REPORT

OF THE

METEOROLOGICAL COUNCIL

TO THE

ROYAL SOCIETY,

For the Year ending 31st of March 1880.

Presented to both Houses of Parliament by Command of Her Majesty.

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CONTENTS.

THE METEOROLOGICAL COUNCIL

1879–80.

Professor HENRY J. S. SMITH, F.R.S., Chairman.

MR. WARREN DE LA RUE, F.R.S.

Captain FREDERIC J. O. EVANS, C.B., F.R.S., Hydrographer to the Admiralty.

MR. FRANCIS GALTON, F.R.S.

Professor GEORGE GABRIEL STOKES, F.R.S.

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

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Introductory

THE Council during the financial year has consisted of the Members originally nominated by the Council of the Royal Society in 1877; Lieutenant-General Strachey, on his return from India in April 1879, having resumed the place which had been temporarily occupied during his absence by Sir J. H. Lefroy.

The executive department of the Office remains in the hands of Mr. R. H. Scott, F.R.S., the Secretary to the Council, assisted by Captain H. Toynbee, F.R.A.S., as Marine Superintendent.

International Congress at Rome.

In the last Report it was stated that the Chairman and Secretary had been deputed to represent the Office in the International Congress held at Rome in 1879. The Report of the Congress has appeared in English, French, and German; the Office having undertaken the preparation and publication of the English edition. The Congress appointed an International Meteorological Committee to assist in maintaining combined action between the meteorological systems of different countries, and the Council have sanctioned the acceptance by Mr. Scott of the honorary post of Secretary to this Committee.

The present Report is arranged under three headings:—

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

PART I.

OCEAN METEOROLOGY.

Collection of Information.—The methods followed by the Office in collecting and tabulating the observations relating to Marine Meteorology have undergone no change. A concise account of these methods will be found in Appendix I. (p. 57).

Appendix II. (p. 61) contains a list of all the observers whose logs have been classed as "excellent," during the past year. Some of the observers have regularly co-operated with the Office for many years; the names which now appear in the list for the first time are as follows:—

List of observers who have contributed "excellent" logs.

Captain's Name.	Ship.
*C. W. de la Poer Beresford, R.N.	H.M.S. "Alert."
G. Campbell - -	Ship "Janet Cowan."
Robert Chitham -	S.S. "Torrington."
F. S. Clayton, R.N. -	H.M.S. "Rifleman."
H. W. Dyke - -	Barque "Agnes Wilson."
*J. H. C. East, R.N. -	H.M.S. "Alert."
H. Emmett - -	Barque "Sophia Joakim."
H. von Freeden -	Brig "W. von Freeden."
J. G. Greig - -	Ship "British Peer."
W. P. Hughes - -	„ "Royal Alexandra."
J. F. L. Maclear, R.N. -	H.M.S. "Alert."
J. Metcalfe - -	S.S. "Oceanic."
Peter Murdoch - -	Ship "Sierra Madrona."
J. Seymour - -	S.S. "Kangaroo."
J. H. Stiven - -	Ship "Arethusa."
Thomas Young - -	Ship "City of Agra."

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

The following is the total number of logs received from April 1, 1879, to March 31, 1880, and the number of logs which have been classified as "excellent":—

Total No. of Logs received.	No. of Excellent Logs.	Per-centage of Excellent Logs.
148	91	61

The average number of logs received annually during the five years, 1874–8, was 105, and the per-centage of excellent logs among these was 68.

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

Districts from which observations are obtained.

On the 31st of March 1880 the ships carrying instruments supplied by the Office were pursuing the following voyages:—

To Baffin's Bay or Greenland - - -	7
„ North America, East Coast - - -	14
„ „ „ West „ - - - -	5
Off East Coast of North America - - -	3
To West Indies - - - - - -	4
„ South America, East Coast - - - -	5
„ „ „ West „ - - - -	6
„ Africa, East Coast - - - - -	1
„ „ „ viâ Suez - - - -	2
„ Australia and New Zealand - - - -	18
„ India, viâ Cape of Good Hope - - -	24
„ East Indies, viâ Suez - - - -	3
„ China Seas, viâ Cape of Good Hope - -	7
„ „ „ Suez - - - -	5
„ Mediterranean Ports - - - -	4
„ Ports in the North Sea, &c. - - -	2
„ Cape of Good Hope - - - -	6
Total number of ships - - -	116

* Sub-Lieutenants.

Documents received.

The Council again draw attention to the fact that the observations received by the Office from the Mercantile Marine relate mainly to certain definite routes, and that although the information is gradually increasing, the observations for some oceanic areas are still less numerous than could be desired.

Appendix III. (p. 63), supplies a list of all the logs and other documents received at the Office during the year.

The "Cape Squares."

The Six Ten-Degree Squares lying near the Cape of Good Hope.—The Council have devoted much time during the year to the consideration of the best methods of publishing the results relating to these squares, regard being had to the requirements of the seaman as well as of the scientific meteorologist.

The methods represented by the specimen charts of wind-roses and currents given in the last Report have been retained, but other information has been inserted in the Charts. Isotherms of Sea Surface Temperature have been drawn on the Current charts, and isotherms of Air Temperature and diagrams of the relative Frequency of different Barometrical readings in various parts of the area are exhibited on the Wind charts. It is anticipated that the charts for currents and sea temperature, as well as those of winds, air temperature and pressure, will be completed in the course of the summer.

The methods of treatment of the Specific Gravity of the Sea, the Disturbance of the Sea, the Clouds, the Weather, and the Remarks extracted from the Log Books are under consideration, and some progress has already been made with the discussion of these data. A detailed account of the charts and of the discussion upon which they are based will appear in next year's Report.

The Pacific Ocean.

Surface Temperature and Currents of the Pacific Ocean.—This investigation, commenced in 1879, has now been entrusted to Navigating Lieutenant Charles W. Baillie, R.N. (formerly Director of Nautical Studies at the Imperial Naval College at Tokio, Japan). This officer commenced his duties in the Office in October 1879, and is making use of all the data available for the Pacific in the Meteorological Office, as also of the information contained in the Remark Books of Her Majesty's Ships deposited at the Admiralty.

In the greater part of the South Pacific Ocean, as also on the western side of the American Continent, the observations for sea temperature are sufficiently numerous to show the contour lines of equal temperature with a fair approach to precision. In the less frequented parts of the ocean the charts will probably require revision hereafter, but even in their present state they form a considerable addition to existing knowledge.

The Sea Surface Temperature Charts for the four representative months (February, May, August, and November) are now nearly complete, and the Current Charts for the same months are in preparation.

The August and February Charts of the Sea Surface Temperature, as representing the extreme seasons of the year in both the northern and southern hemispheres, are likely to prove of interest in connexion with the study of the climate of the Pacific.

The Pacific Ocean.

As a general result it may be mentioned that in August a band of warm water, varying in temperature from 80° to 86° Fahr., extends across the Pacific, for the most part north of the Equator. It is narrowest in mid-ocean, where its breadth is about 150 miles, and on either side it expands both to the northward and southward.

In the extreme east, by the Mexican Coast, its breadth is probably somewhat less than 800 miles; in the extreme west its influence is traceable from latitude 15° S. to the shores of Japan.

In February a large area of warm water of the same temperature lies between the Low Archipelago and New Guinea, and extends from latitude 25° S. to 15° N.

Sea Temperature Observations.

Sea Temperature Observations round the Coasts of the British Isles.—As stated in the last Report, the Council, with the courteous assistance of the Admiral Superintendent of Naval Reserves, the Trinity House, and the Commissioners of Irish Lights, have organized a series of sea-surface temperature observations to be carried on for a limited period round the coasts of the United Kingdom. The stations selected for these observations are shown on the subjoined chart (see p. 9).

The observations are taken twice a day, at sunrise and at 4 p.m., these epochs corresponding with the daily minimum and maximum temperatures of the sea surface; the temperature of the air is also observed on each occasion. The returns for the first year have been received, and are now under discussion. The Council consider the inquiry of so much interest that they have obtained leave from the above-named authorities to continue the observations for another year.

Arctic Meteorology.

"*Contributions to our Knowledge of the Meteorology of the Arctic Regions.*"—These "Contributions" refer to the part of the Arctic Regions extending from the Meridian of 45° W. to that of 120° W., and from the Parallel of 60° to that of 80° N. of which a map is given in the accompanying plate (Plate I.) The First Part, which appeared in 1878 and was mentioned in the Report for that year, contained a discussion of the observations taken at certain land stations, six in number. The Second Part has now been completed, and will be shortly published. It relates to the records from ships blocked in by ice, and thus deals principally with the time of their long-continued sojourn in winter quarters. The following is the list of the expeditions, the records from which have been employed in this Part:—

