTY INSTRUMENTS on April 1st, 1890.

Afloat in Royal Navy -	-	211	480	1,328	289	258	167	53
In use at stations -	-	61	63	208	21	21	3	11
In store at M.O. -	-	15	67	390	87	109	38	49
" Chatham -	-	6	6	26	8	6	2	13
" Sheerness -	-	5	5	18	7	7	5	9
" Portsmouth -	-	11	33	51	10	13	10	9
" Devonport -	-	14	29	37	7	6	2	20
" Queenstown -	-	2	5	21	1	1	—	8
" Gibraltar -	-	2	2	14	—	—	—	4
" Malta -	-	4	7	4	—	2	—	17
" Bombay -	-	4	3	12	4	4	1	4
" Halifax -	-	3	10	16	2	3	—	14
" Bermuda -	-	4	16	24	1	6	—	15
" Jamaica -	-	3	3	19	2	2	—	—
" Cape of Good Hope -	-	2	7	20	6	5	3	8
" Trincomalee -	-	4	3	21	4	4	—	—
" Hong Kong -	-	6	21	32	15	12	—	17
" Coquimbo -	-	2	5	23	1	2	—	19
" Sydney -	-	3	6	13	6	4	—	—
" Esquimalt -	-	8	9	26	3	3	—	—
Total, April 1st, 1890 -	-	370	780	2,303	474	468	231	270
Lost, &c. since April 1st, 1889 -	-	1	12	202	23	8	12	16
Under repair -	-	35	—	—	—	—	—	—

APPENDIX V.

INSTRUMENTS supplied, &c. to Mercantile Marine.

Per Account.	Baro- meters.	Com- passes.	Thermometers.				Hydro- meters. ★
			Ordinary.	Max.	Min.	Screens.	
April 1st, 1889, afloat -	116	—	699	—	—	120	379
Issued since -	88	—	532	—	—	79	275
Returned since -	204	—	1,231	—	—	199	654
	97	—	595	—	—	93	312
April 1st, 1890, afloat -	107	—	636	—	—	106	342

INSTRUMENTS at Stations, viz., Telegraph Offices, Observatories,
Fishing Villages, &c.

April 1st, 1889, in use -	256	3	275	58	58	36	10
Issued since -	15	1	11	1	1	3	1
Returned since -	271	4	286	59	59	39	11
	15	—	39	4	2	4	—
April 1st, 1890, in use -	256	4	247	55	57	35	11

DISPOSITION of Board of Trade Instruments on April 1st, 1890.

In merchant ships -	107	—	636	—	—	106	342
In use at stations -	256	4	247	55	57	35	11
In store at M.O. -	39	2	198	19	55	8	98
At Liverpool Agency -	10	7	52	—	—	8	44
„ Aberdeen „ -	2	—	18	—	3	4	8
„ Glasgow „ -	3	—	29	—	—	3	29
„ Dundee „ -	13	—	15	—	—	11	28
„ Hull „ -	8	—	30	—	—	6	26
„ Southampton „ -	8	—	39	—	—	8	30
„ Cardiff „ -	—	—	—	—	—	—	—
Total, April 1st, 1890 -	446	13	1,264	74	115	189	616
Lost, &c. since April 1st, 1889 -	8	—	186	3	3	31	91
At opticians -	26	—	14	—	—	—	2

APPENDIX VI.

List of STATIONS reporting Meteorological Observations to the Office by Telegraph on 31st March 1890, with the Names of Observers.

*†Sumburgh Head	-	Rev. W. Brand	-	-	Minister of Dunrossness.
*†Stornoway	-	J. Forbes	-	-	Nicolson Institution.
Wick	-	J. Sinclair	-	-	Watchmaker.
Nairn	-	Miss Penny	-	-	Schoolmistress.
*†Aberdeen	-	W. Boswell	-	-	Assistant at the Observatory.
Leith	-	W. Hay	-	-	Telegraph Clerk.
*†Shields	-	J. W. Irvine	-	-	Do.
Spurn Head	-	J. H. Watson	-	-	Lightkeeper.
†York	-	H. M. Platnauer, F.G.S.	-	-	Curator of Museum.
Loughboro'	-	W. Berridge	-	-	—
†Ardrossan	-	J. W. Mayes	-	-	Telegraph Clerk.
Malin Head	-	O. O'Doherty	-	-	Signalman, Lloyd's.
*†Mullaghmore	-	K. Kerr	-	-	Retired Coastguard Officer.
*†Belmullet	-	Miss M. J. Tolan	-	-	Telegraphist.
†Donaghadee	-	T. MacGowan	-	-	Postmaster.
Parsonstown	-	E. Haines	-	-	Assistant Observer at Lord Rosse's Observatory.
*†Holyhead	-	Capt. Richards	-	-	Keeper of Sailors' Home.
Liverpool	-	J. Hartnup, F.R.Met.Soc.	-	-	Bidston Observatory.
*†Valencia	-	J. E. Cullum, F.R.Met.Soc.	-	-	Superintendent of the Observatory.
†Roche's Point	-	W. Kennedy	-	-	Telegraph Clerk.
Fembroke	-	S. Blake	-	-	Lightkeeper.
*†Scilly	-	A. Hicks§	-	-	Signalman.
†Prawle Point	-	W. Hewitt	-	-	Coastguard Officer.
†Hurst Castle	-	G. G. Appleton	-	-	Lightkeeper.
†Jersey	-	J. Fisher	-	-	Station Master.
*†Dungeness	-	W. Batton	-	-	Assistant Lightkeeper.
*†London	-	F. Gaster, F.R.Met.Soc.	-	-	Clerk, Meteorological Office.
Oxford	-	W. Wickham	-	-	Radcliffe Observatory.
Cambridge	-	H. Todd	-	-	Observatory.
*†Yarmouth	-	G. T. Watson	-	-	Secretary, Sailors' Home.
†Hawes Junction	-	W. H. Bunce	-	-	Station Master.

In addition to the above reports are received daily from the following Continental Stations.

Station.	Authority.	Station.	Authority.
Haparanda	} Meteorological Office, Sweden.	†The Helder	} Bureau Central Météorologique, Paris.
Hernösand		Cape Gris Nez	
†Stockholm		†(Brest, St. Mathieu)	
Wisby		Lorient (Île de Groix)	
Bodö	} Meteorological Institute, Norway.	*†Rochefort (Île d'Aix)	} Bureau Central Météorologique, Paris.
†Christiansund		†Biarritz	
*†Skudesnaes		†Paris	
Faerder		Belfort	
†The Scaw	} Meteorological Institute, Denmark.	Lyons	} Cent. Met. Inst. of Germany.
Fanö		Nice	
Cuxhaven	} Deutsche Seewarte, Hamburg.	Perpignan	} Cent. Met. Inst. of Germany.
		Berlin	
		Wiesbaden	
		Munich	} Observatory, Lisbon.
		Corunna	
		†Lisbon	

Note.—Those stations marked with an asterisk (*) report also at 2h. p.m.; and those with a dagger (†) at 6h. p.m.; Lisbon reports at 8h. a.m. and 4h. p.m.

† This station now reports by post only.

§ W. Thomas died in March 1890.

The reports from Barrow-in-Furness ceased at end of 1889.

APPENDIX VII.

REPORT OF INSPECTIONS, IRELAND AND WALES.

GENTLEMEN,

I HAVE to report that I have completed the inspection of the Irish and Welsh stations, and have also visited the fishery barometers which lay in my way.

TELEGRAPH STATIONS.

Holyhead, visited August 6.—I found this station in good order. No remarks are called for.

Donaghadee, visited August 7.—This station was also satisfactory. I regret to say the health of the observer is not good.

Malin Head, visited August 12.—The new observer, Owen O'Doherty, is more satisfactory than his predecessor, J. Farren, and I hope that the station will now be useful. The instruments were in good order.

Mullaghmore, visited August 13.—This station was, as usual, in very good order.

Belmullet, visited August 15.—The instruments were all in good order and the station satisfactory.

Valencia, visited August 22, and found in good order. I authorised some necessary repairs to be carried out at the observatory.

Roche's Point, visited August 26.—The instruments were in fair order; the wet bulb was not satisfactorily mounted.

Parsonstown, visited August 28.—The observer, Haines, is attentive, and does his duty well.

St. Ann's Head, visited September 2.—This station was in good order.

STATIONS OF THE SECOND ORDER AND WEEKLY WEATHER REPORT STATIONS.

Armagh, visited August 8.—Dr. Dreyer was absent, but I saw Mr. Faris, his assistant. The instruments were in proper order.

Colebrooke, visited August 9.—The instruments were in order. It is possible that this station may be discontinued.

Londonderry, visited August 9.—The station calls for no remark.

Markree, visited August 14.—The station was, as usual, in good order.

Currygrane, visited August 17.—The new assistant, F. Warrington, continues to work well.

Killarney, visited August 24.—The observer was absent, but the substitute was efficient and the instruments in good order.

Foynes, visited August 27.—These observations are only carried on while Lord Monteagle is residing at the place.

Parsonstown, visited August 28.—The observer, Sergeant Whelan, is failing in health.

Dublin (Fitzwilliam Square), visited August 29.—The station continues in excellent order.

Dublin, Glasnevin, visited August 29.—The only matter calling for remark is that the new gauge which was supplied in 1888 shows a larger fall than the old one, owing to difference of situation. I have directed the observer to discontinue the use of the old gauge.

Dublin, Mountjoy, visited August 29.—The only matter calling for notice is that it has been found that the anemometer, though on a high stage, registers 40 per cent. less than Holyhead.

Kilkenny, visited August 30.—The instruments were in good order, but there is no prospect of the station becoming one of the Second Order.

Waterford (Brooklawn) visited August 31.—This station, like Foynes and Kilkenny only takes readings for the Weekly Weather Report.

St. David's, visited September 3.—This station was, as usual, quite satisfactory.

Llandoverly, visited September 4.—This also is only a station for the Weekly Weather Report; as such, it is fairly satisfactory.

I visited also certain fishery barometers which lay on my route. These were Ballyglass (Broadhaven), Ballycastle (Co. Mayo), Howth, Malahide, Hakin (Milford), and Angle, Milford Haven. At the last-named station the barometer has been exposed to weather. The instrument is serviceable if not moved about.

At several of these stations lectures would be appreciated.

(Signed) ROBERT H. SCOTT.

The following table shows the results of the thermometric comparisons:—

Corrections to be applied to the readings of—

STATIONS.	Dry Bulb.	Wet Bulb.	Max.	Min.	Spare Therm.	Remarks.
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STATIONS OF THE SECOND ORDER.

Armagh	-0.3	-0.5	-0.9	—	—	Grass min. 2.5 of spirit separated.
Brookeborough	-0.2	-0.7	-0.1	+0.2	—	
Dublin (City)	-0.3	-0.4	-1.1	-0.3	—	
Dublin (Phoenix Park)	-0.9	-1.0	-0.3	-0.3	-1.0	Grass min. -1.6.
Edgeworthstown	-0.5	-0.3	-0.3	+0.6	—	Do. +0.7.
Glasnevin	-0.6	-0.5	-1.0	0	—	Do. -1.0.
Londonderry	-0.3	-0.2	+0.2	+0.3	-0.3	
Markree Castle	-0.7	-0.7	-0.2	-0.1	—	
Parsonstown	-0.8	-0.1	-0.8	-0.3	—	
St. David's	-0.7	-0.7	-0.4	-0.1	—	

TELEGRAPHIC REPORTING STATIONS.

Holyhead	-0.2	-0.4	-0.6	-0.1	-0.6	New observer:
Malin Head	-0.1	-0.9	+0.1	-0.3	-0.4	
Mullaghmore	-0.5	-0.6	-0.4	+0.4	-0.6	
Belmullet	-0.6	-0.5	-0.4	-0.5	—	
Donaghadee	-0.8	-1.1	-1.1	-0.4	-0.7	
Parsonstown	-0.8	-0.1	-0.8	-0.3	—	
Valencia	-0.8	-0.5	-0.5	-0.1	+0.2	
Roche's Point	-0.9	-0.8	-0.8	+0.2	—	
St. Ann's Head	-0.2	0.0	0.0	+0.3	-0.1	

WEEKLY WEATHER REPORT STATIONS.

Londonderry	-0.4	-0.3	+0.1	+0.2	-0.4	Casella's mercurial min.: — not read. 2.5 of spirit separated in grass, min. — ther.
Armagh	-0.4	-0.6	-1.0	?	-0.3	
Colebrooke	-0.3	-0.8	-0.2	+0.1	—	
Markree	-0.7	-0.7	-0.2	-0.1	—	
Edgeworthstown	-0.5	-0.3	-0.3	+0.6	—	
Dublin	-0.3	-0.4	-1.1	-0.3	-0.3	
Kilkenny Castle	—	—	0.0	-0.2	—	
Waterford	-0.7	-0.8	+0.1	+0.2	—	
Killarney	-0.2	-0.2	-0.1	+0.2	—	
Foynes	-0.7	—	-0.5	+0.3	—	
Llandoverly	—	—	-1.5	0.0	—	

REPORT OF INSPECTION OF THE SCOTTISH STATIONS FOR 1889.

BAROMETERS.

The inspector's mercurial Standard Barometer No. 690 was used for this year's inspection tour. The results of the inspection of the station barometers are given in the following table. The barometers were found to be in good order, and continue to be observed with the same care and accuracy as in former years.

Stations.	Inspector's Standard, corrected.	Not corrected.		Remarks.
		Rep. Baro.	Check Baro.	
	ins.	ins.	ins.	
Fort William	29.680	29.680	—	
Fort Augustus	29.945	29.943	—	
Glencarron	29.237	29.237	—	
Stornoway	29.908	29.904	29.901	
Swanbister	29.678	29.688	—	
Dunrossness	29.560	29.554	29.558	
Wick	29.186	29.180	29.142*	* Read 15 min. later in house at higher level.
Nairn	29.560	29.558	29.559	
Aberdeen	29.715	29.715	29.712	
Braemar	28.891	28.878	—	
Dundee	29.734	29.730	—	
Ardrossan	30.026	30.020	—	
Pinnore	29.986	29.992	—	
Glenlee	29.736	29.748	—	
Leith	29.264	29.260	—	
Marchmont	29.118	29.118	—	
Ochertyre	29.415	29.424	—	

THERMOMETERS.

The thermometers in use at the stations were compared in water with Standard Thermometer No. 4433. The following table gives the corrected readings of the standard thermometer and the errors of each instrument as determined by the comparisons.

