

Confidential.



R E P O R T
OF THE
METEOROLOGICAL COUNCIL
TO THE
ROYAL SOCIETY,

For the Year ending 31st of March 1889.



LONDON:
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1889.

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THE METEOROLOGICAL COUNCIL.

1888-89.

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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, 1889.

THERE has been no change in the Council during the year. Introductory
The only alteration in the administration of the Office has been that caused by the retirement of Captain Toynbee, as intimated in the last Report. The executive officers now are:—

Mr. R. H. Scott, M.A., F.R.S., Secretary.

Nav.-Lieut. C. W. Baillie, R.N., F.R.A.S., Marine Superintendent.

The attention of the Council having been drawn by the Treasury to the increased cost of printing of the publications issued from the Office, it was resolved that inquiries should be made of the Stationery Office to admit of the reconsideration by the Council of the present system, with a view to effecting every practicable reduction.

On the proposal of Professor Wild (St. Petersburg), that a meeting of the International Meteorological Committee should take place at Zürich, Mr. R. H. Scott, the Secretary of the Council, was authorised to attend, and the meeting took place in September 1888. The report of the proceedings at this meeting has been separately published, the principal conclusion arrived at (apart from those of a purely technical nature, to which reference is not necessary) was that there were insuperable difficulties in the way of continuing to convene International Congresses, of the character of those held at Vienna and Rome, and that henceforth the requirements of the case would be sufficiently met by assembling from time to time, by mutual agreement, representatives of the Meteorological Services in various countries, who were disposed to meet for the discussion of matters of interest. The Meteorological Council assented to this conclusion.

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.

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

Recognition of
"excellent"
observers.

Appendix I. (p.) contains a list of all the observers who have contributed logs during the past year, classed as "excellent." Several of them have regularly co-operated with the Office for many years. The names which appear in the list for the first time are as follow:—

| Captain's Name. | Ship. |
|--------------------------------------|---|
| Belding, R. - - - | "Atlantic." |
| Briscoe, R. F. - - | S.S. "Kaisar-i-Hind." |
| Campbell, Robert - - | S.S. "Elton." |
| Chaddock, E. T. - - | "Elvira." |
| Clark, Alexander - - | S.S. "Cardiganshire." |
| Clarke, A. C., Commr. R.N. - - | H.M.S. "Espiegle." |
| Couper, William - - | "Clackmannanshire." |
| Craig, E. A. - - - | S.S. "Claymore." |
| Field, A. M., Lieut. and Commr. R.N. | H.M.S. "Dart." |
| Hart Dyke, A. - - - | S.S. "La Plata." |
| Haselwood, R. W. B. - - | S.S. "Kaisar-i-Hind" and S.S. "Rohilla." |
| Hicks, G. M. - - - | S.S. "Nile." |
| James, W. D., Esq. - - | "Lancashire Witch." R.Y.S. |
| Jennings, R. C. - - - | S.S. "Colina." |
| Kiddle, Lieut. E. W., R.N. - - | H.M.S. "Egeria." |
| Long, Mr. J. C. - - - | S.S. "Kaisar-i-Hind." |
| Munn, L. A. - - - | S.S. "Durban." |
| Powles, F. W. - - - | S.S. "Essequibo." |
| Rigaud, H. C. - - - | S.S. "Derwent." |
| Ritchie, Alexr. - - - | "Four Winds." |
| Rowsell, P. - - - | S.S. "Tagus." |
| Spooner, I. D. - - - | S.S. "Tamar." |
| Swinton, W. W. - - - | "Banffshire." |

Proportion of
"excellent" to
total number of
logs received.

The total number of logs received in the year ending March 31, 1889, is 189, of which 152 have been classed as "excellent" or 80 per cent., being a larger per-centage of "excellent" logs than has been reported for some years.

The average number of logs received annually during the five years, 1883-87, was 184, of which the per-centage of "excellent" logs was 73.

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

Appendix II. (p. 34) gives a list of all meteorological logs and of meteorological reports from stations abroad, received at the Office during the year.

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 | - | - | - | 6 |
| „ North America, East Coast | - | - | - | 16 |
| „ „ „ West „ | - | - | - | 5 |
| Off East Coast of North America | - | - | - | 3 |
| To South America, East Coast | - | - | - | 15 |
| „ „ „ West „ | - | - | - | 10 |
| „ Australia and New Zealand, viâ Cape of Good Hope | - | - | - | 35 |
| „ „ „ „ Suez | - | - | - | 2 |
| At Australian stations | - | - | - | 8 |
| To India, viâ Suez | - | - | - | 16 |
| „ India, viâ Cape of Good Hope | - | - | - | 25 |
| „ China Seas, viâ Suez | - | - | - | 10 |
| „ Cape of Good Hope | - | - | - | 7 |
| „ West Indies | - | - | - | 18 |
| Between British Ports | - | - | - | 6 |
| To Mediterranean Ports | - | - | - | 7 |

Districts from which observations are obtained.

North Atlantic Weather Charts.—These charts, which refer to the 13 months ending September 3, 1883, have now been issued. They may justly be regarded as supplying the most complete representation of Atlantic weather which has yet appeared, the material collected for their preparation being unusually copious and trustworthy. Their value is enhanced owing to the observations made during the same period by the International Polar Expeditions, as well as those made on land and at sea in co-operation with the work of those expeditions. The very complicated series of phenomena recorded in these charts is undergoing a preliminary investigation by the Secretary. See Note A., p. 22.

North Atlantic Weather Charts.

Red Sea Charts.—The discussion of the Meteorology of the Red Sea, mentioned in former Reports, is still in progress, and the work is now well advanced. The observations used in addition to those contained in the Office logs are in the logs of H.M. ships obtained from the Admiralty; these data are supplemented when necessary by information obtained from the Royal Meteorological Institute of the Netherlands, and the Peninsular and Oriental Steamship Company.

Meteorology of the Red Sea.

The Charts of Barometrical Pressure for the Atlantic, Pacific, and Indian Oceans for the months of February, May, August, and November have been issued. A chart showing the mean barometrical pressure for the year and another to indicate the extent of range of irregular fluctuations, have also been prepared for the same oceans, and will shortly be published. These charts will, it is hoped, be of great value to mariners.

Barometrical pressure charts.

Current Charts for the Atlantic, Pacific, and Indian Oceans.—Considerable progress has been made during the year in the construction of these charts, and it is hoped that by the end of the year the whole of the data relating to currents contained in the Office logs will have been entered on the charts. A large amount of valuable information is being obtained from the logs

Current charts.

- Current charts. of Her Majesty's ships. Among the interesting points brought out during the investigation, shown by the small amount of information obtained from the anticyclonic regions of the great oceans, is that these regions, characterised by calms and light variable winds, are practically avoided by navigators.
- Cape Guardafui. *Cape Guardafui Charts.*—The charts referred to last year as originally designed to represent the winds, currents, temperature of the sea, &c., off Cape Guardafui during the South-west Monsoon are now being prepared for each month of the year. They will probably be completed in the course of the autumn. Authentic and trustworthy records of the rapid changes of temperature over comparatively short distances in this part of the ocean and of the varying winds during the course of the year, will be of considerable value to sailors navigating these seas, and are likely to throw light on important physical questions relating to the circulation of the ocean waters.
- Charts of the Aden cyclone, 1885. *The Aden Cyclone of June 1885.*—As stated in last year's Report, Synchronous Daily Charts of the North Indian Ocean have been prepared to illustrate the progress of this storm, which was of a somewhat exceptional nature, and therefore appeared to call for special treatment. These charts are in the press and in an advanced stage.
- Indian Ocean cyclone tracks. *Cyclone Tracks in the Southern Indian Ocean.*—These charts are now nearly complete, and only await the receipt of additional data from Dr. Meldrum. As intimated in the Report for 1887, the information they will convey, as to the frequency and tracks of cyclones in this area for a period of nearly 20 years, will be of great importance to seamen.
- Foreign stations. Tobago. *Supply of Instruments to Foreign Stations.*—Meteorological instruments have been supplied on loan to the Island of Tobago, where Dr. J. S. Tulloch, Colonial Surgeon, has undertaken to keep a record.
- Perim. *Observations at Aden and Perim.*—A communication having been made to the Director of the Indian Meteorological Department as to the importance of obtaining meteorological registers from these stations, he replied that an observatory had been established at Aden, and that endeavours would be made to obtain observations from Perim.
- Sanchez. *Observatory at St. Domingo.*—The late Dr. W. Reid having presented to the Office three volumes of Meteorological Observations extending over the years 1886, 1887, and 1888, made at Sanchez, Samaná Bay, at the east end of St. Domingo, the Council resolved to print them in a condensed form, the information being regarded as of considerable scientific value.
- Future work. *The future Marine Work of the Office.*—As already intimated, a discussion of the meteorological information available for the region from the Cape of Good Hope to New Zealand will be proceeded with by the Marine Department during the year as opportunity offers, on the method adopted in dealing with parts of the Atlantic.

Contributions to our Knowledge of the Meteorology of the Arctic Regions.—Part V. of this work has now been published, and completes the discussion of the data furnished by the Franklin Search Expeditions for the months in which the ships were in winter quarters. Arctic meteorology.

Supply and Stock of Instruments.—In Appendix III. (p. 41) is given a list of the meteorological instruments supplied by the Office to ships in the Royal Navy during the year, with a statement of the stock and distribution of the instruments standing on the books, to the account of the Admiralty, on the 31st March 1889. Instruments belonging to the Office.

Appendix IV. (p. 42) 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.

There have been no changes in the service during the year, and there are no serious interruptions to chronicle. Administrative

The following changes in the reporting staff may be noted :—at Malin Head, Mr. Owen Doherty has succeeded Mr. J. O'D. Farren ; at Spurn Head, Mr. J. B. Smith has been replaced by Mr. Watson ; and at Aberdeen, Mr. Boswell has succeeded Mr. J. M'Cormack whose death was mentioned in the last Report.

A list of the telegraphic reporters is given in Appendix V. (p. 43). A Map showing the stations was inserted in last year's Report.

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 Telegraphic Reporting Stations.—The telegraphic reporting stations have been inspected during the year, in Scotland by Mr. Buchan, and in Ireland and Wales by Mr. Scott. The Inspector for England, the Rev. W. Clement Ley, was unfortunately prevented by serious illness from discharging his duties during the year, and the English inspections were therefore incomplete. Some of the stations, however, were inspected by Captain Toynbee and by members of the Office staff. The reports submitted by the Inspectors to the Council, which are printed in Appendix VI. (p. 44), show that the efficiency of the service continues to be satisfactorily maintained. Inspection of the Stations.

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 VII. (p. 57). The Daily Weather Report is distributed free of cost as follows :—To newspapers, three copies ; to seaports, for public exhibition, 60 copies ; to Government offices and public institutions, 76 copies ; to correspondents of the Office, 58 copies ; and to foreign meteorological establishments, 35 copies. Nearly 200 copies are issued regularly to subscribers. Discussion of the reports.

Forecasts.

Weather Forecasts.—Forecasts continue to be prepared three times a day, 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 supplied for 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 prepared at 8.30 p.m. are intended primarily for the newspapers, but any forecast is available for the information of anyone who applies for it at the Office.

Inquiries at the Office.

The inquiries received through the Post Office for special forecasts during the year amounted to 63, and the personal applications to 52. The rules of the Office relating to such inquiries are stated in Appendix VII. (p. 64).

Testing of the Forecasts.

The results of a comparison of the Forecasts issued at 8 p.m. during the year with the weather actually experienced are given in Appendix X. (p. 68). The following summary shows the successes and failures over the whole United Kingdom estimated as explained in that Appendix:—

SUMMARY OF RESULTS of 8.30 p.m. FORECASTS, 1888.

| Districts. | Per-centages. | | | | Total per-centage of Success. |
|--------------------|-------------------|-------------------|-------------------|----------------|-------------------------------|
| | Complete Success. | Partial* Success. | Partial* Failure. | Total Failure. | |
| SCOTLAND, N. - - | 54 | 31 | 10 | 5 | 85 |
| „ E. - - | 54 | 30 | 11 | 5 | 84 |
| ENGLAND, N.E. - - | 52 | 33 | 8 | 7 | 85 |
| „ E. - - | 51 | 34 | 9 | 6 | 85 |
| MIDLAND COUNTIES - | 49 | 34 | 11 | 6 | 83 |
| ENGLAND, S. - - | 55 | 31 | 10 | 4 | 86 |
| SCOTLAND, W. - - | 41 | 36 | 15 | 8 | 77 |
| ENGLAND, N.W. - - | 48 | 33 | 12 | 7 | 81 |
| „ S.W. - - | 53 | 33 | 9 | 5 | 86 |
| IRELAND, N. - - | 48 | 33 | 12 | 7 | 81 |
| „ S. - - | 47 | 31 | 14 | 8 | 78 |
| Summary - - | 50 | 33 | 11 | 6 | 83 |

* Note “partial” implies “more than half.”

* 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.

The following table shows for each year from 1881 to 1889 the per-centages of complete and partial success of the Forecasts issued at 8 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 the means of obtaining information of atmospheric changes to the westward continues to be limited, as it is at present, by the barrier caused by the Atlantic.

Testing of
Forecasts.

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 |
| Average | - | - | 47 | 34 | 81 |

Checking Forecasts.—Special attention has been directed to the system under which estimates of success in forecasting, such as those furnished in the foregoing tables, are obtained by a comparison of the actual weather with the predictions made in the Forecasts; so that a constant watch may be kept on the preparation of the Forecasts by the assistants specially charged with this branch of the work, and their attention may be directed to any erroneous judgments they may have formed, and the nature of such errors as far as possible indicated to them.

Hay Harvest Forecasts.—The Council renewed in 1888 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 a record of the weather actually experienced sent

Hay Harvest
Forecasts.

**Hay Harvest
Forecasts.**

weekly to the Office. The Societies accepted the proposal, and the Forecasts were issued as shown in the following table :—

**LIST of those who received HAY HARVEST FORECASTS
in 1888.**

| Districts. | To whom sent. | Address. |
|------------------------|--|---|
| 0. SCOTLAND, N. | Rev. Dr. Joass - Major Smith - | Golspie. Munlochy, Inverness. |
| 1. SCOTLAND, E. | J. Whitton - W. W. Kerr - G. Murdock - C. L. W. Forbes - | Glamis, by Forfar. Ferrygate, North Berwick. Rothiemay, Huntly. Aberfeldy. |
| 2. ENGLAND, N.E. | 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. | High House, Thorpe, Norwich. Rothamsted, Harpenden. |
| 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 - | Barming House, Maidstone. The Moot, Downton, Wilts. Stammerham, Horsham. |
| 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 - | Eweny Priory, Bridgend, Glamorganshire. Spring Park, Gloucestershire. Long Ashton, Clifton, Bristol. Butleigh Court, Glastonbury. |
| 9. IRELAND, N. | Rev. Canon Nesbitt - E. F. Farrell - | Hollymount Rectory, Co. Mayo. 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. |

The issue of the forecasts commenced June 11th with those for England S. and E., and later for the other districts.

They were continued for nearly six weeks, and only ended for Scotland on August 25th.

In more than one case the forecasts were continued, until the completion of the corn harvest, at the cost of those who received the telegrams.

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:—

Hay Harvest Forecasts.

SUMMARY OF RESULTS.—HAY HARVEST FORECASTS, 1888.

| Districts. | Names of Stations. | Percentages. | | | | Total percentage of Success. |
|------------------|---|-------------------|------------------|------------------|----------------|------------------------------|
| | | Complete Success. | Partial Success. | Partial Failure. | Total Failure. | |
| SCOTLAND, N. | Golspie and Munlochy | 48 | 34 | 17 | 1 | 82 |
| " E. | North Berwick, Glamis, Aberfeldy, and Rothiemay. | 43 | 41 | 11 | 5 | 84 |
| ENGLAND, N.E. | Chatton and Ulceby | 50 | 27 | 17 | 6 | 77 |
| " E. | Thorpe and Rothamsted | 48 | 30 | 10 | 3 | 87 |
| MIDLAND COUNTIES | Cirencester and East Retford | 53 | 32 | 9 | 6 | 86 |
| ENGLAND, S. | Horsham, Maidstone, and Downton | 52 | 40 | 6 | 2 | 92 |
| SCOTLAND, W. | Dumbarton, Islay, and Stranraer | 45 | 41 | 8 | 6 | 86 |
| ENGLAND, N.W. | Leyburn and Prescott | 57 | 24 | 11 | 8 | 81 |
| " S.W. | Bridgend (Glamorgan), Clifton, Glastonbury and Spring Park (Gloucestershire). | 46 | 36 | 13 | 5 | 80 |
| IRELAND, N. | Moynalty and Hollymount | 43 | 38 | 14 | 5 | 81 |
| " S. | Moneygall, Kilkenny, Ardfert Abbey | 53 | 31 | 10 | 6 | 84 |
| | Mean for all districts, 1888 | 49 | 35 | 11 | 5 | 84 |
| | " " 1887 | 56 | 32 | 8 | 4 | 88 |

These figures show that the result of last year's checking fell four per cent. below that of 1888, and this may be attributable to the very broken character of the weather during the summer of last year which added considerably to the difficulties of forecasting.

The highest percentage of success was in England S., and the lowest in England N.E.

In addition to the gentlemen who received the forecasts gratuitously, nine large landowners residing in different parts of the country applied to be furnished with the forecasts at their own expense.

Additional testimony as to the general correctness of the forecasts during the summer of 1888, and their value to, and appreciation by, the agricultural community, was transmitted to the Office by the Rev. Dr. Joass (Sutherlandshire), Mr. Turner (Lincolnshire), Mr. Wray (Yorkshire), Mr. Fergusson (Suffolk), Mr. Neville Grenville (Wiltshire), and Mr. Dawson Milward (co. Kilkenny).

A correspondence took place between the Meteorological Office and the Agricultural Department of the Privy Council on the subject of the possible wider diffusion of the information supplied by the Hay Harvest Forecasts. The Meteorological Council expressed their readiness to co-operate in any way in their power in an object the utility of which had been sufficiently established by its general recognition by the well-qualified persons to whom the forecasts had been supplied in past years. At the

Hay Harvest
Forecasts.

same time, they intimated that the funds at their disposal were insufficient to admit of any gratuitous issue of forecasts in excess of that now going on. The Agricultural Department having stated that they had no funds at their disposal and that the Treasury had declined to make a grant for the purpose, the matter was dropped. The Council, however, hope that some arrangement may be found possible under which this desirable object may be carried out, the cost of which would be insignificant if spread over the large area that would benefit by it, though the aggregate amount is quite beyond the means of the Meteorological Office.

Storm warn-
ings.

Storm Warnings for the Coasts of the United Kingdom.—In Appendix IX. (p. 66) 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.

These stations were, at the end of March 1889, 146 in number, situated:—

70 in England, 14 in Wales, 41 in Scotland, 15 in Ireland, 3 in the Isle of Man, and 3 in the Channel Islands.

With a view to 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 sufficiency of the warnings will be better checked.

A comparison has been made in the Office between the warnings issued in 1888 and the weather experienced on our coasts, the warnings being tested by the method explained in Appendix VII. (p. 64). 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 1888.

| 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 - | 57 | 32 | 11 | 13 | — | 1 | — | March 11. Dec. 25. |
| „ East - | 64 | 28 | 25 | 7 | — | 4 | — | |
| Scotland, East - | 70 | 43 | 12 | 12 | — | 3 | — | May 13.* Oct. 12.* |
| „ West - | 55 | 25 | 25 | 4 | — | 1 | — | |
| England, North-west | 56 | 38 | 11 | 7 | — | — | — | |
| „ West - | 53 | 26 | 21 | 6 | — | — | — | |
| „ South-west | 46 | 26 | 12 | 8 | — | — | — | March 11. |
| „ South - | 46 | 31 | 10 | 5 | — | — | — | |
| „ South-east | 40 | 19 | 15 | 5 | — | 1 | — | |
| „ East - | 52 | 30 | 12 | 10 | — | — | — | |
| Totals - | 539 | 298 | 154 | 77 | — | 10 | — | |
| Per-centages - | — | 55·3 | 28·6 | 14·3 | — | 1·8 | — | |

* These gales were not felt south of Aberdeen.

NOTES as to GALEs in 1888 for which WARNINGS were not issued. Storm warn-ings.

March 11.—Strong South-westerly to Westerly gale in the S.W. of England, and North-westerly gale in the S. of Ireland.—At 6 p.m. on March 10th there was no indication of a storm on our coasts, although the distribution of pressure was of a rather complex character. By 10 p.m. a shallow disturbance had been developed off our south-western coasts, and subsequently grew deep with extraordinary rapidity. By 8 a.m., 11th, the centre had reached Pembroke, where the barometer had fallen 0·85 in. (to 28·87 ins.), and a gale had set in on all our south-western coasts. At 6 p.m. the centre was over Lincolnshire.

May 13-14.—Strong North-westerly gale in extreme N.E. of Scotland.—At 8 a.m., 13th, a depression lay off the W. of Norway, whence it moved steadily to the south-eastward. There is nothing in the information available at present to explain why the wind attained a force so great as it did in this region.

October 12.—Strong North-westerly gale in extreme N.E. of Scotland.—At 8 a.m., 12th, a well-formed, but not deep, depression lay off the N.W. of Norway and was moving east-south-eastwards. The gale in question seems to have been the result of some small secondary system not shown by our 8 a.m. reports, and of the existence of which it was impossible to know anything, owing to the necessary absence of stations to the north-westward of the Shetland Islands.

December 25.—Strong Southerly gale in Ireland, S.—This gale was brought about by the rapid advance to our western coasts of a well-formed depression from the south-westward. At 6 p.m. on December 24th there was nothing to indicate the approach of the disturbance. At Valencia the wind was light from W.N.W., and the barometer stood at 29·60.

The following table contains a comparative statement of the storm warnings and their results in 1888, and in the ten preceding years. It will be seen that the total percentage of warnings justified is 83·9, being slightly higher than that for the preceding year :—

Comparison of results for 1888 with previous years.

| 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. |
|--------|-------------------------------|---|--|---------------------------|---|
| 1878 | 485 | 56·7 | 20·8 | 77·5 | 17·9 |
| 1879 | 509 | 30·5 | 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 |

The Council desires to record its obligation to "Lloyds" for an offer to co-operate in the supply of information likely to be useful to the Meteorological Office from their signal stations, an offer of which the Council were very ready to avail themselves.

**Fishery
barometers.**

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 169, of these 59 are in England, 5 in Wales, 48 in Ireland, 53 in Scotland, 3 in the Isle of Man, and 1 in Jersey. The list is given in Appendix VIII., p. 65.

The inspection of the fishery barometers referred to as contemplated in last Report has been partially carried out during the year. The whole of the Scotch stations have been visited by Mr. H. N. Dickson, F.R.S.E., who was entrusted with the duty by the Scottish Meteorological Society, which body has consented, at the request of the Council, to undertake the general supervision of the public barometers maintained by the Office in Scotland. Some stations in the north of Ireland were visited by Captain Toynbee, and some on the east coast of England by the Hon. R. Abercromby. The result of the inspection is, on the whole, satisfactory; in only a few instances was it thought necessary to recommend any change either in the situation or care of the instruments.

The inspectors have in many cases found the fishing population desirous of obtaining information as to the principles on which the scientific forecasting of weather is carried out, and instruction on this subject has been given as far as was possible.

**Atlantic tele-
grams.**

Atlantic Telegrams.—As stated in last year's Report, the Council then discontinued their participation in the payment for these telegrams, but, through the kindness of Professor Mascart, have received copies of them by post from Paris. These were for a long period regularly examined, and the information entered on charts, with a view to their value as aids to weather forecasting being further tested. The result has been the conclusion that, in the present state of our knowledge, such telegrams are of no practical utility for the object in question, and the Council, though with some hesitation, determined that the time required for their study could no longer be devoted to them, with due regard to the many other demands on the special staff employed on the difficult and responsible duty of preparing the forecasts.

Publications.

Weather Reports.—The Daily Weather Report has appeared regularly; for details, see Appendix VII., p. 64.

The Weekly Weather Report has been further modified and improved, 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. The small charts have been enlarged so that the area represented now covers nearly the whole of Europe.