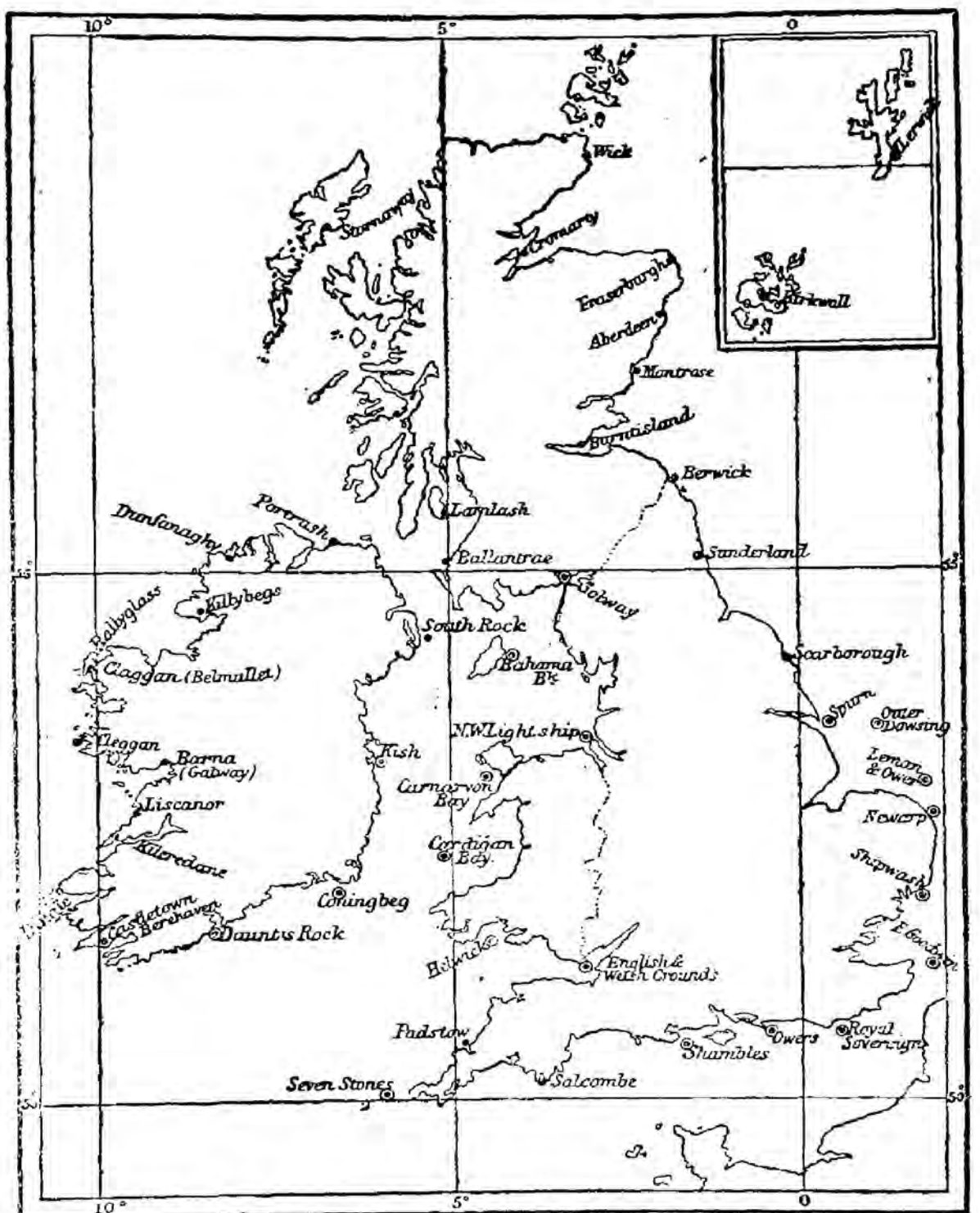
Locality.	Ship.	Captain.	Years.	No. of Months.	Observations.
Boothia - - -	"Victory" - -	Sir John Ross	1829-32	27	Hourly.
Hudson's Strait - -	H.M.S. "Terror" -	Sir G. Back -	1836-7	12	Two-hourly.
Griffith Island - -	H.M.S. "Resolute" -	Sir H. Austin	1850-1	12	Do.
Assistance Bay - -	"Lady Franklin" -	W. Penny -	1850-1	12	Four-hourly.
Northumberland Sound	H.M.S. "Assistance"	Sir E. Belcher	1852-3	12	Two-hourly.
Do. do.	H.M.S. "Pioneer" -	Sherard Osborn	Do.	12	Do.
Wellington Channel -	H.M.S. "Assistance"	Sir E. Belcher	1853-4	12	Do.
Do. do. -	H.M.S. "Pioneer" -	Sherard Osborn	Do.	12	Do.
Baffin's Bay - -	"Fox" - - -	Sir F. Leopold M'Clintock.	1857-8	9	Four-hourly.
Port Kennedy - -	Do. - - -	Do. do.	1858-9	12	Do.

PLATE I.

CHART OF THE PART OF ARCTIC AMERICA
SHOWING THE STATIONS FOR WHICH DATA ARE GIVEN IN PARTS I AND II
OF "CONTRIBUTIONS TO OUR KNOWLEDGE OF THE METEOROLOGY OF THE ARCTIC REGIONS."

PLATE I.

CHART OF THE PART OF ARCTIC AMERICA SHOWING THE STATIONS FOR WHICH DATA ARE GIVEN IN PARTS I AND II OF "CONTRIBUTIONS TO OUR KNOWLEDGE OF THE METEOROLOGY OF THE ARCTIC REGIONS."



MAP SHOWING STATIONS AT WHICH SEA SURFACE TEMPERATURE OBSERVATIONS ARE BEING TAKEN 1879-1880.

Coast Stations, ○ —— *Lightships,* ⊗

Arctic Meteorology.

As this list does not exhaust the catalogue of British Expeditions wintering in the area under discussion, the Council propose to publish a Third Part, which will include, so far as possible, a resumé of the observations of every other British expedition wintering in the same region. The following is a list of these expeditions :—

Wintering Stations.	Ships.	Commanders.	Years.	What Information has been published.
1. Melville Island	"Hecla" and "Griper"	Parry	1819–20	Abstracts published in Parry's first, second, and third voyages.
2. Lyon's Inlet	"Fury" and "Hecla"	Do.	1821–2	
2. Igloolik	Do. do.	Do.	1822–3	
3. Port Bowen	"Hecla" and "Fury"	Do.	1824–5	
4. Port Leopold	"Enterprise" and "Investigator."	James Ross	1848–9	Mean monthly temperatures published in the "Last of the Arctic Voyages."
5. Whale Sound	"North Star"	Saunders	1849–50	
6. Minto Inlet	"Enterprise"	Collinson	1851–2	Nothing published.
6. Cambridge Bay	Do.	Do.	1852–3	
7. Prince of Wales's Strait.	"Investigator"	McClure	1850–1	Monthly means of Meteorological elements are given in Dr. Armstrong's "Personal Narrative."
7. Mercy Bay	Do.	Do.	1851–2	
Mercy Bay	Do.	Do.	1852–3	
8. Dealy Island	"Resolute" and "Intrepid."	Kellett	1852–3	Abstracts in Capt. McDougall's "Voyage of the "Resolute.'"
8. Barrow Strait	Do. do.	Do.	1853–4	
9. Beechy Island	"North Star"	Pullen	1852–3–4	Nothing published.
10. Smith Sound	"Alert"	Nares	1875–6	Published as a Parliamentary Paper, No. C. 2176, Session 1878.
	"Discovery"	Stephenson		

With these it is intended to combine the results of the following four exploring expeditions of the United States :—

Wintering Stations.	Ships.	Commanders.	Year.	What Information has been published.
Drifting in the pack.	"Advance" and "Rescue"	E. J. De Haven, U.S.N.	1850–1	Abstract log in "U.S. Grinnell Expedition," by E. K. Kane, M.D.
Rensselaer Harbour.	"Advance"	E. K. Kane, M.D., U.S.N.	1853–4–5	Meteorological Abstracts in "Arctic Explorations," by E. K. Kane, M.D., and discussed in "Smithsonian Contributions to Knowledge, No. 104."
Port Foulke	"United States"	Isaac J. Hayes, M.D., U.S.N.	1860–1	Discussed in "Smithsonian Contributions to Knowledge, No. 196."
Thank God Bay	"Polaris"	C. F. Hall	1871–2	"Scientific Results of the U.S. Arctic Expedition," by Emil Bessels, M.D.
Life Boat Cove	"	S. O. Buddington	1872–3	

Indian Ocean.

Meteorology of the Indian Ocean.—In the last Report it was mentioned that the India Office had requested the Council to supply to Mr. Blanford at Calcutta a copy of all meteorological information for the Indian Seas contained in the Office logs, the cost of extraction to be borne by the Indian Government. The extracts required have now been completed, at a cost of about 1,000*l.*, the number of sets of observations* copied amounting to 120,000. The Council record with satisfaction that this portion of the stores of information collected in the Office has been placed at the disposal of the Meteorological Department of the

* A "set" of observations includes date and hour, position of the ship, wind (direction and force), readings of barometer and of dry and wet bulb thermometers, observations of the temperature and specific gravity of the sea, of the sea disturbance, of the clouds and weather, with a selection from the remarks made by the observer. To these observations of current (direction and velocity) are occasionally added.

Government of India, and is likely to be turned to immediate account. Instruments

Supply and Stock of Instruments.—In Appendix IV. (p. 74), will be found a list of the meteorological instruments supplied by the Office to ships in the Royal Navy during the year, with a statement of the entire stock and distribution of instruments standing on the books, to the account of the Admiralty, on the 31st March 1880. This latter statement is prepared from the latest returns furnished by the storekeepers at the respective dockyards, &c.

Appendix V. (p. 75), gives similar information with regard to the Board of Trade instruments.

PART II.

Weather Telegraphy.

Telegraphic Reporting Stations.—The communication with all the stations has been maintained with some slight interruptions during the year. The three cables to Shetland, Scilly, and the Channel Islands all suffered some temporary intermissions of service, but none of such long duration as have occasionally been experienced in previous years. Arrangements for reporting.

The changes in the stations during the financial year have been five in number. On the east coast of England Spurn Head has been substituted for Scarborough, as proposed in the last Report. In Ireland the station at Kingstown has been superseded, inasmuch as the wind reports, for the sake of which that station was originally selected, are affected by the neighbouring hills to such an extent that their indications as to wind prevailing in the offing are untrustworthy. The Council have therefore, by the kind permission of the Earl of Rosse, substituted his observatory at Birr Castle for Kingstown, thus obtaining for the Office telegraphic information, hitherto wanting, as to the weather prevailing in the central districts of Ireland.

The Midland Railway Company has, with commendable public spirit, allowed a reporting station to be organized at Hawes Junction. As this point is 1,100 feet above the sea level (whereas no other reporting station is at a higher level than 210 feet) it is anticipated that the information thus obtained will be of exceptional value.

The station at Thurso has been discontinued, a measure which, as indicated in the last Report, has been for some time in contemplation, as the proximity of Wick enables the Office to dispense with reports from Thurso.

Lastly, in March 1880, the Council received a liberal offer from Sir James Ramsden to maintain at his own cost a reporting station at Barrow-in-Furness. This offer was at once accepted, and the station, which commenced working in March, has already proved of great service, not only because it is reasonably

Arrangements for reporting.

near to Hawes Junction and thus affords an opportunity for comparing the records of two neighbouring stations at very different levels, but also because it forms a valuable intermediate point of observation on the west coast of Great Britain between Liverpool and Ardrossan.

A change in the time for making the first afternoon report has been introduced since the 1st of January 1880, in order to render possible an earlier preparation of the afternoon forecasts, as will be explained subsequently. The observations are now taken $1\frac{1}{4}$ hours earlier than was formerly the practice; viz., at 0h. 45m. instead of 2h. p.m.

List of reporters.

A list of the telegraphic reporters will be found in Appendix VI. In addition to the changes already noticed, the post of observer at Ardrossan has been taken by Mr. G. Carrick, in place of Mr. M'Neil, promoted to be Postmaster at Troon in July 1879. At Hurst Castle Mr. G. G. Appleton succeeded Mr. Lanceley in September. At Leith Mr. J. Hutchinson has taken the duty on the death of Mr. J. Turnbull in March 1880; and at Oxford Mr. H. E. Bellamy has been appointed in the place of Mr. C. A. Jenkins.

Inspections.

Inspection of Stations.—The reporting stations have been inspected during the year, in England (including Jersey and the Isle of Man) by the Rev. W. C. Ley, in Scotland by Mr. Buchan, and in Ireland and Wales by Mr. Scott. The reports submitted by the Inspectors to the Council show that the efficiency of the service has been adequately maintained.

"Cirrus" cloud observations.

Cirrus Observations.—During the year a plan for regularly observing and reporting "cirrus" clouds, has been adopted as a tentative measure. The proposal originated with the Inspector for England, Mr. Clement Ley, whose researches on the genesis, form, and character of clouds, more especially of upper clouds, are well known, and who has been led to believe that observations of upper clouds may be of essential service in the preparation of forecasts.

Objections to the use of marine barometers on shore.