Stations.	Standard No. 4433, corrected.	Dry Bulb.	Wet Bulb.	Spare Ther- mometer.	Max. Ther- mometer.	Min. Ther- mometer.	Time in Water in Minutes.	Change of Tempera- ture.	Remarks.
Fort William	57.8	0.0	+0.2	—	+0.2	-0.1	40	Uniform	
Fort Augustus	58.3	+0.1	+0.1	—	0.0	-0.4	60	Do.	
Glencarron	57.1	0.0	-0.1	—	0.0	-0.2	90	Do.	
Stornoway	57.6	+0.5	+0.6	+0.4	-0.2	-0.4	150	Do.	About 0°.2 of min. ther. at top of tube. Put right.
Swanbister	59.1	+0.1	+0.1	+0.8	-0.2	-0.4	90	+0.2	
Dunrossness	59.2	+0.4	+0.4	—	+0.2	-0.0	200	+0.2	
Wick	58.6	+0.4	+0.4	—	-0.3	-0.4	70	Uniform	
Laing	57.0	+0.2	+0.2	—	-0.2	0.0	60	Do.	
Nairn	55.8	+0.7	+0.7	+0.1	0.0	+0.0	80	+0.3	In reading 1°.0 is subtracted from min.
Aberdeen	56.3	+0.2	+0.1	—	0.0	+0.1	90	Uniform	
Braemar	55.3	+0.6	+0.4	—	0.0	-0.1	70	Do.	
Dundee	58.7	+0.5	+0.5	—	+1.3	-0.3	90	+0.4	
Ardrossan	51.5	+0.2	+0.3	—	-0.2	-0.2	120	Uniform	
Pinnore	50.6	+0.2	+0.4	—	-0.1	+0.1	90	+0.2	
Glenlee	51.5	+0.2	+0.2	—	-0.3	0.0	140	Uniform	
Leith	50.0	+0.1	+0.4	—	+0.1	-0.6	50	Do.	
Marchmont	51.0	-0.2	-0.2	—	0.0	0.0	225	+0.5	
Ochertyre	49.0	0.0	0.0	—	+0.6	0.0	130	Uniform	

As requested by the Office, the minimum thermometers were very specially examined, and only at Stornoway was this instrument found out of order. The quantity which was lodged in the top of the tube directly under the clamp was only 0°.2. This was rectified in presence

of the observer, who was at the same time instructed how to put it right if it should in future get out of order.

Neither the maximum nor minimum thermometer at Dunrossness is etched on the stem. As regards the minimum thermometer, the fiducial points 32° , 62° , and 92° are only very slightly above the corresponding points of the attached scale, certainly not more than two-tenths. The large error of this thermometer, about a degree, is therefore due to a faulty construction, or to some change in the mass of the fluid, or internal capacity of the tube since its graduation. Both this station and Nairn should be supplied with new minimum thermometers. At Nairn the practice has been to subtract a degree from each reading of the minimum thermometer, whereas at Dunrossness, where the error is equally great, the readings are telegraphed as made.

HYGROMETERS.

Again on this inspection, the dry and wet bulbs were read instantly on opening the thermometer screens, and in all cases the arrangements for correct hygrometric observations were satisfactory.

NOTES ON THE STATIONS.

Fort William, August 6, 1889.—The instruments were all in good order and observed correctly and with care.

This is the low-level station at which observations have been made five times daily by Mr. Livingstone since the opening of the Ben Nevis Observatory in 1883.

The building of the low-level observatory was in progress, and it was expected that it would be finished about the end of October. A delay of from three to four weeks has been occasioned by the drought of last summer, owing to which the stones brought from Elgin could not be conveyed through the Caledonian Canal, but had to be taken round Cape Wrath to Fort William.

Fort Augustus, August 7.—The instruments were in excellent order and observed with great care and intelligence. The one or two omissions of observations, which recently occurred were occasioned by the new official duties of Father Martin. In future all the observations will be taken by the new observer, Father Cody. A new sunshine recorder has been erected in an excellent position.

Glencarron, August 9.—Everything, including the Richard thermograph and barograph, were in excellent order, and well read and attended to. A new sunshine recorder has been erected, constructed for the latitude, and with the usual three stages. The house of Glencarron shelters the instrument from the sun before setting behind the hills about midwinter; and during the summer months the sun sets behind the hills about 6 p.m.; but the exact times will be observed in the course of the year.

Stornoway, August 12.—As the clamp of the minimum thermometer is just over the top of the tube, any evaporated spirit lodged here cannot be seen. A gas flame was applied to it and the result showed that two-tenths had been evaporated. All the other instruments were in good order, and very well observed.

A misunderstanding on the part of Mr. Forbes had seriously limited the number of cases of variations of pressure inserted in his daily telegraphic reports. He now quite understands what is wanted and how to handle the aneroidogram, so that his daily report will show the more

marked changes of pressure, and the non-instrumental phenomena of storms, for which the help of his assistants and others will be enlisted.

Swanbister, August 14.—The instruments were all in the best order, and very accurately observed.

Dunrossness, August 17–19.—Everything was in excellent order, and the observations are made with great care and accuracy. Neither the maximum nor the minimum thermometer has its stem engraved. As regards the minimum, which reads nearly a degree too low, the three fiducial scratches on the stem are each about $0^{\circ}\cdot 2$ above these readings; the instrument has therefore been in error from the beginning.

Wick, August 20.—The instruments were in very good order, and the observations taken by both observers with accuracy and despatch. The rain-gauge had been recently repaired and is now in good order.

Lairg, August 21.—The instruments were removed in May from their old positions to the house and garden of the new observer, Mr. Young, of the public schools. The new positions are very good. A new rain-gauge and supports for the thermometer screen are required, which will shortly be supplied, otherwise the instruments were in good order and are well observed. The height of the new station is 335 feet.

Nairn, August 22.—The instruments were in excellent order, and the observations well taken by all the observers.

Aberdeen, August 24.—All the instruments were in very good order and are well observed.

Braemar, August 27.—The instruments are well kept and observed. Since, however, they have been in use for the long period of 33 years, it is desirable that some changes and repairs be made, which are now being attended to.

Dundee, August 28.—The instruments continue to be thoroughly well kept, and the observations carefully and correctly made.

Ardrossan, September 30.—The Stevenson screen required pretty extensive repairs and repainting, which were ordered to be done. The rain-gauge has been repaired, but is not quite firmly fixed, this was to be done on the following day. Otherwise the instruments were in good order, and very intelligently observed. On the two days when the wet bulb was found to be dry, the cup of the hygrometer had been upset. The observer was told what to do should this recur. As Mr. Mayes is now settled in Ardrossan, satisfactory arrangements will shortly be made for making the 10 p.m. observation. The new assistant read the instruments correctly, and made up the telegram also correctly.

Pinmore, October 1.—The instruments were all in excellent order, and are very carefully observed. As explained in previous reports, this station is situated in a rather deep valley, only from 150 to 300 yards in breadth, and virtually shut in on all sides. The instruments are in an open position in the garden, but all round there is much fine old wood. Thus the prevalent calms are a striking feature of this limited district, as also are the rapid fall of temperature in the early evening and the rather frequent frosts.

Glenlee, October 2.—The instruments were in particularly good order, and are observed with much care and intelligence.

Leith, October 10.—The supports of the thermometer screen and the enclosure for the instruments require to be repaired and repainted, and orders were given to have this done. Otherwise the instruments were in very good order, and the observations are made with much care and intelligence.

Marchmont, October 11-12.—All the instruments were in particularly good order, and the observations are made with intelligence and accuracy. The following additional instruments are at this station:—Maximum and minimum black bulbs; a minimum thermometer suspended outside the thermometer screen; three underground thermometers; a second rain-gauge, 12 inches square, with its rim 15 inches high; a glycerine sunshine recorder, designed by Mr. Loney, and an aneroidograph.

Ochertyre, October 17.—All the instruments were in singularly good order, and observed with great care and intelligence. The following additional instruments are at this station:—A complete set of duplicates of thermometers and rain-gauge; three underground thermometers at depths of 3, 12, and 22 inches; maximum and minimum exposed thermometers.

(Signed) ALEXANDER BUCHAN.

REPORT of INSPECTION of the ENGLISH STATIONS, 1889.

TELEGRAPHIC REPORTING STATIONS.

Dungeness, inspected June 7.—There appears to be some improvement in the observations taken at this station, but the wet-bulb thermometer was dirty and the bulb itself much crusted with lime. I found, by testing, that the water used on the day of my visit was hard. There is a rather large difference between the corrected readings of the reporting and check barometers, but the first-named instrument is correct. I question whether the lowness of the barometric readings, as frequently reported from this station, is due to carelessness on the part of the observers. As regards the low temperatures sometimes reported from Dungeness, I adhere to my opinion that these are correct, and are principally due to the character of the soil. The Dungeness temperatures give a very inadequate idea of the climatology of the neighbouring coast. The exposure of the station is, however, excellent.

Jersey (St. Aubin's), June 9.—The reports from this station continue to be very good. The situation of the sunshine recorder was at the time of my visit not very satisfactory. The instrument was sheltered in early morning and late evening in summer; and the extreme steepness of the slope on the summit of which it was situated, rendered it necessary for the observer to employ a substitute to attend to the instrument. I subsequently received a letter from Mr. Fisher, suggesting a new site, half-way between St. Aubin's and St. Brelade's, at the summit of the hill leading down into the latter village, where the exposure would be perfect, in the garden of a lady who promised to take charge of the instrument. After some correspondence, a personal friend in whose skill in such matters I have full confidence, the Rev. H. W. P. Yorke, of St. Helier's, removed the instrument to the new situation on November 20th.

I notice that, as anticipated, the summer maxima are higher than those reported when the thermometers were at Noirmont.

Hurst Point, June 12.—The instruments at this station were in good order. The thermometer screen much needed repairs and repainting, which has since been done. The observer still continues every now and then to make inaccurate reports.

Scilly (St. Mary's), June 15 and 16.—The observer, Mr. Thomas, was somewhat ill and unequal to taking accurate observations at the

date of my visit. I gave careful instructions to the observer's son (who frequently attends to the observations), as to reports of changes of pressure indicated by the self-recording aneroid, a matter of some importance at this station. Mr. A. Hicks continues to be at any time ready to assist in or to conduct the observations.

A new block was needed for the rain-gauge and was ordered.

The anemometer was in as good working order as usual, giving occasionally blurred anemographs, owing to the saltiness of the water particles in the atmosphere. One of the clock wheels required much rubbing with emery, and needs more frequent lubricating. This I attended to.

Prawle Point, June 18.—The observations at this station, for which Mr. Mehegan seems to be almost entirely responsible, are very accurate, and are carefully reported. The minimum, No. 307, again contained exactly $0^{\circ}\cdot9$ of detached spirit, a defect which had only recently recurred and for which the observer had applied a correction. By refrigerating the bulb and applying strong heat to the other end of the tube, I rectified the defect for the time.

Spurn Head, July 12.—The instruments at this excellent station are in good order, and the new lightkeeper appears to attend to them carefully, and to read them with accuracy. The station would be as faultless a one as could be found on our coasts, were it not for the drifting of the dry sand around the outdoor instruments.

Barrow-in-Furness, July 19.—Mr. Whitworth was absent from home on the day of my visit. The thermometers were in good order, but the wet-bulb was not clean. I only succeeded in expelling an exceedingly small bubble of air from the barometer tube. This tube has been since refilled and has been employed again since August 1st. A new rain-gauge had been substituted for the old one previously to my visit. The instrument is a good one and has a fair exposure. As regards the winds felt at this station, I may be permitted to refer back to previous inspection reports.

North Shields, July 24.—The barometers were in good order. They will probably have to be removed from their present site in the course of the coming winter, as new post office buildings are being erected. I have given full instructions as to their removal.

Dockwray Square is now open to the public, and is much employed for tennis. Children frequently meddle with the rain-gauge and have already injured it. The observer, Mr. J. Irvine, recommends that the outdoor instruments should be shifted towards the south-west corner of the Square, where they will be at a much safer distance from the entrance gate. I would suggest that the gauge should be surrounded by an iron fence, similar to that employed at York and some other places. Except this Square there appears to be no place in the immediate neighbourhood available for the outdoor observations.

York, July 26.—The barometer No. 156, employed as the reporting instrument at this station was last year supposed to be out of order, and No. 138 was sent down for employment either instead of, or to check, the readings of the former instrument. The observer reported No. 138 to be also out of order. I found both 156 and 138 to be in perfect order. I recommend that the old barometer should be retained as a reporting barometer, and No. 138 as a check for the present; but it will perhaps be better that No. 138 should eventually be used as the reporting instrument.

Yarmouth, September 18.—The observations taken at this station continue to be in all respects satisfactory, and I found all the instruments in good order.

Cambridge, September 18.—The instruments were all in good order. The low wind velocities characteristic of this station are, in all probability, as I have previously mentioned, the result, to a great extent, of the wooded character of the country round Cambridge.

Oxford, September 19.—The reports from this station are very good, and I found all the instruments in a satisfactory condition. There is a slight deposit on the wet-bulb.

Loughborough, September 27.—The observer had to leave his house on business almost immediately after my arrival, and I therefore could not on this occasion compare his readings of the instruments with my own. The standard barometer having been conveyed in a warm railway carriage and omnibus, had a much higher temperature when suspended than the reporting barometer at the station. I had also to suspend the former out of doors, not finding a place which I liked to avail myself of within the house, and the sun shone occasionally on part of the instrument. At the time of comparison the attached thermometer of the standard read $3^{\circ}9$ higher than that of the reporting barometer. Correcting to equivalent temperatures the standard read 0.021 in. above the observer's instrument, but as I do not consider the comparison satisfactory I have entered no figure in the table. All the other instruments were in good order, and no observer could be more punctual and painstaking than Mr. Berridge. The thermometer corrections are not in accordance with my expectations.

The following, which are not Telegraph Reporting Stations, were inspected by me this year.

Eastbourne, June 8.—The observations at this station are good, and I found all the instruments to be in excellent order. The sunshine recorder has been raised 1 foot and erected on the middle of the turret (instead of on one side) upon a substantial pedestal. The observer undertook to send the readings of the solar radiation thermometer on overcast days, which had not hitherto been done. The station, which is in the hands of the Town Council, seems likely to be permanently maintained.

Plymouth, June 13.—Dr. Merrifield was absent at the time of my visit. The instruments were in good order. The rain-gauge occupies a much better site than that which it had at the Navigation School. The sunshine recorder had a very fair, but not absolutely perfect, exposure. It required a trifling adjustment. The old screen is in use, and is a wall screen. The observations appear to be carefully conducted.

Prestwich, July 13.—Dr. Clunn, who superintends the observations for this station, was much engaged at the time of my visit, and the observer who usually takes the readings was absent. The returns from this station unfortunately continue to be greatly in arrear. The barometer is correct. The outdoor instruments are excellently situated. The thermometers were compared in 1878 in melting ice, and the corrections then obtained were assumed to vary as the old Kew corrections throughout the scale, but at 55° the 1878 corrections are (if my comparisons this year were correct) inapplicable.

Isle of Man (Cronkbourne), July 21.—Mr. Moore was absent at the time of my visit. His deputy takes the observations with great accuracy. The instruments were in excellent order, with the exception of the grass minimum, the tube of which contained $2^{\circ}7$ of detached

spirit, which I restored. Mr. Murphy had applied an additive correction of 2° since noticing the defect. The returns from this station are good.

Isle of Man (Douglas, Prospect Hill), July 22.—Since my inspection of this station in 1887 all the outdoor instruments have been moved to a new site about 70 yards from their former position, but on the same level. The ground now occupied by them affords an improved, though not absolutely perfect, exposure. The barometer is not a reliable instrument. It had at the time of my visit a considerable error, but I re-adjusted the tube on the scale so that it read correctly when I left the station. The thermometers were in good order; and the returns appear to be carefully attended to.