The Quarterly Summary, issued as Appendix I. to the Weekly Weather Report, gives summaries for each quarter, and for the whole year, of the Rainfall and Temperature for each district, for the 23 years 1866-1888, and also the Monthly and Progressive values of Accumulated Heat, Rainfall, and Bright Sunshine for all the districts in each month of 1888. Appendix II. to the same Report gives the Weekly and Progressive values for the same elements during the year 1888 (in continuation of Appendix II. for the year 1887), and Appendix III. gives the Mean Weekly values for the following number of years:—

Accumulated Heat and Rainfall, 11 years, 1878 to 1888.

Bright Sunshine - - - 8 „ 1881 „ 1888.

Appendix IV. gives for each district, for the 11 years 1878 to 1888, the mean temperature for each week in the year.

The Monthly Weather Report, which has been discontinued as a separate publication, will appear in future as a supplement to the Weekly Weather Report.

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 6,070, and from the Mercantile Marine, 7,380.

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 completeness or fulness with which they are made.

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. Self-recording observatories.

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 useful in connexion with storms, and as affording, amongst other uses, evidence available in courts of law with respect to collisions at sea, and damage done by wind. Anemographic stations.

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

4. The Telegraphic Reporting Stations at which eye observations are taken, supplemented in some cases by self-recording Telegraphic Reporting Stations.

- Stations.** 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 furnish 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 35 stations in the British Isles, of which some are first or second order stations, whilst from others the sunshine record is alone received. See p. 69.
- 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 XII., p. 70.
- Documents received.** Appendix XIII., p. 75, contains a list of all documents relating to the land meteorology of the British Isles received at the Office during the year.
- Regulations of Work at principal Observatories.*—The regulations for the management of the self-recording instruments have been carefully revised. The experience of nearly 20 years has shown that in all essentials the instruments are thoroughly satisfactory, and that very small alteration was required in the instructions for their use originally issued.
- 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. J. 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 VI., p. 44.
- Reports supplied to Registrar General for Ireland.** *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.
- Publications.** *Quarterly Weather Report.*—Parts III. and IV., completing the volume for 1879 of the old series, have been issued. This form of Report will end with the publication of the volume for 1880, of which Part I. is in the press.

The publication of the *Hourly Readings* obtained from the records of the self-registering instruments at the four principal observatories for 1886 is completed. Publications.

It has been resolved to compute the mean hourly values of the observed temperature of the air and barometrical pressure, for each month, and for all the observatories, for the year 1883; the question of extending this computation to other years was postponed for future consideration.

Mr. F. C. Bayard having computed the mean monthly hourly values of the barometric pressure for the seven self-recording observatories, for the years 1877 to 1880, to which he has been able to add records from Greenwich and Bidston, the Council considered the results sufficiently valuable to print them, together with those obtained by Mr. H. S. Eaton for 1876. Mr. Bayard's tables.

Observations at Stations of the Second Order.—The volume for 1884 has appeared, and that for 1885 is nearly complete.

Observations on Ben Nevis.—The arrangements with the Directors of the Observatory established on the summit of Ben Nevis, at a height of 4,406 feet above the sea, detailed in the Report for 1885, have been continued during the year. 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. Observations on Ben Nevis.

The Directors of this Observatory having completed arrangements under which they would be enabled to erect at Fort William, at the base of the mountain, a supplementary observatory in connexion with that on the summit, the Council have undertaken to supply at their own charge an outfit of an observatory of the first class, to be equipped with self-recording instruments, a set of which, formerly used at Armagh, is available. The Council have further agreed to grant in aid of the maintenance of the Fort William Observatory a sum of 250*l.* yearly for five years, on the terms, as to the supply of copies of observations to the Meteorological Office, and the like, on which a similar grant is made to the Observatory at Falmouth.

Cloud Photography and Measurement.—This subject has continued to receive attention. Many photographs have been taken at Kew, but unforeseen difficulties have arisen in obtaining satisfactory results from them, which, however, it is hoped, may be overcome by improving the instrumental appliances and the method of computation. Cloud photography.

The Bridled Anemometer.—The Council having learned that Mr. W. H. Dines, B.A., was engaged in making experiments with anemometers with the aid of a whirling apparatus, requested him to undertake an investigation with the view of determining a scale for interpreting the indications of the bridled anemometer that has been in operation for several years at Holyhead. This Mr. Dines has consented to do, and the subject continues under his observation. The object which this form of anemometer is Bridled anemometer.

Bridled anemometer. designed to accomplish is the measurement of the varying force of the wind, and particularly of the strongest gusts; a question on which great doubt exists, and the solution of which involves considerable difficulties, while it is of no little practical importance in connexion with the stability of engineering works.

Squalls. *Record of Squalls.*—The ordinary self-registering anemometer supplies a satisfactory record of the aggregate movement and velocity of the wind, but fails to indicate sufficiently those momentary or sudden increases of force which constitute heavy gusts and accompany violent squalls, and the occurrence of which is at times a cause of such great destruction. The trace made by this instrument at high velocity can hardly be trusted to give reliable results for a shorter time than 15 minutes, and inquiry is being made as to the frequency of occasions during which a velocity of 10 miles in that time, or 60 miles in an hour, has been recorded. (Note B., p. 27.)

Electrical anemometer. *Electrical Anemometer.*—The Council regret to have to record that after very prolonged trial, and repeated attempts to remedy defects, the use of this apparatus has had to be abandoned, for the present at least. The instrument will be removed from Valencia to Kew, where a close examination of its working will be instituted, in the hope that some means may be found for rendering its indications trustworthy, which has not hitherto been accomplished.

The Harmonic Analyser.—This instrument continues to be employed for the determination of the harmonic coefficients of the formulæ expressing the diurnal variation of temperature and of barometric pressure. The analysis of the curves obtained from the barographs at the seven observatories of the Office has been completed for the ten years 1871–80 and the curves for 1881 have been dealt with for four of the seven stations.

The harmonic coefficients for the mean diurnal range of temperature were published in 1886, and since then a considerable amount of time has been expended in endeavouring to trace by their aid the sequence of causes which combine to modify the mean diurnal curve of temperature at different seasons of the year and in different parts of the kingdom. To assist in this investigation, the coefficients for periods of five days for the same interval, 1871–1882, are now being calculated.

Records from stations of the Royal Engineer 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 is now in the press.

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 in a more

or less detailed form a very large mass of Meteorological observations Library. data from all parts of the world, and extends 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 XIV., p. 79, 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.

Appendix XV., p. 98, shows the receipts and payments Financial during the year ending 31st March 1889. 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 1888-89, as compared with the previous year :—

| NET EXPENDITURE. | 1887-88. | 1888-89. | Increase. | Decrease. |
|--|----------------------|----------------------|--------------|--------------|
| <i>General Administration.</i> | | | | |
| Payment of Council - | £ s. d. 1,000 0 0 | £ s. d. 1,000 0 0 | £ s. d. — | £ s. d. — |
| Secretary - | 800 0 0 | 800 0 0 | — | — |
| Office - | 806 15 6 | 798 8 0 | — | 8 7 6 |
| Rent, fuel, and lighting - | 738 17 10 | 709 17 11 | — | 28 19 11 |
| Alterations to premises, attendance, and contingencies - | 497 5 11 | 436 4 0 | — | 1 1 11 |
| Expenses incidental to International Meteorological Congress - | — | 22 2 3 | 22 2 3 | — |
| Pensions - | 42 16 4 | 138 16 4 | 96 0 0 | — |
| Special Researches - | 734 11 10 | 570 5 0 | — | 164 6 10 |
| Land Meteorology - | 3,141 10 10 | 3,353 7 1 | 211 16 3 | — |
| Weather Information - | 3,929 15 5 | 3,845 10 4 | — | 84 5 1 |
| Inspections - | 524 10 4 | 702 5 1 | 177 14 9 | — |
| Ocean Meteorology - | 2,517 4 6 | 2,795 3 3 | 277 18 9 | — |
| Total - | £ 14,673 8 6 | 15,171 19 3 | 785 12 0 | 287 1 3 |

(Signed)

Chairman.

NOTE A.

NOTES of some RESULTS of an EXAMINATION of the ATLANTIC CHARTS published by the OFFICE; by ROBERT H. SCOTT, F.R.S., Secretary.

IN the last Report of the Council, that for the year ending March 31, 1888, a short notice was included, on the subject of the subject of the severe gales which had visited the British Isles between August 1882 and August 1883 inclusive. These storms, as represented on the charts, were discussed with the object of ascertaining to what extent intelligence of their approach to our coasts might possibly have been obtained from telegrams from the other side of the Atlantic. The result of the inquiry was not satisfactory, as will be seen from the Note.

During the past year the study of these charts has been continued, as opportunity offered, and a few facts of some interest have been elicited, which I venture to submit to the Council.

It has been already explained that all the clearly marked barometrical depressions or cyclonic systems have been laid down on their proper positions on 13 charts, one for each month, and lines were drawn connecting these positions, as seemed justifiable. Storm tracks were thus formed.

The next step was to tabulate the whole of these tracks, according to longitude, in columns of 10 degrees each. Speaking very generally, these disturbances travel over 10 degrees of longitude in 24 hours. To each day's entry are appended the latitude of the position, the lowest barometer reading recorded, and the principal strong winds reported. These data enable any one consulting the tables to gain a general idea of the history of the disturbance, as they show whether it is increasing in intensity or the reverse, as indicated by the fall or rise of the barometer at its centre, and whether the wind is stronger or weaker. To these entries are added the distance the disturbance has travelled in the preceding 24 hours.

The amount of material contained in these forms is considerable, but it did not seem advisable to attempt to calculate the average height of the barometer or the average rate of travel, say, at each tenth meridian, inasmuch as the number of depressions in each column was very irregular, and the directions of the tracks were not by any means parallel to each other.

A series of small charts was next prepared, one from each storm-track, with the view of sorting them out, so as to group together those whose tracks resembled each other.

The total number of separate tracks which have been made out is 273, and it seemed of interest to find out how long each of these atmospheric disturbances lasted, *i.e.*, for how many days each was recognisable on the charts.

The result of this investigation is given in the subjoined table, which exhibits the distribution of the depressions as to months and as to duration:—

TABLE I.

| | Duration of Depressions in Days. | | | | | | | | | | | | | | | | | | | | Monthly Totals. |
|-----------|----------------------------------|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----------------|
| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. | 15. | 16. | 17. | 18. | 19. | 20. | |
| 1882. | | | | | | | | | | | | | | | | | | | | | |
| August | — | — | — | 3 | — | — | — | 2 | 1 | — | 2 | 1 | — | — | — | — | — | — | — | — | 9 |
| September | 1 | — | 3 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | — | — | — | — | — | — | 1 | — | — | — | 14 |
| October | 1 | 6 | 6 | — | 3 | 2 | 3 | 1 | — | — | 1 | — | 1 | — | — | — | — | 1 | — | 1 | 24 |
| November | 3 | 2 | — | 2 | — | 1 | 2 | — | 1 | — | 1 | 1 | — | 1 | — | 1 | — | — | — | — | 15 |
| December | 4 | 1 | 3 | 4 | 3 | 1 | 2 | — | 1 | 2 | 2 | 1 | — | — | — | — | — | — | — | — | 24 |
| 1883. | | | | | | | | | | | | | | | | | | | | | |
| January | 3 | 2 | 4 | 2 | 4 | 2 | — | 2 | — | 1 | 2 | — | — | — | — | — | — | — | — | — | 22 |
| February | 3 | 4 | 5 | 1 | 2 | 1 | 1 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | 19 |
| March | 7 | 3 | 7 | 2 | 3 | 6 | 2 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 31 |
| April | — | — | 2 | 6 | 3 | 2 | 4 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | 18 |
| May | 3 | 5 | 1 | 2 | 3 | 1 | 1 | — | 2 | 4 | — | 1 | 1 | — | — | — | — | — | — | — | 24 |
| June | 6 | 4 | 6 | 3 | 1 | 1 | 1 | 2 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | 26 |
| July | 4 | 5 | 2 | 6 | 2 | 2 | 1 | 2 | — | — | — | — | 1 | 1 | — | — | — | — | — | — | 26 |
| August | 1 | 1 | 1 | 2 | 1 | 3 | 4 | 3 | — | 3 | — | — | — | — | — | — | — | — | — | — | 19 |
| | 36 | 33 | 40 | 34 | 27 | 23 | 22 | 16 | 8 | 13 | 8 | 4 | 3 | 2 | — | 1 | 1 | 1 | — | 1 | 273 |

It appears from this table that out of the 273 depressions, 143, or more than one half, lasted less than five days. The instances of duration of more than 10 days were rare, and those lasting more than 13 days extremely so, and almost entirely confined to the autumn months, September, October, and November. One of these was the storm which Mr. H. Harries considers he has traced from the Philippine Islands to the Baltic, over a distance of 14,000 miles (*Quart. Journ. R. Met. Soc.*, vol. xii., p. 10).

Looking at the monthly distribution, the disproportionately small number of tracks noted in August 1882 attracts notice, but this is possibly in some measure attributable to the fact that in the first month the number of observers was not as large as it subsequently became.

As regards the number of these depressions which were traceable across the Atlantic so as to reach our coasts, and cause serious gales, the Note in last year's Report shows that this was insignificant.

The number of depressions which appeared over the Atlantic to the southward of the parallel of 40°, the latitude of Philadelphia, during the period of 13 months, was 63, thus distributed:—

| | No. of Depressions appearing South of Lat. 40°. | | No. of the Depressions in Col. 1, which passed from Long. 60° to Long. 0°. | |
|-----------|---|---|--|----|
| 1882. | | | | |
| August | — | — | 1 | 0 |
| September | — | — | 4 | 3 |
| October | — | — | 7 | 1 |
| November | — | — | 5 | 2 |
| December | — | — | 7 | 1 |
| 1883. | | | | |
| January | — | — | 8 | 2 |
| February | — | — | 1 | 0 |
| March | — | — | 9 | 0 |
| April | — | — | 4 | 2 |
| May | — | — | 5 | 1 |
| June | — | — | 4 | 0 |
| July | — | — | 3 | 1 |
| August | — | — | 5 | 2 |
| | | | 63 | 15 |

The second column shows the number, 15 in all, of these, which, starting beyond the 60th meridian, crossed the Atlantic, though some passed the meridian of Greenwich in very high latitude, and it will be seen that these were fairly equally distributed over the year. When, however, we take those which took their rise in lower latitudes below 35° N., we find traces of periodicity. This is to be expected, when it is remembered that this class includes the West India hurricanes. The columns have the same meaning as before.

| | | | | No. of Depressions appearing below Lat. 35° . | No. of Depressions in Col. 1, which passed from Long. 60° to Long. 0° . |
|-----------|---|---|---|--|---|
| 1882. | | | | | |
| August | - | - | - | 0 | 0 |
| September | - | - | - | 2 | 2 |
| October | - | - | - | 5 | 1 |
| November | - | - | - | 4 | 2 |
| December | - | - | - | 1 | 1 |
| 1883. | | | | | |
| January | - | - | - | 2 | 1 |
| February | - | - | - | 0 | 0 |
| March | - | - | - | 1 | 1 |
| April | - | - | - | 2 | 1 |
| May | - | - | - | 2 | 1 |
| June | - | - | - | 0 | 0 |
| July | - | - | - | 0 | 0 |
| August | - | - | - | 4 | 2 |
| | | | | 23 | 12 |

Out of these 23 disturbances, 12, or more than one half, possessed sufficient energy to cross the ocean. When such a phrase is used it must not be understood to imply that the cyclonic system had throughout its course, or even at any part of it, sufficient energy to be ranked as a storm or to have been a source of danger to shipping, but it would certainly have produced disturbances of weather when it approached our coasts.

We see, therefore, that of the depressions appearing near the American coast south of 40° N., nearly one fourth crossed the Atlantic, but that those appearing south of 35° N. had greater vitality, more than one half living until they reached the meridian of 20° W.

Another point of interest was to trace the instances in which disturbances showed themselves over the Central or Eastern Atlantic, near the Azores or Canaries. Of these one appeared in each of the months January to July inclusive, and none in any other month.

Another subject which appeared to present features of interest was the circumstance that occasionally depressions proceeding from the Temperate Zone passed up into Baffin's Bay, and eventually died out there. This phenomenon did not take place in the winter months, from October to March inclusive, but for the other

months the list of occurrences is as follows: the length of time for which the system remained within the article circle is given in each case :—

| | | | | |
|-----------|---|---|---|--------------------------------|
| September | - | - | 1 | 5 days. |
| April | - | - | 1 | 3 days. |
| June | - | - | 2 | Each 4 days. |
| July | - | - | 2 | One 15 days, the other 3 days. |
| August | - | - | 1 | 4 days. |

The fact that as many as seven cyclonic systems absolutely died out gradually when they reached high latitudes, from apparent failure of energy, is a point not without some interest in the study of the origin and subsequent maintenance of these atmospheric whirls.

An attempt was also made to study the anticyclones or areas of high barometrical readings. It seemed impracticable to study the position of the entire areas enclosed on each day by the isobars of 30·0 even of 30·1 inches, as these frequently embraced nearly the entire area of the maps. The isobar of 30·2 inches was then selected, as indicating the regions where the excess of barometrical pressure was most strongly accentuated, and as enclosing areas which were manageable.

A map was then drawn for each day on tracing paper showing the positions of these areas. These maps were then combined for successive days, by the method of a sort of composite portraiture and the several areas for the different days were drawn in different coloured chalks, the same sequence of colour being preserved throughout, and the last chart of each series being always reproduced as the first of the next.

It was found that, as a general rule, not more than three days could be combined without confusing the pictures.

These combination maps were then again combined in order to see what evidence was procurable of movement of the areas of excessive barometrical pressure (those of 30·2 inches and upwards) in the middle latitudes of the charts. It was not apparently of importance to trace those north of latitude 60° or even those over Europe, as both of these classes frequently passed beyond the limits of the charts.

Thus much, however, has become apparent that the area of excessive barometrical pressure, the Atlantic anticyclone, which lies over the Atlantic to the westward of the Canary Islands for the greater part of the year, is constantly being replenished by travelling anticyclonic areas which advance slowly from the westward. They move, therefore, in the same general direction as the cyclonic disturbances, the depressions, but at a much slower rate.

The number of such areas that have been definitely traced as advancing from the western portion of America to the Central

Atlantic during the 13 months is 15, and the dates of their first appearances are as follow :—

| | | | | |
|--|--|--|---|--|
| | 1882. August 30. September 13. October 6. " 16. " 25. | November 29. December 4. " 9. 1883. March 9. | April 2. " 8. July 17. August 1. " 13. " 25. | |
|--|--|--|---|--|

It will be seen that no motion of the nature indicated above was noticed between the middle of December and the beginning of March, nor again during May or June.

As regards these periods. During the winter the belt of readings above 30·2 ins. generally stretched across the Atlantic from Africa to North America. In January this was occasionally interrupted, but from February 1 to 21 there was hardly any change noticeable in this anticyclonic area, as far as the portion lying over the Atlantic is concerned.

As regards the second period, the reason that no anticyclones started from America to travel eastwards at that time is apparently that during the month of May, and June particularly, there was hardly a day on which areas of 30·2 ins. showed themselves over the United States.

In conclusion, it must be said that the endeavour to connect paths of anticyclones with paths of cyclonic disturbances at the same date by any obvious relation such as parallelism, &c., has not been successful.

NOTE B.

MEMORANDUM on the MEASUREMENT of SQUALLS shown on the TRACES yielded by ROBINSON ANEMOMETERS of the "STANDARD" PATTERN; submitted to the COUNCIL by RICHARD H. CURTIS, F.R.Met.Soc.

IN attempting to make measurements of squalls from the traces yielded by our standard-pattern anemometers, it is necessary to bear in mind three points connected with the instrument itself, each of which tends to limit the amount of reliance which can fairly be placed upon the results obtained, and also to make the operation of measuring more or less one of difficulty.

The first of these points is the cramped time-scale of the curves, in which an hour is represented by a space of less than four-tenths of an inch, strictly by $\cdot 365$ inch.

The second is the enormous reduction undergone by the revolutions of the cups before they are registered upon the papers. The circular path of the centre of one of the cups is $12 \cdot 57$ feet, and therefore since we still adopt Dr. Robinson's factor (3) for the relation between the velocity of the cups to that of the wind, one revolution of the cups is taken to indicate a horizontal movement of the air of $12 \cdot 57$ yards, and 7,000 revolutions will be required for the passage of every 50 miles of wind over the cups:— $12 \cdot 57 \times 7,000 = 87,990$ yards = 50 miles very nearly. But by means of a train of wheels this number of revolutions of the cups is reduced to *one*, and causes one turn of the cylinder carrying the spiral which makes the trace upon the paper as a piece of line $2 \cdot 75$ inches in vertical length.

The third point is also very important, namely, that the trace itself which is made by the pencil on the paper is not a fine, sharply-defined line, such as might be made by a pointed pencil, but a broad and rather ill-defined mark about $\cdot 04$ inch wide, produced by the combined movements of the spiral pencil as it is turned by the wind upon the paper, and of the paper as it is moved under the pencil by the clock.

The method adopted for tabulating the anemograms is to measure the number of miles recorded during 60 consecutive minutes. By this system we practically obtain the mean velocity for the hour, and the plan is therefore not adapted for giving a just idea of a gale, either as regards its maximum strength or its gustiness, the latter being a most important point to determine in any inquiry as to the destructive power of a gale.

It is quite true that it is only within certain limits that the traces of the Robinson anemometer can be used for obtaining information on these points, but an examination of the traces themselves will readily show that in many cases a great deal more can be got from them than is at present sought for.

In nearly every curve there may be seen certain deviations of a more or less marked character in the angle which the trace makes with the time lines. Each of these indicates a variation in the velocity of the wind, and they are therefore, under certain circumstances, of considerable importance, *e.g.*, as when it is desired to ascertain whether, during a gale, the wind attained to an extreme strength, beyond anything, that is to say, which the hourly totals measured would indicate. These features of the curves are sometimes very marked with strong winds, and it is these which we are accustomed to speak of—I think erroneously—as “squalls.”

But the ordinary squall, the sudden isolated gust of wind, lasting generally for only a few seconds, is of far too brief duration to produce any appreciable effect upon a trace made under such conditions as those just pointed out, and therefore it may be said at once that singly they cannot be detected upon these anemograms. No doubt during the continuance of such gusts the velocity of the cups becomes very high indeed; but even assuming it to reach such a rate as 250 miles per hour, in which case the cups should make 10 revolutions per second, and to maintain that rate for 15 seconds—which is probably an extremely liberal allowance in both directions—we should then register only one mile of wind, which would be shown by a piece of trace only $\cdot 055$ inch in length and almost as broad as it was long.

There is no doubt that gales of wind differ a good deal in character as regards the prevalence of squalls, some being remarkable for the frequency and strength of the gusts while in others this feature is comparatively rare. The records of the “bridled” anemometer, however, enable us to learn a good deal about them, and of the way in which they probably influence the anemograms of the “Robinson” cup instrument. What ordinarily takes place seems to be much as follows:—

First of all there is a fluctuation of the wind within certain limits (which varies in nearly every gale) above and below its average strength, the variations following each other in quick succession so that even on the bridled anemogram, which has a very open time-scale, it is impossible to pick out any individual one except when the exceptionally wide time-scale, which can be used when desired, is in operation. The resulting trace is a broad mass of shading produced by the rapid oscillations of the pencil, the width of the belt of shading depending upon the average strength of these minor gusts.