Sluggishness of Marine Barometers.—Mr. Buchan, the Inspector of the Office for Scotland, in his Report for 1878, had called the attention of the Council to the "sluggishness" of the marine barometers at the Telegraphic Reporting Stations: a defect which in his judgment forms a serious objection to the use of these instruments at land stations. At the request of the Council, Professor Stokes undertook an investigation of this subject, of which a detailed account is given in Note A. (p. 28). Although from this investigation it results that the greater part of the irregularity, at least in the case of instruments in good condition, can be determined and allowed for, the Council, in order to remove all ground of question on the subject, have resolved to replace the marine barometers at the reporting stations by instruments with uncontracted tubes; this change is in course of being carried out.

Publication of information.

Publication of the Information received.—A description of the practice of the Office in the collection, discussion, and dissemination of the meteorological information received by telegraph

is given in Appendix VII. A list of the institutions and persons who received the Daily Weather Charts free of cost in 1879 forms Appendix VIII.

Arrangements with the three London daily papers.

The arrangements with the "Times," "Standard," and "Daily News," described in former reports, have been maintained during the year.

Fishery barometers.

Fishery Barometers.—In order to put as much meteorological information as possible at the disposal of the fishing and coasting population, barometers are issued on loan for public exhibition at small ports and fishing stations. The whole number of stations on our coasts supplied with these instruments by the Office is at present 151, being four in excess of the previous year. Of these stations, 55 are in England, 5 in Wales, 37 in Ireland, 50 in Scotland, 3 in the Isle of Man, and 1 in Jersey. The list is given in Appendix IX.

Storm warnings.

Storm Warnings.—In Appendix X. will be found the names of the stations which are 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 1880, 136 in number, situated :—

68 in England, 13 in Wales, 35 in Scotland, 14 in Ireland, 3 in the Isle of Man, and 3 in the Channel Islands.

Results of storm warnings.

The usual comparison has been instituted in the Office between the warnings issued in 1879 and the weather experienced on our coasts, the warnings being tested by the method explained in Appendix VII. The results of the comparison are shown in the following tables:—

RETURN of the Result of the Comparison between the Warnings issued and the Weather experienced in 1879.

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 -	70	31	20	10	—	2	1	——
,, East -	63	20	22	19	—	1	1	——
Scotland, East -	46	24	9	11	—	2	—	Feb. 9, May 6.
,, West -	51	24	13	12	—	1	1	Feb. 9.
England, North-west	63	36	5	20	—	1	1	July 20.
,, West -	64	33	16	12	—	1	2	Aug. 17.
,, South -	79	47	18	11	—	2	1	Feb. 17*, April 14*, Aug. 17, Nov. 1.*
,, South-east	25	15	7	2	—	1	—	Jan. 23.
,, East -	48	27	12	8	—	1	—	Feb. 6†, May 6†, May 15†, July 20†.
Totals - -	509	257	128	105	—	12	7	
Per-centages -		50·5	25·1	20·6	—	2·4	1·4	

* Storms on the S. Coast marked thus were only felt at the entrance to the Channel.
† E. Coast on the north-east coast of England.

The following table contains a comparative statement of the storm warnings and their results in 1879 and the nine preceding years. It will be seen that the percentage of warnings justified remains about the same :—

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.
1870	349	46·7	21·7	68·4	22·4
1871	299	46	17·7	63·7	22·0
1872	379	61	19·5	80·5	11·9
1873	250	45·2	34·0	79·2	16·8
1874	317	45·4	32·8	78·2	16·4
1875	248	41·1	35·1	76·2	21·0
1876	265	61·1	21·5	82·6	11·7
1877	475	53·3	25·9	79·2	16·4
1878	485	56·7	20·8	77·5	17·9
1879	509	50·5	25·1	75·6	20·6

Forecasts.

Forecasts.—In the last Report the preliminary arrangements for the issue of daily Forecasts were described. The publication of these commenced on April 1, 1879. They are drawn up for 11 districts, identical with those adopted in the Weekly Weather Report, Appendix XIII. At first they were prepared thrice daily, at 11 a.m., 4 p.m., and 8 p.m., the first two being supplied at a low rate to the public and the press, while those drawn up at 8 p.m., being entirely based on information obtained at the cost of the three London daily papers already named, were not supplied to the public, or to any other newspapers.

Since the 1st of January 1880 these arrangements have been modified. The Forecasts are now drawn at 11h. a.m., 2h. 30m. p.m., and 8h. p.m. The first of these is prepared specially for the use of the London evening papers. The Forecast drawn at 2h. 30m. p.m., on the information derived from the reports for 0h. 45m. p.m., is posted up in several public places in London,* and is also supplied to London and Provincial newspapers, and to 125 other subscribers. A specimen of this Forecast is given in Appendix XII. The issue of the 8 p.m. Forecasts is still restricted to the three subscribing newspapers. All the Forecasts are posted up at the Office door, for the information of the public, as soon as they are drawn up.

Replies to inquiries.

In addition to the regular issue of Forecasts, the Office, as stated in last Report, has announced its readiness to answer, by telegraph, inquiries as to probable weather for not more than one day in advance. The charge for each inquiry is 3*s.*, of which 2*s.* are for the message and reply, and 1*s.* is for the trouble to the postal authorities and the Meteorological Office. The number of

* Viz., in the City, at the Mansion House, at Lloyd's Rooms, and at Messrs. R. & J. Beck's, Cornhill; in the West End, in the Libraries of the House of Lords and House of Commons, at Messrs. Elliott's, Strand, Messrs. Stanford's, Charing Cross, Messrs. Negretti & Zambra, Regent Street, and Messrs. Pastorelli, New Bond Street.

inquiries received through the Post Office during the year was 340, and the number of personal inquiries at the Office during the same period was 78, so that, although the public appears to take a great interest in the weather information supplied by the newspapers, there is not at present any considerable demand for private information. Replies to inquiries.

The results of a comparison of the Forecasts issued at 8 p.m. with the weather actually experienced during the year is given in Appendix XI., and the following summary shows that the average of success over the whole United Kingdom has been 75 per cent. The district of Scotland (West), giving the lowest percentage, and that of England (South) the highest:— Testing of Forecasts.

SUMMARY OF RESULTS.

Districts.	Percentages.				Total percentage of Success.
	Complete Success.	Partial Success.	Partial Failure.	Total Failure.	
SCOTLAND, N. -	29	49	18	4	78
„ E. - -	29	50	17	4	79
ENGLAND, N.E. -	27	48	20	5	75
„ E. - -	34	46	16	4	80
MIDLAND COUNTIES -	26	46	23	5	72
ENGLAND, S. - -	33	50	14	3	83
SCOTLAND, W. - -	24	44	24	8	68
ENGLAND, N.W. -	22	50	22	6	72
„ S.W. -	27	44	24	5	71
IRELAND, N. - -	29	46	21	4	75
„ S. - -	29	45	19	7	74
Summary - -	28	47	20	5	75

Hay Harvest Forecasts.—In order to put the forecasting system to a practical test, the Council, in the month of June, made proposals to the Royal Agricultural Society, the Royal Dublin Society, and the Highland Society to send daily Forecasts *gratis* during the hay season to a number of observers selected by the Councils of those Societies, on the two conditions, that the information should be made as widely known as possible, and that a record should be kept of the value of each prediction. The Societies entered cordially into the scheme, and the following list of recipients of the Forecasts was ultimately prepared:—

Testing of Forecasts.

List of those who received Hay Harvest Forecasts in 1879.

District.	Names of Addressees.	Address.
	By Wire.	
Scotland, N.	Rev. Dr. Joass	Golspie, N.B.
Scotland, E.	W. S. Macdonald	Craigielaw, Longniddry, N.B.
	*J. Fortune	Post Office, Ratho, N.B.
	C. Johnstone (for the Earl of Strathmore).	Glammis, by Forfar, N.B.
	C. S. France	Bank House, Penicuik, N.B.
	J. McGregor	Ladywell, Dunkeld.
	†W. Allan	Gogar Maim, Gogar Station, Edinburgh.
	A. Buchan, Esq., F.R.S.E.	Scottish Meteorological Society, Edinburgh.
	Rev. W. P. Robinson, D.D.	Trinity College, Glenalmond, Perthshire (by post).
England, N.E.	J. Wilson	Woodhorne Manor, Morpeth.
	W. Scarth	Raby Castle, Darlington.
	G. Wray	Leyburn, Yorkshire.
	J. Turner	The Grange, Ulceby.
„ E.	R. C. Gripper (for Messrs. Ransome & Simms).	16, Coleman Street, Ipswich.
	J. B. Lawes, F.R.S.	Rothamsted, Harpenden.
	D. McIntosh	Havering Park, Romford.
Midland Counties	The Royal Agricultural College.	Cirencester.
	Major Dashwood	Kirtlington, Oxford.
	R. R. Fowler	Prebendal Farm, Aylesbury.
England, S.	C. Whitehead	Barming House, Maidstone.
	E. P. Squarey	The Moot, Downton, Wilts.
Scotland, W.	J. S. R. Ballingal	Eallabus House, Bridgend, Islay, N.B.
	Sir J. W. Orde, Bart.	Auchnaba House, Lochgilphead, N.B.
England, N.W.	A. Ashworth	Egerton Hall, Bolton-le-Moors.
	Mr. Harrison (for the Earl of Derby).	The Gardens, Knowsley Hall, Prescott.
	D. R. Davies	Agden Hall, Lymm, Warrington.
„ S.W.	T. Dyke	Long Ashton, Clifton.
	J. Phillips (for the Earl of Ducie).	Whitfield, Falfield R.S.O., Gloucestershire.
	R. Neville	Butleigh Court, Glastonbury.
Ireland, N.	Dr. Bentley	Oldcastle, County Meath, Ireland.
	J. Simson	Cloona Castle, Ballinrobe, Ireland (by post).
„ S.	D. A. Millward	New Ross, Ireland (by post).

* Since deceased.

† In lieu of Mr. Fortune, deceased.

Several of the recipients took great interest in the experiment, and, in more than one case, considerable trouble and expense was incurred by them to ensure the speedy dissemination of the intelligence. Of this some evidence is afforded by the following letter, addressed to the Royal Agricultural Society by one of the observers, and forwarded by the Society to the Office:—

"I have much pleasure in giving you some particulars of the weather forecasts which were obligingly supplied to me from the Meteorological Office, during the hay and corn harvest months

last season. Their remarkable accuracy rendered them most popular over a considerable agricultural district in my neighbourhood, and their daily arrival was looked for each day with much interest, not only by the farmers themselves, but by their labourers also, who could be seen collected in groups at each station after the day's labour to learn the prospects of promise for the following day. Testing of Forecasts.

"I have reason to believe these forecasts were of much use and real practical value during the season, so fickle and disastrous generally. The better classes were also much interested, and many could be seen driving in their carriages in the direction of the stations to inform themselves for the following day's plans.