Newton Reigny, July 22.—This is a most excellent station. All the instruments were in admirable order, and the returns are very complete and accurate. The sunshine recorder has an almost perfect exposure. Mr. Benn and his assistant are most careful in the attention bestowed on the observatory.

Seaham, July 25th.—The instruments at this station were found to be in good order, except that there was a considerable deposit on the wet bulb, the muslin of which requires to be very frequently changed. The corrections of the dry and wet-bulb thermometers, as determined by me this year, differ from those obtained in previous years, but the old corrections may advantageously be retained for the present. A new door was required for the screen, which also needed to be re-painted. Mr. Aird had the repairs attended to directly after my visit. The returns from this station are satisfactory.

Durham, July 25.—I found all the instruments at the observatory in very good order, except the grass minimum, which contained $1^{\circ}\cdot3$ of detached spirit. A correction of this value has been in use. The returns from Durham are good and complete.

York, July 25 and 26.—The thermometers were in good order. The returns from the station are fairly good. I do not, however, consider the observer to be entirely trustworthy as regards punctuality and accuracy.

The sunshine recorder is still kept at the Friends School, Bootham. There is some little difficulty in getting it well and punctually attended to during the vacations, but the records are on the whole satisfactory. Mr. R. Thompson expressed his willingness to take the instrument into his own charge at his new residence (Dringcote), should the change be considered desirable. The question may, I think, be deferred till next inspection.

Oswald Kirk.—The sunshine recorder at this place is the property of Mr. R. Thompson. It is well attended to, but the exposure is not quite perfect.

Epsom, September 17.—It being still vacation at the Royal Medical College, the observer was absent. His substitute appeared to require a little instruction in reading the barometer. The instruments were in good order. Errors of reading and reduction are still noticeable in the returns from this not unimportant station. The barometer, when the correction for index error has been employed, reads $\cdot009$ too low.

Rugby, December 9.—The returns from this station are still of little value, as the a.m. readings of the barometer are not punctually taken, and the outdoor observations are left to Mr. Kirk, the gardener, whose observations of wind and cloud appear to me of no value. He reads the thermometers well; and all the instruments (except the rain-gauge,

which is nearly worn out) are in excellent order. The barometer is inconveniently situated. I have advised that the rain-gauge be shifted to the south-east of its present position (where it is slightly sheltered), and be repaired. I have but little hope that the returns from this station can, at least for some years to come, be usefully employed, as the school arrangements interfere with the punctual performance of the meteorological work.

Sutton Coldfield, December 31.—The returns from this station have been until lately considerably in arrear, but there is, I think, every prospect of their now being punctually attended to. There has been some falling off in punctuality since Mr. Fletcher left the station. However, Mr. Marston, the new observer, promised me to pay full attention to the work. His assistant, Mr. J. H. Smythe, read the instruments with great accuracy. The Jordan's sunshine recorder is on the south corner of the roof of the municipal buildings; it has an admirable exposure, but the time-lines do not seem correctly printed. Barometer is a Fortin by Bailey of Birmingham. It is certified as having a very small error, but at 29.80 it read .005 lower than my standard. The outdoor instruments were situated in Mr. Fletcher's garden, where the position is very good. Mr. Marston informed me that they would shortly have to be moved into his own garden, where the position is by no means so well exposed. The removal actually took place, as I am informed, on January 6th. The observer promised to have the screen, which has hitherto been of a green colour, painted white on the date of its removal.

The following table gives the results of the comparisons made by me in 1889, and contains its own explanation. The barometer employed by me as a standard up to July 24th was the contracted Adie No. 216. The tube up to the time of its unfortunate breakage at Newcastle remained free from air. After that date I employed as a standard the uncontracted Adie No. 590, which has also kept in excellent order. The results of the thermometric comparisons may be, I think, regarded as fairly satisfactory. The rain-gauges were all found in good order except in those cases mentioned in this report. The same remark may be made of the sunshine recorders. But to these latter instruments I intend to devote a separate and minute investigation in the course of the present year. At one station only of those this year inspected was the barometer tube found to contain air. In three only was the thread of spirit in the minimum thermometer found to be broken, and in none of these had the defect escaped the observer's attention. Care as regards the cleanliness of the wet-bulb and accuracy in reading thermometers to the tenth of a degree, show an unmistakable improvement.

NAME OF STATION. (The Names of the Telegraphic Reporting Stations are in <i>Italics</i> .)	BAROMETER.			THERMOMETER.										General Condition.
	Difference of Reporting meter.	Difference of Check from Inspector's Barometer.	Difference of Observer's Readings.	Temperature of Water.		DRY BULB.		WET BULB.		MAXIMUM.		MINIMUM.		SPARE.
<i>Barrow</i>	-.011	+.002	-.001	60.1	-0.8	-0.4	-0.3	-0.8	-0.1	-0.1	0.0	-0.1	-	-
<i>Cambridge</i>	+.002	-.017	+.003	57.0	-0.4	-	-0.3	-	-0.8	-	0.0	-	-	-
<i>Dunagess</i>	-.000	-.005	-.002	64.8	-0.1	-	-0.0	-	0.0	-	-0.1	-	-	-
<i>Hurst Point</i>	-.001	-.001	-.000	59.7	-0.3	-	-0.5	-	0.0	-	-0.2	-	-	-
<i>Jersey</i>	-.008	-.001	-.000	62.2	-0.3	-	-0.4	-	-0.1	-	-0.05	-	-	-
<i>Loughborough</i>	-.028	-	-.001	57.4	-0.45	-0.4*	-	-0.4*	+0.5	-0.7*	+0.2	-0.2	+0.6	-
<i>Oxford</i>	-.001	+.005	-.000	55.0	-0.05	-	-0.0	-	-0.1	-	0.0	-	-	-
<i>Pringle Point</i>	+.002	-.001	-.002	56.4	-0.1	-	-0.0	-	-0.6	-	+0.1	-	-	-
<i>Selly</i>	+.008	-.001	-.000	57.6	-0.1	-	-0.3	-	0.0	-	+0.2	-	-	-
<i>Shields</i>	+.004	+.005	+.001	61.6	-0.2	-	-0.6	-	+0.2	-	+0.2	-	-	-
<i>Spurn Head</i>	+.003	-.003	-.002	57.2	+0.2	-	-0.1	-	-0.3	-	-0.1	-	-	-
<i>Yarmouth</i>	-.010	-.002	-.001	56.6	-0.1	-	-0.1	-	-0.4	-	+0.1	-	-	-
<i>York</i>	-.013	-.002	-.001	56.6	-0.1	-	-0.1	-	-	-	+0.7	-	-	-
<i>Cronkbourne</i>	-.000	-	-.002	60.0	-0.3	-	-0.4	-	0.0	-	0.0	-	+0.1	A
<i>Durham</i>	+.008	-	-	55.0	0.0	0.0	0.0	0.0	0.0	+0.1	+0.7	+0.5	+1.3	A
<i>Eastbourne</i>	+.002	-	+.000	60.1	+0.65	0.0	+0.1	0.0	+0.05	-0.1	+0.1	0.0	-0.4	A
<i>Epsom</i>	-.009	-	-.009	53.2	-0.2	-0.3	+0.1	-	+0.2	-0.3	0.0	-	-	B
<i>Newton Reigny</i>	-.004	-	-.000	55.3	-0.2	-0.3	-0.3	-0.4	-0.1	-0.3	+0.2	0.0	+0.4	A
<i>Plymouth</i>	-.035	-	-	62.3	-0.2	-0.3	-0.1	-0.2	-0.5	-	+0.6	-	0.0	A
<i>Prestwich</i>	-.002	-	+.002	61.1	-0.1	-0.3	0.0	-0.2	-0.1	-0.5	+0.1	-0.2	+0.3	A
<i>Prospect Hill (Douglas)</i>	-.000	-	+.000	60.0	0.0	0.0	+0.65	0.0	-0.2	-0.3	+0.1	-0.1	-0.6	B
<i>Rugby</i>	-.066	-	-.004	43.2	0.0	0.0	0.0	0.0	-0.25	-	+0.3	-	0.0	C
<i>Seabam</i>	-.003	-	+.000	61.4	-0.5	0.0	-0.4	0.0	+0.4	+0.5	+0.4	+0.5	-	A
<i>Sutton Coldfield</i>	-.001	-	+.001	30.6	-0.1	-	-0.2	-0.1	+0.3	0.0	+0.02	0.0	-	A
<i>York</i>	-.013	-.002	-.001	56.6	-0.1	-	-0.1	-	-	-	+0.7	-	-	B

* NOTE.—Mr. Stone has retested the thermometers and finds that their previous corrections continue to apply, and that his readings are sensibly correct.

FISHERY BAROMETER STATIONS.

At the desire of the Secretary, I visited a few Fishery Barometer Stations this year.

On June 10th I visited the harbour-master at *Gorey*, Jersey, in hopes that the thick and rough weather prevailing might enable me to get together an audience of fishermen. In this I was unsuccessful, perhaps on account of the heavy rain. The number of fishing boats now kept at this station is very small, and is rapidly decreasing. The fishery barometer reads low, but contains no air.

I convened a meeting of fishermen on the morning of Saturday, July 20th, at *Port St. Mary*, Isle of Man. The weather was all that could be desired, being thick and wet with an E.S.E. wind. I lectured for about 80 minutes to about 30 men, many of whom, especially the younger, appeared very attentive. Mr. Luatrough, the harbour-master, gave me every assistance. The fishery barometer at this station read 29·720 at 60°·2, while my standard read 29·710 at 60°·5. The fishery barometer is well placed, and the tube is free from air.

On the same day in the afternoon I gave a lecture to about 30 men in the Sailors' Rest at Peel. The men were most attentive; some of the older men held peculiar tenets as to the action of the barometer. The weather was most propitious, enabling me to foretell as probable the strong N.W. breeze which burst over the island the following afternoon. The fishery barometer is well situated on the pier close to the Sailors' Rest, and a few yards from the harbour-master's offices. The instrument (184) read 29·605 at 64°·9. The standard suspended by me within the building at the same elevation read 29·608 (corrected for index error) at 65°·5. The Kew certificate gives ·000 as index error for No. 184.

The case of the cistern of the fishery barometer is much coated with rust externally.

I am of opinion that a short manual or guide to the use of the fishery barometer, containing knowledge brought up to date, expressed in language suitable to the attainments of our fishermen, would form a useful treatise, and be fully appreciated by the majority of those for whom it would be intended.

(Signed) W. CLEMENT LEY.

REPORT ON INSPECTIONS of the SELF-RECORDING OBSERVATORIES and ANEMOGRAPH STATIONS.

The *Valencia Observatory* was visited from July 29th to August 2nd. The instruments were all inspected and found in good order, the clocks of the barograph and thermograph being cleaned and the light shutters re-adjusted. The anemograph required painting externally, which would be done after inspection, and the direction shaft inside the observatory was loose at some of the joints. It was tightened up, and new pins put in to make it fast. A slight want of repair in the thermograph screen was pointed out to Mr. Cullum.

The mercury in the Beckley gauge was taken out, cleaned, and replaced, with the addition of a quantity of fresh metal to supply a certain amount which had been lost.

The usual comparisons of the thermograph thermometers with the observer's standard, K.O. 682, were made with the following results:—

Dry, No. 399, correction at 60°	-	-	-	0·6
Wet, „ 398, „	-	-	-	-0·5
Max., „ 1003, „	-	-	-	0·0
Min., „ 2497, „	-	-	-	-0·2

The *Armagh Observatory* was visited from August 5 to August 7. In the absence of Dr. Dreyer, the director, I was received by the Rev. E. Faris, who was in charge.

The anemograph was found to be much choked and corroded with bad oil, which has been employed for its lubrication; this, however, was removed, and the bearings cleaned. Unfortunately, the new sperm oil purchased by the Meteorological Office for the especial purpose of anemometer oiling had not arrived at the time of my visit, and I was compelled to make use again of the unsatisfactory lubricant in the absence of better.

The Beckley rain-gauge was cleaned, the mercury filtered, and the lifter re-adjusted, all being in satisfactory condition.

Falmouth Observatory, visited August 10 to 15. On examination I found the anemograph, barograph, rain-gauge, and thermograph all in first-rate order, and merely requiring the usual cleaning and oiling, which operations were duly performed.

The thermometers were compared with my standard, and the corrections found to be as follows:—

Dry, No. 383, correction at 63°	-	-	-	0.5
Wet, „ 388, „	-	-	-	-0.4
Max., „ 104, „	-	-	-	-0.5
Min., „ 308, „	-	-	-	0.0

The thermometer attached to the standard barometer still requires a correction of $-0^{\circ} \cdot 7$; this, however, is never applied to its readings, the observers not having received official instruction to do so.

The anemograph at the *Holyhead* pier-head was inspected whilst a gale was blowing on July 24, and therefore was not dismantled.

It was found to be in very good order both inside and outside, all the bearings appearing to be well oiled and quite free. The pins of the connecting shafts were, however, nearly shaken out and had to be driven home tight. I called the attention of Mr. Hugh Williams to them in order that they may be watched in case they should loosen again.

The *Phoenix Park* anemograph, visited July 25, was found working well and in excellent order. The vane bearing, however, has been running in glycerine instead of oil, and this, by absorbing water freely, causes a constant dripping of greasy matter on the curves, which produces a disfigurement.

I suggested the suspension in future of a small zinc cup beneath the bearing in a position to catch the drops.

(Signed) G. M. WHIPPLE.

(M.O. 1951.)

DEAR SIR;

Kew Observatory,
October 1889

I HAVE the honour to hand you herewith my report and inspection notes regarding the self-registering instruments at the following observatories, Stonyhurst, Glasgow, and Aberdeen, and also the anemograph station at Fleetwood.

(Signed) T. W. BAKER.

To R. H. Scott, Esq., F.R.S.

Stonyhurst, visited September 17-18.—Here all the instruments were working satisfactorily.

The thermograph and barograph had their clocks, lenses, and fittings cleaned, after which the various thermometers were compared at 55° by means of Kew Standard No. 682, and the following corrections determined :—

Dry, Standard 619	-	-	-	-	-	-0.1
Wet, „ 382	-	-	-	-	-	-0.3
Maximum, M.O. 439	-	-	-	-	-	-0.3
Minimum, M.O. 501	-	-	-	-	-	+0.1

The anemometer was entirely dismantled, and although found in excellent condition the different parts were cleaned, and fresh oil applied to all the bearings. Afterwards the orientation was tested and found correct.

Mr. Carlisle informed me that the barometer now in use for the control observations is not very satisfactory, the residual corrections varying considerably according as to whether the mercury is rising or falling.

The sunshine recorder is fixed to a stone balustrade about 4 feet above the roof of the magnetic chamber, and is properly adjusted both as regards time and level. A shadow, however, is cast upon it for a few minutes at 2 p.m. during a part of December by the finial ornament fixed on top of a summer house about 30 yards distant south-west, otherwise the exposure is good all the year round.