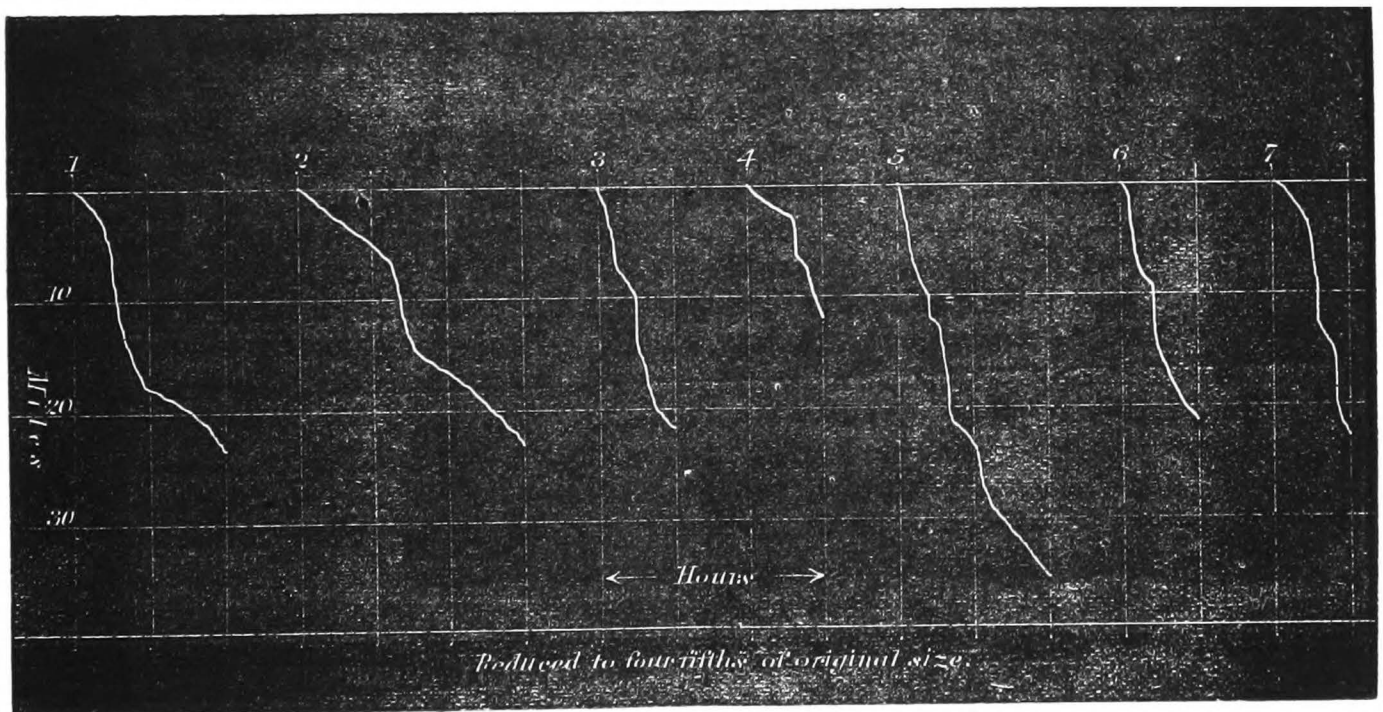
In addition to these, there are always a number of heavier gusts which cause the pencil to pass beyond the upper limits of the shaded belt, and which occur at longer intervals, say of a few minutes, although not unfrequently a number of them will succeed each other very quickly. The strength and frequency of these squalls varies very much in different gales, in some being only rarely experienced, while in others they are extremely frequent and violent,—with perhaps a few of very exceptional strength.

The very open time-scale which can be used at pleasure with the bridled anemometer allows these variations of force to be distinctly seen and followed.

From this, therefore, it would seem that the main portion of the traces of the Robinson instrument is really built up of a succession of tiny pieces of line inclined at varying angles to the hour-lines, but each piece so small that with the conditions under which the trace is made they cannot be separately distinguished, and they therefore form in the aggregate a line which roughly approximates more or less to a straight line, and which by summing up the gusts and lulls gives at least an approximation to the *average* velocity over the period selected for measurement.

When, however, the squalls are more than usually heavy and frequent, they are able to produce an effect upon the trace of the Robinson instrument which can be distinctly seen, the inclination of the trace being altered over a space sufficiently great to allow in many cases of its being measured with considerable accuracy. These are the appearances of the line which we commonly call "squalls," but which would probably be more correctly described as due to a *succession of squalls* rather than to one.

That these deviations of the line are sufficiently well defined to be readily recognised and dealt with, and that they are also of sufficient importance as to be worthy of measurement, the following specimens traced from a few Holyhead and Yarmouth curves will show :—



1. Yarmouth, December 20, 1887.
2. " " 20, 1886.
3. Holyhead, October 9, 1886.
4. " September 17, 1886.
5. " January 10, 1889.
6. " May 28, 1886.
7. " November 20, 1888.

The first of these examples shows how easily the hourly measurements may give a totally wrong idea of the wind-force :— two consecutive hourly measurements of 11 miles each were recorded here, the temporary increase of velocity being divided between them, and in this way the fact that for a portion of the time the velocity was fully 35 miles per hour was hidden altogether.

With reference to the method which should be adopted for measuring these “squalls” it is clear that, first of all, care must be taken to avoid any chance of mistaking deviations of the line due to mechanical defects for those really caused by augmentations of the wind velocity. This, however, is easily guarded against by a little intelligent inspection of the curve, since such faults nearly always repeat themselves at corresponding portions of every line. Further, since with high velocities, very small differences of angle in the trace make large differences in the corresponding velocities, no piece of line should, as a rule, be measured which is under certain minimum dimensions, say, of 10 minutes of the horizontal, or of 10 miles of the vertical scale.

For the measurements themselves the plan which I have myself adopted appears to me, after a good many trials of it and of others, to be the best and easiest, viz., to lay a line etched on a glass plate fairly along the centre of the portion of trace to be measured, and by means of an arc attached to the line to note the angle it makes with the time-lines, and then from a table of corresponding velocities take out the hourly rate to which it is equivalent.

For the purpose, however, of quickly deciding whether a piece of trace reaches the given minimum limit of 10 miles in 15 minutes, which the Council recently decided to fix, I have upon the same scale etched a line enclosing a space of 10 minutes in one direction and of 10 miles in the other, and this being moved across a curve will readily show whether any portion of it reaches the minimum fixed.

In conclusion, however, I would like to add that although these “squalls” are really indications of important increases of wind-force—caused by actual revolutions of the cups and not due to mechanical eccentricities,—yet it ought to be remembered that absolutely nothing is at present known about instrumental errors at such high velocities as they indicate ; and further that, when with lower velocities we speak of so many miles per hour, we quote velocities which we know to be too high, since all recent investigations have shown Dr. Robinson’s factor to be about one-sixth too great.

APPENDIX.

APPENDIX I.

LIST of CAPTAINS (and Officers) who have sent in Logs classed as "Excellent" during the year ending March 31, 1889. 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 "Excellent" Logs. | Ship. |
|---|-----------------------------|----------------------------------|
| Adamson, A. W. - - | 6 | S.S. "Kaisar-i-Hind." |
| Alderton, T. J. - - | 4 | S.S. "Brindisi." |
| Aldrich, Pelham, R.N. - | 16 | H.M.S. "Egeria." |
| Atkinson, S. P. H. - - | 3 | "Prior Hill." |
| Balfour, Lieut. Andrew, R.N. - | 23 | H.M.S. "Rambler." |
| Barker, D. Wilson, F.R. Met. Soc. | 11 | S.S. "International." |
| Becket, Alexander - - | 10 | "Amana." |
| Belding, R. - - - | 1 | "Atlantic." |
| Bennett, E. C. - - - | 13 | "Thessalus." |
| Blackburn, Mr. H. S. - - | 6 | S.S. "Robilla." |
| Bourke, Edmund G., R.N., F.R. Met. Soc. | 6 | H.M.S. "Hyacinth." |
| Bright, H. - - - | 3 | "Beltana." |
| Briscoe, R. F. - - - | 2 | S.S. "Kaisar-i-Hind." |
| Brown, E. - - - | 3 | "Moorhill." |
| Buchan, James - - - | 20 | "Oban Bay." |
| Cameron, J. G. - - - | 3 | S.S. "Adriatic." |
| Campbell, Hugh - - - | 7 | "Zemindar." |
| Campbell, Robert - - - | 2 | S.S. "Elton." |
| Carr, H. C. - - - | 3 | "Superb." |
| Chaddock, E. T. - - - | 1 | "Elvira." |
| Chaddock, G. A. - - - | 5 | "Elissa." |
| Clapp, Staff Comr. E. S., R.N. | 8 | L.H. Tender "Richmond." |
| Clark, Alexr. - - - | 1 | S.S. "Cardiganshire." |
| Clarke, Commr. A. C., R.N. - | 2 | H.M.S. "Espègle." |
| Clarke, James - - - | 10 | S.S. "Olbers." |
| Couper, William - - - | 1 | "Clackmannanshire." |
| Craig, E. A. - - - | 1 | S.S. "Claymore." |
| Crichton, A. T. - - - | 3 | S.S. "Colina," and S.S. "Circe." |
| Cromarty, D. S. - - - | 2 | "Cassandra." |
| Crowley, C. - - - | 2 | "Alexander Lawrence." |
| Crutchley, W. C., R.N.R. - | 16 | S.S. "Kaikoura." |
| Dart, L. C. - - - | 9 | "Alcester." |
| Dawson, Comr. L. S., R.N. - | 6 | H.M.S. "Sylvia." |
| Douglas, Lt. H. H., R.N. - | 6 | H.M.S. "Sylvia." |
| Draper, R. - - - | 6 | S.S. "Monarch." |
| Dunbar, J. I. - - - | 14 | S.S. "Arracan." |
| Dyke, A. H. - - - | 2 | S.S. "La Plata." |
| Dyke, H. W. - - - | 6 | "Accrington." |

| Captain's Name. | Number of "Ex- cellent" Logs. | Ship. |
|--|--|---|
| Ellery, William - - | 19 | "Talookdar," "Majestic," and "Holkar." |
| England, Thomas - - | 7 | "Jane." |
| Exham, T. K., F.R.A.S. - | 3 | S.S. "Esk." |
| Field, Lieut. and Comr. A. M., R.N. | 3 | H.M.S. "Dart." |
| Fraser, W. D. - - | 3 | "Thomas S. Stowe." |
| Fullarton, D. - - | 4 | "Timaru." |
| Gordon, James - - | 14 | S.S. "City of Agra." |
| Graham, W. V. - - | 5 | "Bolan." |
| Gray, David - - | 15 | S.S. "Eclipse." |
| Gray, John - - | 12 | S.S. "Hope." |
| Haselwood, R. W. B. - - | 2 | S.S. "Kaisar-i-Hind" and S.S. "Ro- hilla." |
| Hepworth, C. M. W., R.N.R., F.R.Met. Soc. | 7 | S.S. "Port Pirie." |
| Hicks, G. M. - - | 1 | S.S. "Nile." |
| Hird, W. - - | 4 | "Marlborough." |
| Hoskyn, Comr. R. F., R.N. - | 17 | H.M.S. "Myrmidon." |
| Hughes, W. P. - - | 9 | "Candahar." |
| James, W. D., Esq. - - | 1 | "Lancashire Witch." |
| Janes, George - - | 3 | "Middlesex." |
| Jennings, R. C. - - | 1 | S.S. "Colina." |
| Jones, Richard - - | 2 | "Thomas Hilyard." |
| Jones, S. Griff - - | 7 | "Hermine." |
| Kemp, A. H. - - | 2 | "Hudson." |
| Kiddle, Sub-Lieut. E. W., R.N. | 3 | H.M.S. "Egeria." |
| King, J. W. - - | 3 | "Philomene." |
| Leportier, T. - - | 8 | S.S. "Mira." |
| Long, Mr. J. C. - - | 4 | S.S. "Kaisar-i-Hind." |
| MacHugh, R. H. - - | 3 | S.S. "Ching Wo." |
| McLean, Archibald - - | 6 | S.S. "Concordia." |
| Marshall, Frederick - - | 4 | "Berkshire." |
| Maxwell, Joseph - - | 4 | "Oamaru." |
| Mesnard, Thomas - - | 7 | "Sierra Miranda." |
| Millican, J. W. - - | 3 | "Myrtle Holme." |
| Milne, W. F. - - | 6 | S.S. "Esquimaux." |
| Milner, W. H. - - | 5 | S.S. "Avon." |
| Moignard, Philip - - | 3 | "Astoria." |
| Molony, E. J. - - | 7 | "British Merchant." |
| Moore, W. U., R.N. - - | 13 | H.M.S. "Ranbiler." |
| Munn, L. A. - - | 1 | S.S. "Durban." |
| Murdoch, Peter - - | 2 | "Sierra Lucena." |
| Murray, Alexr. - - | 6 | S.S. "Perseverance." |
| Newton, Mr. T. C., F.R.Met. Soc. | 5 | S.S. "Minia." |
| Norman, Francis - - | 6 | "Cape Clear." |
| North, W. G. - - | 10 | S.S. "Tiger." |
| Parry, Moses, F.R.Met.Soc. - | 13 | S.S. "Prydain." |
| Parson, G. F. - - | 8 | "Earnock." |
| Pearson, C. W. - - | 28 | S.S. "Strathleven." |
| Peebles, R. - - | 13 | "Braeadale." |
| Powles, F. W. - - | 3 | S.S. "Essequibo." |
| Pritchard, Lieut. C. E., R.N. - | 3 | H.M.S. "Espiegle." |

| Captain's Name. | Number of "Ex- cellent" Logs. | Ship. |
|-------------------------------|--|-----------------------------|
| Quaile, D. W. A. - | 3 | "Orissa." |
| Randall, William - | 10 | "Laomene." |
| Read, G. W., F.R.G.S. - | 4 | S.S. "Auretta." |
| Richardson, Mr. W. H. - | 3 | S.S. "Auretta." |
| Rigaud, H. C. - | 1 | S.S. "Derwent." |
| Ritchie, Alexander - | 1 | "Four Winds." |
| Rowsell, P. - | 1 | S.S. "Tagus." |
| Russell, C. J. - | 9 | "Khyber" and "Belfast." |
| Sargent, A. H. - | 4 | "Glenlora." |
| Scott, George - | 4 | "Houghton Tower." |
| Shearer, George - | 9 | "Thetis." |
| Simpson, Alexander - | 10 | S.S. "Australasian." |
| Smith, Lieut. F. B., R.N. - | 7 | H.M.S. "Myrmidon." |
| Spooner, I. D. - | 1 | S.S. "Tamar." |
| Spratly, W. - | 12 | S.S. "Mozart." |
| Sturdee, H. K. - | 11 | L.H. Tender "Richmond." |
| Swinton, W. W. - | 1 | "Banffshire." |
| Thompson, J. E. - | 2 | S.S. "Monarch." |
| Trott, Samuel, F.R.Met.Soc. - | 13 | S.S. "Minia." |
| Trunks, H. - | 3 | "Aldbrough." |
| Walker, Henry - | 10 | S.S. "Cephalonia." |
| Waring, William - | 15 | S.S. "Breconshire." |
| West, Frederick - | 2 | S.S. "Port Adelaide." |
| Wheaton, N. J. - | 8 | "Eliza." |
| Wilson, John - | 3 | S.S. "Ethiopia." |
| Wilson, W. - | 4 | "Horsa." |
| Woolward, Robert - | 3 | S.S. "Don" and S.S. "Nile." |

Names of observers deceased printed in italics.

LIST of DOCUMENTS received from SHIPS.

| Captain's Name. | Ship. | Voyage. | Year. |
|---|----------------------|--|---------|
| ¹ Adamson, A. W. - | S.S. Kaiser-i-Hind - | Calcutta, via Suez - | 1888 |
| ² Alderton, T. J. - | S.S. Brindisi - | " " " " - | 1888 |
| ³ Aldrich, Pelham, R.N. - | H.M.S. Egeria - | Mauritius, King George's Sound, Hobart, Sydney, and Auckland - | 1887-88 |
| ⁴ " " - | " - | Australia - | 1888 |
| ⁴ " " - | " - | " " " " - | 1888 |
| Anderson, Charles - | S.S. Achilles - | China, via Suez - | 1886-87 |
| " " - | " - | " " " " - | 1887-88 |
| ⁵ Armstrong, G. R. - | S.S. Elbe - | River Plate - | 1888 |
| Asquith, W. - | S.S. Deucalion - | China, via Suez - | 1886-87 |
| " " - | " - | " " " " - | 1887 |
| " " - | " - | " " " " - | 1887-88 |
| Atkinson, S. P. H. - | Barque Priorhill - | Port Elizabeth, Lyttelton - | 1887-88 |
| ⁶ Bailey, T. S. - | Drumcraig - | Melbourne, Newcastle (N.S.W.), San Francisco - | 1887-88 |
| ⁷ Barker, D. W., R.N.R., F.R. Met. Soc. - | S.S. International - | Massowah, via Suez, Naples - | 1887-88 |
| Batt, H. - | S.S. Hector - | China, via Suez - | 1887 |
| " " - | " - | " " " " - | 1887 |
| Becket, Alexander - | Amana - | Cape Town, Newcastle (N.S.W.), San Francisco, Port Townshend (W.I.), Melbourne - | 1887-88 |
| Belding, R. - | Barque Atlantic - | Buenos Ayres, Valparaiso, Tal- cahuano - | 1887-88 |
| " " - | " - | Buenos Ayres, Port Nolloth - | 1888-89 |
| Bennett, E. C. - | Thessalus - | Sydney, San Francisco, Portland (Or.) - | 1887-88 |
| " " - | " - | " " " " - | 1887 |
| Bigley, W. B. - | S.S. Diomed - | China, via Suez - | " |
| Bourke, Comr. Ed- mund, R.N. - | H.M.S. Hyacinth - | Panama and coast of Chili and Peru - | 1887-88 |
| " " - | " - | " " " " - | 1888 |
| Brehant, G. J. - | Barque Achievement - | Chile, Sandwich Islands - | 1887-88 |
| Bremner, A. W. - | S.S. Ulysses - | Callao, Iquique - | 1886-87 |
| Bright, H. - | Barque Beltana - | China, via Suez - | " |
| " " - | " - | Adelaide, Newcastle (N.S.W.), Tahiti - | 1888-89 |
| Brisco, R. W. - | Barque Ponemah - | Callao, Coquimbo, Baltimore, Bull River, U.S.A. - | 1887-88 |
| ¹ Briscoe, R. F. - | S.S. Kaiser-i-Hind - | " " " " - | 1888 |
| ¹ " " - | " - | Calcutta, via Suez - | 1888-89 |
| Brown, E. - | Barque Moorhill - | Bombay, via Suez - | " |
| " " - | " - | Paysandu, Monte Video, Pernam- buco - | 1888 |
| " " - | " - | " " " " - | 1887 |
| Brown, R. J. - | S.S. Titon - | China, via Suez - | 1887-88 |
| Buchan, James - | Barque Oban Bay - | Monte Video, Esquimalt, Astoria - | 1888 |
| ⁸ Buckler, J. H. - | S.S. Dec - | West Indies - | 1888 |
| Butler, S. H. - | S.S. Priam - | China, via Suez - | 1886-87 |
| " " - | " - | " " " " - | 1887 |
| " " - | " - | " " " " - | 1887-88 |
| ⁹ Cameron, J. G. - | S.S. Adriatic - | " " " " - | 1887-88 |
| " " - | " - | New York - | 1888 |
| " " - | " - | " " " " - | 1887-88 |
| ¹⁰ Campbell, Archibald - | S.S. Circassia - | " " " " - | 1888 |
| Campbell, Hugh - | Zemindar - | Calcutta - | 1888 |
| ¹¹ Campbell, Robert - | S.S. Elton - | India via Suez - | 1888 |
| " " - | " - | " " " " - | 1888 |
| " " - | " - | " " " " - | 1888-89 |
| " " - | " - | " " " " - | 1887-88 |
| Carr, H. C. - | Superb - | Melbourne - | 1888-89 |
| ¹² Chaddock, E. T. - | Barque Elvira - | Altata (Mexico) - | " |
| Chaddock, G. A. - | Barque Elissa - | Rosario, Mauritius, Bombay, Chittagong - | 1887-88 |
| " " - | " " - | Mauritius, Kurrachee, Rangoon, Boston - | 1888 |
| " " - | " " - | Rangoon, Boston, Cadiz - | 1888-89 |
| Chrimes, H. - | S.S. Sarpedon - | China, via Suez - | 1887 |

| Captain's Name. | Ship. | Voyage. | Year. |
|--|-------------------------------|--|---------|
| ¹³ Clapp, Staff-Comr. E. S., R.N. | Schooner Richmond | Bahamas - - - - | 1887-88 |
| " " " | " " | " - - - - | 1888 |
| " " " | " " | " - - - - | 1888 |
| ¹⁴ Clark, Alexander | S.S. Cardiganshire | China and Japan, viâ Suez | 1888 |
| ¹⁵ Clarke, Comr. A. E., R.N. | H.M.S. Espiègle | Madeira, Monte Video, Sandy Point, Port Otway, and Co- quimbo - - - - | 1887-88 |
| ¹⁵ " " " | " " | Coquimbo, Valparaiso, Honolulu, Esquinialt - - - - | 1888 |
| Clarke, James | S.S. Olbers | West coast of South America | 1888 |
| Couper, William | Clackmannanshire | Adelaide, Wallaroo - - - - | 1887-88 |
| Craig, E. A. | S.S. Claymore | China, viâ Suez - - - - | 1888 |
| Crighton, A. T. | S.S. Colina | Quebec - - - - | 1887 |
| " " " | S.S. Circe | " - - - - | 1888 |
| Cromarty, D. S. | Barque Cassandra | Sydney, Port Augusta - - - - | 1887-88 |
| Crowley, C. | Barque Alexander Lawrence. | Sydney, Wilmington, Portland (Oregon) - - - - | 1887-88 |
| " " " | " " | Sydney - - - - | 1888-89 |
| ¹⁶ Crutchley, W. C., R.N.R. | S.S. Kaikoura | Cape Town, Hobart, Lyttelton, Rio Janeiro, Santa Cruz - - - - | 1888 |
| ¹⁶ " " " | " " | Cape Town, Hobart, Wellington, Rio Janeiro - - - - | 1888 |
| Dart, L. C. | Alcester | India - - - - | 1887-88 |
| ¹⁷ Dawson, Comr. L. S., R.N. | H.M.S. Sylvia | Red Sea, Gulf of Volo - - - - | 1888 |
| ¹⁸ Dickinson, L. R. | S.S. Elbe | River Plate - - - - | 1888 |
| ¹⁹ Draper, R. | S.S. Monarch | Coast of British Isles - - - - | 1888 |
| Dunbar, J. I. | S.S. Arracan | India, viâ Suez - - - - | 1887-88 |
| " " " | " " | " " - - - - | 1888 |
| " " " | " " | " " - - - - | 1888-89 |
| Dunlop, George | S.S. Belair | West Indies - - - - | 1887 |
| ²⁰ Dyke, A. Hart | S.S. La Plata | South America - - - - | 1888 |
| ²¹ " " " | " " | West Coast of South America - - - - | 1888-89 |
| Dyke, H. W. | Accrington | Calcutta, Mauritius, New York - - - - | 1885-88 |
| Ellery, William | Talookdar | Calcutta - - - - | 1887-88 |
| " " " | Majestic | " - - - - | 1888 |
| " " " | Holkar | " - - - - | 1888-89 |
| England, Thomas | Barque Jane | Matanzas (Cuba), Philadelphia, Havana, Buenos Ayres, Ship Island, Pascagoula - - - - | 1887-88 |
| Exham, T. K., F.R.A.S. | S.S. Esk | West Indies - - - - | 1888 |
| " " " | " " | " - - - - | 1888 |
| ²² Field, Lieut. " and Comr. A. M., R.N. | H.M.S. Dart | Australia - - - - | 1888 |
| ²² " " " | " " | Townsville, Cooktown, New Guinea - - - - | 1888 |
| ²² " " " | " " | Sydney, Tasmania - - - - | 1888 |
| Fordyce, William | County of Haddington | Calcutta - - - - | 1887-88 |
| Fraser, W. D. | Barque Thomas S. Stowe | Brisbane, Newcastle, N.S.W., Port- land (Oregon) - - - - | 1887-88 |
| Fullarton, D. | Timaru | Auckland - - - - | 1888 |
| Gibson, M. | Jessie Readman | New Zealand - - - - | 1887-88 |
| ²³ Gordon, J. | S.S. City of Agra | Calcutta, viâ Suez - - - - | 1888 |
| Gould, H. W. | S.S. Ocean King | New Orleans, Newport (Newfound- land), Bremerhaven, Norfolk (V. A.) - - - - | 1888-89 |
| ²² Graham, W. V. | Bolan | Calcutta - - - - | 1887-88 |
| Gray, David | S.S. Eclipse | Greenland - - - - | 1888 |
| Gray, John | S.S. Hope | " - - - - | 1888 |
| Gray, Robert | S.S. Port Phillip | Australia, viâ Cape and Suez - - - - | 1888-89 |
| Grier, J. K. | S.S. Antenor | China, viâ Suez - - - - | 1887 |
| Grier, John | " " | " - - - - | 1887 |
| ²⁵ Griffin, E. J., R.N.R. | S.S. Moor | Cape Town - - - - | 1888 |
| ²⁶ " " " | " " | " - - - - | 1888 |