"The forecasts were despatched daily (Sunday excepted) from the London Office between 4 and 5 o'clock p.m. to our nearest post office, distance about three miles from my residence, and they usually reached me about 5h. 45m. p.m. by a messenger who travelled on a velocipede. First, a copy of the telegram was retained and posted at the post office (the place being a village with a considerable population), then over a district letter box on the highway between two large towns, and at a meeting of cross roads 2½ miles from the receiving office. I had a small box with glass face, under lock and key, fixed over the letter box, where the messenger deposited another copy of the telegram on his way here. This was again repeated two miles farther, on the same highway, and the meeting of cross roads in a village, over the letter box there. A copy from here was again posted a mile off in another direction. By this means a tolerably wide circulation was obtained, most acceptable to my neighbours, and for which I was repeatedly thanked."

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

SUMMARY of RESULTS of HAY HARVEST FORECASTS.

Districts.	Names of Stations.	Percentages.				Total percentage of Success.
		Complete Success.	Partial Success.	Partial Failure.	Total Failure.	
SCOTLAND, N.	Golspie	47	34	11	8	81
„ E.	Longniddry, Glamis, Dunkeld, and Edinburgh (2)	44	31	16	9	75
ENGLAND, N.E.	Morpeth, Darlington, Leyburn, and Cleeby	51	30	11	8	81
„ E.	Ipswich, Rothamsted, and Romford	47	23	20	10	70
MIDLAND COUNTIES	Cirencester, Oxford, and Aylesbury	65	18	13	4	83
ENGLAND, S.	Maidstone and Dowuton	55	33	12	0	88
SCOTLAND, W.	Islay and Lochgilphead	44	23	14	19	67
ENGLAND, N.W.	Bolton, Prescot, and Warrington	51	23	18	8	74
„ S.W.	Clifton, Falfield, and Glastonbury	51	21	17	11	72
IRELAND, N.	Ballinrobe and Oldcastle	43	37	9	11	80
„ S.	New Ross	27	32	26	15	59
	Mean for all districts	48	28	15	9	76

Testing of Forecasts.

For Great Britain the lowest percentage of success was attained in "Scotland, W.," but it may be remarked that, of the two stations in this district, only Islay has sent in a detailed return, and the values for Lochgilphead have, therefore, been estimated merely from the opinions of the recipient, as expressed by letter. It must, moreover, be remembered that a region on the Atlantic coast is unfavourably situated for forecasting. "England, E." shows the next lowest percentage.

The low percentage of "complete success" in "Scotland, E.," was due to the failure of those portions of the Forecasts which related to the direction of the wind rather than those which related to the weather in its more generally accepted sense.

The highest percentage of success was in "England, S.," for which district both the observers reported an entire absence of "total failures."

The Council consider the results of the experiment sufficiently encouraging to induce them to repeat it in the summer of 1880. The Royal Agricultural Society, the Royal Dublin Society, and the Highland Society have all expressed their willingness to co-operate, and have supplied lists of persons to whom the Forecasts should be sent. The issue is to commence on the 1st of July.

Synchronous observations.

Synchronous Observations.—The Office has continued its co-operation with the system of synchronous observations, at 0h. 43m. p.m. Greenwich time, which was organised in 1873 by the Chief Signal Office at Washington. The list of observers at this hour during 1879 is given in Appendix XIII. It will be found to comprise the names of 38 observers resident in the United Kingdom, while (as in former years) valuable information has been supplied from six extra-European stations by officers of the Army Medical Department, and by colonial observers.

A form for the entry of the synchronous observations is bound up with every ship's log issued by the Office, and whenever a captain has filled up this form, a copy of his entries is supplied to Washington, U.S. In addition, probable readings for the epoch of the simultaneous observations are calculated by interpolation from every log of a vessel crossing the Atlantic which reaches the Office, and are forwarded to the Chief Signal Officer.

The Bureau Central Météorologique and the Depôt des Cartes et Plans in Paris having undertaken the preparation of synoptic charts of a portion of the North Atlantic for 6h. 35m. p.m. Paris mean time, have requested the Council to assist them by the supply of observations, and a copy of the readings taken at that time at the self-recording observatories is now regularly forwarded to Paris.

The publication of Captain Hoffmeyer's synoptic charts of Atlantic weather terminates in the present year, the last charts being those for 1876.

The Weekly Weather Report.

Weekly Weather Report.—The publication of the Weekly Weather Report, of which a specimen in its present form will be found in Appendix XIV., has been continued, and the Council

have again to express their thanks to the Meteorological Society (of London) for supplying to this publication returns from several of its stations at no other cost than that of copying.

Climatic averages for the various agricultural districts.

A supplement to the volume for 1879 has been prepared, containing the averages of rainfall and temperature during the last 14 years for the eleven districts into which the United Kingdom has been divided for the purposes of this Report. These averages, referring as they do to considerable areas, cannot lay claim to great accuracy, inasmuch as the reports from half-a-dozen stations scattered over as many counties cannot be expected to represent all the special conditions of climate of each locality. The Council think, however, that such a compendious, if only roughly approximate, representation of the varying climate of the British Isles as that contained in this supplement will be found useful and interesting.

Records of sunshine.

At the close of the financial year the Council resolved to increase the amount of information given in this Report by a Table showing the weekly duration of bright sunshine in each district, and the percentage proportion this bears to the duration of possible sunlight. The data for this table are furnished by the Sunshine Recorders which will be described in Part III. The following is a list of the stations to which they have been supplied :—

Sandwick Manse, Orkney.
Stornoway.
Aberdeen.
Glenalmond.
Glasgow.
Silloth, Cumberland.
Durham.
Douglas, Isle of Man.
York.
Stonyhurst.
Kelstern, Lincolnshire.
Llandudno.
Hillington, Norfolk.
Leicester.
Churchstoke, Montgomeryshire.
Cambridge.
Cirencester.
St. Ann's Head, Pembrokeshire.
Oxford.
London Institution.
„ Queen Anne's Mansions.
Kew.
Southampton.
Falmouth.
St. Aubin's, Jersey.
Armagh.
Markree.
Dublin.
Parsonstown.
Valencia.

"Aids to the Study of Weather."

"*Aids to the Study and Forecast of Weather.*"—The publication of the Manual by the Rev. W. Clement Ley, mentioned in the last Report under the title of the "Aids to the Study and Forecast of Weather," has been delayed during the year in the hope of obtaining a series of cloud pictures suitable for insertion therein. The Council have found that satisfactory drawings could not be obtained without considerable further delay, and the work will therefore appear immediately without such illustrations.

PART III.

Land Meteorology of the British Isles.

The stations. The observatories and stations maintained by or in connexion with the Office are of five classes: (1) Observatories continuously recording all the meteorological elements; (2) Anemographic stations at which the wind is recorded continuously; (3) Stations of the Second Order, observing at regular intervals; (4) The Telegraphic Reporting Stations already referred to in Part II., of which a list is given in Appendix VI; and (5) Extra stations, giving returns of more or less completeness, but in less detail than those of class 3. The stations in classes 1–4 are shown in the subjoined map (see page 21.)

Observatories. (1.) The seven self-recording observatories, Aberdeen, Glasgow, Armagh, Valencia, Stonyhurst, Falmouth, and Kew, have been maintained in regular action during the year. They have all been inspected by Mr. Whipple, Superintendent of Kew Observatory, and any defects pointed out by him in the instrumental arrangements have been remedied.

At the end of 1879 Mr. E. J. Stone, F.R.S., the Radcliffe Observer, expressed his willingness to erect at the Radcliffe Observatory a spare set of self-recording instruments which the Office has had in reserve in order to provide for the occurrence of a breakdown at any of their observatories. The Council, considering that it would be desirable to compare the action of two precisely similar sets of instruments at two stations at the distance apart of Kew and Oxford (about 50 miles), readily agreed to lend the instruments, which were accordingly set up at Oxford in January 1880.

Quarterly Weather Report. The engraving of the photographic curves for the Quarterly Weather Report for 1876 and 1879 has been continued, and the plates for these two years are completed up to the months of August and October respectively.

The Council have decided to remodel the plan of the text of this publication, with the view of furnishing year by year a more systematic summary of the weather than has hitherto been the case. The first quarterly part on the new plan, that for January to March 1876, is in the press.

Anemographic Stations. (2.) Continuous records of the wind are, as in former years, received from the five following stations, which are all provided with anemographs similar to those erected at the self-recording observatories:—

Station.	Supplied by	Superintended by
Alnwick Castle -	Duke of Northumberland, K.G.	Major F. Holland,
Holyhead - -	Meteorological Office -	The Harbour authorities.
Orkney - -	,, ,, -	Rev. C. Clouston, LL.D.
Seaham - -	L. J. Crossley, Esq. - -	G. H. Aird.
Yarmouth - -	Meteorological Office -	Secretary, Sailors' Home.

MAP SHOWING STATIONS IN CONNECTION WITH THE OFFICE

1. Observatories ——— KEW △
2. Stations of Second order Dublin ○
3. Telegraphic Reporting Stations, Wick T
5. Lighthouses, Hull ○

MAP SHOWING STATIONS IN CONNECTION WITH THE OFFICE

1.—*Observatories* ——— KEW △ | 3.—*Stations of Second order*, Dublin ○
2.—*Anemograph Stations*, Alnwick ✢ | 4. *Telegraphic Reporting Stations*, Wick T
5.—*Extra Stations*, Hull ●

Stations of Second Order.

(3.) The following is a list of the Stations of the Second Order (37 in number as against 33 in the preceding year) :—

	Names of Stations.	Observers.
	England and Wales.	
A*	Audley End, Essex	Mr. J. Bryan.
A*	Babbacombe	E. E. Glyde, F.M.S.
A*	Buxton, Derbyshire	E. J. Sykes, F.R.A.S., F.M.S.
A*	Carmarthen	G. J. Hearder, M.D.
*	Cheadle, Stafford	J. C. Philips, F.M.S.
A*	Cheltenham	R. Tyrer, B.A., F.M.S.
†	Chigwell Row, Essex	J. Campbell, Staff Surgeon, R.N.
A*	Churchstoke, Montgomery	Philip Wright, F.C.S., F.M.S.
A*	Dartmoor Prison, Devonshire	R. E. Power, L.R.C.P., F.M.S.
A†	Douglas, Isle of Man	A. W. Moore, Esq.
A†	Durham	G. A. Goldney, Esq.
†	Folkestone	A. Henry Taylor, F.M.S.
A	Hastings, Sussex	Alex. E. Murray, F.M.S.
A*	Hillington, Norfolk	Rev. H. Ffolkes, M.A., F.M.S.
†	Hull, Yorkshire	Rev. W. P. Mackay, M.A., M.D.
A*	Kelstern, Lincolnshire	D. G. Briggs, F.M.S.
†	Leicester	W. J. Harrison, F.G.S.
A*	Llandudno	J. Nicol, M.D., F.M.S.
A*	Marlborough, Wilts	Rev. T. A. Preston, M.A., F.M.S.
A	Oscott, Warwickshire	Rev. S. J. Whitty, B.A.
	Prestwich, Lancashire	T. R. H. Clunn, M.D., and H. R. O. Sankey, M.D.
A*	Ramsgate	Rev. A. E. O'Gara, O.S.B., F.M.S.
A†	St. Aubin's, Jersey	J. E. Vibert, M.A.
†	St. David's, Pembroke	W. P. Propert, LL.D., F.G.S.
†	Seaham, Durham	Mr. G. H. Aird.
†	Southampton (Ordnance Survey Office)	J. T. Cook and R. W. Scorey for Col. A. C. Cooke, R.E., C.B.
A*	Strathfield Turgiss, Hants	Rev. C. H. Griffith, B.D., F.M.S.
A	Uppingham, Rutlandshire	Rev. G. H. Mullins, M.A., F.M.S.
A*	Wakefield	H. Clarke, L.R.C.P., F.S.S.
	Scotland.	
A†	Glenalmond, Perthshire	Rev. W. P. Robinson, D.D., F.M.S.
A†	Laudale, Argyllshire	A. Fletcher, for T. H. G. Newton, Esq.
†	Sandwick Manse, Orkneys	Rev. C. Clouston, LL.D.
	Ireland.	
†	Colebrooke, Co. Fermanagh	W. Ferguson, for Sir Vincent Brooke, Bart., F.L.S.
A†	Dublin	J. W. Moore, M.D.
A†	Londonderry	J. Conroy, F.M.S.
A†	Markree Castle, Sligo	E. Salles, for Col. Cooper, F.R.A.S.
A†	Parsonstown (Birr Castle), King's Co.	W. Harding, for the Earl of Rosse, F.R.S.