Glasgow, visited September 20–21.—According to the usual practice the thermograph and barograph clocks were cleaned as well as the other instrumental parts. Cardboard shields were fitted to the thermograph lenses in order to keep reflected light from discolouring the photographic sheets.

The zero lines were changed to the winter position, and the various thermometers compared and found to require the following corrections at 50° :—

Dry, Standard 550	-	-	-	-	-	-0.1
Wet, „ 472	-	-	-	-	-	-0.4
Maximum, 58,846	-	-	-	-	-	+0.1
Minimum, 63,942	-	-	-	-	-	-0.1

The grass minimum (59003) read low by $0^{\circ} \cdot 6$, but this was owing to a small quantity of spirit which had become detached from the main column and lodged in the upper portion of the tube. After putting the instrument in order the correction was found to be $+0^{\circ} \cdot 1$.

The barograph thermometer requires a correction of $-0^{\circ} \cdot 8$, and the attached thermometer to the standard barometer $-0^{\circ} \cdot 5$.

As regards the anemometer, the instrument was completely dismantled and cleaned, and fresh oil applied to all its bearings. The clock was also examined and a new line attached.

The orientation was then tested and the sheet containing the result accompanies this report.

New lines were attached to the rain-gauge clock and the usual cleaning performed.

The sunshine recorder is very well placed on the roof of the observatory, and has a good exposure all the year round. It is also properly adjusted for the time and level, but the surface of the glass sphere is somewhat corroded, though it does not appear sufficient to diffuse the light to such an extent as to blur the solar image on the card.

Aberdeen, September 24-27.—The various instruments at this observatory were in very good order.

My special attention having been called to the stray light which at times was very marked on the thermograph sheets, I dismantled both the dry and wet thermograph tubes and applied several coatings of lamp black mixed with varnish to each tube, after which cardboard shields were fitted to both lenses, and subsequent curves seem to show that the light has been now effectually excluded.

Both the barograph and thermograph clocks as well as the lenses, &c. were cleaned.

The barograph mahogany case did not fit very well, having become slightly warped; this I had put right.

According to instructions the thermometers were tested in pounded ice, and the following corrections were determined at 32°:—

Dry, Standard 397	-	-	-	-	-	-0·1
Wet, „ 395	-	-	-	-	-	-0·6
Maximum, 1,002	-	-	-	-	-	0·0
Minimum, 5,056	-	-	-	-	-	0·0
Attached thermometer (to Standard barometer) No.						
K.O. 71,061	-	-	-	-	-	-0·3
Barograph thermometer (no number)	-	-	-	-	-	-2·0

The external portions of the anemometer were dismantled, and all parts cleaned and fresh oil applied, but the clock and recording apparatus only required oiling. Afterwards the orientation was examined and found satisfactory.

“Squeezes” were taken of both the self-registering and spare rain-gauges.

The Beckley gauge was in excellent order, as well as the clock.

Fleetwood, October 1-2.—On dismantling the anemograph at this station it was found that the oil in the direction bearing had become very thick and hard, but in the velocity bearing it was in a much better condition. The instrument was thoroughly overhauled, and all parts cleaned and fresh oil applied. After remounting it was oriented.

The clock was taken to pieces and cleaned and new lines attached.

(Signed) T. W. BAKER.

APPENDIX VIII.

METHOD of DEALING with TELEGRAPHIC WEATHER INTELLIGENCE.

THE operations connected with the preparation and issue of the Forecasts and Storm Warnings have not undergone any material change. The Daily Weather Report also has not been altered during the year.

The Office receives, when the telegraphic communications are perfect, fifty-eight* reports every morning, seventeen every afternoon (except

* The Reports from Barrow-in-Furness have ceased.

on Sundays), and twenty-nine each evening, the arrangement of which is explained in the reports for recent years.

At the British and Irish stations the morning observations are taken at 8 a.m. Greenwich time, and most of the telegrams arrive in London at about 9 o'clock, when the Intelligence Department of the Post Office extracts from them the portions required for its wind and weather reports. They are then transmitted to the Meteorological Office by its private wire.

DAILY WEATHER REPORT.

No important change has been made during the past year in the form of the Daily Weather Report, a detailed description of which is given in the Annual Report for 1887. The Report still fills four large quarto pages, and contains on page 1 the whole of the 58 reports from which the maps for the day (given on page 2) are prepared, and the 6 p.m. reports of the previous day, together with the maximum and minimum temperatures of the air, and the rainfall for the previous 24 hours.

On page 2 are two maps, showing (1) for 8 a.m. the distribution of pressure, the prevalent winds, and the sea disturbance, with necessary explanations; (2) the distribution of temperature at 8 a.m., the weather at each station, and the distribution of rainfall during the past 24 hours. Tables are added, giving the means of pressure, temperature, and rainfall as heretofore.

Page 3 contains (1) notes on the "General situation at 8 a.m.," and the "Probable changes in system now prevalent;" and (2) the forecasts drawn up for each district at 11 a.m., relating to the weather likely to be experienced during the 24 hours ending at noon on the day succeeding that of publication, and an explanation of the meaning of the storm signals exhibited on our coasts.

Page 4 contains the observations made at 2 p.m. on the previous day, and "General Remarks on the Weather over Europe during the past 24 hours."

The standing portion of the report (maps, &c.) is printed in blue, while the information for each day is in black.

The subscription for the Report is —

<i>For delivery by hand, where feasible,</i>	<i>£2 per annum;</i>
<i>Do. by book post</i>	<i>£1 „</i>

MS. copies of the observations and remarks can be supplied at the rate of 2*l.* 10*s.* per annum. Arrangements can also be made for the supply of charts drawn from the 8h. a.m. or 6h. p.m. observations, such as appear in the "Times."

Correction and Addition List.

The following additional steps are taken to insure accuracy in the Daily Weather Report. Monthly returns are received, from nearly all of the telegraphic reporting stations, of all the observations which have been transmitted to London by wire. These are used for checking the daily telegrams, for the preparation of the average and other values of the different elements, and also as evidence in the case of legal proceedings. A lithographed sheet is then issued with the Daily Weather Report, containing corrections for all discrepancies which have been discovered, and supplying any observations which have been omitted in the daily reports.

WEEKLY WEATHER REPORT.

The Weekly Weather Report, which has appeared since February 1878, was rearranged at the commencement of 1890, and is now prepared for the conventional week, Sunday to Saturday, in order to bring it into agreement with other weekly publications. This enables it to be published on Thursdays instead of Saturdays. The three daily synchronous maps which it contains have also been greatly improved, the standing portion (showing the outline of the land and sea) being printed in blue, while the information on them is in black. These maps show (1) for 8 a.m., the temperature, weather, and sea disturbance; and (2) for 8 a.m. and 6 p.m., the distribution of pressure and the winds, over and on the coasts of Europe.

The Summary on the first page contains the average and extreme temperatures, the rainfall values, and the total amount of bright sunshine in each week for twelve districts in Great Britain and Ireland, together with the difference between them and the respective mean values for the corresponding week in previous years. The district values for Accumulated Temperature, Rainfall, and Bright Sunshine are also given, both for the week and for the whole period since the beginning of the year, with their differences from the average values. This information is derived from observations made at 76 stations, the individual values for which are now given on the second page of the Report.

The tables of Accumulated Temperature are designed to give persons engaged in agriculture better means of estimating the manner in which vegetation is affected by temperature than that afforded by the more usual methods of treating the readings of the thermometer. They show for each week, and for the whole period from the beginning of the year, the weekly and progressive values respectively, of the combined amount and duration of the excess or defect of the air temperature, above or below a suitably fixed standard or *base temperature*. The base adopted is 42° F., as being nearly equivalent to 6° Cent. which has been considered by continental writers on these subjects to be the critical value, the temperature above which is mainly effectual in starting and maintaining the growth, and in completing the ripening of agricultural crops in a European climate. This base is also convenient as being 10° F. above the freezing point.

Accumulated Temperature is expressed in Day-degrees; a Day degree signifying 1° F. of excess or defect of temperature above or below 42° F. continued for 24 hours, or any other number of degrees for an inversely proportional number of hours.

An explanation of these rules will be found in the last Annual Report, and full details as to the facts on which the rules are founded are published in Appendix II. to the Quarterly Weather Report for 1878.

The temperature means, derived from the daily maxima and minima, are corrected so as to agree as closely as possible with the true mean daily value, and, the average values for the corresponding period in former years are:—

For Temperature	-	-	20 years 1861-80
„ Rainfall	-	-	20 „ 1866-85

The values for temperature, accumulated heat, rainfall, and sunshine for *each station** are given on the second page of each Report.

The Synchronous Charts referred to on page 17, with the daily Remarks thereon, occupy the third to sixth pages.

* The sunshine values are furnished for only a limited number of carefully selected stations. See p. 103.

In addition to the reports from the Telegraphic Reporting Stations, and the returns from the self-recording Observatories, weekly returns from 43 volunteer observers are used, the names of the stations and observers being as under :—

Names of Stations.	Names of Authorities.
Alnwick Castle - - -	Lieut.-Col. F. Holland, for the Duke of Northumberland, K.G.
Arlington (N. Devon) - - -	J. Carter, for Lady Chichester.
Bawtry (Hesley Hall) - - -	B. I. Whitaker, J.P., F.R. Met. Soc.
Blackpool - - - <i>MS</i>	J. Wolstenholme.
Braemar - - - <i>S</i>	J. A. Aitken, J.P.
Brookeborough - - -	Mr. Ferguson, for Sir Victor Brooke, Bt., F.L.S.
Cheadle - - - <i>MS</i>	J. C. Philips.
Churchstoke - - - <i>MS</i>	P. Wright, F.C.S., F.R. Met. Soc.
Cirencester - - -	The Royal Agricultural College.
Cullompton - - - <i>MS</i>	T. Turner, J.P., F.R. Met. Soc.
Douglas (Isle of Man) - - -	A. W. Moore, M.A., J.P.
Dublin - - -	J. W. Moore, M.D., F.R. Met. Soc.
Durham Observatory - - -	H. J. Carpenter.
Edgeworthstown (Currygrane) - - -	J. M. Wilson, J.P.
Fort Augustus - - - <i>S</i>	Rev. E. G. Cody.
Foynes - - -	W. Ward, for Lord Monteagle, K.P.
Geldeston - - -	E. T. Dowson, F.R. Met. Soc.
Glen Carron - - - <i>S</i>	D. D. Munro.
Glenlee - - - <i>S</i>	G. Maxwell and W. Melville.
Hastings (St. Leonard's) - - -	H. Colborne, M.R.C.S.
Hereford - - - <i>MS</i>	T. A. Chapman, M.D.
Hillington - - - <i>MS</i>	Rev. H. E. B. Ffolkes, M.A., F.R. Met. Soc.
Ingatestone - - -	L. J. Petre, F.R. Met. Soc.
Kilkenny - - -	H. Carlton, for the Marquis of Ormonde, K.P.
Killarney - - -	The Ven. Archdeacon Wynne, F.R. Met. Soc.
Lairg - - - <i>S</i>	J. Young, Ground Officer.
Laudale (Loch Sunart) - - -	A. Fletcher, for T. H. G. Newton, M.A., F.R. Met. Soc.
Llandovery - - -	J. Watkins, F.R. Met. Soc.
Llandudno - - - <i>MS</i>	J. Nicol, M.D., F.R. Met. Soc.
Londonderry - - -	J. Conroy, F.R. Met. Soc.
Marchmont - - - <i>S</i>	P. Loney.
Markree Castle (Co. Sligo) - - -	A. Marth, F.R.A.S., for Colonel Cooper, F.R.A.S.
Newton Reigny (Penrith) - - -	T. G. Benn, F.R. Met. Soc.
Ochertyre - - - <i>S</i>	G. Croucher.
Oswaldkirk (sunshine only) - - -	R. Thompson.
Plymouth - - -	J. Merrifield, LL.D., F.R.A.S.
Prestwich (Manchester) - - -	T. R. H. Clunn, M.D., F.R. Met. Soc.
Rothamsted - - -	Rainfall by Sir J. B. Lawes, Bart., LL.D., F.R.S., and J. H. Gilbert, Ph.D., F.R.S.; temperature by T. Wilson, F.R. Met. Soc.
Scarborough - - - <i>MS</i>	W. Robinson.
Southampton - - -	J. T. Cook, R.E., Ordnance Survey Office.
Stowell - - - <i>MS</i>	Rev. H. J. Poole, F.R. Met. Soc.
Strathfield Turgiss - - - <i>MS</i>	Rev. C. H. Griffith.
Thurcaston (sunshine only) - - -	Rev. T. A. Preston, F.R. Met. Soc.
Waterford (Brook Lodge) - - -	C. Percival Bolton, J.P.
Westgate-on-Sea (sunshine only) - - -	J. Norman Lockyer, F.R.S.
Worksop (sunshine only) - - -	H. Mellish, J.P., F.R. Met. Soc.

The returns marked "*MS*" are supplied through the Royal Meteorological Society, those marked "*S*" are through the Scottish Meteorological Society.

The report is now prepared on Tuesday in every week, and is ready for sale on Thursday afternoon, but the summary on its first page is sent to the "Times," "Daily News," and several other papers on Tuesday evening.

Appendices.

Appendices, four in number, have appeared, similar to those for last year, with a Monthly Summary.

Monthly Summary.

The publication of the *Monthly Weather Report* has ceased, but a Supplement to the Weekly Report is issued in the form of a *Monthly Summary*, giving for each calendar month the mean and principal values for the different elements, Pressure, Temperature, Rainfall, and Sunshine, with four maps, and some brief notes as to the chief features exhibited. These have all been issued to date.

ISSUE OF FORECASTS.

Remarks on the actual state of the weather, and forecasts *for not more than one day in advance*, are prepared at the Meteorological Office as under :—

On Week Days.

- (1.) At 11 a.m. (from the morning reports), for the 24 hours ending at Noon on the day following the date of issue. These are intended especially for the early editions of the evening papers, for the clubs, and for exhibition at certain selected stations. See page 9.
- (2.) At 3.30 p.m. (from the morning and afternoon reports), for the day following that of issue. This set of forecasts is not intended for publication in newspapers, but a copy is exhibited regularly at the door of the Meteorological Office.
- (3.) At 8.30 p.m. (from the 8 a.m., 2 p.m., and 6 p.m. reports), for the day following that of issue. These are now supplied gratis to any newspaper or news agency which may apply for them, and send for them regularly. A very large number of the most important papers and news agencies avail themselves of this advantage.

The forecasts are made for the following districts :—



0. SCOTLAND, NORTH.
1. SCOTLAND, EAST.
2. ENGLAND, N.E.
3. ENGLAND, EAST.
4. MIDLAND COUNTIES.
5. ENGLAND, SOUTH.
6. SCOTLAND, WEST (with Isle of Man).
7. ENGLAND, N.W. (with North Wales).
8. ENGLAND, S.W. (with South Wales).
9. IRELAND, NORTH.
10. IRELAND, SOUTH.