| Captain's Name. | Ship. | Voyage. | Year. |
|---|-------------------------------|--|---------|
| Guthrie, W. E. | S.S. Bellerophon | China, viâ Suez | 1886-87 |
| " | " | " | 1887 |
| Hannah, W. T. | S.S. Glaucus | " | 1887 |
| " | " | " | 1887 |
| ¹ Haselwood, R. W. B. | S.S. Kaisar-i-Hind | India, via Suez | 1888 |
| ²⁷ " " | S.S. Rohilla | Calcutta, viâ Suez | 1888-89 |
| ²⁸ Hepworth, C. M. W., R.N.R. | S.S. Port Pirie | Adelaide, viâ Cape of Good Hope, Newcastle (N.S.W.), Java, Bangkok | 1887-88 |
| ²⁹ Hicks, G. M. | S.S. Nile | Buenos Ayres | 1888 |
| Hird, W. | Marlborough | New Zealand | 1887-88 |
| Horne, James | Loch Garry | Melbourne | 1888-89 |
| ³⁰ Hoskyn, Comr. R. F., R.N. | H.M.S. Myrmidon | Townsville, Sydney, Tasmania | 1887-88 |
| Hughes, W. P. | Candahar | Calcutta | 1887-88 |
| Hutchinson, John | S.S. Orestes | China, viâ Suez | 1887 |
| " | " | " | 1887 |
| ³¹ Irving, P. J. | S.S. Celtic | New York | 1888 |
| Jackson, Charles | S.S. Palamed | China, viâ Suez | 1887 |
| " | " | " | 1887 |
| Jackson, M. H. F. | S.S. Telamon | " | 1887 |
| " | " | " | 1887 |
| Jackson, T. S. | S.S. Palinurus | " | 1887 |
| James, W. D. | Schooner Lancashire Witch. | Spitzbergen, Nova Zembla | 1888 |
| Janes, George | Middlesex | Singapore, Chittagong | 1888-89 |
| Jennings, R. C. | S.S. Colina | Montreal | 1888 |
| ³² Jones, E. T. | S.S. Arab | Cape Town | 1888 |
| Jones, Henry | S.S. Telemachus | China, viâ Suez | 1887 |
| Jones, Richard | Thomas Hilyard | Rio Janeiro, Quebec | 1888 |
| Jones, S. Griff. | Barque Hermine | Vancouver, Valparaiso, Taltol, Talcahuano | 1888-89 |
| Kemp, A. H. | Barque Hudson | New Zealand | 1887-88 |
| King, J. W. | Philomene | Mauritius, Adelaide, Newcastle (N.S.W.), Valparaiso, Rotterdam | 1887-89 |
| ³³ Lamb, O. | Iron Cross | New York, Chittagong, Salem (U.S.A.) | 1887-88 |
| Lapage, W. P. | S.S. Anchises | China, viâ Suez | 1887 |
| Lelean, J. E. | Barque Delscey | Valparaiso, Lobos de Afuera, Mauritius, Buenos Ayres, Chile | 1886-88 |
| Leportier, T. | S.S. Mira | Calcutta, viâ Suez | 1888 |
| " | " | " | 1888-89 |
| Lourison, G. M. | Eaton Hall | San Francisco | 1888-89 |
| McGonnell, James | Barque Matilda C. Smith | Ensenada (Brazil), Mobile | 1888-89 |
| Machugh, R. H. | S.S. Ching Wo | China, viâ Suez | 1888 |
| " | " | " | 1888-89 |
| ⁹ McLean, A. | S.S. Concordia | Montreal | 1887-88 |
| " | " | " | 1888 |
| Marshall, Frederick | Barque Berkshire | Rangoon | 1887-88 |
| Maxwell, Joseph | Oamaru | Auckland, Wellington | 1888 |
| Mesnard, Thomas | Sierra Miranda | India | 1887-88 |
| ³⁴ Miller, A. T., R.N. | H.M.S. Conway | Birkenhead | 1888 |
| Millican, J. W. | Barque Myrtle Holme | Adelaide | 1887-88 |
| " | " | " | 1888-89 |
| Milligan, John | S.S. Jason | China, viâ Suez | 1887 |
| " | " | " | 1887-88 |
| Milligan, Samuel | " | " | 1886-87 |
| " | S.S. Stentor | " | 1887 |
| Milne, W. F. | S.S. Esquimaux | St. John's (Newfoundland), Davis Straits | 1888 |
| ⁹ Milner, W. H. | S.S. Avon | West Indies | 1888 |
| ³⁵ " " | " | " | 1888 |
| ³⁶ " " | " | " | 1888 |
| ³⁵ " " | " | " | 1888-89 |
| Mitchell, George | S.S. Trinacria | Naples, New York | 1887-88 |
| " | " | Naples, New York, Miramichi, Mediterranean Ports | 1888 |

| Captain's Name. | Ship. | Voyage. | Year. |
|--|---|---|--|
| Mitchell, John - Moignard, Philip - | Cape Verde - Barque Astoria - | Vancouver, Melbourne, Wallaroo San Diego (Cal.), Tacoma (Puget Sound) - - - | 1888 1887-88 |
| Molony, E. J. - 37 Moore, W. Ushorne, R.N. - | British Merchant - H.M.S. Rambler - | Sydney, San Francisco - China Sea - - - | 1888-89 1888 |
| 87 " " - 38 Munb, L. A. - | " " - S.S. Durban - | " " - Cape Town - - - | 1888 1888-89 |
| Munro, George - Murdoch, Peter - Murray, Alexander - Nelson, R. - | Barque Peeblesshire - Sierra Lucena - S.S. Perseverance - S.S. Menelaus - | Brisbane, Portland (Oregon) - India - - - Cumberland Strait - China, via Suez - | 1887-88 1887-88 1887-88 1886-87 |
| " " - Nish, H. - | " " - S.S. Cyclops - | " " - China, Madras, via Suez - | 1887-88 1886-87 |
| " " - Norman, Francis - | " " - Barque Cape Clear - | " " - Wellington (N.Z.), Newcastle (N.S.W.), Callao, Peru - | 1887-88 1888 |
| North, W. G. - " " - " " - | S.S. Tiger - " - " - | Hamburg - " - - - " - - - | 1888 1888-89 1887-88 |
| 39 Owen, Owen - Parry, Moses - | Barque Cordelia - S.S. Prydain - | Valparaiso - Savona, Philadelphia, New Orleans, Norfolk (Va.), Antwerp, Civita Vecchia, Odessa - | 1887-88 1887-88 |
| " " - " " - | " - " - | Odessa, Antwerp, Bremerhaven, Sevastopol, Constantinople - | 1888 |
| 9 Parson, G. F. - Pasifull, E. J. - Pattman, R. - | Earnock - Rahane - Loch Torridon - | Adelaide, Wallaroo - San Francisco - Calcutta and New York - | 1888 1888 1887-88 |
| 40 Pearson, C. W. - Peebles, Robert - | S.S. Strathleven - Barque Bracadale - | Yokohama, New York, via Suez - Calcutta - - - | 1888 1887-88 |
| " " - Powles, F. W. - | " " - S.S. Essequibo - | " " - West Indies - - - | 1888-89 1888 |
| " " - " " - | " " - " " - | " " - " " - | 1888 1888 |
| 9 Purdy, Thomas - " " - " " - | S.S. Dardanus - " - " - | China, via Suez - China, Madras, via Suez - China, via Suez - | 1886-87 1887 1887-88 |
| 9 Quaille, D. W. A. - Randall, W. - | Orissa - Laomene - | Townsville, San Francisco - Calcutta, Mauritius, New York - | 1887-88 1888 |
| 41 Read, G. W., F.R.G.S., F.R.A.S. - | S.S. Aurette - | India, via Suez - - - | 1888 |
| 41 " " - " " - | " - " - | Odessa - - - Genoa, Odessa - - - | 1888 1888-89 |
| Reynolds, Robert, R.N.R. - | S.S. German - | Table Pay - - - | 1888 |
| 42 Rigaud, H. C. - Riley, James - Ritchie, Alexander - | S.S. Derwent - S.S. Ajax - Four Winds - | Barbados - China, via Suez - India - - - | 1888 1887 1887-88 |
| 43 Rowsell, P. - Russell, C. J. - | S.S. Tagus - Khyber - | River Plate - India - - - | 1888 1887-88 |
| " " - Rutherford, G. D. - Sargent, A. H. - Saul, John - Scale, R. F. - | Belfast - Barque King Alfred - Barque Glenora - Barque Coronilla - S.S. Laertes - | Calcutta - San Francisco, Portland (Or.) - New Zealand - Hobart, Port Pirie - China, via Suez - | 1888-89 1887-88 1888 1887-88 1886-87 |
| " " - Scott, George - | " " - Hoghton Tower - | " " - Chittagong, Mauritius - | 1887 |
| " " - Scougall, H. - | " " - Barque Tynron - | Mauritius, Chittagong, St. Helena Freemantle (W.A.), Mauritius, Adelaide, Port Natal, Melbourne - | 1888 1887-88 |
| Shearer, George - Simpson, Alexander - | Barque Thetis - S.S. Australasian - | Pisagua - Melbourne, via Cape Town, Mauri- tius, Bombay, via Suez - | 1887-88 1887-88 |
| " " - | " - | Cape Town, Australia - | 1888-89 |

| Captain's Name. | Ship. | Voyage. | Year. |
|---|---------------------|---|---------|
| Mitchell, John | Cape Verde | Vancouver, Melbourne, Wallaroo | 1888 |
| Moignard, Philip | Barque Astoria | San Diego (Cal.), Tacoma (Puget Sound) | 1887-88 |
| Molony, E. J. | British Merchant | Sydney, San Francisco | 1888-89 |
| ²⁷ Moore, W. Usborne, R.N. | H.M.S. Rambler | China Sea | 1888 |
| ²⁷ " " | " " | " " | 1888 |
| ²⁸ Munn, L. A. | S.S. Durban | Cape Town | 1888-89 |
| Munro, George | Barque Peeblesshire | Brisbane, Portland (Oregon) | 1887-88 |
| Murdoch, Peter | Sierra Lucena | India | 1887-88 |
| Murray, Alexander | S.S. Perseverance | Cumberland Strait | 1887-88 |
| Nelson, R. | S.S. Menelaus | China, via Suez | 1886-87 |
| " " | " " | " " | 1887-88 |
| Nish, H. | S.S. Cyclops | " " | 1886-87 |
| " " | " " | China, Madras, via Suez | 1887 |
| Norman, Francis | Barque Cape Clear | Wellington (N.Z.), Newcastle (N.S.W.), Callao, Peru | 1887-88 |
| North, W. G. | S.S. Tiger | Hamburg | 1888 |
| " " | " " | " " | 1888 |
| " " | " " | " " | 1888-89 |
| ²⁹ Owen, Owen | Barque Cordelia | Valparaiso | 1887-88 |
| Parry, Moses | S.S. Prydain | Savona, Philadelphia, New Orleans, Norfolk (Va.), Antwerp, Civita Vecchia, Odessa | 1887-88 |
| " " | " " | Odessa, Antwerp, Bremerhaven, Sevastopol, Constantinople | 1888 |
| ³ Parson, G. F. | Earnock | Adelaide, Wallaroo | 1888 |
| Pasifull, E. J. | Rahane | San Francisco | 1888 |
| Pattman, R. | Loch Torridon | Calcutta and New York | 1887-88 |
| ⁴⁰ Pearson, C. W. | S.S. Strathleven | Yokohama, New York, via Suez | 1888 |
| Peebles, Robert | Barque Bracadale | Calcutta | 1887-88 |
| " " | " " | " " | 1888-89 |
| Powles, F. W. | S.S. Essequibo | West Indies | 1888 |
| " " | " " | " " | 1888 |
| ⁹ " " | " " | " " | 1888 |
| Purdy, Thomas | S.S. Dardanus | China, via Suez | 1886-87 |
| " " | " " | China, Madras, via Suez | 1887 |
| " " | " " | China, via Suez | 1887-88 |
| ⁵ Quile, D. W. A. | Orissa | Townsville, San Francisco | 1887-88 |
| Randall, W. | Laomene | Calcutta, Mauritius, New York | 1888 |
| ⁴¹ Read, G. W., F.R.G.S., F.R.A.S. | S.S. Aurette | India, via Suez | 1888 |
| ⁴¹ " " | " " | Odessa | 1888 |
| ⁴¹ " " | " " | Genoa, Odessa | 1888-89 |
| Reynolds, Robert, R.N.R. | S.S. German | Table Bay | 1888 |
| ⁴² Rigaud, H. C. | S.S. Derwent | Barbados | 1888 |
| Riley, James | S.S. Ajax | China, via Suez | 1887 |
| Ritchie, Alexander | Four Winds | India | 1887-88 |
| ⁴³ Rowsell, P. | S.S. Tagus | River Plate | 1888 |
| Russell, C. J. | Khyber | India | 1887-88 |
| " " | Belfast | Calcutta | 1888-89 |
| Rutherford, G. D. | Barque King Alfred | San Francisco, Portland (Or.) | 1887-88 |
| Sargent, A. H. | Barque Glenlora | New Zealand | 1888 |
| Saul, John | Barque Coronilla | Hobart, Port Pirie | 1887-88 |
| Scale, R. F. | S.S. Laertes | China, via Suez | 1886-87 |
| " " | " " | " " | 1887 |
| Scott, George | Hoghton Tower | Chittagong, Mauritius | 1887-88 |
| " " | " " | Mauritius, Chittagong, St. Helena | 1888 |
| Seagull, H. | Barque Tynron | Freemantle (W.A.), Mauritius, Adelaide, Port Natal, Melbourne | 1886-88 |
| Shearer, George | Barque Thetis | Pisagua | 1887-88 |
| Simpson, Alexander | S.S. Australasian | Melbourne, via Cape Town, Mauritius, Bombay, via Suez | 1887-88 |
| " " | " " | Cape Town, Australia | 1888-89 |

| Captain's Name. | Ship. | Voyage. | Year. |
|--------------------------------|-------------------------|--|---------|
| Simpson Alexander | Barquentine Traveller - | Greenland - - - | 1888 |
| ⁸⁴ Smith, J. H. | H.M.S. Worcester - | Greenhithe - - - | 1887-88 |
| ⁴⁴ Spooner, I. D. | S.S. Tamar - - - | West Coast S. America - - | 1888-89 |
| Spradly, William | S.S. Mozart - - - | Monte Video - - - | 1887-88 |
| " " | " - - - | Monte Video, Buenos Ayres, Rio Janeiro - - - | 1888 |
| Stewart, Alexander | County of Selkirk - | Calcutta - - - | 1888-89 |
| ⁴⁶ Swinton, W. W. | Barque Banffshire - | Brisbane, Wallaroo - - - | 1887-88 |
| Thompson, A. | S.S. Patroclus - - - | China, via Suez - - - | 1886-87 |
| " " | " - - - | " - - - | 1887-88 |
| ¹⁹ Thompson, J. E. | S.S. Monarch - - - | Coast of British Isles - - | 1888 |
| Thompson, J. S. | S.S. Nestor - - - | China, via Suez - - - | 1886-87 |
| " " | " - - - | " - - - | 1887 |
| ⁴⁶ Trott, Samuel | S.S. Minia - - - | Halifax - - - | 1887-88 |
| ⁴⁶ " " | " - - - | " - - - | 1888 |
| ⁴⁶ " " | " - - - | North Atlantic - - - | 1888 |
| Trunks, H. | Barque Aldborough - | Antwerp, Melbourne, Newcastle (N.S.W.), San Francisco - | 1887-88 |
| ³⁸ Tyson, John | S.S. Durban - - - | Cape Town - - - | 1888 |
| ⁴⁷ Wait, A. McLean | S.S. Spartan - - - | " - - - | 1888 |
| ⁴⁸ " " | " - - - | Natal - - - | 1888-89 |
| Walker, Henry | S.S. Cephalonia - - | Boston - - - | 1888 |
| ⁴⁹ Waring, William | S.S. Breconshire - | China and Japan, via Suez - | 1888 |
| ⁴⁹ " " | " - - - | " - - - | 1888-89 |
| Webster, J. K. | S.S. Prometheus - - | China, via Suez - - - | 1886-87 |
| " " | " - - - | " - - - | 1887-88 |
| ⁵⁰ West, Frederick | S.S. Port Adelaide - | Yokohama, via Suez, Hong Kong, Vancouver, San Francisco, New York, West Point (Virginia) - | 1888-89 |
| Wheaton, N. J. | Barque Eliza - - - | Barbadoes, Minatitlan (Mexico) - | 1888 |
| Wilding, James | S.S. Agamemnon - - | China, via Suez - - - | 1887 |
| " " | " - - - | " - - - | 1887 |
| ⁵¹ Williams, Henry | Dynomene - - - | Philadelphia, Hiogo, Java - | 1887-88 |
| Wilson, John | S.S. Ethiopia - - - | New York - - - | 1888 |
| " " | " - - - | " - - - | 1888-89 |
| Wilson, William | Horsa - - - | Melbourne, Talcahuano, Pisagua - | 1887-88 |
| ⁵² Woolward, Robert | R.M.S. Nile - - - | West Indies - - - | 1887-88 |
| ⁵³ " " | S.S. Don - - - | " - - - | 1888 |

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

- ¹ Kept by J. C. Long, R.N.R., Chief Officer.
- ² Kept by H. S. Blackburn, J. C. Babot, R. A. Lindan, and W. C. Templeton.
- ³ Kept by Lieut. N. T. Chen, I.C.N., and Sub-Lieut. E. W. Kiddle, R.N.
- ⁴ Kept by Sub-Lieut. E. W. Kiddle, R.N.
- ⁵ Kept by R. J. Hingston, Chief Officer, and J. J. Henry, 4th Officer.
- ⁶ Kept by J. A. Davies, 2nd Mate.
- ⁷ Assisted by T. Dawson, Chief Officer, G. Lever, 2nd Officer, and G. Boothby, 3rd Officer.
- ⁸ Kept by the Officers.
- ⁹ Assisted by Officers.
- ¹⁰ Kept by James Adams, 3rd Officer.
- ¹¹ Assisted by Lt. Maxfield and F. Simpson.
- ¹² Assisted by R. A. Newby.
- ¹³ Kept by H. K. Sturdee.
- ¹⁴ Kept by W. C. Mitchell and J. S. Bateman.
- ¹⁵ Kept by Lieut. C. E. Pritchard, R.N.
- ¹⁶ Kept by J. L. Berryman, 4th Officer.
- ¹⁷ Kept by Lieut. H. H. Douglas, R.N.
- ¹⁸ Kept by R. J. Hingston, Chief Officer, and J. J. Henry, 4th Officer.
- ¹⁹ Kept by C. J. Hall, 3rd Officer.
- ²⁰ Kept by C. S. Tindall, Chief Officer, and A. W. Hackland, 3rd Officer.
- ²¹ Kept by Arthur Hackland, 3rd Officer.
- ²² Kept by W. H. Jones, Signalman.
- ²³ Assisted by D. Morrison and W. R. More.
- ²⁴ Assisted by Chief and Second Officers.
- ²⁵ Kept by J. V. Williams, 4th Officer.
- ²⁶ Kept by H. Strong and J. D. Williams.
- ²⁷ Kept by H. S. Blackburn, Chief Officer, and H. A. Cottrell, 5th Officer.
- ²⁸ Kept by Walter Newman, 2nd Officer.
- ²⁹ Kept by P. S. Newton, 2nd Officer.
- ³⁰ Kept by Lieut. F. Bowden Smith, R.N.
- ³¹ Kept by J. J. Lossius and D. Kerr, 2nd and 3rd Officers.
- ³² Kept by Mr. Brackenbury.
- ³³ Kept by Arthur Walter Tomlinson.
- ³⁴ Kept by the Cadets.
- ³⁵ Assisted by A. Jolliffe.
- ³⁶ Assisted by W. Persse, Chief Officer.
- ³⁷ Kept by Lieut. Andrew F. Balfour, R.N.
- ³⁸ Kept by Louis Wood Baylden, 3rd Officer.
- ³⁹ Assisted by J. Stockman, Mate.
- ⁴⁰ Assisted by A. Keith, 2nd Mate.
- ⁴¹ Kept by W. H. Richardson, 1st Mate.
- ⁴² Kept by H. W. Beal, 2nd Officer.
- ⁴³ Kept by Edward Watt, 4th Officer.
- ⁴⁴ Kept by D. Constantine, 2nd Officer.
- ⁴⁵ Assisted by E. P. Dicks.
- ⁴⁶ Kept by T. C. Newton, F.R.Met.Soc., Chief Officer.
- ⁴⁷ Kept by Messrs. Kennedy and Mosley, 2nd and 3rd Officers.
- ⁴⁸ Kept by G. H. Dawson and E. Simmons, 4th Officers.
- ⁴⁹ Assisted by F. R. Newport and E. N. Reed.
- ⁵⁰ Kept by D. E. Jamieson, 2nd Officer, and F. Williams, 3rd Officer.
- ⁵¹ Kept by Peter McCabe, 3rd Officer.
- ⁵² Kept by F. S. Newton, 2nd Officer.
- ⁵³ Kept by Herbert Davis and G. P. Ellis.

APPENDIX III.

INSTRUMENTS supplied, &c. to the Royal Navy.

| Per Account. | | Baro- meters. | Ane- roids. | Thermometers. | | | | Hydro- meters. |
|---------------------------|---|------------------|----------------|---------------|------|------|---------|-------------------|
| | | | | Ordinary. | Max. | Min. | Screen. | |
| April 1st, 1888, afloat - | - | 195 | 445 | 1,283 | 249 | 211 | 136 | 108 |
| Issued since - | - | 60 | 118 | 384 | 57 | 55 | 29 | 33 |
| Returned since - | - | 255 | 563 | 1,667 | 306 | 266 | 165 | 141 |
| | - | 65 | 108 | 412 | 44 | 39 | 23 | 63 |
| April 1st, 1889, afloat - | - | 190 | 455 | 1,255 | 262 | 227 | 142 | 78 |

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

| | | | | | | | | |
|---------------------------|---|----|-----|-----|----|----|---|----|
| April 1st, 1888, in use - | - | 67 | 84 | 239 | 5 | 25 | 2 | 18 |
| Issued since - | - | 2 | 20 | 51 | 17 | 2 | 1 | — |
| Returned since - | - | 69 | 104 | 290 | 22 | 27 | 3 | 18 |
| | - | 10 | 40 | 98 | 5 | 9 | — | 6 |
| April 1st, 1889, in use - | - | 59 | 64 | 192 | 17 | 18 | 3 | 12 |

DISPOSITION of ADMIRALTY INSTRUMENTS on April 1st, 1889.

| | | | | | | | | |
|-----------------------------------|---|-----|-----|-------|-----|-----|-----|-----|
| Afloat in Royal Navy - | - | 190 | 455 | 1,255 | 262 | 227 | 142 | 78 |
| In use at stations - | - | 59 | 64 | 192 | 17 | 18 | 3 | 12 |
| In store at M.O. - | - | 87 | 83 | 257 | 42 | 59 | 14 | 41 |
| " Chatham - | - | 7 | 3 | 20 | 6 | 5 | 4 | 9 |
| " Sheerness - | - | 15 | 19 | 44 | 16 | 15 | 9 | 15 |
| " Portsmouth - | - | 3 | 7 | 22 | 5 | 5 | 14 | 9 |
| " Devonport - | - | 1 | 4 | 23 | 1 | 1 | — | 20 |
| " Queenstown - | - | 2 | 5 | 21 | 1 | 1 | — | 8 |
| " Gibraltar - | - | 2 | 2 | 14 | — | — | — | 4 |
| " Malta - | - | 5 | 12 | 23 | 6 | 6 | 2 | 17 |
| " Bombay - | - | 5 | 3 | 10 | 2 | 3 | 1 | — |
| " Halifax - | - | 3 | 10 | 16 | 2 | 3 | — | 14 |
| " Bermuda - | - | 8 | 12 | 30 | 3 | 4 | — | 15 |
| " Jamaica - | - | 3 | 3 | 19 | 2 | 2 | — | — |
| " Cape of Good Hope - | - | 5 | 7 | 30 | 10 | 5 | 3 | 30 |
| " Trincomalee - | - | 3 | 1 | 1 | 2 | 2 | — | — |
| " Hong Kong - | - | 8 | 12 | 43 | 20 | 15 | 1 | 19 |
| " Coquimbo - | - | 4 | 7 | 26 | 3 | 2 | — | 19 |
| " Sydney - | - | 4 | 9 | 24 | 6 | 4 | — | — |
| " Esquimalt - | - | 2 | 4 | 22 | 3 | 3 | — | — |
| Total, April 1st, 1889 - | - | 416 | 722 | 2,092 | 409 | 380 | 193 | 310 |
| Lost, &c. since April 1st, 1888 - | - | 8 | 31 | 370 | 16 | 20 | 13 | 26 |
| Under repair - | - | — | 4 | — | 1 | 1 | — | — |

APPENDIX IV.