Relations with Meteorological Society.

The stations marked A in the preceding list are those for which the observations are being published for 1879 *in extenso*. Those marked with an asterisk are stations in connexion with the Meteorological Society (of London) from which returns are received for publication on the international form,* the cost of copying being defrayed by the Meteorological Office.

In order to secure the efficiency of these stations and the accuracy of their returns, the Council have for the last three

* A specimen of this Form was given in the Report for 1874.

years made a small regular allowance, as recommended in the Report of the Treasury Committee (1877), towards the cost of inspection of the Society's stations. Stations of the Second Order.

The Self-Recording Observatories and the Anemographic Stations are regularly visited each year by the Inspectors of the Office. The Stations of the Second Order, which are in immediate connexion with the Meteorological Office, are visited at least once in every two years. Those visited in the past year are marked thus † in the list. The extra stations are inspected as opportunity offers.

The returns from these stations are published on the international plan, as explained in previous Reports, either in full or as monthly summaries of mean results. This publication now appears as an annual volume under the title of "Meteorological Observations at Stations of the Second Order," and forms a contribution to the climatology of the British Isles which is much fuller than the Weekly Weather Report, and is intended for scientific meteorologists rather than for popular use.

(4.) In addition to the daily telegraphic reports, monthly copies of the observations taken at all the telegraphic reporting stations are regularly transmitted to the Office. Telegraphic Reporting Stations.

(5.) Returns of various degrees of completeness are received from the following observers:— Extra stations.

Names of Stations.	Observers.
England.	
Alnwick Castle, Northumberland	Major F. Holland, for the Duke of Northumberland, K.G.
†Chatham (School of Military Engineering), Kent	Major M. Lambert, R.E.
Chiswick (Royal Horticultural Society), Middlesex	W. P. Thomson.
Cooper's Hill (Indian Civil Engineering College), Surrey	Prof. H. McLeod, F.C.S.
Farley, near Cheadle	C. L. Wragge, F.G.S.
†Geldeston, near Beccles	E. T. Dowson.
†Harpenden, Hertfordshire	T. Wilson, F.M.S.
Helston, Cornwall	M. P. Moyle, F.R.C.S.
†Netley, Hants	Prof. F. de Chaumont, M.D., F.R.S.
†Rugby, Warwickshire	Rev. T. N. Hutchinson, M.A
Saffron Walden, Essex	J. G. Bellingham, Esq.
Sheffield, Yorkshire	W. F. Cooper, F.M.S.
Silloth, Cumberland	Rev. F. Redford, F.R.S.E.
Southport, Lancashire	J. Baxendell, F.R.A.S.
Stokesay, Salop	Rev. J. Digges La Touche.
Winchester, Hants	Rev. G. Richardson, M.A.
Worksop, Notts	H. Mellish, Esq.
†York	J. Purves, M.D.
Scotland.	
Annanhill, Ayrshire	W. H. Dunlop, F.M.S.
Ireland.	
†Dublin, Mountjoy Observatory (Phœnix Park)	Lieut.-Col. C. N. Martin, R.E.
Ennis, Co. Clare	J. Hill, C.E.
Waterford	Joseph Neale.
„	Harbour Authorities.

Information supplied to the General Register Office, Ireland.

Reports from the Irish stations of the Office have been regularly supplied to the Registrar General for Ireland, for use in his Weekly and Quarterly Returns.

Rainfall averages for 15 years.

Rainfall of the United Kingdom.—In Part II. mention has already been made of the averages, lately published, of rainfall and temperature for the several agricultural districts of the British Isles. But the phenomena of rainfall are so local and so variable from year to year that the Council attach great importance to the publication of the fullest and most accurate information available on this subject; they have accordingly made an arrangement with Mr. G. J. Symons, F.R.S., to furnish them with monthly values and averages of the rainfall during the 15 years ending with December 1880 for the entire area of the British Isles from all the stations included in his system, nearly 300 in number, which afford an unbroken series of records for the whole period.

Influence of height on temperature.

Observations at the Pagoda in Kew Gardens.—In the year 1872 the Meteorological Committee instituted a series of observations at the Pagoda in the Royal Gardens, Kew, in order to examine the differences between the simultaneous readings of thermometers placed at different heights above the ground. The thermometers employed at each elevation were four in number (dry bulb, wet bulb, maximum, and minimum), and the instruments were placed in small wall screens, such as are used on board ship. The readings were carried on during two winters and two summers.

The discussion of the observations by Mr. Scott has now been completed, and will appear as an appendix to the Quarterly Weather Report for 1876. The general result is to show that the influence of such moderate differences of elevation as those under consideration (not much exceeding 100 feet) is almost inappreciable in the mean results, but that in particular states of the weather the divergence between the indications of the instruments at the different levels becomes remarkable.

Sunshine Recorders.

Sunshine Recorders.—After carefully considering the various forms which may be given to the instrument invented in 1856 by Mr. J. F. Campbell, of Islay, F.G.S., for recording the duration of bright sunshine, the Council have adopted a stand for the glass sphere and a frame for holding the recording slip of cardboard, devised by Professor Stokes. The stand and frame contain no movable parts, and therefore nothing liable to derangement, while the construction of the frame is such that the observer cannot fail to place the card in the position proper for each season of the year, and also such that the image of the sun is at all times focussed upon the card with sufficient accuracy. A special investigation, undertaken by Professor Stokes with the view of determining the best colour for the recording cards, resulted in the selection of a pale blue tint. Hour lines are printed in white upon the cards to facilitate the reduction

of the records. A more detailed description of the instrument and a copy of the instructions for its use will be found in Note B. (p. 32).

Hygrometric Investigations.

Comparison of different Hygrometers.—The Council have intrusted to Mr. W. N. Shaw, Fellow of Emmanuel College, Cambridge, an experimental investigation of the behaviour, under different conditions, of the various instruments at present in use for ascertaining the hygrometric state of the atmosphere; the object being to compare the indications of these instruments with one another, and with the absolute determination by chemical methods of the quantity of water vapour present in a given volume of air. A preliminary memorandum by Mr. Shaw, describing the course of experimentation which he proposes to pursue, has been approved by the Council, and is printed as Note C. (p. 43) to this Report. The arrangements made by Mr. Shaw have been inspected by Mr. De La Rue on behalf of the Council.

The Harmonic Analyser.

The Harmonic Analyser.—The Harmonic Analyser mentioned in the two preceding Reports has been delivered at the Office. A series of preliminary trials has been made with it, and the instrument is now in working order. A memorandum by Professor Stokes on the use of the Analyser for Meteorological Reductions will be found in Note D. (p. 46).

Cloud Photography.

Photography of Clouds.—An apparatus for the photographic observation of clouds, with a view to determine their heights and velocity of motion, referred to in the Report of the Council for 1878–9, Note D., has been designed by Captain Abney, F.R.S., and is in the course of construction.

Balloon observations.

Observation Balloons.—The importance to Meteorology of observations made in balloons is so great that the Council have felt themselves justified in applying to the War Office for permission to have meteorological observations made in the balloon ascents now systematically undertaken for military purposes. This application has been favourably entertained, and the Council have accordingly placed sets of instruments and forms for recording observations at the disposal of the officers (Captain Templer and Captain Elsdale, R.E.) who are charged with the conduct of these ascents. In the present year (owing to the nature of the duties imposed on these officers) systematic records can hardly be expected, but the Council anticipate that the occasional observations may prove of considerable value.

Library.

The library contains standard works on Meteorology and the allied sciences. It consists at present of 3,000 volumes, with nearly 3,000 pamphlets, exclusive of charts and MS. records of observations. The books and other documents are accessible to scientific men.

Donations to Library.

Appendix XV. contains a list of the donations made to the library during the year. In addition a few volumes have been purchased.

Expenditure.

Appendix XVI. shows the receipts and payments during the year ending 31st March 1880. The amount voted by Parliament was 14,500*l.*, as in the previous year.

The following abstract of expenditure shows the true amount chargeable to the year in question, and its distribution under the various heads, together with the increase or decrease in 1879–80, as compared with the previous year :—

Net Expenditure.	1878-79.	1879-80.	Increase.	Decrease.
Payment of Council -	1,000 0 0	1,000 0 0	—	—
Secretary - -	800 0 0	800 0 0	—	—
Office salaries - -	712 10 8	712 1 0	—	0 9 8
Rent, fuel, and lighting -	578 12 10	778 1 2	199 8 4	—
Alterations to premises, attendance, and contingencies - -	383 2 2	504 16 11	121 14 9	—
Expenses incidental to International Meteorological Congress -	—	104 8 1	104 8 1	—
Special Researches -	775 3 11	941 3 10	165 19 11	—
Land Meteorology -	3,832 5 6	3,847 5 1	14 19 7	—
Weather Information -	3,074 13 5	3,191 9 7	116 16 2	—
Inspections - -	407 18 5	508 15 7	100 17 2	—
Ocean Meteorology -	2,218 7 10	2,371 3 4	152 15 6	—
Total - £	13,782 14 9	14,759 4 7	976 19 6	0 9 8

The increase under "Rent, fuel, and lighting" is due to the rental and the purchase of the lease of extra rooms required for the Marine Branch. The increase under "Alterations to premises, &c." is mainly due to arrangements for the accommodation of the Department of Weather Telegraphy, to the cost of new furniture, and of apparatus for warming the Marine Room. The item of expenses incidental to International Congress was in former years included under "Contingencies;" in the present year the amount is exceptionally large, owing to the meeting of the International Congress at Rome. The amount expended on "Special Researches" shows an increase (165*l.* 19*s.* 11*d.*) on the amount devoted to the same purpose in 1878, but still falls short by 58*l.* 16*s.* 2*d.* of the maximum sum of 1,000*l.* The increase under "Land Meteorology" is small, but the additional expenditure on the ordinary work of this department of the Office has been larger than appears, owing to the fact that the purchase of a Galton Pantagraph had been charged in the previous year under that head. The smallness of the increase under "Weather information" is due to the amounts repayable under this head for the special 8 p.m. Forecasts supplied to three of the leading London newspapers. The charge under "Inspections" has now reached the amount allocated to this branch. Under "Ocean Meteorology"

the increase is due to an increase in the staff, and the increase would have been greater, except for the fact that a portion of the staff of the Office had been engaged on the extraction of Indian data for publication by the Meteorological Office of Calcutta, the expense of which is repayable to the Office.