The remarks and forecasts are posted at the doors of the Meteorological Office, 63, Victoria Street, S.W., on week days,* for the inspection of the public. Copies, or extracts from them, are communicated under the conditions stated below, but no information which is not substantially included in them can be supplied.

Arrangements have lately been made for exhibiting on the front of the Office, a series of boards showing in large type the state of the wind, weather, and sea disturbance at six stations, situated on our S.E., S., and S.W. coasts. The stations selected are Yarmouth, Dungeness, The Needles, Scilly, Holyhead, and Valencia Island, and the observations posted up are those for 8 a.m. and 2 p.m. daily, except on Sundays.* The information can be easily read from the road.

FORECASTS FOR SUBSCRIBERS.—Any person can be supplied with a copy of the 11 a.m. Forecasts, once on each week day,* on payment of a subscription of ten shillings per annum, or 2s. 6d. per official quarter, *or any part thereof, in addition to the cost of transmission*; the charges will therefore be, by *letter* post, 9s., by *book* post, 5s. 9d. per quarter.

The forecasts for any of the districts and for any of the hours mentioned on p. 90 can be forwarded by telegraph daily, on payment of 3d. per day for any definite period, in addition to the cost of telegraphy.

FORECASTS FOR CLUBS.—These are drawn up at 11 a.m., for all the districts, and are supplied to Clubs, for a subscription of ten shillings per annum. They are delivered free, by hand, to Clubs situated in or near Pall Mall. Special arrangements can be made for delivery at a greater distance by hand or by post.

FORECASTS FOR HAY AND CORN HARVESTS, OR FOR PUBLIC USE.—Special facilities are offered for the transmission of Forecasts for these purposes, a nominal fee of 2s. 6d. being charged for a quarter or any part thereof, in addition to the cost of the telegrams.

EXHIBITION OF TELEGRAPHIC FORECASTS AT LOCAL POST OFFICES.—The Post Office has sanctioned the exhibition of Forecasts at Local Post Offices, provided space is available, if the persons to whom they are addressed desire them to be so exhibited instead of being delivered.

Unless otherwise arranged, all forecasts transmitted by post are sent by book post, not as letters.

INQUIRIES AS TO THE WEATHER.

INQUIRIES PERSONALLY OR BY MESSENGER.—Any person applying at the Meteorological Office between 11 a.m. and 8 p.m. on week days, and between 7 p.m. and 8 p.m. on Sundays, can be supplied, in writing, with the latest information in the possession of the Office and with the latest forecast issued for any specified district, on payment of one shilling for each inquiry.

INQUIRIES BY LETTER.—Application may be made by letter, enclosing thirteen pence in stamps if the reply is to be *by post*, and one shilling in stamps, in addition to the cost of the reply (consisting of ten words, exclusive of the address) if the reply is to be *by telegraph*.

INQUIRIES BY TELEGRAPH.—Any person may obtain *by telegraph* from the Meteorological Office the latest information as to the weather

* Good Friday and Christmas Day are reckoned as Sundays.

in any district of the United Kingdom by payment of a fee of 1s. in addition to the cost of a telegram and reply to any post office. The telegram containing the inquiry must be addressed as follows:

WEATHER,
LONDON.

The payment for the reply should be for at least ten words in addition to the address.

Application may also be made for similar information to be sent either *by telegraph* or *post* on some future specified day.

CHECKING OF FORECASTS.

In order to test the accuracy of the forecasts they are compared carefully with the weather reported in the various districts on the days to which they referred, and the results of the checking for 8.30 p.m. are given in this Report (page 10).

In carrying out this comparison the portions of the forecasts which referred to wind have been carefully separated from those relating to weather. The detailed results of the comparison will be found in Appendix X., page 94.

CHECKING OF STORM WARNINGS.

The testing of the warnings is still conducted in the manner indicated in earlier reports.

In order to render the information in the possession of the Office as to the weather experienced on our coasts still more complete, the Council have, as in preceding years, made application to the various Light-house Boards, and have obtained from them the original log-books from some of the most exposed lightships and lighthouses. They would here express their cordial thanks for the co-operation so readily granted to them by these Boards.

The result of the checking for 1889 will be found on page 13.

In the course of the ensuing year improvements are to be made both in the issue and checking of these storm warnings.

APPENDIX IX.

CORRESPONDENCE with CHIEF SIGNAL OFFICE, WASHINGTON, as to
FORECASTS.

(M.O. 825.)

Signal Office,
War Department, Washington City,
April 26, 1889.

DEAR SIR,

I SHALL be very much gratified if you will kindly furnish me with certain information concerning the methods, form, and extent of weather forecasts made by the weather service under your direction. Information upon the following points is especially desired:—

First. At what hour of the day are the observations made on which weather forecasts are based.

Second. At what hour of the day are the predictions themselves issued.

Third. Are these forecasts distributed generally by telegraph, or by what means and to what extent do they reach the general public.

Fourth. Are the weather forecasts generally displayed throughout your country, or is their use limited largely to the central station.

Fifth. How long a period in advance is covered by these forecasts, and does such period count from the hour of observation or from the hour of making the forecast.

Sixth. Are daily weather maps or bulletins issued for current use, and, if so, how long after the hour of observation is it before they reach the general public.

I should be very much gratified also if you would give the benefit of your advice, based on your experience in forecasts, as to whether you believe that forecasts general in their nature best meet meteorological needs, or whether they should be sharply defined as to time, locality, and phenomena.

I should be also pleased to know whether you find it to be true or not that the greater part of the rain which falls comes rather in patches and as local showers than as general rains which cover the entire country.

Appreciating the courtesy you extend to me by giving me information on these points, and asking the great favour of an early reply,

I am, &c.

(Signed) A. W. GREELY,
Brigadier General and
Chief Signal Officer.

Mr. R. H. Scott,
Secretary of the Meteorological Committee,
116, Victoria Street, London, S.W., England.

(P.C. 1113.)

Meteorological Office,
June 1, 1889.

DEAR SIR,

IN reply to your letter of April 26, I am instructed by the Council to supply you with the following answers to the queries contained therein.

First.—The observations are made at 8h. a.m., 2h. p.m., and 6h. p.m.

NOTE.—The Postal Telegraphic offices are, generally speaking, not opened before 8h. a.m., and are closed at 8h. p.m.

Second.—Forecasts are prepared three times daily on week days, viz., at 11h. a.m., 3h. 30m. p.m., and 8h. 30m. p.m. Only those prepared at 11h. a.m. and 8h. 30m. p.m. are issued to the public, except in the summer during the harvest. (*See answer to questions 3 and 4.*)

On Sundays the only forecasts drawn out are those at 8h. 30m. p.m. for publication on Monday mornings, the Sunday morning observations are used as data for the issue of storm warnings only. The afternoon service is suspended on Sundays.

Third and Fourth.—The 8.30 p.m. forecasts are supplied at the office gratuitously to the newspapers, either directly or through the press agencies, and appear in the leading newspapers all over the kingdom on the following morning. They are not issued otherwise by the office.

The 11h. a.m. forecasts are printed at the office on separate fly-sheets, and supplied to subscribers, almost exclusively resident in London, at a yearly charge of 10s. They are also distributed gratuitously for exhibition to the public at various places in London,

including the Meteorological Office, the Mansion House, and many of the shops of leading opticians. These forecasts are also reproduced in the lithographed Daily Weather Report, and appear in some of the evening newspapers in London, to which they are supplied gratuitously.

The 3h. 30m. p.m. forecasts are exhibited at the Meteorological Office, and during the Hay Harvest operations are sent by telegraph at the expense of the Office to about 30 selected stations where they are exhibited to the public.

A few persons are also supplied with these forecasts during the harvest on the payment of a nominal fee and the cost of telegraphy.

Fifth.—The forecasts cover a period of about 24 hours. Those prepared at 11h. a.m. cover the period till noon next day. Those prepared at 3h. 30m. and 8h. 30m. p.m. refer to the next civil day.

Sixth.—The lithographed Daily Weather Report is issued to the extent of over 480 copies, of these 60 are supplied gratuitously for exhibition at seaports. About 150 are forwarded also gratuitously to scientific institutions, &c. at home and abroad, and nearly 200 are supplied to private subscribers.

The forecasts are sub-divided as to the 11 districts into which the United Kingdom has been divided, on agricultural considerations. These are shown in the key map published with the Weekly Weather Report.

In the opinion of the Council it is not possible to define forecasts sharply either as to time, locality, or phenomena.

No discussion of the rainfall has as yet been carried out with a view to showing the extent to which it is general in its distribution or partial. This would probably be found to be in some measure dependent on the season of the year, as well as on the particular atmospheric conditions under which the rain fell.

In all cases the existence of a line of hills transverse to the direction of the wind, renders the fall locally more or less partial.

I am, &c.

(Signed) ROBERT H. SCOTT,
Secretary.

P.S.—I enclose copies of Circulars 27 and 27*a*, which explain the supply of weather information to the public and the press.

APPENDIX X.

REPORT ON THE COMPARISON OF THE FORECASTS ISSUED AT 8h. 30m. p.m. WITH THE WEATHER SUBSEQUENTLY EXPERIENCED, for the 12 Months, April 1889 to March 1890. The results are for the United Kingdom as a whole.

The letters used have the following signification :—

a = complete success.		c = partial failure.
b = partial (more than half) success.		d = total failure.

The checking has been conducted on the same system as that employed in previous years, *i.e.*, each forecast has been considered under the separate headings of "Wind" and "Weather," but the results of the 8.30 p.m. Forecasts only are here published.

The first column gives the percentage of success in "Wind," the second in "Weather," and the third the average of the two.

The Summary for the whole year is given at page 10.

Months.		Per-centages.				Months.		Per-centages.			
		Wind.	Weather.	Average.	a + b.			Wind.	Weather.	Average.	a + b.
April	a b c d	46 36 13 5	50 28 11 11	48 32 12 8	80	October	a b c d	36 40 16 8	54 26 13 7	45 33 15 7	78
May	a b c d	59 27 10 4	50 30 12 8	55 28 11 6	83	November	a b c d	55 28 11 6	39 45 7 9	47 37 9 7	84
June	a b c d	59 31 9 1	57 23 10 10	58 27 10 5	85	December	a b c d	41 30 17 12	41 33 14 12	41 32 15 12	73
July	a b c d	55 29 12 4	51 27 16 6	53 28 14 5	81	January	a b c d	41 32 20 7	48 34 10 8	45 33 15 7	78
August	a b c d	49 34 9 8	52 35 8 5	51 34 9 6	85	February	a b c d	60 24 10 6	53 30 8 9	57 27 9 7	84
September	a b c d	52 30 11 7	51 31 9 9	52 30 10 8	82	March	a b c d	33 36 23 8	46 35 8 11	40 35 16 9	75

APPENDIX XI.

TELEGRAPHIC WEATHER INTELLIGENCE.

THE following stations are supplied with telegraphic information of storms, free of expense, and signal "cones" have been furnished to most of them, all further expenses attendant on the maintenance and repair of the apparatus being borne locally. The stations are situated, 88 in England and Wales, 44 in Scotland, 15 in Ireland, 3 in the Isle of Man, and 3 in the Channel Islands.

NORTH.	WEST.	SOUTH.	EAST.
SCOTLAND, N.E.	IRELAND, S.W.	ENGLAND, S.W.	ENGLAND, E.
Lerwick.	New Ross.	Scilly.	Harwich.
Scalloway.	Dunmore East.	St. Just.	Ipswich.
Dunrossness.	Dungarvan.	St. Sennen.	Southwold.
Stromness.	Youghal.	Penzance.	Yarmouth.
Kirkwall.	Queenstown.	Falmouth.	Cromer.
Holborn Head.	Passage.	Pendennis.	Sheringham.
Wick.	Cork.	Mevagissey.	Lynn.
Avoch.	Kinsale.	Plymouth.	Sutton Bridge.
Inverness.	Tralee.	Devonport.	
Nairn.	Limerick.	Teignmouth.	
Burghead.	Galway.	Exmouth.	
Lossiemouth.			
Buckie.	IRISH SEA.		
Port Knockie.	Belfast.		
Cullen.	Donaghadee.		
Portsoy.	Howth.		
Banff.	Kingstown.		
Fraserburgh.	Ramsey (I. of M.).	ENGLAND, S.	
Peterhead.	Douglas "	Guernsey.	
Aberdeen.	Castletown "	St. Heliers	
	Silloth.	(Jersey).	
	Maryport.	Gorey (Jersey).	ENGLAND, N.E.
	Workington.	Weymouth.	Boston.
	Whitehaven.	Poole.	Cleethorpe.
	Barrow.	Cowes.	Grimsby.
SCOTLAND, E.	Morecambe.	Ryde.	Goole.
Stonehaven.	Fleetwood.	Portsmouth.	Hull.
Montrose.	Blackpool.	Littlehampton.	Bridlington Quay
Broughty Ferry.	Lytham.	Brighton.	Filey.
Dundee.	Southport.	Newhaven.	Whitby.
St. Andrews.	Liverpool.		Redcar.
Anstruther.	Runcorn.		Middlesborough.
Pittenweem.	Counali's Quay.		Sunderland.
Burntisland.	Penmaenmawr.		South Shields.
Grangemouth.	Port Penrhyn.		Tynemouth.
Bo'ness.	Port Dinorwic.		Berwick - on -
Granton.	Carnarvon.	ENGLAND, S.E.	Tweed.
Newhaven.	Holyhead.	Hastings.	
Leith.		Rye.	
Fisherrow.	ST. GEORGE'S	Sandgate.	
Dunbar.	CHANNEL.	Folkestone.	
Cockburnspath.	Aberystwith.	Dover.	
Eyemouth.	Milford.	Margate.	
	BRISTOL CHANNEL.	Faversham.	
	Pembrey.	Sheerness.	
	Llanelly.	Chatham.	
	Swansea.		
SCOTLAND, N.W.	Briton Ferry.		
Port of Ness	Porthcawl.		
(Island of Lewis).	Penarth.		
	Cardiff.		
	Newport.		
	Weston-super-		
	Mare.		
	Burnham.		
SCOTLAND, W.	Ilfracombe.		
Glasgow.	Barnstaple.		
Greenock.	Appledore.		
Rothsay.	Boscastle.		
Campbelton.	Port Isaac.		
Girvan.	Newquay.		
Ballantrae.	Hayle.		
	St. Ives.		

APPENDIX XII.

CORRESPONDENCE with the BOARD OF TRADE as to the WASHINGTON MARITIME CONFERENCE.

(M.O. 1977.)

Board of Trade, (Marine Department),
London, S.W.

November 11, 1889.

SIGNALS.

SIR,

I AM directed by the Board of Trade to request that you will be good enough to lay the following circumstances before the Council of the Meteorological Office for their consideration.

A Maritime Conference (to which Her Majesty's Government have sent delegates) is now sitting at Washington. It was at first arranged that the British Delegates should not proceed beyond a discussion of (1) the Regulations for preventing Collisions at Sea; and (2) the draft to which vessels should be loaded.

Her Majesty's Government have, however, now decided to join in the discussion of other matters, among which the following are included:—

(a.) The transmission of warnings;

(b.) The uniformity of signals employed.