INSTRUMENTS supplied, &c. to Mercantile Marine.

| Per Account. | | Baro- meters. | Com- passes. | Thermometers. | | | | Hydro- meters. |
|---------------------------|---|------------------|-----------------|---------------|------|------|----------|-------------------|
| | | | | Ordinary. | Max. | Min. | Screens. | |
| April 1st, 1888, afloat - | - | 122 | — | 744 | 1 | 1 | 125 | 380 |
| Issued since - | - | 92 | — | 596 | — | 3 | 84 | 327 |
| | | 214 | — | 1,340 | 1 | 4 | 209 | 707 |
| Returned since - | - | 98 | — | 641 | 1 | 4 | 89 | 328 |
| April 1st, 1889, afloat - | - | 116 | — | 699 | — | — | 120 | 379 |

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

| | | | | | | | | |
|---------------------------|---|-----|---|-----|----|----|----|----|
| April 1st, 1888, in use - | - | 254 | 3 | 267 | 57 | 60 | 36 | 13 |
| Issued since - | - | 24 | 2 | 22 | 6 | 5 | 2 | 1 |
| | | 278 | 5 | 289 | 63 | 65 | 38 | 14 |
| Returned since - | - | 22 | 2 | 14 | 5 | 7 | 2 | 4 |
| April 1st, 1889, in use - | - | 256 | 3 | 275 | 58 | 58 | 36 | 10 |

DISPOSITION of Board of Trade Instruments on April 1st, 1889.

| | | | | | | | | |
|-----------------------------------|---|-----|----|-------|----|-----|-----|-----|
| In merchant ships - | - | 116 | — | 699 | — | — | 120 | 379 |
| In use at stations - | - | 256 | 3 | 275 | 58 | 58 | 36 | 10 |
| In store at M.O. - | - | 52 | 3 | 108 | 25 | 44 | 30 | 78 |
| At Liverpool Agency - | - | 7 | 7 | 49 | — | — | 7 | 23 |
| „ Aberdeen „ - | - | 4 | — | 33 | — | 3 | 5 | 24 |
| „ Glasgow „ - | - | 1 | — | 15 | — | — | 3 | 8 |
| „ Dundee „ - | - | 15 | — | 27 | — | — | 12 | 31 |
| „ Hull „ - | - | 7 | — | 29 | — | — | 9 | 24 |
| „ Southampton „ - | - | 2 | — | 8 | — | — | — | 1 |
| „ Cardiff „ - | - | 1 | — | 8 | — | — | 3 | 15 |
| Total, April 1st, 1889 - | - | 461 | 13 | 1,251 | 83 | 105 | 225 | 593 |
| Lost, &c. since April 1st, 1888 - | - | 12 | — | 169 | 2 | 7 | 15 | 75 |
| At opticians - | - | 1 | — | 6 | — | — | — | — |

APPENDIX V.

LIST of STATIONS reporting Meteorological Observations to the Office by Telegraph on 31st March 1889, with the Names of Observers.

| | | |
|-------------------|---------------------------|---|
| *†Sumburgh Head | Rev. W. Brand | Minister of Dunroesness. |
| *†Stornoway | J. Forbes | Nicolson Institution. |
| Wick | J. Sinclair | Watchmaker. |
| Nairn | Miss Penny | School mistress. |
| *†Aberdeen | W. Boswell | Assistant at the Observatory. |
| Leith | W. Hay | Telegraph Clerk. |
| *†Shields | J. W. Irvine | Do. |
| Spurn Head | J. B. Smith | Assistant Lightkeeper. |
| †York | H. M. Platnauer, F.G.S. | Curator of Museum. |
| Loughboro' | W. Berridge, F.R.Met.Soc. | |
| †Ardrossan | J. W. Mayes | Telegraph Clerk. |
| Malin Head | P. O'Doherty§ | Signalman, Lloyd's. |
| *†Mullaghmore | K. Kerr | Retired Coastguard Officer. |
| *†Belmullet | Miss M. J. Tolan | Telegraphist. |
| †Donaghadee | T. MacGowan | Postmaster. |
| Parsonstown | — Haines | Assistant Observer at Lord Rosse's Observatory. |
| Barrow-in-Furness | W. S. Whitworth | Engineer, Barrow-in-Furness Railway. |
| *†Holyhead | Capt. Richards | Keeper of Sailors' Home. |
| Liverpool | J. Hartnup, F.R.Met.Soc. | Bidston Observatory. |
| *†Valencia | J. E. Cullum | Superintendent of the Observatory. |
| †Roche's Point | W. Kennedy | Telegraph Clerk. |
| Pembroke | S. Blake | Lightkeeper. |
| *†Scilly | W. Thomas | Signalman. |
| Prawle Point | W. Hewitt | Coastguard Officer. |
| †Hurst Castle | G. G. Appleton | Lightkeeper. |
| †Jersey | J. Fisher | Signalman. |
| *†Dungeness | P. Curnow | 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. |

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

† This station now reports by post only.

§ Mr. J. O'D. Farren left.

|| Mr. Curnow has now been removed to another lighthouse.

APPENDIX VI.

REPORT OF INSPECTION OF THE IRISH AND WELSH STATIONS, 1888.

I have to report that I have completed the inspection of these stations, with three exceptions. *Armagh* where scarlet fever was in the house, *Foynes* and *Waterford* where I thought the inspection might be omitted this year.

TELEGRAPH STATIONS.

Holyhead, visited September 29.—There is nothing calling for remark at this station.

Parsonstown, visited October 1.—At this station there has been a change of observer, the present reporter Haines has only recently been appointed, and Dr. Boëddicker has kindly undertaken to instruct him.

Valencia, visited October 4.—There is nothing special to be remarked about the telegraphic service, except that the attendance at the local post office on Sunday mornings is not punctual. We have difficulty on this score at Malin Head also.

The electrical anemograph had been erected shortly before my visit. The registration of direction was not satisfactory at the date of my presence at Valencia.

I am sorry to say that the water obtained by the Abyssinian well which was sunk last year, though abundant in quantity, is so charged with peaty matter as to be unfit for domestic use. This is unfortunate, as it was unexpected, a well close at hand yielding water which is quite pure from peaty contamination, as that water runs through limestone gravel.

Roche's Point, visited October 5.—This station remains in good order. The light to the barometers is not good, and never will be while the house is unchanged.

Donaghdee, visited October 9.—The observations are well taken. I have arranged that a weathercock be supplied for erection on a flag-staff, the property of the observer.

Malin Head, visited October 12.—I am glad to say that Lloyd's are repairing the signal tower where the barometers are placed, which has hitherto been in a dilapidated condition.

Mullaghmore, visited October 15th.—This station was in very good order, as usual.

Belmullet, visited October 17.—This station continues to work well.

St. Ann's Head, visited October 25.—There is nothing calling for special remark at this station.

STATIONS OF THE SECOND ORDER AND WEEKLY WEATHER REPORT STATIONS.

Killarney (W.W.R. station), visited October 3.—Archdeacon Wynne was absent. The instruments were in good condition, and Miss C. Wynne, the second daughter, seemed capable and careful in registration.

Colebrooke, visited October 10.—This station was satisfactory.

Londonderry, visited October 11.—The exposure at this station is not so good as formerly, the observer has changed his residence, and his garden is not so open as that attached to his previous house.

Markree, visited October 16.—Mr. Marth has trained an assistant, Miss L. Frizelle, to take the readings, and during his absence in Germany in June last she managed the station satisfactorily.

Currygrane (Edgeworthstown), visited October 19.—This station has recently become one of the second order, having previously only furnished observations for the Weekly Weather Report. The observer is young, but seems very careful and anxious to learn.

Dublin, Glasnevin, visited October 23.—The observations are well taken. The exposure of the rain-gauge is not open enough, and I propose to supply another gauge to test the effect of exposure, as an open site is attainable.

Dublin (Fitzwilliam Square), visited October 23.—This station calls for no special remark. It continues to be the most satisfactory station we have, except as regards the exposure of thermometers and rain-gauge.

Dublin, Phoenix Park, visited October 23.—The only matter calling for notice here is that the observers have compiled for themselves a table of proportion between velocity and Beaufort's scale of wind, which is not satisfactory. A new one will be supplied to them.

Kilkenny, visited October 24.—The observations for the Weekly Weather Report are well taken.

St. David's, visited October 26.—This station is, as usual, in very good order.

I also visited the fishery barometers at Belfast, Bangor, Groomsport, Donaghadee, Valencia, Wicklow, and Kingstown, and took over new barometers for two stations in the co. Donegal, Kincaslugh (near Burton Port), and Portnoo (near Ardara). At Wicklow the barometer had air in the tube, which I removed.

(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. |
|-------------------------------|-----------|-----------|------|------|--------------|--------------------------------|
| STATIONS OF THE SECOND ORDER. | | | | | | |
| Brookeborough | -0.8 | -0.0 | -0.5 | -0.4 | — | |
| Dublin (City) | -0.1 | -0.1 | -0.1 | -0.2 | — | Grass min. +0.2. |
| Dublin (Phoenix Park) | -0.6 | -0.4 | -0.4 | -0.3 | — | Do. -0.3. |
| Edgeworthstown | -0.3 | -0.2 | -0.4 | +0.3 | -0.1 | Do. +0.5. |
| | | | | | | Spare ther. is a Kew standard. |
| Glasnevin | -0.1 | -0.4 | -1.0 | +0.3 | — | Grass min. +0.4. |
| Londonderry | -0.4 | -0.4 | 0 | +0.2 | -0.5 | |
| Markree Castle | -0.6 | -0.4 | -0.2 | -0.2 | — | |
| Parsonstown | -0.5 | 0 | -0.6 | -0.2 | — | Grass min. -0.1. |
| St. David's | -0.1 | -0.1 | -0.2 | 0 | — | Do. -0.1. |

TELEGRAPHIC REPORTING STATIONS.

| | | | | | |
|----------------|------|------|------|------|------|
| Holyhead | 0.0 | -0.2 | -0.4 | +0.1 | 0 |
| Malin Head | -0.5 | -0.5 | -0.4 | -0.3 | -0.6 |
| Mullaghmore | -0.5 | -0.4 | 0 | -0.4 | -0.7 |
| Belmullet | -0.7 | -0.5 | -0.3 | -0.8 | — |
| Donaghadee | -0.1 | -0.2 | -0.2 | +0.1 | -0.1 |
| Parsonstown | -0.5 | 0.0 | -0.4 | -0.2 | — |
| Valencia | -0.9 | -0.6 | -0.6 | +0.2 | — |
| Roches Point | -0.5 | -0.5 | -0.5 | +0.2 | — |
| St. Ann's Head | -0.4 | -0.2 | -0.5 | -0.7 | -0.3 |

WEEKLY WEATHER REPORT STATIONS.

| | | | | | |
|-----------|------|------|------|-----|---|
| Kilkenny | — | — | -0.2 | 0.0 | — |
| Killarney | -0.6 | -0.5 | -0.2 | 0.0 | — |

REPORT OF INSPECTION OF THE SCOTTISH STATIONS FOR 1888.

BAROMETERS.

The inspector's mercurial Standard Barometer No. 532, which has been repaired, was taken with me on the tour of inspection. Unfortunately in driving from Kirkwall to Swanbister the horse came down, and the barometer was broken by the shock. Hence for the stations inspected after Wick, the barometers could not be compared with an inspector's mercurial standard.

The results of the inspection of these instruments, such as they are, are shown by the following table. I am able, however, to report that the barometers were all in good order and observed with the same accuracy as in former years.

| — | Inspector's Standard, corrected. | Not corrected. | | Remarks. |
|------------------|--|----------------|-------------|--|
| | | Rep. Baro. | Check Baro. | |
| | ins. | ins. | ins. | |
| Rothsay - - - | 29.953 | 29.958 | — | Check barometer is 8 feet higher in flat above, where at the time temp. was 40.7 higher. |
| Laudale - - - | — | 29.968 | 29.974 | |
| Lairg - - - | 29.316 | 29.313 | — | Temp. of rep. barometer was 1.4 higher than standard barometer. |
| Dunrobin - - - | 29.633 | 29.638 | — | |
| Wick - - - | 29.602 | — | 29.598 | In house. |
| Do. - - - | 30.098 | 30.094 | — | In shop, compared the following morning. |
| Swanbister - - - | — | 30.486 | — | The observatory barometer read 30.162. |
| Stornoway - - - | — | 30.292 | 30.288 | |
| Nairn - - - | — | 30.360 | 30.360 | |
| Aberdeen - - - | — | — | 30.158 | |
| Braemar - - - | — | 29.167 | — | Check barometer in Salt-coats. Do. in house. |
| Dundee - - - | — | 30.280 | — | |
| Ardrossan - - - | — | 30.416 | — | |
| Leith - - - | — | 29.946 | — | |

THERMOMETERS.

The thermometers at the various stations were compared in water with the Standard Thermometer No. 2395. The next table gives the "corrected readings of the standard" and the errors of each thermometer as ascertained by the comparisons made. None of the minimum thermometers were this year found to be out of order; and as regards the maximum thermometers, provision is now made where required, against displacement of the index during high winds.

| — | Standard No. 2395, Corrected. | Dry Bulb. | Wet Bulb. | Spare Ther- mometer. | Max. Ther- mometer. | Min. Ther- mometer. | Time in Water in Minutes. | Change of Tempera- ture. | Remarks. |
|---------------------------------|-------------------------------------|-----------|-----------|-------------------------|------------------------|------------------------|------------------------------|--------------------------------|----------|
| Rothsay - | 56.0 | -0.1 | 0.0 | — | +0.1 | -0.4 | 130 | Uniform | |
| Laudale - | 59.1 | +0.2 | +0.2 | — | +0.2 | +0.2 | 150 | Do. | |
| Lairg - | 58.2 | +0.1 | 0 | — | -0.1 | -0.1 | 90 | Do. | |
| Dunrobin - | 58.1 | -0.5 | -0.4 | — | +0.6 | -0.6 | 130 | -0.2 | |
| Wick - | 54.5 | +0.3 | +0.4 | — | -0.3 | -0.1 | 75 | +0.3 | |
| Swanbister - | 58.6 | 0.0 | +0.2 | — | +0.2 | -0.3 | 120 | +0.3 | |
| Stornoway - | 57.5 | +0.5 | +0.5 | +0.3 | -0.3 | -0.5 | 120 | +0.2 | |
| Nairn - | 55.0 | +0.6 | +0.7 | 0 | -0.1 | +0.9 | 80 | Uniform | |
| Aberdeen - | 57.0 | +0.1 | +0.1 | — | +0.6 | 0 | 135 | +0.4 | |
| Braemar - | 59.0 | +0.6 | +0.4 | — | 0 | -0.2 | 150 | Uniform | |
| Dundee - | 54.7 | +0.5 | +0.6 | — | +1.4 | -0.2 | 75 | Do. | |
| Ardrossan - | 53.0 | +0.2 | +0.2 | — | -0.3 | -0.3 | 105 | +0.3 | |
| Leith - | 52.0 | +0.1 | +0.5 | — | +0.1 | -0.4 | 50 | Uniform | |
| Aberdeen, King's College. | 57.0 | — | — | — | 0 | -0.2 | — | — | |

HYGROMETERS.

In this inspection, as in the previous one, the dry and wet bulbs were read instantly on opening the thermometer screens, with the view of collecting data as to the condition in which these instruments are kept at the stations. The results, which are quite similar to those in last year's report, are not given in this report. It may, however, be noted that at Ardrossan, where the hygrometer was in fairly good order, the readings were $52^{\circ}\cdot4$ and $50^{\circ}\cdot5$, the difference being much smaller than might have been expected from the dry bracing air at the time. As the screen was at the time running wet with the heavy dew, the real hygrometric state of the air could not be observed by the dry and wet bulbs in the screen.

NOTES ON THE STATIONS.

Rothsay, August 30th, 1888.—The instruments were all in good order, and are observed with great care and intelligence.

Laudale, September 1st.—The instruments were in excellent order, and are, on the whole, well observed.

Fort Augustus, September 4th.—A hasty visit was made to this station during the interval it took the steamer to pass the locks at Fort Augustus, when I found everything in excellent order.

Lairg, September 5.—The instruments were all in good order, and are very well and carefully observed. The observer makes good use of his position, as ground officer for the Duke of Sutherland, in noting some of the more prominent effects of the weather on the growing crops.

Dunrobin, September 6.—The instruments were in very good order, and the observations were carefully made.

Wick, September 6.—The instruments were in good order, and the observations made with care and intelligence.

Swanbister, September 8.—Mr. Fortescue being from home at the time of my visit, his maid servant, aged 17, who was in charge, accompanied me round the instruments, including the anemometer, read them, and answered all questions put to her regarding their manipulation, &c. with remarkable intelligence. Everything was in excellent order.

Stornoway, September 12.—The instruments were in excellent order, and particularly well observed; Miss Riddoch, the first assistant, made the observations and prepared the telegram with correctness and despatch, and Miss Forbes, the second assistant, observed the instruments correctly, and is being taught to make up the telegram.

The wind observations were gone into with care in connexion with the queries received from the Office regarding the wind observations of the previous observer.

Nairn, September 13.—The instruments were in good order, and read by Miss Penny and the two assistants with particular care. The grass plat in the garden where the instruments are has been considerably extended. The Stevenson screen had recently been repaired by Mr. Penny in a workmanlike manner and is in good order.

Aberdeen, September 17.—The instruments were removed from Mr. M'Cormack's, the late observer, to Mr. Boswell's in the beginning of July. One of the barometers, No. 537, has been hung beside the old standard barometer of the observatory, the other one, No. 538, in Mr. Boswell's house. The Stevenson screen has been placed in Mr. B.'s garden, and the rain-gauge beside the thermometers in King's College grounds.

The instruments were in excellent order, and in all respects well attended to and observed.

Braemar, September 18.—The scale of the maximum thermometer, which has been in use for 30 years, has become very indistinct, and cracked in various directions, rendering a new one desirable. All the other instruments were in good order and well attended, and read expertly and correctly by both observers.

Dundee, September 19.—The instruments were in very good order, and well attended to and observed. The wind observations continue to be accurately made, both as respects force and direction.

Ardrossan, September 20th.—As Mr. Mayes removes to Ardrossan in May next, better arrangements will be made for utilizing the check barometer. The rain-gauge requires extensive repairs, the nails holding its outer casing to the wooden box having been rusted out three months previously.

The observations were carefully and correctly made by Mr. M. and his assistant.

Leith, October 29th.—The instruments were in very good order, and attended to, observed and reported with conscientious care.

Dunrossnes.—This year the station was inspected by Mr. Dickson while in that part of Shetland, inspecting the Fishery Barometers. He reported that the errors of the thermometers were in accordance with previous reports, and the readings of all the observers were accurately made.

Aberdeen, King's College Observatory, September 17th.—Everything here was in excellent order, and the work of the observatory appeared to be well attended to.

(Signed) ALEXANDER BUCHAN.

INSPECTION OF OBSERVATORIES AND ANEMOGRAPHS. 1888.

THIS year I have visited the observatories at Aberdeen, Glasgow, Oxford, and Stonyhurst, and inspected the anemographs at Fleetwood, North Shields, Swanbister, and Yarmouth.

Aberdeen, visited September 4th.—The instruments were all examined and duly cleaned where necessary, as usual, the schedule of examination notes being also filled in. A Stonyhurst discharger, after it had undergone adjustment at Kew, was fitted to the Beckley rain-gauge.

The reference standard thermometers, as well as the maximum and minimum thermometers for eye observations, were tested at their freezing points by means of melting ice, and their readings found to be as follows:—

| | | | | | |
|-----------------------|---|---|---|---|-------|
| Dry standard, No. 397 | - | - | - | - | -32·0 |
| 458 | | | | | |
| Wet „ No. 395 | - | - | - | - | -32·6 |
| Max., M.O. 1002 | - | - | - | - | -32·0 |
| Min. 5056 | - | - | - | - | -32·0 |
| M.O. 89 | | | | | |

The minimum thermometer is not in good repair, the fitting piece at one extremity of the tube being replaced by putty.

The Richard barograph having had a new pen fitted, I re-adjusted the zero to the barometric pressure as indicated by the standard.

Glasgow, September 14th.—I examined, and with the aid of White's men, cleaned all the meteorological instruments at this observatory. I found all in proper repair and in good condition with the exception of the anemograph the fan spindle of which is almost worn out.

The thermometers were compared with Kew Standard 682, with the following results:—

| | | | |
|---|---|---|-------|
| Corrections to dry-bulb standard, No. 550 | - | - | -0°·4 |
| „ wet „ „ „ 472 | - | - | -0·6 |
| „ Standard barometer, Att. Th. K.O. 2479 | - | - | -0·7 |
| „ Barograph thermometer, B.T. | - | - | -0·9 |
| „ Maximum, No. 58,846 | - | - | 0 |
| „ Minimum, No. 63,942 | - | - | -0·2 |

Stonyhurst, September 20th.—All the instruments were found to be in good order, and carefully kept. The joints of the anemograph shafting were, however, somewhat loose, but were improved by forcing the pins home harder in the Hook's joints. One Robinson cup is loose on its axis, and the spindle was found to be a good deal worn. This Mr. Carlile remedied by grinding the bearing up again.

The thermometers were compared with Kew Standard 682, with the following results:—

| | | | |
|---|---|---|-------|
| Corrections to dry-bulb standard, No. 619 | - | - | -0°·2 |
| „ wet „ „ „ 382 | - | - | -0·5 |
| „ maximum, M.O. 439 | - | - | -0·3 |
| „ minimum, B.T. 501 | - | - | +0·2 |

Radcliffe Observatory, Oxford, September 25th.—The instruments at this observatory were all in good order, and working properly. Mr. Wickham alluded to a difficulty he had had with the cylinder clips breaking, and mentioned the desirability of having duplicate cylinders for use under such circumstances.

I compared the thermometers with my standard, with the following results:—

| | | |
|---|---|------|
| Correction to Radcliffe dry-bulb standard of reference, | ° | |
| No. 576 | - | -0·3 |
| „ Radcliffe wet-bulb standard of reference, | | |
| No. 575 | - | -0·4 |
| „ Stevenson's screen, dry-bulb, No. B.T. | | |
| 1710 | - | -0·4 |
| „ Stevenson's screen, wet-bulb, No. 1709 | - | -0·4 |
| „ barograph thermometer, No. 12,259 | - | -0·2 |

ANEMOGRAPH.

Yarmouth.—The anemograph was inspected on August 28th and 29th. Unfortunately the weather was very stormy at the time, and it was not easy to dismount it entirely under the circumstances. I found, however, that the instrument was in good order, well oiled, and carefully kept. The cups and stays are much worn, and will require to be replaced by new ones next year; one stay had quite given way, but I repaired it with wire; the fans are quite perfect. The registering apparatus is in excellent order, the clock having been recently cleaned by a local watchmaker.

North Shields, August 30th and September 1st.—This instrument is well cared for by Captain Harrison, the light-keeper, who is assisted by a local mechanic who well lubricates it every three months. I entirely dismounted it and had every part cleaned and oiled.

The recorder having become somewhat dusty by material fallen from the old brickwork in the tower, I took that also to pieces, as well as the clock, and got all cleaned. At the same time I had some of the pivot holes in the clock re-bushed by a watchmaker so as to improve its going, which was not quite satisfactory.

Swanbister, Orkney.—This instrument was inspected September 10th. Mr. Fortescue takes great care of it, and it is kept well oiled and painted. I thoroughly dismantled and cleaned it.

Mr. F. had observed that heavy rain had during the winter entered the cup at the top of the velocity shaft, and, by displacing the oil, filled it with water, which in subsequently freezing had stopped the instrument during frost. I requested him to be particular in replacing the plug in the oil hole after oiling, in order, if possible, to prevent the recurrence of this accident.