(Signed) HENRY J. S. SMITH,
Chairman of the Council.

NOTE A.

On the Effect of Sluggishness on the Readings of Marine Barometers on Shore, by Professor Stokes.

Mr. Buchan in his report called the attention of the Council to the discrepancy in the relative readings of the portable barometer with a highly contracted tube, belonging to the Office, which he carried about with him on his tour of inspection, and of a barometer with uncontracted tube, belonging to the Scottish Meteorological Society. If there were merely a difference of index error, the difference between the readings of the two ought of course to be constant. It was found, however, that the difference varied according as the barometer was rising or falling. The character of the change was such as to indicate that the barometer with contracted tube was retarded in following the actual changes of the true barometric height. The variation was sufficient to affect slightly the second place of decimals of the height expressed in inches.

It is obvious that an effect of the kind must be produced by the resistance which the capillary part of the tube presents to the flow of the mercury through it. If this be the sole cause why the barometer with contracted tube is behindhand in its indications of barometric changes, the circumstances of the retardation may be determined by mathematical calculation.

It is known that in the case of the slow motion of liquids through narrow tubes the resistance, depending on the viscosity of the liquid, varies as the first power of the velocity. This leads to a differential equation of the simplest kind connecting the variation of the height of the mercury with the difference between the actual and true heights at the time; namely—

$$\frac{dx}{dt} + q\,(x-h) = 0 \qquad - \quad - \quad - \quad - \quad (1)$$

where x is the height of the mercury in the barometer with contracted tube, t the time, q a constant, and h the true height, which will be a function of t. This equation as it stands, or rather put into the form—

$$h = x + \frac{1}{q}\frac{dx}{dt} \qquad - \quad - \quad - \quad - \quad - \quad - \quad (2)$$

when once the constant q is known, gives the height in terms of the observed height and its rate of variation. For the apparent height in terms of the true height we have from (1)—

$$x = q\,e^{-qt}\int e^{qt}\,h\,dt = q\int_{-\infty}^{t} e^{-q(t-t')}\,h'\,dt' \qquad - \quad - \quad (3)$$

where h' is the same function of t' as h is of t. In this expression, as we shall see when we come to determine the value of q, the part of the integral relating to times more than 20 minutes or so earlier than the time t is practically insensible, and the inferior limit may be taken accordingly.

NOTE A.

On the Effect of Sluggishness on the Readings of Marine Barometers on Shore, by Professor Stokes.

Mr. Buchan in his report called the attention of the Council to the discrepancy in the relative readings of the portable barometer with a highly contracted tube, belonging to the Office, which he carried about with him on his tour of inspection, and of a barometer with uncontracted tube, belonging to the Scottish Meteorological Society. If there were merely a difference of index error, the difference between the readings of the two ought of course to be constant. It was found, however, that the difference varied according as the barometer was rising or falling. The character of the change was such as to indicate that the barometer with contracted tube was retarded in following the actual changes of the true barometric height. The variation was sufficient to affect slightly the second place of decimals of the height expressed in inches.

It is obvious that an effect of the kind must be produced by the resistance which the capillary part of the tube presents to the flow of the mercury through it. If this be the sole cause why the barometer with contracted tube is behindhand in its indications of barometric changes, the circumstances of the retardation may be determined by mathematical calculation.

It is known that in the case of the slow motion of liquids through narrow tubes the resistance, depending on the viscosity of the liquid, varies as the first power of the velocity. This leads to a differential equation of the simplest kind connecting the variation of the height of the mercury with the difference between the actual and true heights at the time; namely—

$$\frac{dx}{dt} + q\,(x-h) = 0 \qquad - \quad - \quad - \quad - \quad (1)$$

where x is the height of the mercury in the barometer with contracted tube, t the time, q a constant, and h the true height, which will be a function of t. This equation as it stands, or rather put into the form—

$$h = x + \frac{1}{q}\frac{dx}{dt} \qquad - \quad - \quad - \quad - \quad - \quad - \quad (2)$$

when once the constant q is known, gives the height in terms of the observed height and its rate of variation. For the apparent height in terms of the true height we have from (1)—

$$x = q\,e^{-qt}\int e^{qt} h\,dt = q\int_{-\infty}^{t} e^{-q(t-t')}\,h'\,dt' \qquad - \quad - \quad (3)$$

where h' is the same function of t' as h is of t. In this expression, as we shall see when we come to determine the value of q, the part of the integral relating to times more than 20 minutes or so earlier than the time t is practically insensible, and the inferior limit may be taken accordingly.

When the barometer is steadily rising or falling, so that the rate of change is tolerably constant for a good many minutes, h is a slowly varying function of the time, and (3) may be converted into a rapidly converging series by integration by parts. It will be sufficient to take the first two terms, giving—

$$x = h - \frac{1}{q}\frac{dh}{dt} \quad - \quad - \quad - \quad - \quad - \quad (4)$$

which determines the error of lagging for a known rate of barometric change, just as (2) gives the correction for lagging, supposing the rate of change of the apparent height observed.

It seemed doubtful *à priori* whether the resistance could still be taken to vary as the velocity when we come to the, comparatively speaking, enormously rapid changes of apparent height which take place in the process of testing for sluggishness. In this the time (which I will call the testing-time, and denote by T) is observed which the mercury takes to fall from 1·5 to 0·5 inch above its true height. To examine this question I made an experiment at the Office on Barometer No. 261, with Mr. Scott's assistance. The mercury having been raised, one of us set the vernier to heights successively decreasing by 0·1 inch, and called out when the mercury reached the mark; the other observed the time, and wrote down the time and the height. Two experiments in which the mercury descended from 1·1 to 0·1 and from 1·2 to 0·1 above the true height, were made, and the mean of the times, which agreed well, was taken.

Supposing the law true, we have, putting h constant in (1)—

$$x = h + C\,e^{-qt} \quad - \quad - \quad - \quad - \quad - \quad (5)$$

and the logarithm of the excess of the apparent over the true height is of the form $a - b\,t$. On plotting the mean result of the experiments by taking the time for abscissa and the logarithm of the excess for ordinate, a curve was obtained which certainly was very nearly a straight line, from which it did not certainly differ by quantities exceeding the limits of errors of observation.

It follows that our equations may be applied even to the more rapid changes which occur in testing, and the value of q may be deduced from that of T. It will be observed that $\frac{1}{q}$ expresses a time; this may conveniently be called the "lagging time," and be denoted by L. It is that the mercury takes to fall from a height moderately exceeding the true height to another in which the excess is reduced to its $\frac{1}{e}$th part. It follows, from the definition of T, that—

$$3 = e^{qT}, \text{ whence } L = 0{\cdot}910\,T.$$

The permitted limits of T being 3 m. to 6 m., those of L will be 2 m. 44 s. to 5 m. 28 s.: average, say 4 m.

The last terms in (2) and (4) are simply the lagging time into the rate of change, or what comes to the same thing if the rate be taken as uniform, the change during the lagging time. It follows that a reading taken at 8 h. a.m. gives the true height at a time earlier by the lagging time, say at 7 h. 56 m. a.m. Unless there-

fore the observers at the secondary stations can be trusted for great punctuality, the influence of lagging may be neglected; and if they can they have only to date the observations earlier than the times by the lagging times of their respective barometers.

Further, in comparing two barometers the more prompt should be read first, and after an interval equal to the difference of the lagging times the more sluggish, and the two readings treated as simultaneous.

We learn also that in the most sluggish barometer allowed, for which T = 6 m., when the barometer is set up after carriage, 39 m. from the time the mercury stood at 1·5 inch above the true height will suffice for the error of lagging, so far as depends on previous carriage, to be reduced to less than 0·001 inch. For T = 3 m. the time would of course be halved.

The simple expression (4) was obtained on the supposition that the rate of barometric change was sensibly uniform for a good many minutes, and it would not therefore apply to the small rapid heavings which are sometimes observed when a storm is approaching. It is obvious that the sluggishness tends to efface rapid fluctuations. To take a simple example, suppose that x is subject to a fluctuation expressed by $c \sin n t$, so that—

$$h = \mathrm{H} + c \sin n t,$$

where H is either constant or a slowly varying function of t.

From the linearity of equation (1) we may express separately the parts of x depending on H and on c, and the expression for the former has already been given. For the part of x depending on the fluctuations in h we have

$$\frac{c q}{q^2 + n^2}\left(q \sin n t - n \cos n t\right), \text{ or } \frac{c q}{\sqrt{q^2 + n^2}} \sin n \overline{t - \lambda}$$

where

$$\tan n\lambda = \frac{n}{q} = \frac{2\pi \mathrm{L}}{\mathrm{P}}$$

P being the period of the fluctuation. We see that the phase of the inequality in the apparent height x lags behind that of the barometric inequality by the time λ, and the coefficient is reduced in the ratio of $\sqrt{(q^2 + n^2)}$ to q, or $\sqrt{(\mathrm{P}^2 + 4\pi^2 \mathrm{L}^2)}$ to P.

Supposing L = 4 m., and taking for P in succession 0 m. 30 s., 1 m., 2 m., 4 m., 8 m., 16 m., 32 m., and putting m for the multiplier of the coefficient, we have—

P =	0 m. 30 s.	1 m.	2 m.	4 m.	8 m.	16 m.	32 m.
λ =	0 m. 7 s.	0 m. 15 s.	0 m. 28 s.	0 m. 53 s.	1 m. 36 s.	2 m. 34 s.	3 m. 22 s.
m =	·029	·040	·079	·157	·303	·535	·786.

As P increases, λ tends to 4 m. and m to 1 as its limit.

The experiment above referred to was calculated in the first instance on the supposition that the true height of the barometer at the time was 30·09 inches, according to data supplied by the Office. Partly as this figure did not profess to be extremely accurate, and partly in order to be independent of index error, &c., and to make the experiment self-contained, I re-calculated the result assuming the true height as an additional unknown quantity to be determined from the experiment itself. I took as

known the time for height 31·2, 30·7, 30·3, and determined all the elements from these three numbers. I found:—

Calculated lagging time 4 min. 12·7 sec.