Under these circumstances, Lord Salisbury and Sir Michael Hicks-Beach are desirous of sending to Washington at once an additional delegate competent to take part in the discussion on these points; and I am to request that you will ask the Council of the Meteorological Office to favour the Board of Trade with their observations in the matter, and to suggest the name of a gentleman they think suitable for the duty in question.

I am, &c.

The Secretary,

(Signed)

HENRY G. CALCRAFT.

Meteorological Office,

116, Victoria Street, S.W.

(P.C. 2148.)

Meteorological Office,

SIR,

November 13, 1889.

I HAVE to acknowledge the receipt of your letter of the 11th instant, addressed to the Secretary of the Meteorological Council, relative to a proposal to send to the Maritime Conference now sitting at Washington a delegate qualified to take part in a discussion on storm warnings, which subject is among those to be brought before the conference.

Understanding it to be important that no time should be lost in dealing with this matter, I think it better to inform you at once of the conclusions I have come to, after discussion with the Secretary to the Council, rather than wait to bring it before the full Council, which would necessarily involve a delay of some days. I feel satisfied, however, that the opinions I shall express would be confirmed by the Council.

I cannot think that any practical advantage would be derived from sending a delegate to Washington for the purpose in question. The subject of storm warnings and of forecasting weather, on which the issue of such warnings depends, has been constantly before the Meteorological Office from its first formation, and the Council has been in frequent and intimate communication with the Meteorological Office at Washington as well as with the corresponding departments of the chief States of Europe on the subject, and it regularly interchanges telegraphic infor-

mation with these last for the purpose of weather forecasting. For more than two years the Council received from Washington daily telegrams designed to convey from the other side of the Atlantic information obtained there, and considered to be likely to be useful in the forecasting of weather in the British Isles. A very prolonged and patient discussion of the data thus procured has satisfied the Council, and I may add all the staff employed in the preparation of forecasts, which is composed of very intelligent persons, having very prolonged experience in this branch of duty, that no advantage whatever could at present be derived from communications received from the coasts of America. The Council have therefore for nearly a year ceased to participate in this special telegraphic service, and there seems to be no prospect of the character of the available information being so modified as to justify its renewal.

Doubtless great advantage may be obtained by improving and extending the transmission of information along the coasts of the continent of America from and to suitable stations, and there is every reason to think that the Meteorological Offices of the United States and the Dominion of Canada fully appreciate this, and act in concert in giving effect to it.

But the preparation of weather forecasts, and the issue of warnings as to expected storms, must in the very nature of the subject be dealt with locally, and it is very questionable whether any useful purpose would be gained by the adoption of uniformity of methods, otherwise than so far as the general progress of scientific knowledge indicates the direction of possible improvement, and this it is hardly necessary to say is more likely to be secured by looking favourably on independent working rather than the reverse.

Even in such a matter as that of weather signals, it also seems doubtful whether the attempt to introduce uniformity would be successful or useful. Such signals are virtually made for the use of the shipping or fishing vessels in the harbours or proposing to leave them, and so long as their significance is clearly understood by the local population, they may be held to have performed the functions expected of them.

Finally. I may observe that there is no one whom the Council is likely to name, should the deputation of a delegate be resolved on, except their Secretary, Mr. R. H. Scott, who no doubt possesses all the necessary qualifications. But such a mission would be entirely outside the duties of his office, and he could hardly be expected to undertake it without special remuneration.

I am, &c.

(Signed) R. STRACHEY,
Chairman of the Meteorological Council.

The Assistant Secretary,
Marine Department, Board of Trade.

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I am, &c.

(Signed) R. STRACHEY,
Chairman of the Meteorological Council.

The Assistant Secretary,
Marine Department, Board of Trade.

APPENDIX XIII.

CORRESPONDENCE with the BOARD OF TRADE as to a METEOROLOGICAL STATION at BERMUDA.

METEOROLOGY.

(M.O. 1222.)

Board of Trade (Marine Department,)

SIR,

London, S.W., July 9, 1889.

I AM directed by the Board of Trade to transmit to you, to be laid before the Council of the Meteorological Office, a letter with inclosures, which they have received from the Colonial Office on the subject of a proposal which has been made to establish a meteorological station at Bermuda, and I am to state that, before replying to Lord Knutsford, the Board would be glad to be favoured with the views of your Council on the subject, both as regards the expediency of establishing such a station and the probable cost of so doing.

I am to request that the inclosures may be returned with your reply.

I am, &c.

The Secretary,

(Signed) THOMAS GRAY.

Meteorological Office,

116, Victoria Street, Westminster, S.W.

SIR,

Downing Street, July 3, 1889.

I AM directed by Lord Knutsford to transmit to you, to be laid before the Board of Trade, a copy of a despatch from the Governor-General of Canada, and of a letter from the High Commissioner for Canada in London, recommending the establishment of a meteorological station at Bermuda.

Lord Knutsford would be glad to learn the views of the Board of Trade on this proposal, and also to be furnished with any information which may be in the possession of the Board of Trade as to the probable cost of establishing and maintaining such an observatory.

I am, &c.

The Secretary to the
Board of Trade.

(Signed) R. H. MEADE.

Sir C. TUPPER to the COLONIAL OFFICE.

9, Victoria Chambers, Westminster, S.W.,

SIR,

June 24, 1889.

I HAVE the honour to transmit to you herewith, a copy of an order of the Privy Council of Canada, dated the 27th May 1889, with reference to the proposed telegraphic communication between Bermuda and Halifax.

I venture to think that the proposal made by the Minister of Marine and Fisheries that a meteorological station should be established at Bermuda, and that observations should be telegraphed regularly therefrom to the head office in Toronto, worthy of the consideration of Her Majesty's Government. I beg, therefore, that you will be so good as to move Lord Knutsford to bring the matter to the notice of the proper authorities, and trust that the suggestion will have the benefit of his Lordship's powerful support.

I am, &c.

(Signed) CHARLES TUPPER.

The Under Secretary of State,
Colonial Office.

LORD STANLEY OF PRESTON to LORD KNUTSFORD.

Canada, New Richmond P.Q.,

MY LORD,

June 4, 1889.

THE Director of the Meteorological Service at Toronto having drawn the attention of the Dominion Government to the fact that the Bermuda Islands will shortly be in telegraphic communication with Halifax, and that great benefit would accrue to the service by the establishment of a meteorological station at Bermuda, I have the honour to transmit to your Lordship a copy of an approved minute of the Privy Council, embodying a report of my Minister of Marine and Fisheries upon the subject.

I have, &c.

(Signed) STANLEY OF PRESTON.

The Right Hon. Lord Knutsford,
&c. &c. &c.

CERTIFIED COPY of a REPORT of a COMMITTEE of the Honourable the PRIVY COUNCIL, approved by his Excellency the GOVERNOR GENERAL in Council on the 27th May 1889.

ON a report dated 20th May 1889 from the Minister of Marine and Fisheries stating that the Director of the Meteorological Service at Toronto has drawn attention to the fact that the Bermuda Islands will shortly be in telegraphic communication with Halifax, and that great benefit would accrue to the service by having a meteorological station at Bermuda, and observations telegraphed therefrom twice a day to the head office in Toronto.

The Minister states that it appears that there is a class of storms which frequently do a large amount of damage in the Maritime Provinces and the Gulf of St. Lawrence, the occurrence of which the Meteorological Service are unable at present to foresee for any considerable time before they strike the shores of Canada, and the Director is of opinion that if he had regular returns from Bermuda of observations, taken at the same time as those on the Continent, he would probably be able, as a rule, to locate the position of these storms with sufficient accuracy to give at least 24 hours warning of their approach to the coast, a warning which would be the means of saving much loss of life and destruction of property.

The Minister is of opinion that the establishment of a station at Bermuda would be of benefit not only to Canada, but that it would also be attended with much advantage to Her Majesty's ships of war stationed at Halifax, and he recommends that the matter be brought under the consideration of Her Majesty's Government, and inquiry be made as to whether they would not assume the cost of establishing a station at Bermuda and transmitting the telegraph messages required to the head office of the Dominion Meteorological Service at Toronto, it being understood that the cost of issuing the necessary warning to shipping on the receipt of such messages is to be defrayed by the Government of Canada.

The Committee concurring in the above recommendation of the Minister of Marine and Fisheries advise that your Excellency be moved to forward a copy of this minute to the Right Honourable the Secretary of State for the Colonies.

All which is respectfully submitted for your Excellency's approval.

(Signed) JOHN MCGEE, Clerk,
Privy Council.

(P.C. 1482.)

SIR,

Meteorological Office, July 31, 1889.

YOUR letter of the 9th instant relative to the proposed establishment of a meteorological station at Bermuda having been considered by the Meteorological Council, I am directed to convey to you the following expression of the opinions they have formed on the questions submitted to them.

The Council can have no doubt that advantage should be taken of the establishment of telegraphic communication with Bermuda to obtain regular meteorological reports from that island, to be utilised in improving the forecasts of weather to be expected on the coasts of the North Atlantic. They consequently do not hesitate to support the proposal of the Government of the Dominion of Canada to form a meteorological station at Bermuda, from which regular reports should be transmitted to Halifax and Toronto.

The Council are not in possession of precise information as to the system of forecasting adopted by the Central Canadian Meteorological Office at Toronto, but it is presumed that information is obtained from the United States Bureau at Washington as to the advance of any atmospheric disturbances from the south, likely to have influence on the weather in Canada. It is necessary to remark that, for any reliable forecast of changes of weather likely to result in Canada from disturbances in the neighbourhood of Bermuda, it would be necessary to consider the effect of changes that might occur in the intervening region, and the atmospheric conditions along the coasts of the United States. These are systematically taken cognizance of at the Office at Washington, which would unquestionably desire to be furnished with any meteorological reports sent from Bermuda. The well-known liberality of the Washington Office leads the Council to expect that information of the nature now in question, which that Office might obtain, would be readily communicated to Toronto, and, combined with this, the reports from Bermuda might reasonably be expected to supply very valuable data for forecasting the weather on the coasts of Canada, the importance of accuracy in which to the ships of Her Majesty's Navy, as well as the Mercantile Marine, is indisputable.

With reference to the cost of establishing and maintaining such a meteorological station, I am to state the usual equipment of instruments for a telegraphic reporting station is about 12*l*. No special building is needed, and suitable places for the instruments could, no doubt, readily be found in or near the telegraph office. Further, as the requisite observations would only occupy a few minutes two or three times a day, it would probably be possible to secure the services of one or other of the telegraph signallers by a small payment, such as is usual at similar stations in this country, which would not exceed 15*l*. to 20*l*. yearly.

I am, &c.

(Signed)

ROBERT H. SCOTT,

Secretary.

The Assistant Secretary,

Marine Department, Board of Trade.

(P.C. 1482.)

SIR,

Meteorological Office, July 31, 1889.

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I am, &c.

(Signed) ROBERT H. SCOTT,

The Assistant Secretary,

Secretary.

Marine Department, Board of Trade.

APPENDIX XIV.

FISHERY BAROMETERS.

LIST of PLACES supplied with FISHERY BAROMETERS.

Shetland Isles.—*Balta Sound, *Uya Sound, *Nesting, *Lerwick, *Sandsair, *Scalloway, *Symbister.

Orkney Isles.—Westray, *Burra, *Kirkwall.

Scotland, east coast.—Freswick, Auchengill, *Keiss, *Staxigoe, *Wick, *Sarclet, *Lybster, *Dunbeath, *Portmahomack, *Cromarty, *Avoch, *Nairn, *Burghead, *Portessie, *Port Knockie, *Portsoy, *Whitehills, *Gardenstown, *Roseheart, *Pitullie, *Inverallochy, *Pointlaw, *Findon, *Portlethen, *Skateraw, *Stonehaven, *Arbroath, *Broughty Ferry, *St. Andrews, *Crail, *Cellardyke, *St. Monance, *Burntisland, *Newhaven.

England, east coast.—*Berwick, *North Shields, *South Shields, *Sunderland, *West Hartlepool, *Staithes, *Scarborough, *Filey, *Flamborough, *Bridlington Quay, Withernsea, Hull, *Lynn (2), *Wells, *Gorleston, *Harwich, *Brightlingsea, *Margate, *Deal, *Kingsdown, *Dover.

England, south coast.—Bognor, Ryde, East Cowes, Bembridge, Brixton, Atherfield, Ventnor (2), *Gorey (Jersey), Haslar Hospital, Poole, Weymouth, Portland, Budleigh Salterton, Exmouth, Cawsand, Mevagissey, Gorranhaven, Devoran, Portscath, Penryn, Durgan, Porthallow, Falmouth, Coverack, Newlyn, Mousehole.

England, south-west coast.—St. Ives, Hayle, Padstow, Port Isaac, Boscastle, Highbridge, Weston-super-Mare.

Wales.—Briton Ferry, Swansea, *Angle, *Milford, Nevin, Carnarvon.

England, north-west coast.—*Fleetwood, *Morecambe, *Maryport.

Isle of Man.—*Douglas, *Port St. Mary, *Peel.

Scotland, south-west coast.—*Port Patrick, *Stranraer.

Ireland, east coast.—*Cushendall, *Belfast, *Bangor (Co. Down), *Groomsport, *Donaghadee, *Ardglass, *Carlingford, *Greenore, *Dundalk, *Malahide, *Howth, *Kingstown (2), *Bray, *Wicklow.

Ireland, south coast.—Dunmore East, Dungarvan, Crosshaven, Kinsale, Union Hall, Castletownsend, Baltimore, Schull, Crookhaven.

Ireland, west coast.—*Valencia, Dingle, Tralee, Tarbert, Kilcredane, Kilronan, Spiddal, *Elly Bay, *Ballyglass, *Ballycastle (Co. Mayo), *Donegal, *Tribane, *Killybegs, *Teelin, *Portnoo, *Burton Port, *Kincaslough, *Bunbeg.

Ireland, north coast.—*Dunfanaghy, *Rathmullen, *Buncrana, *Moville, Greencastle, *Portrush, *Portstewart.

Scotland, west coast.—*Tarbert (Loch Fyne), *Campbeltown, *Carradale, *Portree (Isle of Skye), *Plockton, East Mey, *Stroma.

Hebrides.—*Stornoway, Portnaguiran, *Obb, Valtos, Carloway, *Ness.

SUMMARY of STATIONS supplied with INSTRUMENTS.

England and Wales -	-	-	-	-	66
Scotland and Isle of Man -	-	-	-	-	62
Ireland -	-	-	-	-	49
					<hr/>
					177
					<hr/>

APPENDIX XV.

LIST of STATIONS from which CONTINUOUS RECORDS of BRIGHT
SUNSHINE have been received.