Fleetwood.—The instrument was examined on September 21st and 22nd and found to be in good order throughout. Being in a building open to the public, I found the anemograph is looked upon with much interest by the visitors, but owing to the care of Mr. Gaultier and the keeper of the pavilion, it has not suffered any damage at their hands.

(Signed) G. M. WHIPPLE.

DEAR SIR,

Kew Observatory, November 17. 1888.

I BEG to hand you herewith my report to the Meteorological Council regarding the condition of their self-recording instruments at the Valencia and Falmouth observatories, as well as for the anemograph stations at Holyhead and at Mountjoy barracks, Dublin.

Holyhead, visited October 1st–2nd.—At this station the anemograph was in good working order, and is evidently well cared for. The external parts of the instrument I had dismantled, and carefully examined the same, but neither the fans nor the cup arms showed any signs of wear. After cleaning and replenishing the bearings with fresh oil, the orientation was examined, and the observer was instructed to orientate the instrument once a month and forward the result to the Meteorological Office.

Mountjoy Barracks, October 3rd.—The anemograph here was going satisfactorily, but the clock badly required cleaning. This was duly done, and the other parts of the instrument were cleaned and all the bearings oiled, with the exception of the direction brake, which had only been quite recently attended to.

The orientation was tested, and the observer instructed to perform the operation monthly and send result to the Office.

Valencia, visited October 6th–10th.—As is usual at this observatory all the instruments were in good order.

The clocks of both the barograph and thermograph were taken to pieces and cleaned and new lines attached. The lenses, condensers, &c. received the usual cleaning, and the zero dots were shifted to the winter position. At the time of my visit the photography was very good, but owing to a considerable amount of stray light falling upon the thermograph cylinder, the sheets were discoloured; this, however, was entirely got rid of by the re-blackening of both the dry and wet tubes.

With regard to the definition of the wet-bulb trace in a certain part of the scale this cannot be improved, as has already been pointed out in previous reports.

In both instruments the action of the light stop was slightly prolonged, so that now in the case of the thermograph the light is cut off at two minutes before the even hour and comes on again at four minutes past the hour, whereas for the barograph the stop comes into action at four minutes to the even hour and ceases at two minutes past the hour.

The thermometers were compared by means of a Kew standard thermometer No. 682 at 55 degrees, and their correction found to be as follows :—

| | | | | | | |
|--|---|---|---|---|---|------|
| Dry, Standard 399 | - | - | - | - | - | -0.8 |
| Wet, Standard 398 | - | - | - | - | - | -0.6 |
| Maximum, M.O. 1003 | - | - | - | - | - | 0 |
| Minimum, 2497 | - | - | - | - | - | -0.3 |
| Standard barometer, attached thermometer, 71,062 | - | - | - | - | - | -0.1 |
| Barograph thermometer (no number) | - | - | - | - | - | -2.1 |

The rain-gauge was taken to pieces and cleaned, a new line attached and a Stonyhurst discharger fitted and adjusted to same.

Anemometer.—The external parts of this instrument were entirely taken down and cleaned, and the bearings replenished with fresh oil. The orientation was then tested, and the result is appended to this report.

Falmouth, visited October 15th–19th.—Everything here was carefully tended and in good order. The anemometer was completely dismantled and all parts cleaned, the different bearings afterwards being replenished with fresh oil. The cup stays showed no signs of wear, but two blades of one of the fans were found loose; these I had resoldered before again erecting the instrument.

The clock was taken to pieces and cleaned, and the orientation examined, the sheet being sent herewith.

As regards the barograph and thermograph, the usual cleaning of the clocks was performed and the lenses and other parts attended to. The photography was excellent, but the thermograph sheets were more or less discoloured owing to stray light; this was, however, effectually remedied by the re-blackening of one of the tubes. At the time I noticed that the dry and wet dots of light were not quite vertically one over the other on the cylinder; this was duly put right.

In the case of the barograph, a slight alteration was made in the action of the light stop.

The thermometers were compared with Kew Standard No. 682, and found to have the following corrections at 63 degrees :—

| | | | | | | |
|--|---|---|---|---|---|-------|
| Dry, standard 383 | - | - | - | - | - | -0.75 |
| Wet, Standard 388 | - | - | - | - | - | -0.45 |
| Maximum, M.O. 104 | - | - | - | - | - | -0.6 |
| Minimum, M.O. 308 | - | - | - | - | - | -0.2 |
| Barograph thermometer (no number) | - | - | - | - | - | -0.8 |
| Standard barometer, attached thermometer (no number) | - | - | - | - | - | -0.9 |

The rain-gauge clock was taken to pieces and cleaned, and a new line attached, while at the same time a Stonyhurst discharger was fitted and adjusted to the instrument. With reference to the slight sagging of the pencil trace towards midnight I was unable to detect the cause; it was certainly not due to faulty attachment of the paper, as this was carefully examined and by measurement found accurately adjusted to the cylinder.

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

(Signed)

T. W. BAKER.

REPORT ON INSPECTIONS, 1888.

TELEGRAPHIC REPORTING STATIONS.

Dungeness, December 5th, 1888.—The instruments generally were in good order. One of the stays of the rain-gauge funnel had gone, which prevented it from being quite horizontal; this Mr. Curnow promised to have repaired.

The four light-keepers take it in turns to have charge of the higher low light, two to each light. The two in charge of the high light take the observations; they change at noon on Fridays. Messrs. Curnow and Batton were on duty during my visit, and seemed to understand the work well. They both set and read the barometer rightly.

Messrs. Jenkin and Cutting are the other two light-keepers. I asked Messrs. Curnow and Batton to go through the instruments with them when they came on duty, so as to insure that the others are as correct as themselves.

Hurst Point, November 12th.—The barometers agreed well, and the observer was very correct in his reading. The thermometers were very correct excepting the minimum and spare one, which had errors of $-.8$ and $-.7$ respectively.

It was blowing a gale and raining heavily, and the markings of the thermometers were very indistinct, so that my comparisons here were not so good as they generally are. I requested Mr. Appleton to *blacken the scales* and compare the thermometers again on a lighter and quieter day, and to send in the result to the Office.

Both Mr. Appleton and Mr. Gentry, who acts in his absence, seem well up in the work.

Jersey, November 14th.—The barometers agreed well, and the observer's reading agreed with my own to a thousandth. The thermometers were generally higher than the standard, the dry-bulb had a large error ($-.7$), and the spare one was 1.1 too high; this Mr. Ley had detected, and had made it the spare one on that account. Mr. Fisher seems to understand his work very well; he has not been able to find anybody to act for him in case of his absence, but says he never goes away.

The sunshine recorder has been shifted to a suitable place on Mt. Leroux. I tested its accuracy as well as I could with compass and level. The sun was not shining. It seemed to be correct.

REPORT OF INSPECTION OF SOME ENGLISH STATIONS IN 1888.

Scilly (St. Mary's), November 7th.—Mr. Thomas did his work well, and his son read and corrected the barometer rightly.

The barometers agreed well, and it will be seen that Mr. Thomas's readings agreed with mine. All the thermometers excepting the minimum had large minus errors. The index of the minimum had slipped to 32° . Mr. Thomas said it had done so before, so I raised the bulb end a little by tying a thick piece of string round its rest.

The anemometer is much exposed, and moisture unavoidably gets into its works whilst the paper is being changed. Would advise that a second barrel be provided on which the paper can be fixed in a sheltered place, then the glass door need only be open during the short time required for changing the barrel. Would construct a sheltered place under the ladder where the barrel might be prepared. Mr. Thomas tells me that the paper sometimes gets so wet that the pencil tears it. I think this exposure accounts for the defective markings which are complained of.

North Shields, November 22nd, 1888.—The observations seem to be very carefully taken, and Mr. Irvine takes great interest in the work; he is well represented by Messrs Clarke and Moat in his absence. One of these gentlemen set and read the barometer quite correctly in my presence.

The wet-bulb thermometer was rather loosely fitted; re-fitted it, and explained the best method to Mr. Irvine.

The anemometer seemed in good order, and Captain Harrison showed me how he managed it and its record.

Spurn Head, November 24th, 1888.—The instruments were in good order.

Went through the special questions on the notes with Mr. Watson, and found that he quite understands how to carry up the last decimal point of the barometer. He read and corrected the barometer to M.S.L. and 32° quite rightly. Unfortunately the assistant keeper (Mr. Grainger), who acts in Mr. Watson's absence, had had an accident, and I could not test his powers.

The rain-gauge glass is badly cracked.

Yarmouth, November 27th, 1888.—The barometers differed about .03, but they seemed to work well, and to be in good order.

The maximum thermometers read too high, but it was probably due to the water having been colder than the air, and the index not having been shaken down before reading. I am afraid this may have affected my maximum readings in other cases, as I was not sufficiently careful on that point.

The wet-bulb was very dirty though moist. I re-fitted it and explained how it should be done in future.

The rain-gauge was 3 feet 5 inches above the ground, which seemed necessary on account of neighbouring walls.

The anemometer seemed to work very well. Mr. Watson pointed out a good place for a sunshine-recorder on the roof of the Sailors Home, if such observations were needed in that neighbourhood.

York, November 21st, 1888.—The reporting barometer seemed to work well; the check (No. 138) read about .16 too low, and had been fixed at one reading for some time. Found the wet-bulb thermometer very roughly fitted; re-fitted it and explained how it should be done.

For note on sunshine recorder, see Stations of the Second Order report.

WEEKLY WEATHER REPORT STATION.

Arlington Court, November 10th, 1888.—There is no barometer at this station. The thermometers were fairly correct. The wet-bulb was not well fitted, but I refitted it in the presence of Mr. Carter, the head gardener, who looks after the instruments, and seemed very willing to do his best.

STATIONS of the SECOND ORDER.

Eastbourne, December 7th, 1888.—The instruments are placed as explained in the last report. They belong (I understand) to the town authorities.

The anemometer is on the inland-side of a round tower, and does not project much above its edge, so that I should think its winds are much affected by the tower.

The barometer has a defective vernier, which needs repair, and I advised Mr. Sheward to compare it with another available barometer

for a week, so as to find the differences, and then to send *his* instrument to be repaired, using the other in its place.

The wet-bulb was dirty and not well fitted.

The rain-gauge is iron and very rusty, with a copper or brass rim and a curved pipe; its frame is defective, having one side driven in by a stone which had been thrown at it, but it works correctly.

The solar radiation thermometer and sunshine recorder are on the top of a high hotel.

Epsom, December 11th, 1888.—Found the instruments at this station well placed and generally in good order. The damp-bulb was not well fitted and it was dirty; re-fitted it with fresh cambric and lamp cotton, and explained how it should be done in future.

The direction of the wind had been observed by holding up a pocket-handkerchief. Drew a *true* north and south line, and explained how the direction of the wind is better got by considering the motion of the *lowest* clouds and of smoke, as well as by its direct action on the observer himself.

Mr. Jackson seemed anxious to do good work, and he has an able and willing assistant in Mr. Montgomery, one of the senior pupils. Mr. Jackson's college work is increasing, and he finds it more and more difficult to devote his own time to meteorological work.

Market Rasen, November 26th, 1888.—Mr. Jevons, who is a chemist in the town, did not give any particular reason for stopping his observations, but promised to commence regularly on December 1st. He quite understood the work, and will, I think, become a good observer. One of his assistants undertakes the work in his absence. His instruments are in good order and well placed.

St. Leonards, December 6th, 1888.—Dr. Colborne's instruments were well placed, and he read them very correctly.

He was taken ill in April, and then ceased observing at 9 p.m. He hopes to get the assistance of the gardener who is in charge of the public garden where the thermometers are placed, and to start regularly the 9 p.m. observations again. He is paid something by the town authorities for this work.

The sunshine recorder is somewhat out in adjustments, but it is so firmly cemented on to an iron pillar that it cannot be adjusted. In some cases the observer is obliged to slip the card into the lower part of its groove *only*, otherwise the focal point would fall on the frame instead of on the card. It was well placed in the Waterworks, and had a good range. The man in charge of the works looked after it; he seemed very intelligent.

Southampton, November 13th, 1888.—The barometer was poorly placed for bringing the quicksilver up to the ivory pointer, but Mr. Cook seemed to find no difficulty, and our readings of the vernier agreed. The maximum thermometer had rather a large error.

Everything was in first rate order at this station, and Mr. Cook takes great interest in the work.

Ketton Hall, Stamford, November 26th, 1888.—The instruments here belong to Mr. Coventry, who has been living with his brother-in-law, Mr. Hopwood, the owner of the place. Mr. Coventry is about to leave the place, and thinks it probable he will leave the instruments with the head gardener.

When I arrived, both Mr. Coventry and the head gardener (Mr. Divers) were absent. Mr. Tunnington, the second gardener, took me round.

The barometer was locked up in the head gardener's house, and not available. The thermometers had very small errors.

Mr. Coventry arrived before I left, and told me he applied no errors to his printed observations.

As Mr. Coventry was about to leave the neighbourhood and he had not decided what he should do with the instruments, I did not think it advisable to spend another day merely to see the barometers. Mr. Tunnington, the second gardener, seemed very intelligent. He expressed the wish that they had a sunshine recorder, showing that he was not afraid of the work.

York, November 21st, 1888.—I found the instruments at this station in fair order, except the wet-bulb, which was roughly fitted. See Telegraphic Station report.

The sunshine recorder was supported by rough wooden legs over the ridge of the roof of a school; it was kept in position by wire braces. It was cemented firmly into a frame which made it impossible to adjust it. It was much out in level E. and W. I think it should have a much firmer foundation to stand upon, and that it should not be cemented into a frame, but that space should be left for slight adjustments, which I am inclined to think would be best done by screws worked by means of a key which could be taken away. The position was rather difficult of access, but it seemed to have a good range. Unfortunately, Mr. J. E. Clark, who has charge of the instrument, was absent, but it was shown to me by an intelligent scholar who helps him.

(Signed) HENRY TOYNBEE.

BAROMETER and THERMOMETER READINGS.

| NAMES OF STATIONS. | BAROMETER. | | THERMOMETER. | | | | | |
|--------------------------------|---|-----------------------|---|---|---|---|---|--|
| | Difference of Observer's from Inspector's Readings. | Temperature in Water. | DRY BULB. | WET BULB. | MAXIMUM. | MINIMUM. | SPARE OR GRASS. | |
| | | | Correction to reduce to Inspector's Standard. | Correction to reduce to Inspector's Standard. | Correction to reduce to Inspector's Standard. | Correction to reduce to Inspector's Standard. | Correction to reduce to Inspector's Standard. | |
| Scilly (St. Mary's) | 0 | 53.2 | — .8 | — .7 | — 0.9 | — .3 | — 0.9† | |
| Arlington Court | No barom. | 47.5 | — .1 | — .4 | — .1 | + .4 | None | |
| Southampton | 0* | 52.3 | — .5 | — .6 | — 1.0 | — .0 | — .3‡ | |
| Hurst Point | — .001 | 52.2 | — .2 | — .2 | — .0 | — .8 | — .1‡ | |
| Jersey | — .001 | 54.6 | — .7 | — .3 | — .4 | — .1 | — 1.1‡ | |
| York | + .001 | 50.0 | — 1.0 | — .7 | — 1.0 (a.m. 8) — 0.5 (p.m. 9) | 0 (a.m. 8) 0 (p.m. 9) | None | |
| North Shields | + .001 | 49.9 | — .3 | — .1 | — .2 | + .9 | — .1‡ | |
| Yarmouth | 0 | 49.2 | — .0 | — .3 | — 1.8 | + .4 | — .1‡ | |
| Spurn Head | + .001 | 52.4 | — .6 | — .3 | — .4 | — .2 | None | |
| Market Rasen | 0 | 44.5 | — .1 | — .4 | — .3 | + .6 | — .6‡ | |
| Ketton Hall | Barometer not available. | 48.0 | + .2 | + .2 | + .1 | + .4 | Not put in water.† | |
| Dungeness | + .004 | 55.1 | — .1 | — .1 | — .0 | — .1 | None | |
| St. Leonards | 0 | 52.7 | — .5 | — .7 | — .1 | — .0 | None; grass min. used as min. | |
| Eastbourne (vernier defective) | — .003 | 54.1 | — .1 | — .1 | — .4 | — .0 | None | |
| Epsom | — .002 | 51.0 | — .6 | — .2 | — .0 | — .3 | — 0.3‡ | |

* This merely relates to the setting of the vernier, the setting of the ivory point was too obscure to me, as the surface of the quicksilver was too cloudy to cast a reflection. Mr. Cook did it by actual contact and seemed correct.

† Used for sea water.

‡ Grass minimum.

§ Spare.

REPORT OF INSPECTIONS (ENGLAND).

Prestwich, a Weekly Weather Report and Second Order Station.—Inspected on December 3rd. Barometer has been shifted to a better position; thermometers are in an exceptionally good position and are very good instruments. Rain-gauge fairly good and well exposed. The minimum thermometer was slightly out of order, but this was soon rectified. Observer appears to take great interest in the work.

Barrow-in-Furness, a Telegraphic Reporting Station.—Inspected on December 5th. Barometer had air in tube which I expelled; tube, however, requires “re-boiling” as soon as arrangements can be made to have it done. Thermometer screen needs moving to a more open position. Rain-gauge worn out; new one at once supplied by observer. Wind observations (though apparently defective at first sight) are, I believe, quite accurate.

The testing of the thermometers seems to show that the following corrections are necessary to reduce their indications to true values :—

| — | Dry Bulb. | Wet Bulb. | Max. | Min. | Terrest. Rad. | Temp. at Time. | Time in Water. |
|---------------------|-----------|-----------|------|------|---------------|----------------|----------------|
| Prestwich - | -0.5 | -0.3 | -0.4 | -0.4 | -0.2 | 46.7 | 1 hour. |
| Barrow-in-Furness - | -0.7 | -0.5 | -0.6 | -0.1 | — | 52.1 | 1 hour. |

FREDC. GASTER.

SIR,

Meteorological Office, December 11, 1888.

I BEG to hand you herewith my report and inspection notes respecting the Stations of the Second Order at Uttoxeter and Sutton Coldfield.

Uttoxeter, October 5th.—This is a new station. The barometer is a good one, but the thermometers are all unverified instruments, and are not graduated on the stems. The screen is a rough imitation of Stevenson's, and was not well exposed. The rain-gauge was not firmly fixed and the measuring glass was damaged. At present the evening observations are so frequently omitted as to render the station almost useless, and I fear this difficulty cannot be overcome.

Sutton Coldfield, November 21st.—This is also a new station, but with a complete set of excellent instruments, the property of the Corporation. The barometer is hung in the town hall, on the tower of which (70 feet high) is a small anemometer, and a Jordan Sunshine Recorder. The thermometers and rain-gauge are on the lawn in front of the observer's house, about half-a-mile from the town hall. The screen was painted green at the time of my visit, but will be painted white. The observer (Mr. Fletcher, C.E., borough surveyer) takes great interest in the work. He is very willing to supply tabulations of sunshine if desired to do so.

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

Corrections to be applied to the reading of—

| Stations. | Dry. | Wet. | Max. | Min. | Spare. | Remarks. |
|--------------------|------|-------|------|------|--------|----------|
| Uttoxeter - | + .4 | + 1.2 | — | — | + .3 | |
| Sutton Coldfield - | - .1 | - .1 | - .1 | - .1 | — | |

(Signed) JOHN A. CURTIS.

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

APPENDIX VII.

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 with regard to the home stations, but the work in connection with the information received from the United States has terminated. The Daily Weather Report also has not been altered during the year.

The Office still receives, when the telegraphic communications are perfect, fifty-nine reports every morning, seventeen every afternoon (except on Sundays), and twenty-nine each evening, the arrangement of which is explained in the reports for the past two 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.

As the reports come in, the information is entered on a chart, showing for each station at 8 a.m. the barometrical and thermometrical readings, with their respective alterations during the preceding 24 hours, the direction and force of the wind, and the state of the weather, together with any changes of importance which may have been noticed in the course of the preceding day. This information has been supplemented since January 1st by the subsequent insertion of the reports from all the stations in Russia, Central, Southern, and South-western Europe, which appear in the Bulletin International. From this chart other charts are drawn for publication in the newspapers and the Weekly Weather Report as described further on.

If necessary telegraphic warnings of storms or of atmospherical disturbance are immediately sent to our own coasts and to foreign countries. A brief telegraphic resumé of the weather is despatched shortly after 10 a.m. to the Harbour Authorities and the Chamber of Commerce in Jersey. Another telegraphic message, of about 75 words, is sent to the Underwriters' Association, Liverpool, containing reports of the pressure, wind and weather at 14 stations on the coasts of the British Islands; and a third message of about the same length is forwarded to the Central News and to the Exchange Telegraph Company for despatch to the provinces. The last of these messages consists of a brief statement of the general condition of weather over Western Europe, as shown by the morning reports. It is, however, not in the morning only that storm warnings are issued to the coasts, a constant watch being kept during the day; and, whenever on the receipt of the regular or of special telegrams the condition of the weather appears to be threatening, cautionary messages are at once issued to such parts of the coast as are thought to be menaced by a gale.

Forecasts of the weather, for a day in advance, are prepared each morning, afternoon, and evening; these are drawn up for eleven districts in the British Islands, and issued to subscribers, to certain Clubs, and to many of the London and Provincial newspapers in accordance with the arrangements referred to on p. 10. The districts

for which the Forecasts are prepared are those into which the returns for the Weekly Weather Report are grouped.

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.

About an hour and a quarter is occupied in the preparation and transmission of the provincial and foreign telegrams, and in the drawing up of the "Remarks" and the 11 a.m. Forecasts for the London newspapers, so that the MS. copies for these papers are ready for issue soon after 11 a.m.

Charts are prepared daily for newspaper publication as follows :—

| | | |
|---|-------|-----------------------------------|
| For the "Times," | - | two, viz. : for 8 a.m. and 6 p.m. |
| For the Patent Type Founding Company, on behalf of the "Shipping Gazette," and for distribution to the provincial press | } one | for 8 a.m. |

The 8 a.m. charts are sent out at about 10.15 a.m. and the 6 p.m. chart at about 8.30 p.m.

In addition to the charts here referred to, the Patent Type-founding Company are supplied with various diagrams, showing the changes in Pressure, Temperature, Rainfall, Wind, and Weather for the London district. These are engraved *daily* for the "Daily Chronicle," *weekly* for the "Graphic," and *monthly* for the "Miller," and are all accompanied by remarks on the phenomena exhibited.

Charts are drawn for 8 a.m. and 6 p.m. daily for exhibition at the Office door, and these, together with special Remarks, and with a copy of the latest Forecasts, are posted at the door.

The draft of the Daily Weather Report, with two charts attached, is ready by noon, when it is at once sent to the lithographer to be printed. The copies for delivery by hand and by early post in London are issued at about 1.30 p.m., while the remainder are received at the Meteorological Office at about 3.30 p.m. whence they are transmitted by post to the subscribers and others.

The 2 p.m. observations, taken at fifteen home and two foreign stations (Skudesnaes and Rochefort) are received at about 3 o'clock. Copies of these are issued, together with the 8 a.m. report, to certain newspapers and subscribers, and two copies of the "Remarks" (8 a.m. and 2 p.m.) are sent to the Type-founding Company for issue to provincial newspapers, in order to explain the charts mentioned above.

The evening (6 p.m.) reports arrive at about 7 to 7.30 p.m., and are charted and discussed for the morning daily papers in accordance with the arrangement referred to on p. 10. The forecasts and remarks are usually ready by 8.30 p.m., but in bad weather, owing to the delay of the reports, and the additional care which is necessary in dealing with them, it is occasionally 9 p.m. before they are issued. The "Times" publishes in its First Edition the map showing the distribution of pressure, the winds, temperature, and weather at 6 p.m. on the previous day, and in its Second Edition the similar map for 8 a.m. on the day of issue.

The official charts for 2 p.m. and for 6 p.m. are still much less complete than that for 8 a.m., notwithstanding the great improvements recently made. That for 2 p.m. is drawn on the information received from fifteen home stations, supplemented by two foreign ones, whenever the latter arrive in time to be used. The material for the 6 p.m. charts is supplied by reports from twenty stations in the United Kingdom, supplemented by nine from continental stations. The latter arrive now more promptly than formerly.