Whence testing time 4 min. 37·7 sec.

Calculated final height 30·111 inches.

I subjoin a comparison between the calculated and observed times.

Height.	Time.		Mean.	Calculated.
	Experiment 1.	Experiment 2.		
31·3	—	—18	—18	—22·2
31·2	Taken as origin.		—	Assumed.
31·1	27	27	27	24·3
31·0	51	53·5	52·2	51·3
30·9	73	80	76·5	81·4
30·8	119	114·5	116·7	115·7
30·7	156	154·5	155·2	Assumed.
30·6	204	201	202·5	202·3
30·5	264	266·5	265·2	260·1
30·4	330	335	332·5	335·2
30·3	440	445	442·5	Assumed.
30·2	619	639	629	630·2

The agreement with the observed numbers is very good. It shows that the calculation may safely be trusted, at least for heights ranging from about 0·1 to 1 inch from the true height. The calculated final height is 0·021 above that given us, *about* 30·09, but temperature and index error may account for at least part of it. The irregularity of capillarity, if it existed, would tend to make the height too great, as the mercury was descending. Perhaps a part of the excess 0·021 was due to this cause.

The effect of sluggishness properly so called is, however, mixed up with another which, if sensible, is not so easily allowed for, namely, that of an irregularity in the capillary depression depending on variability in the angle of contact of the mercury and the glass. This effect would certainly be sensible if the tube or mercury were at all dirty, and may perhaps be not insensible even when they are in the best condition. In a barometer with uncontracted tube it is obviated by tapping, which sets the mercury free to take its normal height. But in a marine barometer the effect of tapping is merely to render the angle of contact normal for the moment, altering thereby slightly the curvature at the vertex, on which depends the correction for capillarity, and consequently the equilibrium of the column; but when the previous equilibrium is thus disturbed the mercury does not at once take its level, but only begins to move (or moves at a different rate from what it did before if it were already in motion), and the slow rise or fall again alters the angle of contact from its normal value, and so on. On shipboard the motion of the vessel supplies what is equivalent to a constant tapping, but on land when the mercury is almost at its normal height, and is slowly rising or

falling, this tendency of the edge of the mercurial column to stick where it is produces something of the nature of an additional source of sluggishness, which could be obviated indeed by incessant tapping, but is not quite prevented by tapping only now and then. The Council contemplate gradually replacing the marine barometers at the secondary stations by others in which the tubes are not contracted. The sluggishness arising from viscosity as the mercury flows through the capillary part of the tube affects a barometer on shipboard equally with one on land, and *that* can easily be allowed for if the "lagging time" be known.

NOTE B.

DESCRIPTION of the CARD SUPPORTER for SUNSHINE RECORDERS adopted at the METEOROLOGICAL OFFICE, by Professor STOKES.

THE method of recording sunshine by the burning of an object placed in the focus of a glass sphere freely exposed to the rays of the sun, which was devised by Mr. Campbell, commends itself by its simplicity, and seems likely to come into pretty general use. In the original form of the instrument the rays were received on a hemispherical wooden bowl, concentric with the glass sphere, and of such a radius that the focus should fall on its inner surface. The instrument in this form will give total effects, but only in a very rude manner the results for individual days, since the burnings produced on neighbouring days run into one another, and to use a fresh bowl for each day on which the sun shone, would be out of the question on account of the expense. Accordingly it is expedient to adopt Mr. Scott's modification of the instrument, and to replace the wood by a slip of card, which can be renewed from day to day; and it is necessary to support the slip in such a manner that the image of the sun shall not run off it from sunrise to sunset, and moreover that the focus shall fall, approximately at least, on the surface during that interval.

The most obvious way of supporting the slip would be to make it rest against the inner surface of a hemispherical bowl formed of metal, slate, or earthenware, and such is the plan adopted at the Royal Observatory. But this method could hardly be intrusted to inexperienced observers; for, in order that the slips may sufficiently nearly fit the surface of the hemisphere, they must be narrow; and in that case a moderate error in the placing of a slip would suffice to make the image of the sun run off it in some part of the day. Yet there is nothing to guide the observer as to the proper placing but certain marks on the hemisphere, respecting which he might easily make a mistake, especially as the slip has to be fastened by clamps. The slips have to be cut of a particular form, varying with the declination of the sun; and though correctly cut slips could be furnished from headquarters, so many different patterns are required in the course of the year that there

is risk of confusion on part of the observer. If a dated blank slip were returned to the Office, there would be nothing to indicate whether the absence of marks of burning really arose from cloud, or was due to a misplacement of the slip in the bowl.

Other forms of support have been devised in which the card is simply slipped into its place, so that the fastening presents no difficulty. But these mostly labour under one or other of two defects, namely, that in the course of a long day the image is liable to run off the slip, or that when the sun is a good way from the meridian, its image is too much out of focus.

It seemed therefore desirable to devise a form in which these defects should be avoided, while at the same time it should be sufficiently cheap in construction, and should demand little skill on the observer's part in the placing of the cards.

It is believed that these requirements are satisfied in the form adopted by the Meteorological Office.

It is well known that a piece of paper or card, regarded as a flexible but inextensible plane surface, cannot be bent, without rumpling or tearing, into the form of a sphere, but only into that of some developable surface. The locus of the focus of the sun's image for several successive days is a zone of the focal sphere, and this zone may be replaced without sensible error by a zone of a developable surface touching the sphere along the middle of the zone, that is, along a small circle which represents the path of the image for a single day, the change of declination during the day being neglected. The developable surface which touches a sphere along a small circle is of course a right circular cone. When the sun is in the equator, and the small circle becomes accordingly a great circle, the cone passes into a cylinder.

We must make provision for receiving the image through a range from 23° 28′ north of the equator to 23° 28′ south, or say,

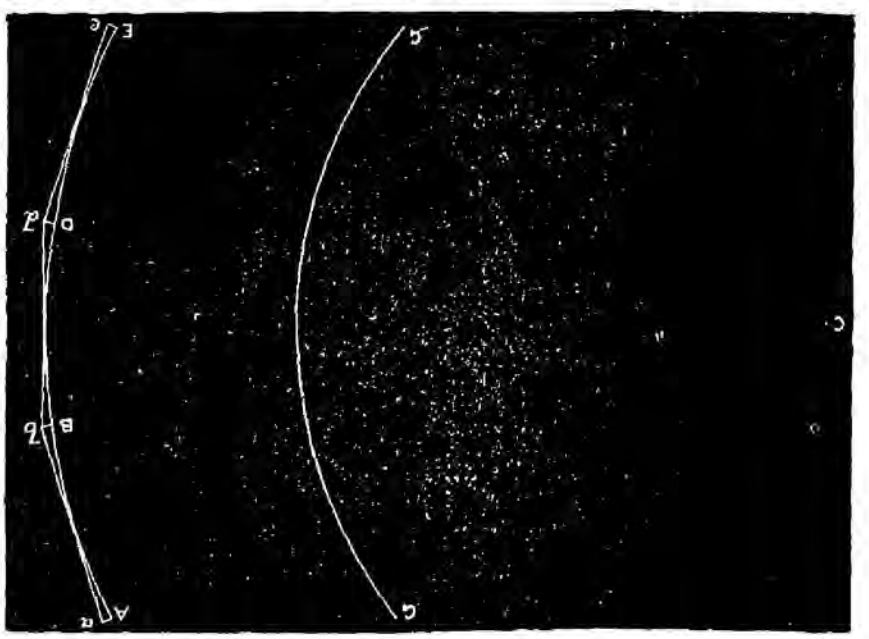


FIG. 1.

from 24° N. to 24° S. for round numbers, and to allow a little

for the breadth of the image. Let C (fig. 1) be the centre of the sphere, A E an arc of a section of the focal sphere by a meridian plane through C, the arc extending from 24° N. at A to 24° S. at E, G G a portion of a section of the sphere. Divide the arc of 48° A E into three equal parts A B, B D, D E, and draw tangents through the middle points of these arcs, cutting the radii through A, B, D, E, in *a*, *b*, *d*, *e*. Then the zone of the spherical surface generated by the revolution of A E may be replaced with very little error by zones of two conical and one cylindrical surface, these zones being generated by the revolution of *ab*, *de*, *bd*; and these being developable surfaces, bits of card may be applied so as to fit them accurately. If R be the radius of the focal sphere, the extreme error of focus committed will be R (sec 8° − 1). If the glass spheres be of 4 inches diameter, and the glass be free from lead, R will be a little under 3 inches, and 3 (sec 8° − 1) = 0·0275 nearly, so that the greatest error of focus would be the 1-36th of an inch. If instead of the central tangents we take lines parallel to them, and passing through the middle points of A*a*, B*b*, D*d*, the greatest error will be halved, or reduced to the 1-72nd of an inch; and as the spheres burn very well through a range of 0·1 in. in distance from the centre, the small error of the 1-72nd of an inch is of little consequence. If we add, say 0·020 inch for the thickness of the card, and deduct $\frac{1}{2}$ 0·0275, or say 0·014, for the reason above mentioned, we get 0·006 to be added to the distance of the best burning focus from the centre to get the perpendicular distance from the centre on any one of the three supporting surfaces. This correction is so small that it may be neglected. In the pattern adopted this perpendicular is taken at 2·89 inches.

'The fiducial supporting surface is now reduced to that generated by the revolution of *a b d e* about the polar axis through C, a line therefore parallel to *bd*. This forms the inner surface of the supporting material; and from the winter to the summer solstice the image travels from *a* to *e*. From about October 14th to February 27th the image is on some part of *ab*; from February 28th to April 10th in some part of *bd*; from April 11th to September 1st on *de*; and from September 2nd to October 13th again on *bd*.

If the cards were in section no larger than the exact sizes *ab*, *bd*, *de*, here given the image would at certain times of the year fall exactly on the edge of a card. The cards must therefore be a little larger; and in order that they may lie without any rumpling on their fiducial developable surfaces, the material of the support must be slightly cut away by prolonging a little in each direction the cuts *ab*, *bd*, *de*. The prolongations of the cut *bd* might even be made to extend a good way towards the middle points of *ab*, *de*, and similarly for the others, without removing more of the supporting surfaces than can perfectly well be spared. The prolongation of the cuts may be utilised for the support of the cards by undercutting, so as to leave flanges under which the edges of

the cards may be slipped. The form thus finally assumed by a section of the supporting surface is represented in fig. 2.

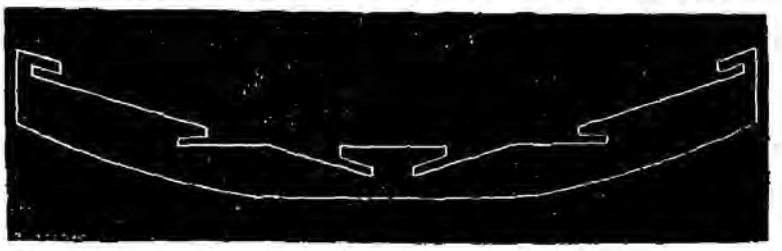


FIG. 2.