Station.	Observer.
Aberdeen Observatory -	Prof. C. Niven, M.A., F.R.S.
Armagh Observatory -	J. L. E. Dreyer, Ph.D., F.R.A.S.
Blackpool -	J. Wolstenholme.
Cambridge -	H. Todd.
Churchstoke -	P. Wright, F.C.S., F.R. Met. Soc.
Cirencester -	Prof. Ohm, B.A., F.R. Met. Soc.
Cronkbourne, Isle of Man -	A. W. Moore, M.A., J.P.
Cullompton -	Thos. Turner, J.P., F.R. Met. Soc.
Dublin -	Major Kirkwood, R.E.
Durham -	H. J. Carpenter.
Eastbourne -	R. Sheward, F.R. Met. Soc.
Falmouth Observatory -	E. Kitto, F.R. Met. Soc.; for the R. Cornwall Polytechnic Soc.
Geldeston, Beccles -	E. T. Dowson, F.R. Met. Soc.
Glasgow -	Prof. R. Grant, M.A., LL.D., F.R.S.
Hastings -	H. Colborne, M.R.C.S.
Hillington -	Rev. H. E. B. Ffolkes, M.A., F.R. Met. Soc.
Jersey (St. Helier's) -	Capt. Richard, Harbour Master.
Kew Observatory -	G. M. Whipple, B.Sc., F.R.A.S.; for the Kew Committee.
Leicester (Thurcaston) -	Rev. T. A. Preston, M.A., F.R. Met. Soc.
Llandudno -	J. Nicol, M.D., J.P., F.R. Met. Soc.
London, Bunhill Row -	Messrs. de la Rue.
„ Westminster -	The Staff, Meteorological Office.
Marchmont -	P. Loney.
Markree Castle -	A. Marth, F.R.A.S.; for Col. E. H. Cooper, F.R.A.S.
Newton Reigny (Penrith) -	T. G. Benn, F.R. Met. Soc.
Oswald Kirk, Yorkshire -	R. Thompson.
Oxford -	E. J. Stone, F.R.S.
Parsonstown -	O. Boeddicker, Ph.D.; for the Earl of Rosse, K.P., F.R.S.
Plymouth -	J. Merrifield, LL.D., F.R.A.S.
St. Ann's Head -	S. Blake.
Southampton -	Sir C. Wilson, Col. R.E., K.C.B., F.R.S.
Stonyhurst -	Rev. W. Sidgreaves.
Stornoway -	John Forbes.
Sutton Coldfield -	C. F. Marston, C.E.
Swanbister (Orkney) -	W. Irvine Fortescue.

Station.	Observer.
Valencia Island - - - -	J. E. Cullum, F. R. Met. Soc.
Westgate-on-Sea - - - -	J. Norman Lockyer, F.R.S.
Worsop - - - -	H. Mellish, F.R. Met. Soc.
York - - - -	J. E. Clarke, B.A., B.Sc.
Georgetown, Demerara - - -	G. S. Jenman.

In addition, the number of hours sunshine recorded each day is reported from the following Stations :—

Glencarron - - - -	D. D. Munro.
Fort Augustus - - - -	Rev. E. G. Cody, O.S.B.
Braemar - - - -	J. A. Aitken, J.P.
Stowell - - - -	Rev. H. J. Poole, F.R. Met. Soc.

APPENDIX XVI.

METHODS FOLLOWED IN DEALING WITH METEOROLOGICAL RETURNS FROM LAND STATIONS IN THE BRITISH ISLES.

These stations are of five classes, as stated on page 16.

I.—*Observatories continuously observing all the Meteorological Elements.*

Returns from
observatories.

Hourly measurements of the curves obtained from the self-recording instruments at the observatories of the Office are made by the observers at each station, on printed forms supplied for the purpose, which, together with the curves, are forwarded to the Office weekly. They comprise measurements of the barograms, of the dry bulb and wet-bulb thermograms, of the anemograms, and of the rain-gauge curves.

Examination of
returns.

The measurements are subjected to a careful examination in order to ensure as far as possible their accuracy, and the regulations which have been adopted to secure this end are in the main the same as those which will be found in the Report of the Office for 1868. They comprise rules for the guidance of observers, as well as of the assistants charged with the examination of the work at the Office. Attention need be called here to only two of these rules, viz., (a) the use of subsidiary sheets on which are entered the results of a second set of measurements of the curves made after, and quite independently of, the first set, and with a different scale, the two sets of measurements being afterwards compared together, and any differences found inquired into and set right; and (b) the re-measurements of the curve made by the assistants at the Meteorological Office, and which always amounts to 40, and in doubtful cases to many more, per month, for each element. The attention of the observers is always drawn to such errors as may be detected, and to any failures in the continuity of the curves arising from failure of the light, stoppage of the clock, defective photography, faulty action of the wet-bulb thermometer, &c.; a report containing the results of the examination of each Observatory being also submitted to the Council periodically. The curves and tabulations are eventually bound and stored in the Office.

Results of
examination and
report to
Council.

Station.	Observer.
Valencia Island - - - -	J. E. Callum, F. R. Met. Soc.
Westgate-on-Sea - - - -	J. Norman Lockyer, F.R.S.
Worsop - - - -	H. Mellish, F.R. Met. Soc.
York - - - -	J. E. Clarke, B.A., B.Sc.
Georgetown, Demerara - - -	G. S. Jenman.

In addition, the number of hours sunshine recorded each day is reported from the following Stations :—

Glencarron - - - -	- D. D. Munro.
Fort Augustus - - - -	- Rev. E. G. Cody, O.S.B.
Braemar - - - -	- J. A. Aitken, J.P.
Stowell - - - -	- Rev. H. J. Poole, F.R. Met. Soc.

APPENDIX XVI.

METHODS FOLLOWED IN DEALING WITH METEOROLOGICAL RETURNS FROM LAND STATIONS IN THE BRITISH ISLES.

These stations are of five classes, as stated on page 16.

I.—Observatories continuously observing all the Meteorological Elements.

Hourly measurements of the curves obtained from the self-recording instruments at the observatories of the Office are made by the observers at each station, on printed forms supplied for the purpose, which, together with the curves, are forwarded to the Office weekly. They comprise measurements of the barograms, of the dry bulb and wet-bulb thermograms, of the anemograms, and of the rain-gauge curves.

The measurements are subjected to a careful examination in order to ensure as far as possible their accuracy, and the regulations which have been adopted to secure this end are in the main the same as those which will be found in the Report of the Office for 1868. They comprise rules for the guidance of observers, as well as of the assistants charged with the examination of the work at the Office. Attention need be called here to only two of these rules, viz., (a) the use of subsidiary sheets on which are entered the results of a second set of measurements of the curves made after, and quite independently of, the first set, and with a different scale, the two sets of measurements being afterwards compared together, and any differences found inquired into and set right; and (b) the re-measurements of the curve made by the assistants at the Meteorological Office, and which always amounts to 40, and in doubtful cases to many more, per month, for each element. The attention of the observers is always drawn to such errors as may be detected, and to any failures in the continuity of the curves arising from failure of the light, stoppage of the clock, defective photography, faulty action of the wet-bulb thermometer, &c.; a report containing the results of the examination of each Observatory being also submitted to the Council periodically. The curves and tabulations are eventually bound and stored in the Office.

Returns from
observatories.

Examination of
returns.

Results of
examination and
report to
Council.

In connexion with this work should be mentioned the general watch which has to be kept over the working of the observatories and of the instruments, not only to secure uniformity amongst them and observance of rules, but also to guard against small changes which are liable to occur at certain times, especially with the thermographs, and which may affect the scale-values of the instrument or the datum lines used for the tabulation of the curves. About twice a year this work calls for special examination, entailing some considerable time and occasionally the engraving of new scales for measuring the curves.

General supervision of observatory work.

The photographic curves are also used in the harmonic analyser; and for this purpose the barograms require a slight special preparation.

Harmonic analyser.

METHOD OF DEALING WITH THE NUMERICAL RESULTS FROM THE SELF-RECORDING OBSERVATORIES.

In dealing with the tabulations the first step is to go over the sheets and fill up by interpolation, wherever possible, any gaps or breaks in the continuity of the record.

Interpolations.

The record having been made as complete as possible, the daily, five-daily, and monthly means of the barometer and of the dry-bulb and wet-bulb thermometers are deduced.

Means.

The hourly vapour tension is then computed by an expansion of Glaisher's Hygrometrical Tables, prepared in the Office, and the work is independently checked.

Vapour tension.

A copy is next prepared of the above-mentioned hourly measurements of the barometer, dry-bulb and wet-bulb thermometers, wind and rain curves, and of the computed values of vapour tension. To these are added the daily means of the three first-mentioned elements, the extremes and daily range of pressure and temperature, and the daily totals of rainfall, and the whole series is printed and published under the title of "Hourly readings from the self-recording Instruments at the Four Observatories under the Meteorological Council."

Hourly Readings.

To ensure accuracy the sheets are read over in proof with the original measurements of the curves. The interpolated readings are printed in *italic* type, but no distinguishing mark is affixed to means which are partly based on them. When the gap in the record is too long to be dealt with by an interpolation of the missing hourly readings, the mean for the day is obtained either from the maximum and minimum readings for the day, or by an interpolation from the adjacent daily means, and the result thus obtained is printed as an approximation.

The five-daily, monthly, and annual means, together with the absolute extremes of pressure and temperature for each month, are printed as part of the "Hourly Readings." The tables are repeated in French measures.

Annual Tables.

The gale tables printed in the text of the Quarterly Weather Report, which show the extent, duration, and degree of severity of all the stronger gales, are prepared from the tabulations of the anemograms received from the self-recording observatories, together with those received from the extra anemographic stations.

Tables for the Quarterly Weather Reports. Gale tables.

II.—Anemographic Stations at which the Wind is recorded continuously.

The anemograms received from the stations enumerated on pages 108 *et seq.* are regularly examined and tabulated in the Office, and the sheets bound up in volumes. Besides special inquiries on legal and other points

that from time to time arise, and in which these documents are of high importance, the tabulations are always employed in the preparation of the summary of weather and gale tables for the Quarterly Weather Report. They are also regularly used in the checking of the Storm Warnings issued by the Office.

III.—*Land Stations of the Second Order.*

Origin and
progress of
system.

Ever since the year 1866 returns of more or less completeness have been received from land stations in the United Kingdom. In that year there was only one station, but by 1871 the number had increased to 15, and five years later to 49, including 14 stations belonging to the Royal Meteorological Society, copies of the returns from which were sent to the Office under a special arrangement with the Society.

At the end of the present year the total number of stations was 97, including 17 belonging to the Royal Meteorological Society and 19 belonging to the Scottish Meteorological Society.

This is an increase of 20 stations as compared with the previous year, which is mainly due to the fresh arrangement mentioned on page 19.

It must, however, be observed that while this number is exclusive of the self-recording observatories and of the anemographic stations, it includes several others from which only very scanty information is received.

The stations are distributed as follows: 43 in England, 4 in Wales, 26 in Scotland, and 24 in Ireland.

The methods followed with regard to the examination and publishing of these returns have been fully detailed in previous reports, and need not now be repeated. The only changes introduced into the volume at present in hand, namely, that for 1886, refer to the barometer readings, which are for the first time given at station-level instead of being reduced to the mean sea-level; and to the humidity, where the depression of the wet-bulb is now shown, the international forms A and B being modified accordingly.

This volume (1886) will contain returns from 66 stations, a larger number than has been included in any volume that has preceded it.

Arrangements have been made under which it is hoped that the arrears of this publication will be rapidly reduced.

Reports from 11 of the Irish stations are regularly supplied to the Registrar-General for Ireland for his Weekly and Quarterly Returns.

New stations.

When an application for the adoption of a new station is received, a schedule is forwarded to the observer containing a series of questions as to the outfit of the station, the exposure of the instruments, and the influence likely to be exerted on their indications by surrounding objects, such as houses and trees. Only mercurial barometers are accepted, and only such as have been duly verified. All thermometers must have been tested at Kew. A plan of the station, showing the positions of the instruments with regard to neighbouring objects, is also required.

On the return of this schedule the answers are considered, and, where necessary, alterations are advised.

If, however, the existing arrangements are satisfactory, tables for reducing the barometer readings to 32° Fahrenheit at mean sea level are prepared and duplicates sent to the observer, together with a set of Hygrometrical Tables, and a copy of "Instructions in the Use of Meteorological Instruments."

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The methods followed with regard to the examination and publishing of these returns have been fully detailed in previous reports, and need not now be repeated. The only changes introduced into the volume at present in hand, namely, that for 1886, refer to the barometer readings, which are for the first time given at station-level instead of being reduced to the mean sea-level; and to the humidity, where the depression of the wet-bulb is now shown, the international forms A and B being modified accordingly.

This volume (1886) will contain returns from 66 stations, a larger number than has been included in any volume that has preceded it.

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On the return of this schedule the answers are considered, and, where necessary, alterations are advised.

If, however, the existing arrangements are satisfactory, tables for reducing the barometer readings to 32° Fahrenheit at mean sea level are prepared and duplicates sent to the observer, together with a set of Hygrometrical Tables, and a copy of "Instructions in the Use of Meteorological Instruments."

The first returns are compared and examined with special care, and a report of the result of the examination is forwarded to the observer, with instructions how best to improve and complete the returns.

There are still many parts of the British Islands very poorly represented by the existing stations, and any information for these districts would be valuable.

The daily records of sunshine which are now received from 39 Stations in the British Islands are examined generally to guard against accidental changes in the adjustment of the instruments. Notes explaining any omission or accidental defect are added to the cards if required, and after their receipt has been acknowledged, they are duly stamped and dated and then stored in the Office. Sunshine records.

A tabulation of these curves is published as part of the Weekly Weather Report, mentioned in Appendix VIII., and for those stations which are also Stations of the Second Order the monthly totals of bright sunshine in hours, together with the percentage of its possible duration, are published as Part IV. of "Returns from Stations of the Second Order." A table showing the daily amount of sunshine at Bushill Row, one of the London stations, is also prepared quarterly for the Royal Meteorological Society. Weekly totals

INSPECTION.

The Stations of the Second Order are regularly inspected, the attention of the inspector being directed by the Office to any special point which may require investigation.

IV.—*Telegraphic Reporting Stations.*

Full particulars relating to these stations, the information received from them, and the method of dealing with that information, will be found in Appendix VII. to the Report for the year 1888-9. A paragraph in that Appendix (p. 60) explains the use that is made of the monthly schedules sent in by the observers.

V.—*Extra Stations.*

No returns from Stations of the Fifth Class are published by the Office, but some of them are regularly used in the checking of the Storm Warnings, and all are available for any special investigation that may be taken up.

The rainfall values at these stations are, however, copied and supplied to Mr. Symons, F.R.S., for publication in "British Rainfall."

APPENDIX XVII.

LIST OF DOCUMENTS RELATING TO THE LAND METEOROLOGY OF THE BRITISH ISLANDS, RECEIVED DURING THE YEAR ENDING MARCH 31ST, 1890.