The Sunday duty is still conducted as follows:—Two of the clerks attend on Sunday mornings at the Central Telegraph Station from 8.30 a.m. to about 10.15 a.m. By an arrangement with the Post Office these clerks are supplied with the telegrams immediately they arrive in London. These are examined and charted, with the view of issuing, when necessary, warnings of coming storms, to our own and neighbouring coasts. It is necessary that great promptitude should be observed in this service, as the observations must be dealt with and the warnings issued so that the latter may reach the coast before the telegraph offices at the outports close for the day, which is in many cases at about 10 a.m. No work of any kind is transacted for the newspapers on Sunday mornings, the main object of the service being to give early information of storms to our coasts; but a telegram is sent to Jersey in the same form as on week days, and there is the ordinary interchange of messages with foreign countries. A copy of the Valencia message is sent to Lisbon as on week days. At 6 p.m. the same clerks attend at the Meteorological Office to receive the evening telegrams and to prepare the 8.30 p.m. Forecasts.

Atlantic Telegrams.

In the course of the year the arrangements for receiving from the United States through M. Mascart, the Director of the French Meteorological Bureau, have been continued, but it has been deemed advisable to allow the plotting of the observatories to remain in abeyance as the value of such information, in its present form, is far from being established.

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 the whole of the 59 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.

Two maps are added, 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

This information is derived from observations made at 77 stations, the individual values for which are given on the last 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 having been recomputed, those now in use are:—

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

These statistics are given on the first page of the publication, the temperature, accumulated heat, rainfall, and sunshine values for *each station** being given on the last page of each report.

In addition to the telegraphic reports, and the returns from the self-recording observatories, weekly returns from 43 volunteer observers are used, the names of the observers at each station 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, F.R. Met. Soc. |
| Blackpool | - | - | SH | J. Wolstenholme, F.R. Met. Soc. |
| Braemar | - | - | S | J. A. Aitken. |
| Brookeborough | - | - | - | Mr. Ferguson, for Sir Victor Brooke, Bt., F.L.S. |
| Cheadle | - | - | SH | J. C. Philips. |
| Churchstoke | - | - | SH | P. Wright, F.C.S., F.R. Met. Soc. |
| Cirencester | - | - | - | The Royal Agricultural College. |
| Cullompton | - | - | SH | 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. |

* The sunshine values are furnished for only a limited number of carefully selected stations. See p. 69.

| Names of Stations. | Names of Authorities. |
|-------------------------------|---|
| Edgeworthstown (Currygrane) - | J. M. Wilson, D.L., J.P. |
| Fort Augustus - - - - - | Rev. W. M. Wall. |
| Foynes - - - - - | W. Ward, for Lord Monteagle, K.P. |
| Geldeston - - - - - | E. T. Dowson, F.R. Met. Soc. |
| Glen Carron - - - - - | D. D. Munro. |
| Glenlee - - - - - | G. Maxwell and W. Melville. |
| Hastings (St. Leonard's) - | H. Colborne, M.R.C.S. |
| Hereford - - - - - | T. A. Chapman, M.D. |
| Hillington - - - - - | 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. |
| Killarney - - - - - | The Ven. Archdeacon Wynne, F.R. Met. Soc. |
| Lairg - - - - - | W. Ross, Ground Officer. |
| Laudale (Loch Sunart) - | A. Fletcher, for T. H. G. Newton, F.R. Met. Soc. |
| Llandovery - - - - - | J. Watkins, F.R. Met. Soc. |
| Llandudno - - - - - | J. Nicol, M.D., F.R. Met. Soc. |
| Londonderry - - - - - | J. Conroy, F.R. Met. Soc. |
| Marchmont - - - - - | P. Loney. |
| Markree Castle (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 - - - - - | G. Croucher. |
| 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 - - - - - | W. Robinson. |
| Southampton - - - - - | J. T. Cook, R.E., Ordnance Survey Office. |
| Stowell - - - - - | Rev. H. J. Poole, F.R. Met. Soc. |
| Strathfield Turgiss - - - | Rev. C. H. Griffith. |
| Thurcaston (sunshine only) - | Rev. T. A. Preston. |
| Waterford (Brook Lodge) - | C. Percival Bolton, J.P. |

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

The report is prepared on Wednesday in every week, and is ready for sale early on Saturday morning, but the summary on its first page is sent to the "Times," "Daily News," and several other papers on Wednesday evening.

Appendices.

Appendices, four in number, have appeared similar to those for last year, and a Monthly Supplement has been added, as already explained on p. 60. This Supplement is issued in lieu of the Monthly Weather Report issued in former years, and the preparation of which it was found impossible to maintain.

MONTHLY WEATHER REPORT.

The publication of the *Monthly Weather Report*, so much interrupted by various unavoidable causes, is to be completed till the close of 1887. From that date the instrumental values will appear, with abbreviated notes, as a supplement to the Weekly Weather Report. The numbers

for three months in 1888 and all the months in 1889 have already appeared.

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. This issue is intended especially for the early editions of the evening papers, for the clubs, and for exhibition at certain selected stations. See p. 10.
- (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 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.

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 above 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

* Victoria Street has been re-numbered, so that the address of the Meteorological Office is now "63, Victoria Street, S.W."

† Good Friday and Christmas Day are reckoned as Sundays.

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 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 (p. 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., p. 68.

CHECKING OF STORM WARNINGS.

The testing of the warnings is conducted in the following manner. The intelligence issued is compared with the weather experienced on the coasts, as indicated by the various self-recording anemometers, by the telegraphic reporters, and by several gentlemen who have volunteered to observe for the Office, and whose names will be found in Appendix XIII., p. 75.

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 1888 will be found on p. 14.

The coasts are subdivided into ten districts, as will be seen in the table. Two large tracts of coast are entirely omitted: viz., the west of Ireland from the Shannon to Malin Head, and the West of Scotland from the Mull of Cantyre to Cape Wrath. No warnings are issued to any place within the limits indicated, except to Galway, and the amount of information as to the weather received from the omitted portion of the Scotch coast is, as yet, very scanty.

It should be remembered that in analysing the reports, all observations of the wind in which the force *exceeded* 7 (a "moderate gale") or the velocity exceeded 40 miles an hour, have been quoted as instances of the occurrence of a gale; but it has not been considered that the signal was hoisted late or was hauled down too soon, unless the force of 9 (a "strong gale") or the velocity of 50 miles an hour, was reached prior to the issue of the order to hoist, or subsequent to the issue of the order to lower.

In the Summaries all cases in which the signal has been shown to be late by a single report either of force 9, or of a velocity of 50 miles an hour, have been specially noted.

APPENDIX VIII.

FISHERY BAROMETERS.

LIST of PLACES supplied with FISHERY BAROMETERS.

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

Orkney Isles.—*Burra, *Kirkwall.

Scotland, east coast.—*Stroma, *Keiss, *Staxigoe, *Wick, *Sanclet, *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 (2).

England, south coast.—Bognor, Ryde, East Cowes, Bembridge, Brixton, Atherfield, Ventnor (2), Gorey (Jersey), Haslar Hospital,

* Inspected.

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, 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, *Groomsport, *Donaghadee, Ardglass, Carlingford, Greenore, Dundalk, Malahide, Howth, *Kingstown (2), *Bray, *Wicklow.

Ireland, south coast.—Dunmore, 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, Kincaslugh, Bunbeg.

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

Scotland, west coast.—*Tarbert, *Campbeltown, *Carradale, *Portree (Isle of Skye), *Plockton.

Hebrides.—*Stornoway, *Cromore, *Obb, *Ness.

SUMMARY of STATIONS supplied with INSTRUMENTS.

| | | | | | |
|--------------------------|---|---|---|---|-------|
| England and Wales - | - | - | - | - | 65 |
| Scotland and Isle of Man | - | - | - | - | 56 |
| Ireland | - | - | - | - | 48 |
| | | | | | <hr/> |
| | | | | | 169 |
| | | | | | <hr/> |

APPENDIX IX.

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,

* Inspected.

84 in England and Wales, 41 in Scotland, 15 in Ireland, 3 in the Isle of Man, and 3 in the Channel Islands.

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

The signals used consist of:—

1. Cone, point downwards for Southerly gales ; S.E. round by S. to N.W.
2. Cone, point upwards for Northerly gales ; N.W. round by N. to S.E.

The signals are to be kept hoisted *during the daylight only*, until 48 hours have elapsed from the time *the telegram was despatched*, unless countermanded. At night, lanterns may be used wherever the local authorities deem it desirable to do so.

The meaning of the signals is that an atmospherical disturbance exists (which will be explained in the telegram), and will probably, but not *necessarily*, cause a gale at the place warned, *from the direction* indicated by the signal.

The Meteorological Office supplies the canvas shapes and lanterns to such places as require them, on loan, but in all cases the local authorities must undertake the charges incidental to the hoisting of the signal, such as flagstaff and gear, oil, &c., and also to the keeping of the apparatus in repair, painting, &c.

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 1888 to March 1889. 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. | Percentages. | | | | Months. | Percentages. | | | | | |
|-----------|------------------|---------------------|----------------------|---------------------|---------|--------------|------------------|----------------------|---------------------|---------------------|----|
| | Wind. | Weather. | Average. | a + b. | | Wind. | Weather. | Average. | a + b. | | |
| April | a b c d | 49 37 11 3 | 47 34 12 7 | 48 36 11 5 | 84 | October | a b c d | 55 28 11 6 | 56 29 10 5 | 56 28 11 5 | 84 |
| May | a b c d | 49 34 12 5 | 57 26 6 11 | 53 30 9 8 | 83 | November | a b c d | 41 36 16 7 | 55 31 7 7 | 48 34 11 7 | 82 |
| June | a b c d | 56 28 8 8 | 49 27 14 10 | 53 27 11 9 | 80 | December | a b c d | 38 31 21 10 | 50 31 12 7 | 44 31 17 8 | 75 |
| July | a b c d | 48 33 12 7 | 55 28 12 5 | 52 30 12 6 | 82 | January | a b c d | 50 29 10 11 | 45 37 14 5 | 47 39 12 8 | 80 |
| August | a b c d | 51 39 6 4 | 45 35 13 7 | 48 37 10 5 | 85 | February | a b c d | 38 44 13 5 | 60 29 6 5 | 49 37 9 5 | 86 |
| September | a b c d | 45 38 13 4 | 59 26 8 7 | 52 32 11 5 | 84 | March | a b c d | 43 37 15 5 | 52 34 6 8 | 48 35 11 6 | 83 |

APPENDIX XI.

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

| Station. | | | | Observer. |
|--------------------------|---|---|---|------------------------------------|
| Aberdeen | - | - | - | Prof. C. Niven, M.A., F.R.S. |
| Armagh | - | - | - | J. L. E. Dreyer, Ph.D., F.R.A.S. |
| Blackpool | - | - | - | J. Wolstenholme, F.R. Met. Soc. |
| 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. |

| Station. | Observer. |
|---------------------------------|--|
| Dublin - - - - | Lt. Col. A. B. Coddington, R.E., and subsequently Major Kirkwood, R.E. |
| Durham - - - - | H. J. Carpenter. |
| Eastbourne - - - - | R. Sheward, F.R. Met. Soc. |
| Falmouth - - - - | 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. Folkes, M.A., F.R. Met. Soc. |
| Jersey (St. Aubin's) - - - - | J. Fisher. |
| 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, 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. S. J. Perry, M.A., F.R.S. |
| Stornoway - - - - | John Forbes. |
| Sutton Coldfield - - - - | J. Fletcher, C.E. |
| Swanbister (Orkney) - - - - | W. Irvine Fortescue. |
| Valencia - - - - | J. E. Cullum. |
| Workop - - - - | H. Mellish, F.R. Met. Soc. |
| York - - - - | J. E. Clarke, B.A., B.Sc. |

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

| | |
|--------------------|----------------------------------|
| Glencarron - - - - | D. D. Munro. |
| Braemar - - - - | J. A. Aitken. |
| Stowell - - - - | Rev. H. J. Poole, F.R. Met. Soc. |

APPENDIX XII.

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

These stations are of five classes, as stated on page 17.

1.—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.

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 amount 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.

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.

Annual Tables.

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.

Tables for the
Quarterly
Weather Reports.
Gale 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.

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

The anemograms received from the stations enumerated on page 75 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.—*Method followed with regard to the Returns from 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 77, including 15 belonging to the Royal Meteorological Society and 5 belonging to the Scottish Meteorological Society.

This number is exclusive of the self-recording observatories, and of the anemographic stations, but it includes several from which only very scanty information is received.

The stations are distributed as follows: 42 in England, 3 in Wales, 12 in Scotland, and 20 in Ireland.

The returns are received at the Office monthly, and are duly entered and stored.

Publication on
Form A.

The publication of the returns is carried out in the following way: For a certain number of stations the observations of pressure (to the second place of decimals), temperature, wind, cloud amount, and weather, at 9 a.m. and 9 p.m. each day, together with the computed vapour tension and relative humidity at those hours, and the daily maxima and minima of temperature, and daily rainfall, are published *in extenso* on the Form A., proposed by the Permanent Committee of the First International Meteorological Congress at Vienna in 1874, and adopted for international use by the Second International Meteorological Congress at Rome in 1879.

The Permanent Committee assigned an inferior limit to the number of stations from which returns should be published *in extenso*, varying from 2 for Belgium to 100 for Russia in Asia, the number in the case of the United Kingdom being 15. In 1875, when the systematic publication of returns from Stations of the Second Order began, the results from only nine stations in connexion with the Office were available, but this number has steadily grown, until for 1880 returns from 33 stations were published on the A. Form. The volume for 1885, which is now completed, contains returns from 32 stations.

Care is taken in adding to the list for publication to see, first, that the station is satisfactory as regards its instruments, their exposure, &c.; secondly, that the returns bear internal evidence of accuracy and care in their preparation; and thirdly, that the district represented by the station is one for which information is needed.

Additions to the list for publication.

Full particulars as to the methods adopted in the examination of the returns will be found in previous reports.

Examination.

Besides this publication in full, the monthly means of the various elements, together with summaries of the wind direction and of the weather, are published on the Form B., also devised by the Permanent Committee of the Vienna Congress, and adopted by the Roman Congress.

Publication on Form B.

Returns from six stations were published in this manner for the year 1873, and from nine stations for the year 1874. In 1875 the list included the names of 26 stations. This number has grown to 46 for the year 1885, and might be even further increased.

All the stations, returns from which are published *in extenso* on Form A., are included in the Form B. list. But this list also includes others, either not quite so good, not so representative, or not so long established. The method of preparation is in the main the same as in the case of the Form A. But the summaries of wind and weather for all the stations are specially prepared for this publication. For wind, the summary shows the number of *observations* at 9 a.m. and 9 p.m. under each of the semi-quadrantal points N., N.E., E., &c., the observations under intermediate points being thrown alternately forward and backward. For weather, the summary gives the number of *days* of rain, snow, hail, thunderstorm, clear sky, overcast, and gale. The days of clear sky and overcast are those when the means of the cloud-amounts at 9 a.m. and 9 p.m. are less than 2, and more than 8 respectively. The days of gale are those when force 7 or upwards, by Beaufort scale, is recorded.

The monthly rainfall values (total, number of rainy days, and maximum) for the observatories and all the Stations of the Second Order are supplied each year to Mr. Symons, F.R.S., for publication in his "British Rainfall."

British rainfall

The observations are taken at 9 a.m. and 9 p.m. local time each day. It sometimes happens, however, that strict punctuality cannot be observed. In such cases, if the difference in time does not exceed 30 minutes, the observations are, in most cases, printed without alteration. When the difference exceeds 15 minutes, a note is inserted in the remarks showing the exact time of observation. If the difference in time is more than half-an-hour, the readings are usually rejected and an interpolation made.

Unpunctual observations.

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.

New stations.

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 complete and perfect the returns.

Sunshine
records.

The daily records of sunshine which are now received from 36 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.

Weekly totals.

A tabulation of these curves is published as part of the Weekly Weather Report, mentioned in Appendix VII., 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, is published as Part IV. of "Returns from Stations of the Second Order." A table showing the daily amount of sunshine at Bunhill Row, one of the London stations, is also prepared quarterly for the Royal Meteorological Society.

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. 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 XIII.

LIST OF DOCUMENTS RELATING TO THE LAND METEOROLOGY OF THE BRITISH ISLANDS, RECEIVED DURING THE YEAR ENDING MARCH 31ST, 1889.

| Stations. | Observers. | Nature of Information received. | Notes. |
|-------------------------|--|---|-----------------|
| I. †Valencia | J. E. Cullum - | Continuous records of pressure, temperature, wind, sunshine, and rain, with eye observations of the clouds and notes on the weather. | |
| †Glasgow | Prof. R. Grant, M.A., LL.D., F.R.S. - | | |
| †Aberdeen | Prof. C. Niven, M.A., F.R.S. - | | |
| †Falmouth | E. Kitto, R.R. Met. Soc. - | | |
| †Stonyhurst | Rev. S. J. Perry, S.J., F.R.S. - | | |
| †Kew | G. M. Whipple, B.Sc., F.R.A.S., F.R. Met. Soc. - | | |
| †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) | The late Lt.-Col. A. B. Coddington, R.E., and 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 - | " | |
| †Swanbister (Orkney) | W. I. Fortescue, Esq. - | " | |
| Scilly | W. Thomas - | " | |
| †Yarmouth | G. T. Watson - | " | |
| Heligoland | J. J. Friederichs - | " | |
| †Kilkenny Castle | The Marquis of Ormonde - | " | |
| London | The Athenæum Club - | Continuous record of pressure. | |
| Nottingham | E. C. Patchett - | " | |
| Waterford | The Harbour Authorities - | " | |
| †Armagh | J. L. E. Dreyer, Ph.D., F.R.A.S. - | " | From May 1888. |
| Aysgarth | Rev. Fenwick W. Stow, M.A., F.R. Met. Soc. - | " | From July 1888. |
| III. †Babbacombe, Devon | E. E. Glyde, F.R. Met. Soc. - | 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. | |
| †Bennington, Herts. | Rev. J. Dunne Parker, LL.D., F.R. Met. Soc. - | | |
| †Berkhamsted | E. Mawley, F.R. Met. Soc. - | | |
| †Braemar | James Aitken, J.P. - | | |

LIST OF DOCUMENTS—continued.

| Stations. | Observers. | Nature of Information received. | Notes. |
|--|---|---|--------|
| †Brookborough (Colebrook Park). | W. Ferguson, for Sir Victor Brooke, Bt., F.L.S. | | |
| †Buxton | E. J. Sykes, M.B., F.R.A.S., F.R. Met. Soc. | | |
| ††Carmarthen | G. J. Hearler, M.D. | | |
| ††Chaddles | J. C. Philips, Esq. | | |
| ††Cheltenham | R. Tyner, B.A., F.R. Met. Soc. | | |
| ††Churchstoke | Philip Wright, F.C.S., F.R. Met. Soc. | | |
| ††Croukbourn, Isle of Man. | A. W. Moore, M.A., J.P. | | |
| ††Douglas, Isle of Man | Thos. Keig, Esq. | | |
| ††Dublin (Botanic Gardens, Glasnevin). | F. W. Moore, M.R.I.A. | | |
| ††Dublin (City) | J. W. Moore, M.D., F.R. Met. Soc. | | |
| ††Dublin (Mountjoy Observatory). | Sergt. Lipscombe, for Major Kirkwood, R.E., Ordnance Survey Office. | | |
| ††Dundee | W. Ross McKelvie, Esq. | | |
| ††Dunrobin Castle | D. Melville, for the Duke of Sutherland, K.G. | | |
| ††Durham | H. J. Carpenter, Esq. | | |
| ††Eastbourne | R. Sheward, Esq., F.R. Met. Soc. | | |
| ††Edgworthstown | J. M. Wilson, J.P. | | |
| ††Epsom (Royal Med. College). | J. S. Jackson, Esq. | | |
| ††Gedeston (Beccles) | E. T. Dowson, F.R. Met. Soc. | | |
| ††Glasgow | Prof. R. Grant, M.A., LL.D., F.R.S. | | |
| ††Glenalmond | Arthur S. Reid, M.A., F.G.S. | | |
| ††Hillington, Norfolk | Rev. H. E. B. Folkes, M.A., F.R. Met. Soc. | | |
| ††Killarney | The Ven. Archdeacon G. R. Wynne, M.A., F.R. Met. Soc. | | |
| ††Laudale (Argyleshire) | A. Fletcher, for T. H. G. Newton, M.A., J.P., F.R. Met. Soc. | | |
| ††Llandudno | J. Nicol, M.D., J.P., F.R. Met. Soc. | | |
| ††Londonderry | J. Conroy, F.R. Met. Soc. | | |
| | | 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. | |

LIST OF DOCUMENTS—continued.

| Stations. | Observers. | Nature of Information received. | Notes. |
|---|--|--|---------------------|
| †Margate - | J. Stokes, F.R. Met. Soc. - | 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 July 1888. |
| †Market Rasen - | W. B. Jevons - | | |
| †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. Boeddicker, Ph.D., for the Earl of Rosse, F.R.S. - | | |
| Pinmore - | Mr. Peter Donald - | | |
| †Prestwich (Manchester) - | T. R. H. Clunn, M.D., F.R. Met. Soc. - | | |
| †Rothesay - | James Kay, Esq. - | | |
| †Rousdon - | C. E. Peck, M.A., F.R.A.S., F.R. Met. Soc. - | | |
| †Scarborough - | Allan Rowntree, F.R. Met. Soc. - | | |
| Seaham - | G. H. Aird - | Regular observations twice (and in some cases three times) daily of pressure, temperature, wind, weather, and sea disturbance. Pressure, temperature (dry-bulb, wet-bulb, max., min.), wind and rainfall, once daily. Pressure, temperature, wind, and weather, once daily. Full monthly summary | Till July 1888. |
| †Southampton - | J. T. Cook, R.E., for Director General of the Ordnance Survey. - | | |
| Stokesay - | Miss M. A. Digges La Touche - | | |
| †Stonyhurst - | Rev. S. J. Perry, S.J., F.R.S. - | | |
| †St. David's, Pembroke - | W. P. Probert, LL.D., F.G.S., F.R. Met. Soc. - | | |
| †St. Leonards - | H. Colborne, M.R.C.S. - | | |
| †Sutton Coldfield - | J. Fletcher, C.E. - | | |
| †Swanbister - | W. L. Fortescue, Esq. - | | |
| Uppingham - | Rev. G. H. Mullins, M.A., F.R. Met. Soc. - | | |
| †Uttoxeter - | Rev. R. Barker, F.R. Met. Soc. - | | |
| †Wakefield - | H. Clarke, L.R.C.P., F.S.S., F.R. Met. Soc. - | Regular observations twice (and in some cases three times) daily of pressure, temperature, wind, weather, and sea disturbance. Pressure, temperature (dry-bulb, wet-bulb, max., min.), wind and rainfall, once daily. Pressure, temperature, wind, and weather, once daily. Full monthly summary | Till December 1888. |
| †York - | J. Wright, for H. M. Platnauer, F.G.S. - | | |
| IV. The Telegraphic Stations, see List on page 43 - | - | | |
| V. †Arlington Court, Devon - | J. Carter, for Lady Chichester - | | |
| Baltimore - | J. Halsey - | | |
| †Bolton - | W. W. Midgley, F.R. Met. Soc. - | | |
| | | | |
| | | | |
| | | | |
| | | | |

LIST OF DOCUMENTS—continued.

| Stations. | Observers. | Nature of Information received. | Notes. |
|---|---|--|----------------------|
| Castletownsend | Lieut. T. W. Cobb, R.N. | } Pressure and temperature four times daily, and wind twice daily. Full return for 9 a.m. | |
| Crookhaven | " | | |
| Chatham (School of Military Engineering). | P. McHugo and D. Harrington, for Instructor in Surveying. | | |
| Cooper's Hill (Egham) | Prof. H. McLeod, F.R.S. | Full return for 9 a.m. and 3 p.m. | |
| Crosshaven | J. W. Bridle | Pressure, temperature, and wind, twice daily. | |
| Cuckfield | John Howe, Esq. | Daily rainfall. | |
| Ennis | J. Hill, C.E., F.R. Met. Soc. | Daily rainfall. | |
| Galway | E. G. Shaw | Pressure and temperature four times daily, with wind. | |
| Gorleston, Norfolk | 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 | G. Coppen | Pressure and temperature four times daily. | |
| Knightstown (Valencia). | John Doughty | Pressure, wind, and weather once daily. | |
| North Arran | Coast Guard | Pressure, temperature of air and sea four times daily, with wind and weather at noon. | From September 1888. |
| Rugby | C. H. Hodges, M.A., Geo. M. Seabrooke, F.R.A.S., and W. N. Wilson, M.A. | Full set of 9 a.m. observations with 9 p.m. temperatures. | |
| Schull | Lieut. T. W. Colb, R.N. | 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, Esq. | Full monthly summary. | |
| Stranraer | P. Doran | 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. | |
| Union Hall (Glandore) | Lieut. T. W. Cobb, R.N. | 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 thus † have been inspected during the year.