Stations.	Observers.	Nature of Information received.	Notes.
CLASS I. †Valencia	J. E. Cullum, F.R. Met. Soc.	Continuous records of pressure, temperature, wind, sunshine, and rain, with eye observations of the clouds and notes on the weather.	
†Aberdeen	Prof. C. Niven, M.A., F.R.S.		
†Falmouth	E. Kitto, F.R. Met. Soc.		
†Kew	G. M. Whipple, B.Sc., F.R.A.S., F.R. Met. Soc.		
†Glasgow	Prof. R. Grant, M.A., LL.D., F.R.S.		
†Stonyhurst	The late Rev. S. J. Perry, F.R.S., and Rev. W. Sidgreaves, S. J.	Continuous records of pressure, temperature, wind, sunshine, and rain.	
CLASS II. †Armagh	J. L. E. Dreyer, Ph.D., F.R.A.S.		
Alnwick Castle	Lt.-Col. F. Holland, for the Duke of Northumberland, K.G.	Continuous record of wind, rainfall, and sunshine.	
†Dublin (Phoenix Park)	Major Kirkwood, R.E.	Continuous record of wind (direction and velocity).	
†Fleetwood	M. S. Gaultier, C.E.	"	
†Holyhead	Hugh Williams, C.E.	"	
†North Shields	Capt. W. Harrison	"	
†Scilly	The late W. Thomas and A. Hicks	"	
†Swanbister (Orkney)	W. Irvine Fortescue	"	
†Yarmouth	G. T. Watson	"	
Heligoland	J. J. Friederichs	"	
†Kilkenny Castle	The Marquis of Ormonde, K.P.	Continuous record of pressure.	
London	The Athenæum Club	"	
Nottingham	E. C. Patchett	"	
†Waterford	The Harbour Authorities	"	
CLASS III. †Armagh	J. L. E. Dreyer, Ph.D., F.R.A.S.	Regular observations at 9 a.m. and 9 p.m. of pressure, temperature (dry-bulb and wet-bulb), wind, cloud and weather, with the daily maxima and minima of temperature, the daily rainfall, and general remarks on the weather.	
Aysgarth	Rev. Fenwick W. Stow, M.A., F.R. Met. Soc.		
†Braemar	James Aitken, J.P.		
†Brookeborough	W. Ferguson, for Sir Victor Brooke, Bt., F.R.S.		
†Carmarthen	G. J. Hearder, M.D.		

LIST OF DOCUMENTS—continued.

Stations.	Observers.	Nature of Information received.	Notes.
†Cronkbourne, I. of Man	A. W. Moore, M.A., J.P.	-	-
†Dartmoor	F. W. S. Stone, M.B.	-	-
†Douglas, Isle of Man	Thos. Keig	-	-
†Dublin (City)	J. W. Moore, M.D., F.R. Met. Soc.	-	-
†Dublin (Phoenix Park)	Serjt. Lipscombe, for Major Kirkwood, R.E.	-	-
†Dublin (Glasnevin)	F. W. Moore, M.R.I.A.	-	-
†Dundee	W. Ross McKelvie	-	-
†Dunrobin Castle	D. Melville, for the Duke of Sutherland, K.G.	-	-
†Durham	H. J. Carpenter	-	-
†Eastbourne	R. Sheward, F.R. Met. Soc.	-	-
†Edgeworthstown	J. M. Wilson, M.A., J.P.	-	-
†Epsom (Royal Med. College).	J. S. Jackson and E. C. Montgomery	-	-
Geldeston (Beccles)	E. T. Dowson, F.R. Met. Soc.	-	-
†Glasgow	Prof. R. Grant, M.A., LL.D., F.R.S.	-	-
†Hillington, Norfolk	Rev. H. E. B. Ffolkes, M.A., F.R. Met. Soc.	-	-
Ladylaw, Hawick	W. R. Wilson	-	-
Laudale (Argyleshire)	A. Fletcher, for T. H. G. Newton, M.A., J.P.	-	-
Liverpool	J. Hartnup, F.R.A.S., F.R. Met. Soc.	-	-
†Londonderry	J. Conroy, F.R. Met. Soc.	-	-
†Margate	J. Stokes, F.R. Met. Soc.	-	-
†Markree Castle, Sligo	A. Marth, F.R.A.S., for Col. Cooper, F.R.A.S.	-	-
†Newton Reigny (Penrith).	T. G. Benn, F.R. Met. Soc.	-	-
†Parsonstown	O. Boeldicker, Ph.D., for the Earl of Rosse, K.P., F.R.S.	-	-
†Prestwick (Manchester)	T. R. H. Chunn, M.D., F.R. Met. Soc.	-	-
†St. David's, Pembroke	W. V. Probert, LL.D., F.G.S., F.R. Met. Soc.	-	-
†Scarborough	Allan Rowntree	-	-
†Seaham	G. H. Aird	-	-
Southampton	J. T. Cook, for Dir. Gen. of Ordnance Survey.	-	-
Stokesay	Miss M. A. Digges La Touche	-	-
		Regular observations at 9 a.m. and 9 p.m. of pressure, temperature (dry-bulb and wet-bulb), wind, cloud and weather, with the daily maxima and minima of temperature, the daily rainfall, and general remarks on the weather.	From January 1890. From August 1889.

LIST OF DOCUMENTS—continued.

Stations.	Observers.	Nature of Information received.	Notes.
†Stonyhurst -	The late Rev. S. J. Perry, F.R.S., and Rev. W. Sidgreaves, S. J.	Regular observations at 9 a.m. and 9 p.m. of pressure, temperature (dry-bulb and wet-bulb), wind, cloud and weather, with the daily maxima and minima of temperature, the daily rainfall, and general remarks on the weather.	
†Sutton Coldfield -	J. Fletcher, C.E., and C. F. Marston, C.E.		
†Swanbister -	W. Irvine Fortescue -		
Uppingham -	Rev. G. H. Mullins, M.A., F.R. Met. Soc.		
‡Wolfelee (Roxburghshire).	M. W. Cockburn, for Lady Elliott -		
†York -	J. Wright, for Yorkshire Phil. Soc. -	Monthly means and summaries on Form B. of observations taken at 9 a.m. and 9 p.m. each day as above.	
Class IIIA. ‡†Babbacombe, Devon.	E. E. Glyde, F.R. Met. Soc. -		
‡†Bennington, Herts -	Rev. J. Dunne Parker, LL.D., F.R. Met. Soc. -		
‡†Berkhamsted -	E. Mawley, F.R.H.S., F.R. Met. Soc. -		
‡†Buxton -	E. J. Sykes, M.B., F.R.A.S. -		
‡†Callton Mor -	J. Russell, for J. Malcolm, of Poltalloch, M.P.		
‡†Cargen (Dumfries) -	P. Dudgeon, F.R.S.E., and Alex. Peacock -		
‡†Cheddle -	J. C. Philips -		
‡†Cheltenham -	R. Tyer, B.A., F.R. Met. Soc. -		
‡†Churchstoke -	P. Wright, F.C.S., F.R. Met. Soc. -		
‡†Cramlington -	W. Donallo, F.R. Met. Soc. -		
‡†Fort Augustus -	Rev. E. G. Cody, O.S.B. -		
‡†Fort William -	C. Livingston, for Directors of Ben Nevis Observatory.		
‡†Glencarron -	D. D. Munro, for the Lord McLaren -		
‡†Glenlee (Kirkcudbrightshire).	W. Melville, for George Maxwell -		
‡†Gordon Castle -	J. Webster, for the Duke of Richmond, K.G. -		
‡†Killarney -	Archdeacon G. R. Wynne, M.A., F.R. Met. Soc.		
‡†Laing -	William Ross, for Duke of Sutherland, K.G. -		
‡†Lednathie (Forfarshire).	W. Morrison, for Stormonth Darling, J.C. -		

LIST OF DOCUMENTS—continued.

Stations.	Observers.	Nature of Information received.	Notes.
Lissan (Co. Tyrone) - Llandudno - Marchmont - Ochtrertyre - Pinmore - Rosewell - Rothesay (Isle of Bute) - Rousdon - Wakefield -	Sir Nathaniel Staples, Bart. - J. Nicol, M.D., F.R. Met. Soc. - Peter Loney, for Sir Hugh P. Campbell, Bt. - G. Croncher, for Sir Patrick Keith Murray, Bt. - Peter Donald, for Capt. Hamilton - R. W. D. Cameron, M.D. - James Kay - C. E. Peek, M.A., F.R.A.S., F.R. Met. Soc. - H. Clarke, L.R.C.P., F.S.S., F.R. Met. Soc. -	Monthly means and summaries on Form B. of observations taken at 9 a.m. and 9 p.m. each day as above.	
CLASS IV. The Telegraphic Stations, see List on page 71.			
CLASS V. Baltimore - Bolton - Bray (Co. Wicklow) - Castletownsend - Chatham (School of Military Engineering). Cooper's Hill (Egham) - Crookhaven - Crosshaven - Cuckfield - Ennis -	J. Halsey - W. W. Midgley, F.R. Met. Soc. - Coast Guard - Coast Guard - Lance Corporal D. Harrington, for Instructor in Surveying. Prof. H. McLeod, F.R.S. - Coast Guard - J. W. Bridle - John Howe - J. Hill, M.I.C.E., F.R. Met. Soc. -	Pressure, temperature, wind, and weather, once daily. Full monthly summary. Pressure and temperature four times daily, with wind and weather twice daily. Pressure and temperature four times daily, and wind twice daily. Full return for 9 a.m. Full return for 9 a.m. and 3 p.m. Pressure and temperature four times daily, and wind twice daily. Pressure, temperature, and wind, twice daily. Daily rainfall. Daily rainfall.	From December 1889.

LIST OF DOCUMENTS—continued.

Stations.	Observers.	Nature of Information received.	Notes.
Galway -	Coast Guard -	Pressure and temperature four times daily, with wind.	July to December 1889.
Gorleston -	R. J. C. Day -	Pressure and wind twice daily.	
Harpenden -	T. Wilson, F.R. Met. Soc. -	Pressure, temperature, and wind, twice daily, with rainfall.	
Haslar Hospital -	G. Coppen -	Pressure and temperature four times daily.	
†Killybegs -	Coast Guard -	Pressure, temperature, wind, and weather once daily.	
Knightstown (Valencia).	Coast Guard -	Pressure, wind, and weather once daily.	May to December 1889.
North Arran -	Coast Guard -	Pressure, temperature of air and sea four times daily, with wind and weather at noon.	
Rosehearty -	Coast Guard -	Pressure once daily -	
†Rugby -	W. N. Wilson, M.A., and H. P. Highton, B.A. -	Full set of 9 a.m. observations with 9 p.m. temperatures.	
St. Leonards -	H. Colborne, M.R.C.S. -	Full set of 9 a.m. observations.	
Schull -	Coast Guard -	Pressure, temperature, and wind twice daily.	
Sheffield (Weston Park)	Elijah Howarth, F.R.A.S. -	Full return for 9 a.m. and 6 p.m.	
Stamford (Ketton Hall)	Fred. Coventry -	Pressure, temperature (max., min., min. on grass), rainfall, and wind once daily.	
Stranraer -	P. Dorau -	Pressure, wind, and weather once daily.	
Sudbury -	W. Bayley Ransom -	Pressure, temperature (dry-bulb, max., min.), wind, cloud, and rainfall, once daily, with general remarks.	
Symbister, Shetland -	J. S. Nicolson -	Pressure and temperature twice daily.	
Tarbert, Harris -	Donald Bethune -	Pressure and wind twice daily.	
Totland Bay -	John Dover, B.A., F.R. Met. Soc. -	Full return for 9 a.m.	
Union Hall (Glandore)	Coast Guard -	Pressure, temperature, and wind, twice daily.	

NOTE.—The Stations marked “†” belong to the Royal Meteorological Society; those marked “‡” belong to the Scottish Meteorological Society; those marked “§” have been inspected during the year.

APPENDIX XVIII.

ACCESSIONS TO THE LIBRARY DURING THE YEAR ENDING
31st MARCH 1890.

|| **Abercromby, Hon. R.**—On Meldrum's rules for handling ships in the hurricanes of the Southern Indian Ocean; with researches on the nature of hurricanes generally. la. 8°. (*Journ. Scott. Meteor. Soc.*, 3rd ser. No. vi.)

* ——— Seas and skies in many latitudes or wanderings in search of weather. 8°. London, 1888.

|| **Aitken, J.**—On improvements in the apparatus for counting the dust particles in the atmosphere. Parts i. and ii. 8°. (*Proc. R. Soc. Edinb.*, xvi., 1889, p. 135.)

Algiers, Service Central Météorologique de l'Algérie.—Bulletin mensuel. 1888, Jan.—Dec. sm. f°. s.l.e.a.

[**Algiers, Service Météorologique du Gouvernement Général de l'Algérie.**]—Bulletin météorologique de l'Algérie. 1889, Jan. 1—Dec. 31. oblong sm. f°. Sheets.

(**Allahabad, Meteorological Office.**)—Administration report of the Meteorological Reporter to Government, North-Western Provinces and Oudh, for the year 1888–89. sm. f°. s.l.e.a.

[———] Brief sketch of the meteorology of the North-Western Provinces, Oudh and Eastern Rajputana, for the year 1888. sm. f°. s.l.e.a.

* **Allan, W.**—Weather wisdom from January to December. Wherein will be found much that is curious, entertaining, and instructive. sm. 8°. London, [1889.]

Altitudes, Table of. sm. 8°. Sheet.

American Meteorological Journal.—A monthly review of meteorology, medical climatology, and geography. Edited by **M. W. Harrington** and **A. L. Rotch**. Vol. V., 1888–1889. la. 8°. Ann Arbor, s.a.

Amsterdam, Kon. Nederlandsch Aardrijkskundig Genootschap.—Tijdschrift . . . onder redactie van **C. M. Kan** en **J. Æ. C. A. Timmerman**. Tweede serie. Deel vi. Meer uitgebreide artikelen. 8°. Leiden, 1889.

——— Tijdschrift . . . onder redactie van **C. M. Kan** en **J. Æ. C. A. Timmerman**. Tweede serie. Deel vi. Verslagen en aardrijkskundige mededeelingen. 8°. Leiden, 1889.

|| **Angot, A.**—Étude sur la marche diurne du baromètre. la. 4°. (*Ann. Bureau centr. météor. France*, 1887, I., p. B. 237.)

Arata, P. N.—El clima y las condiciones higiénicas de la ciudad de Buenos Aires. la. 8°. Buenos Aires, 1889.

Augustin, F.—Untersuchungen über die Temperatur von Prag. la. 8°. [*Sitzungsber. k. böhm. Gesellsch. Wissensch. math.-naturw. Cl.*, 1889, Bd. ii., p. 357.]

Avignon, Commission Météorologique du Département de Vaucluse.—Compte-rendu pour l'année 1888. sm. f°. s.l.e.a.

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APPENDIX XX.

LIST OF PUBLICATIONS, &c. issued under the Authority
of the Meteorological Council.

OFFICIAL.

- No. 1 Report for 1867. Presented to Parliament. 1s.
2. Instructions for Meteorological Telegraphy. [Out of Print.]
3. Fishery Barometer Manual. (New edition, 1887.) 6d.
4. Charts of Surface Temperature, South Atlantic Ocean. 2s. 6d.
5. Report for 1868. Presented to Parliament. 5d.
6. Report for 1869. Presented to Parliament. 10d.
7. Quarterly Weather Report for 1869.—Parts I. to IV. 5s. each.
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* The publication of the Weekly Weather Report began in February 1878.

† The Meteorological Council have given away the copies which were placed at their disposal, but the work can be purchased from the Publishers.

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