APPENDIX XIV.

ACCESSIONS TO THE LIBRARY DURING THE YEAR ENDING
31ST MARCH 1889.

Abercromby, Hon. R.—Cloud-land in folk-lore and in science. A lecture delivered before the Phil. Inst. Edinburgh, Dec. 6, 1887. 8°. (*Folk-lore Journ.*, vi., part 2, 1888, p. 94.)

* ——— Instructions for observing clouds on land and sea, with photographs and engravings. 8°. London, 1888.

* **Ackroyd, W.**—Ackroyd's barometer and weather chart. Oblong 8°. Sheet. Leeds, s.a.

Adelaide, Meteorological Society of Australasia.—Minutes of proceedings. 1886 and 1887. Vol. ii. 1a. 8°. Adelaide, 1888.

? Vol. i. is "The history, rules, and regulations," &c.

[**Adelaide Observatory.**]—Rainfall in South Australia and the Northern territory during 1887 and 1881, with weather characteristics of each month, by **C. Todd.** sm. f°.

|| **Agamennone, G.**—Il tenemoto nel vallo Cosentino del 8 Dicembre 1887. sm. f°. Roma, 1888. (*Annal. Ufficio Centr. Meteor. e Godinam.*, viii., 1886, parte iv.)

Airy, [G. B.]—Table of altitude. Corresponding numbers of elevation in English feet, and of readings of aneroid or corrected barometer in English inches; (the mean of atmospheric temperatures being 50° Fahrenheit). 4°. Sheet.

|| **Aitken, J.**—On the number of dust particles in the atmosphere. 1a. 4°. Edinburgh, 1888. (*Trans. R. Soc. Edin.*, xxxv., part i.)

[**Allahabad, Meteorological Office.**]—Brief sketch of the meteorology of the North-west Provinces, Oudh, and Eastern Rajputana for the year 1887. sm. f°. s.l.e.a.

Allahabad, Meteorological Reporter to Government, North-west Provinces and Oudh.—Administrative report . . . for the year 1887-88. sm. f°. s.l.e.a.

Algiers, Service météorologique [du Gouvernement général] de l'Algérie.—Bulletin mensuel. 1887, Jan.—Dec. Nos. 26-37. sm. f°. s.l.e.a.

[———] Bulletin météorologique de l'Algérie. 1888, Jan. 1—Dec. 31. Oblong sm. f°. Sheets.

|| ——— Observations météorologiques du Réseau Africain. Années, 1884-85. 2 vols. 1a. 4°. Paris, 1887-88. (*Ann. Bureau central. météor.*, 1884-85, II.)

American Meteorological Journal.—A monthly review of meteorology, medical climatology, and geography. Edited by **M. W. Harrington** and **A. L. Rotch.** Vol. III., May, 1887—April, 1888. 1a. 8°. Ann Arbor, s.a.

——— Circular concerning prizes for tornado studies offered by the American meteorological journal. 8°. s.l.e.a.

Amsterdam, Kon. Nederlandsch Aardrijkskundig Genootschap.—Tijdschrift . . . onder redactie van **C. M. Kan** en **J. C. C. A. Timmerman.** Tweede serie. Deel iv-v. Verslagen en Aardrijkskundige Mededeelingen. 2 vols. 8°. Amsterdam, 1887-88.

The title "Koninklijk" commences with Deel. iv.

——— Tijdschrift . . . onder redactie van **C. M. Kan** en **J. C. C. A. Timmerman.** Tweede serie. Deel iv.-v. Meer uitgebreide artikelen. 2 vols. 8°. Amsterdam, 1887-88.

The title "Kiniuklijk" commences with Deel. v.

Anemometers employed in mining operations. 1a. 8°. (*Spons' Dict. Eng.*, London, Nos. 2 and 3, p. 61.)

NOTE.—Books marked * have been acquired by purchase; the others are donations from institutions, societies, or authors. Those marked || are excerpt papers, extra copies of which have been separately printed.

In some cases additional publications have been received besides those specified, but only completed volumes or years are given here.

|| **Augustin, F.**—Über den jährlichen Gang der meteorologischen Elemente zu Prag. 1a. 4°. Prag, 1888. (*Abhandl. d. böhm. Gesellsch. Wissensch.*, vii. Folge, 2 Bd.)

Avignon Commission météorologique de Département de Vaucluse.—Compte-Rendu pour les années, 1886–87. 2 vols. sm. 8°. (Avignon, s.a.)

|| **Ball, J.**—On the measurement of heights by the barometer. 1a. 8°. (London, s.a.) (*Suppl. Papers R. Geogr. Soc.*, ii., part 3.)

Batavia, magnetical and meteorological observatory.—Observations. Published . . . under the direction of Dr. J. P. Van der Stok. Vol. viii., 1883–85, x., 1887. 2 vols. 8°. Batavia, 1888.

——— **Observatorium.**—Regenwaarnemingen in Nederlandsch-Indië. Nieuwe Jaarg., 1887. Door J. P. Van der Stok. 8°. Batavia, 1888.

Title page and preface in the English language also.

Batchelder, J. M.—Temperature of the Saco River. 1a. 4°. (*Science*, xi., 1888, p. 170.)

Berlin, Deutsche meteorologische Gesellschaft.—Berliner Zweigverein der deutschen meteorologischen Gesellschaft. Sechses Vereinsjahr, 1889. 8°. Berlin, 1889.

——— **Hydrographisches Amt der Admiralität.**—Annalen der Hydrographie und maritimen Meteorologie. Organ des hydrographischen Amtes und der Deutschen Seewarte. xvi. Jahrg., 1888. 1a. 8°. Berlin, s.a.

——— **Königlich Preussisches meteorologisches Institut.**—Instruktion für die Beobachter an den meteorologischen Stationen II., III., and IV. Ordnung. (Vouvoert von W. v. Bezold.) 1a. 8°. Berlin, 1888.

[———] Witterung nach den Beobachtungen des königlichen meteorologischen Instituts, 1888. Jan.–Dec. 1a. 4°. (*Statist. Corresp.*, Berlin, xiv–xv., 1888–89.)

|| **Bezold, W. von.**—Über eine nahezu 26-tägige Periodicität der Gewittererscheinungen. 1a. 8°. (*Sitz. phys. math. Cl. k. preuss. Akad. Wissensch.*, Berlin, xxxvi., 1888, p. 905.)

——— Zur Thermodynamik der Atmosphäre. 2 parts. 1a. 8°. (*Sitzungsber. k. preuss. Akad. Wissensch.*, Berlin, 1888, p. 485, und 1189.)

* **(Bianchi, P. und X. de.)**—Gebrauch des universal Thermometrio, aus acht Autoren, als:—De Lisle, Fowler de Ball, M. Michel du Gre, Fahrenheit, M. de Reaumeur, Newton, De Bergen, de la Hire, in eines zusammen getragen, und von uns versertiget. sm. 8°. Prag, 1765.

* ——— Von dem Nutzen und Gebrauch des geraden Barometers oder so genannten Wetterglases, nach Eintheilung des pariser Maas-stabs. sm. 8°. s.l.e.a.

* **(Bianchy, J. von.)**—Das Merkwürdigste vom Barometre und Thermometre. In sieben Abschnitte zusammen getragen und mit einer neuerfundenen Wetterglas-Tafel versehen. sm. 8°. Wien, 1762.

Bibliothèque universelle [et revue suisse]. Archives des sciences physiques et naturelles.—Troisième période. Tomes xix.–xx. 2 vols. 8°. Genève, 1888.

|| **Birkner, O.**—Bericht über die Wasserkatastrophe in der Lausitz während der Nacht vom 17. Zum 18. Mai 1887. 1a. 4°. Chemnitz, s.a. (*Jahrb. d. sächs. meteor. Inst.*, Jahrg. v., 1887.)

|| **Blaserna, P.**—Sull' impianto del servizio geodinamico in Italia. 1a. 8°. Roma, 1888. (*Rend. R. Acad. Linc., Cl. sc. moral., stor. e filol.*, iv., fasc. 13, p. 774.)

* **Bohun, R.**—A discourse concerning the origine and properties of wind. With an historical account of hurricanes, and other tempestuous winds. sm. 8°. Oxford, 1671.

Boileau, J. T.—Meteorological observations made at the magnetic and meteorological observatory at Simla during the years 1841–45, under the direction of Lieut. Col. J. T. Boileau. Vol. ii. 1a. 4°. London, 1877.

Bombay, Government Observatory.—Magaetical and meteorological observations made at the Government Observatory, Bombay, in the year 1886. Under the direction of C. Chambers, with six appendices containing accounts of various magnetic researches. 8°. Bombay, 1888.

(Bombay, Government Observatory.)—Report on the condition and proceedings of the Government Observatory, Colába, for the year which ended with the 30th June 1888. s.l.e.a.

[— Meteorological Office.]—Brief sketch of the meteorology of the Bombay Presidency in 1887–88. f°. (Bombay, s.a.)

(Brisbane, Government Meteorological Observer.)—Preliminary report of the Government meteorologist for the year 1887. (By C. R. Wragge.) sm. f°. Brisbane, s.a.

— Post and Telegraph Department, Meteorological Branch.—Account of the operations of the weather bureau and list of stations. la. 8°. (Brisbane, 1888.)

— Brisbane observatory, Wickham Terrace. Meteorological synopsis. 1887–1888, Jan–Dec. f°. Sheets,

— Climate of Brisbane. Meteorological synopsis for the weeks ending April 11, 1887, to 9 January 1888. f°. Sheets.

Week ending April 18 is missing.

— Table of rainfall during the months of Jan.—Dec., 1837–88. f°. Sheets.

— Weather chart of Australasia. 1888, Jan. 1 to Dec. 31. la. f°. Sheets.

|| Brückner, E.—Die Schwankungen des Wasserstandes im Kaspischen Meer, dem Schwarzen Meer und der Ostsee, in ihrer Beziehung zur Witterung. Vortrag gehalten vor der Allgemeinen Versammlung der Deutschen meteor. Gesellsch. in Karlsruhe, Ostern 1887. la. 8°. Berlin, 1888. (*Ann. Hydr. metr. Meteor.*, 1888, Feb.)

Brussels, Observatoire royal de Bruxelles.—Bulletin météorologique. 1888, Jan. 1—Dec. 31. f°. Sheets.

Bucharest, Ministerul Agriculturii, Industria, Comericiului si Domeniilor.—Buletinul. Anul I., 1885. Nos. 1–12 and Suppl. sm. f°. Bucuresci, 1885–86.

Buenos Ayres, Oficina meteorológica Argentina.—Anales . . . por su Director G. G. Davis. Tomo VI. la. 4°. Buenos Aires, 1888.

Burdwood, J.—Sun's true bearing or azimuth tables, computed for intervals of four minutes between the parallels of latitude 30° and 60° inclusive. la. 8°. London, 1885.

* Butler, T. B.—A concise analytical and logical development of the atmospheric system, and of the elements of prognostication, by which the weather may be forecasted, adapted to the practical mind of the country. Revised edition. sm. 8°. Norwalk, Conn., 1870.

There are apparently two errors in paging in the vol.

*|| Buys-Ballot, [C. H. D.]—Storm warnings. sm. f°. Slip. (*Proc. Lit. Phil. Soc. Manch.*, vi., 1867, p. 83.)

|| — Verdeeling der Wanute over de aarde. 4°. Amsterdam, 1888. (*Verh. Afd. Nat. K. Akad. Wetensch.*, xxvi.)

(Calcutta, Meteorological Office, Bengal.)—Administration report of the meteorological Reporter to the Government of Bengal for the year 1887–88. sm. f°. s.l.e.a.

[— —] Bay of Bengal weather chart. 1888, Jan. 1—Dec. 31. sm. f°. Sheets.

— Bengal daily weather report. 1888. sm. f°. Sheets.

These reports are only published during the rainy season.

(— —) Meteorological and rainfall table of the Province of Bengal for the months of January to December 1888, with annual tables. sm. f°.

(— —) Meteorological and rainfall table of the Province of Bengal for the weeks ending January 6 to December 23, 1888. f°.

— Meteorological Office, India.—Abstract of the results of meteorological observations taken at the Alipore Observatory in the months of Jan.—Dec., 1888. sm. f°. Sheets.

— Abstract of the results of the thermometric observations taken at the Meteorological Office, Chowringhee. 1888, Jan. to Dec. sm. f°. Sheets.

— Charts of the Arabian sea and the adjacent portion of the North Indian Ocean, shewing the mean pressure, winds and currents in each month of the year. 14 pp., 12 charts, oblong f°. s.l.e.a.

Calcutta, Meteorological Office, India.—Cyclone memoirs. Part i. Bay of Bengal cyclone of May 20th—28th, 1887. 1a. 8°. Calcutta, 1888.

[— — —] India daily weather report. 1888, Jan. 1—Dec. 31. f°. Sheets.

[— — —] Indian meteorological memoirs. . . . Prepared under the direction of **F. H. Blanford**. Vol. iii. f°. Calcutta, 1887.

[— — —] Preliminary report on the meteorology for the year 1887, prepared in the Meteorological Office, Government of India. f°. (Simla, 1888.)

[— — —] Report on the administration of the meteorological department of the Government of India in 1887–88. f°. s.l.e.a.

— — — Results of the meteorological observations taken at the Alipore Observatory, from 1st January to 29th December 1888. sm. f°. Sheets.

— — — Results of the thermometrical observations taken at the Meteorological Office, Chowringhee, from 1st January to 29th December, 1888. sm. f°. Sheets.

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APPENDIX XVI.

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. New Edition. (1875.) 6d.
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.
8. Barometer Manual. (Out of print, see Nos. 3, 24, 40, 60, and 61.)
9. Quarterly Weather Report for 1870.—Parts I. to IV. 5s. each.
10. Report for 1870. Presented to Parliament. 10d.
- *11. Contributions to our Knowledge of the Meteorology of Cape Horn and the West Coast of South America. 2s. 6d.
- *12. Currents and Surface Temperature of the North Atlantic Ocean, from the Equator to Lat. 40° N., for each month of the year, with a General Current Chart. 2s. 6d.
13. A Discussion of the Meteorology of the Part of the Atlantic lying North of 30° N., for the Eleven Days ending 8th February 1870. Price, with Book of Charts, 5s.
14. Quarterly Weather Report for 1871.—Parts I. to IV. 5s. each.
15. Report for 1871. Presented to Parliament. 10d.
16. Quarterly Weather Report for 1872.—Parts I. to IV. 5s. each.
17. Report for 1872. Presented to Parliament. 1s.
18. Contributions to our Knowledge of the Meteorology of the Antarctic Regions. 2s.
19. Quarterly Weather Report, 1873.—Parts I. to IV. 5s. each.
20. Charts of Meteorological Data for Square 3. Lat. 0°—10° N. Long. 20°—30° W., and Remarks to accompany the Monthly Charts, which show the Best Routes across the Equator for each Month, &c. 20s.
21. Report of the Proceedings of the Meteorological Congress at Vienna. 1s.
22. Report for 1873. Presented to Parliament. 4d.
23. Report of the Proceedings of the Conference on Maritime Meteorology held in London, 1874. 2s.
24. Instructions in the Use of Meteorological Instruments. [Reprinted 1888.] 2s. 6d.
25. Quarterly Weather Report for 1874.—Parts I., II., and IV. 5s. each. Part III., 5s. 9d.
26. Report for 1874. Presented to Parliament. 6d.

* The Meteorological Council have given away the copies which were placed at their disposal, but the book can be purchased from the Publishers.

LIST OF PUBLICATIONS, &c.—continued.

- No. 27. Charts of Meteorological Data for the Nine 10° Squares of the Atlantic which lie between 20° N. and 10° S., and extend from 10° to 40° W., with accompanying Remarks, ending with the Best Routes across the Equator. 24s.
28. Contributions to our Knowledge of the Meteorology of Japan. By Staff-Commander Thomas H. Tizard, H.M.S. *Challenger*. 1s.
29. Report for 1875. Presented to Parliament. 4d.
30. Quarterly Weather Report for 1875.—Parts I.—IV. 5s. each.
31. Report for 1876–7. Presented to Parliament. 3s. 5d.
32. A Discussion of the Meteorology of the North Atlantic during August 1873, with 31 Synoptic Charts. 15s.
33. Quarterly Weather Report for 1876 (New Series).—Part I., 6s.; Parts II., III., and IV., 5s. each.
- * 34. Contributions to our Knowledge of the Meteorology of the Arctic Regions. Vol. I.,—Part I., 2s.; Part II., 10s.; Part III., 6s.; Part IV., 5s.; Part V., 6s.
35. Report for 1877–8. Presented to Parliament. 1s.
36. Report of the Proceedings of the Meteorological Congress at Rome, 1879. 1s. 6d.
37. Report on the Meteorology of Kerguelen Island. By the Rev. S. J. Perry, S.J., F.R.S. 3s.
38. Report for 1878–9. Presented to Parliament. 5d.
39. Meteorological Observations at Stations of the Second Order for the year 1878. 20s.
40. Aids to the Study and Forecast of Weather, by the Rev. W. Clement Ley, M.A. 1s.
41. Report for 1879–80. Presented to Parliament. 1s.
42. Report for 1880–81. Presented to Parliament. 1s. 2d.
43. Charts of Meteorological Data for the Ocean District adjacent to the Cape of Good Hope, with accompanying Remarks. Price of the Charts, 25s.; of the Remarks, 7s.
44. Report on the Gales experienced in the Ocean District adjacent to the Cape of Good Hope, between Lat. 30° and 50° S., and Long. 10° and 40° E., by Capt. H. Toynbee. 7s. 6d.
45. Meteorological Observations at Stations of the Second Order for the year 1879. 20s.
46. Report on the Storm of October 13–14, 1881. By Robert H. Scott, F.R.S. 1s. 6d.
47. Rainfall Tables of the British Isles for 1866–80. Compiled by G. J. Symons, F.R.S. 7s. 6d.
48. Report for 1881–2. Presented to Parliament. 1s.
49. Quarterly Weather Report for 1879. (New Series.) Appendices and Plates. 27s. Parts I., II., and III., 6s. each. Part IV., 5s. 6d.
50. Quarterly Weather Report for 1880. (New Series.) Appendices and Plates. 28s. Part I. (In the Press.)
51. Hourly Readings, 1881. (New Series.) Part I., 10s. 6d. Parts II., III., and IV., 21s. each.

* The Meteorological Council have given away the copies which were placed at their disposal, but the book can be purchased from the Publishers.

LIST OF PUBLICATIONS, &c.—*continued.*

- No. 52. Quarterly Weather Report for 1877. (New Series.) Appendices and Plates. 27s.; Part I., 10s.; Part II., 5s.; Part III., 4s. 6d.; Part IV., 6s.
53. Meteorological Atlas of the British Isles. 5s. 6d.
54. Hourly Readings, 1882. Parts I. and II., 20s. each. Part III., 22s. 6d. Part IV., 26s.
55. Quarterly Weather Report for 1878. (New Series.) Appendices and Plates. 28s.; Parts I., II., III., and IV., 6s. each.
56. Sunshine Records of the United Kingdom for 1881. 4s.
57. Meteorological Observations at Stations of the Second Order for the year 1880. 34s. 6d.
58. Report for 1882-3. Presented to Parliament. 10½d.
59. Sea Temperature Charts for the Atlantic, Pacific, and Indian Oceans. 21s.
60. Principles of Weather Forecasting. By the Hon. Ralph Abercromby, F.R.Met.Soc. (Second edition, revised), 2s.
61. A Barometer Manual for the Use of Seamen. 1s. 3d.
62. Monthly Weather Report, 1884. Jan., Feb., March, May—Nov., 1s. 6d. each. April (with 2 Appendices), 2s. 6d. Dec., 1s. 9d.
63. Hourly Readings, 1883. Parts I., II., and III., 21s. each. Part IV., 30s.
64. Report for 1883-4. Presented to Parliament. 1s. 2d.
65. Monthly Weather Reports for 1885. Jan. to Dec. 1s. 6d. each.
66. Meteorological Observations at Stations of the Second Order for the year 1881. 35s.
67. Report for 1884-5. Presented to Parliament. 4s. 4d.
68. Monthly Weather Reports for 1886. Jan. to Dec., 1s. 6d. each.
69. Meteorological Observations at Stations of the Second Order for the year 1882. 35s.
70. Hourly Readings, 1884. Part I., 12s.; Part II., 10s.; Part III., 10s. 6d.; Part IV., 15s.
71. Synchronous Weather Charts of the North Atlantic and the adjacent Continents. Aug. 1, 1882 to Sept. 3, 1883. Parts I. to IV. (33 sheets each.) 17s. each.
72. Report for 1885-86. Presented to Parliament. 8d.
73. Meteorological Observations at Stations of the Second Order for the year 1883. 30s.
74. Hourly Readings, 1885. Parts I. and II., 11s. each. Part III., 10s. 6d. Part IV., 12s.
75. Report for 1886-87. Presented to Parliament. 8d.
76. Charts showing the Mean Barometric Pressure over the Atlantic, Indian, and Pacific Oceans. 10s. 6d.
77. Monthly Weather Reports for 1887. January to April, 1s. 6d. each. May. (In the Press.)
78. Meteorological Observations at Stations of the Second Order for the year 1884. 32s.
79. Report for 1887-88. Presented to Parliament. 1s.
80. Daily Weather Charts of the Arabian Sea for the period of six weeks ending June 25, 1885 (The Aden Cyclone). (In the Press.)

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- No. 81. Hourly Readings. 1886. Parts I., II., and III. 10s. 6d. each. Part IV. Price ?
82. Meteorological Observations at Stations of the Second Order for the year 1885. Price ?
83. Results of Observations made at Foreign and Colonial Stations, 1852–1886, by the Royal Engineers and Army Medical Department. (In the Press.)

NON-OFFICIAL.

- No. 1. Report to the Committee on the Connexion between Strong Winds and Barometrical Differences.—By Robert H. Scott, Director of the Office. 6d.
- *2. Report to the Committee on the Meteorology of the North Atlantic.—By Captain H. Toynbee, Marine Superintendent. 1s.
- *3. Report to the Committee on the Use of Isobaric Curves.—By Captain H. Toynbee, Marine Superintendent. 1s.
4. Routes for Steamers from Aden to the Straits of Sunda and back. Translated from a Paper issued by the Royal Meteorological Institute of the Netherlands. 6d.
5. On the Winds, &c. of the North Atlantic along the Tracks of Steamers from the Channel to New York. Translated from a Paper issued by the Deutsche Seewarte, Hamburg. 6d.
6. Report of the Proceedings of the Meteorological Conference at Leipzig. 1s.
7. Notes on the Form of Cyclones in the Southern Indian Ocean.—By C. Meldrum, M.A., F.R.S. 6d. [Out of Print.]
8. Report on Weather Telegraphy and Storm Warnings. Presented to the Meteorological Congress at Vienna. 6d.
9. Report of the Permanent Committee of the Vienna Congress for 1874. 1s. 6d.
10. On the Physical Geography of that part of the Atlantic which lies between 20° N. and 10° S. and extends from 10° to 40° W. A Paper read before the British Association at Bristol, in August 1875.—By Capt. Toynbee, F.R.A.S., F.R.G.S., Marine Superintendent. 1s. 6d.
11. Report of the Permanent Committee of the Vienna Congress for 1876. 2s.
12. Reports to the Permanent Committee of the Vienna Congress on Atmospheric Electricity, Maritime Meteorology, and Weather Telegraphy, 1878. 2s.

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- No. 13. Report of the Permanent Committee of the Vienna Congress for 1878. 6*d*.
14. Report of the International Meteorological Committee Meeting at Berne, 1880. 1*s*.
15. Report of the Second Meeting of the International Meteorological Committee, held at Copenhagen, August 1882. 2*s*. 6*d*.
16. Report of the Third Meeting of the International Meteorological Committee, held at Paris, September 1885. 1*s*.
17. Report of the Fourth Meeting of the International Meteorological Committee held at Zürich, September 1886. 4*d*.
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