The construction of the supporting surface is not expensive. A ring is cast of the approximate form generated by the revolution of the section in fig. 2, the middle zig-zag line being however replaced by a circle as in fig. 1, and the shaping of the inner surface and the undercutting are then done in the lathe. When shaped, the ring is cut into two by a plane through its centre, and inclined to its axis at an angle roughly equal to the latitude of the place for which it is intended. One ring will thus serve for two instruments, each half being mounted independently on a suitable support.

The forms of the cards are easily found. The equinoctial slips are of course straight. The form of the ends of these and of the other slips is not now considered for a reason which will presently appear. If we regard the summer and winter slips as infinitely thin, and coinciding with the surfaces on which they rest, it is evident that when developed they will form portions of circular annuli, the bounding arcs having a common centre where the line *ab* or *de* in fig. 1 (p. 33) cuts the polar axis. The radius of the developed slip, measured to the arc corresponding to the point of contact, will accordingly be 2·89 cot 16°. If we allow 0·02 for the thickness of the card, it will be more accurate to take 2·88 for the coefficient; and if we suppose the depth of the cuttings at the two sides the same, so that the point of contact is in the middle of the card, and if b be the breadth of a card in inches, the outer and inner radii will be $10{\cdot}04 \pm \frac{1}{2} b$ inches.

The pattern of the rings, which form the only part of the apparatus involving much nicety in construction, is common to all the earth, and at whatever place the ring is to be used the circle in which the inner surface is cut by an ideal equatorial plane is divided by the plane of actual section into two equal parts; it is only the inclination of the cutting plane to the equator which changes from place to place. If a common mean latitude were adopted for the whole of England little error would be produced; the semi-rings in the more northerly stations would merely rise slightly above the horizontal plane through the centre of the ball on the northern side of the east and west points, and pass a little below it on the southern side, while for stations south of the mean latitude the error would be reversed. As the sun hardly ever burns when very near the horizon, this would be practically of no moment. In that case a common pattern might be adopted for the ends of the cards of any one of the three kinds, but as it is

desirable to take in somewhat wider ranges of latitude, such as from Jersey to the Orkneys, and as it is just as easy as not to divide the rings according to the actual latitudes of the places where they have to be used, it has been decided merely to provide that the cards shall be long enough for all the stations, and to leave it to the observers to cut off the ends of the cards level with the horizontal edges of the semi-rings, where the complete ring has been divided. It is, however, only in the case of the equinoctial cards that there is any occasion to cut off the projecting ends, as the ends of the summer and winter cards are not in the way of the sun's rays, even at sunrise and sunset.

Each semi-ring is marked inside down its middle, that is, along the line in which it would be cut by a bisecting plane passing through the polar axis. In mounting the stands in the first instance, once for all, this line is to be brought into the plane of the meridian; and in the daily use of the instrument the cards are to be pushed till the noon mark comes to the marked line.

The cards may be graduated beforehand by printing on the cardboard. In planning them, if a batch of cards of the same kind are drawn with the back of one in the bosom of the next, there is very little waste, and the cards can be afterwards cut out by a suitable punch.

For the equinoctial cards the hour lines are evidently a series of parallel straight lines. The interval from one hour line to the next must be taken as $2{\cdot}88\ \pi \div 12$, or 0·754 inch. For the summer and winter slips the hour lines will be straight lines converging (as they lie on the cardboard) to the common centre of

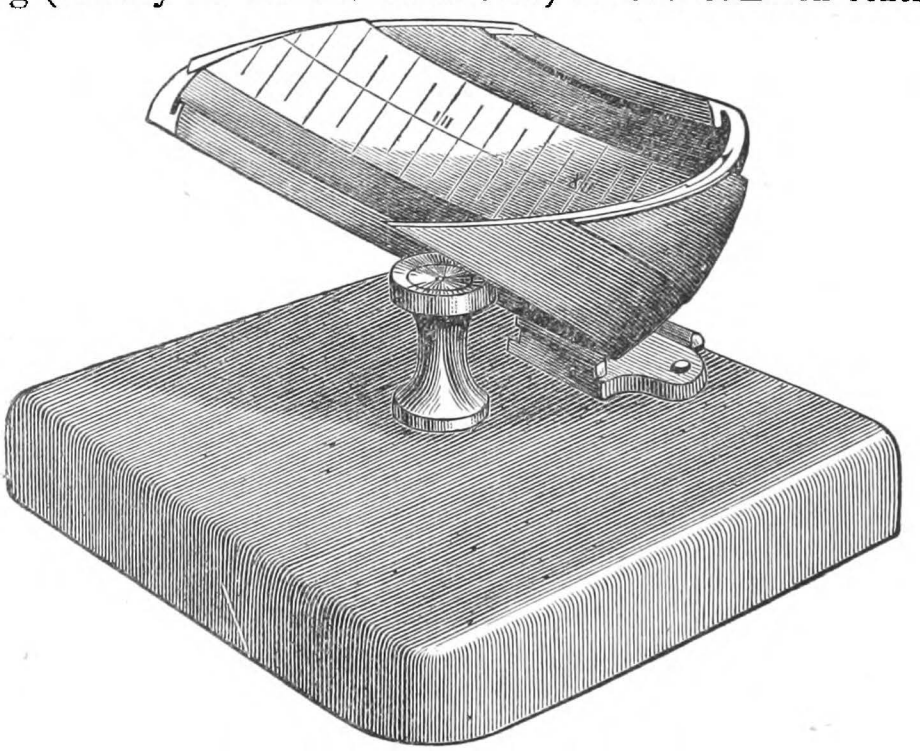


FIG. 3, Showing Stand complete, with an equinoctial card in position and shortened.

curvature of the outer and inner bounding circles. The distance from one hour line to the next, measured along an arc passing

through the point of contact, will be 0·754 cos 16°, or 0·725 inch; and as it subtends at the centre of curvature an angle of only 15° sin 16°, or 4° 7′, the length of the chord will be sensibly the same. If the length of the prolongations of the cuts *ab, de* in fig. 1 is the same towards, as from, the equator, the arc of contact will be equidistant from the two bounding arcs, otherwise not.

Each half ring is mounted on a slab of slate, to which is fastened a brass upright ending above in a flat surface, about 1 inch or 1½ inch square, inclined to the plane of the base by an angle representing an average latitude for the kingdom. The half ring is fastened by screws to this flat piece, being cast for the purpose in a form which is flat in the middle outside, as represented in fig. 2 in section. The complete ring, as cast, differs from a solid of revolution in having two such planes opposite to each other outside, for the purpose of attachment to the slanting plane of the upright. A pedestal ending in a small cup carries the glass ball, which rests there by its own weight; and even should it be blown aside by a very violent gale, it cannot fall out, at least in the instruments suited for our latitudes, as the horns of the half ring are not wide enough to let it through. It may, however, be cemented for security's sake. The instrument is mounted in its place as a fixture, and then contains nothing movable except the glass ball, which (if not cemented) can be lifted out and replaced in its cup at pleasure. The cards are introduced at the edges of the half ring, with their upper and lower edges under their proper flanges, and then readily slip into their places. They are pushed till the noon hour line is a prolongation of the line marked inside on the brass, and the ends (in the case of the equinoctial cards) are then cut off level with the horizontal edges of the half ring, unless they should have been previously cut in the house, from the pattern given by one of the cards that had been mounted and cut in the instrument.

In mounting the instrument in place, the points to attend to are, (1) that it shall be level as regards east or west, (2) that the axis of the ring shall be inclined to the horizon at an angle equal to the latitude of the place, (3) that the plane passing through the axis of the ring and the meridian line marked on its inside shall be in the plane of the meridian. There is no occasion to change the pattern of the upright supporting the half ring, since variations of latitude may be allowed for in bedding the slate.

A large number of experiments were made by means of two similar instruments placed side by side, as well as more roughly in other ways, on the effect of different modes of darkening the cards. It might, perhaps, have been expected beforehand that black cards would have been the most sensitive. Such, however, did not prove to be the case. With blackened cards the earliest indication of an effect of the sun's rays consisted in a slight alteration of the texture, visible only when the card was held so as to catch reflected light; whereas, with a moderately darkened card an alteration of colour produced by the heat could be seen before there was any alteration of texture; and this singe could be seen

simultaneously with the determinate burns without the necessity of holding the card in any particular direction. And though the first change would most probably be produced on a black card, experience proved that the first *visible* change was produced on a suitably darkened card.

The difference between different kinds of cards was, however, far less than might perhaps have been anticipated. It was only in catching a few minutes more or less of a very feeble sunshine that, with the exception, perhaps, of a few pale and unsuitable kinds, one card differed from another. Cards darkened to a grey with carbon were among the best. It was decided, however, ultimately to employ prussian blue only moderately dark. Such cards, when viewed through a red glass, which transmits all the visible rays which are strongest in heating effect, looks almost black, while the rays of high refrangibility which it freely reflects enable the record to be easily seen, while entailing but little loss of absorption of rays powerful in their heating effect. It is needless to remark that if a pigment were chosen *merely* from *à priori* considerations, its behaviour with respect to the invisible rays lying beyond the red would have to be taken into consideration. But to do this experimentally would involve an expenditure of time which the value of the result would hardly justify, since the suitability of a pigment may be ascertained by direct trial.

Directions for Adjusting and Using the Sunshine Recorder, issued by the Meteorological Council.

The instrument when in position faces the south; the glass ball rests on the pedestal, and when the sun is shining casts an image which chars a slip of card previously placed in the instrument. As the sun travels from east to west, the place of the image gradually moves along the card, which is thus scored during sunshine, and left untouched when the sun is hid.

1. *Adjustment for Concentricity.*

It is possible that the instrument may require this adjustment. To see whether it does, put the ball into its cup, and see whether in the horizontal plane passing through the ball's centre the surface of the glass stands at the same distance all round from the middle points of the belts on which the cards are destined to lie. If not, the pillar supporting the ball may be adjusted by loosening the screw underneath which fixes it, moving the pillar in the required direction, and when it is right, turning the screw home.

If the adjustment is not within range of the hole in the slate, which for this object was designedly made a little large, the hole may be enlarged a little in the required direction by filing. Unless you are confident of being able to effect the adjustment thus, you had best not attempt the filing, but write to the Office.

2. *Choice of Position.*

It is almost needless to remark that a position should be chosen where a clear view of the sky, or at least of such portions of it as

the sun is liable to occupy, is as little as may be interfered with by buildings, trees, &c. The instrument itself when roughly in position will show what portions the sun is liable to occupy.

3. *Adjustment for Level.*

The instrument is to be placed level as regards east and west, though at most stations, as will be mentioned presently, it requires to be tilted a little in the plane of the meridian. The plane of the top of the instrument, that is, the plane of section of the bowl, may perhaps not be quite parallel to the upper surface of the slate base, and in adjusting for level it is well not to trust to the surface of the slate, but to use the plane of the top of the bowl.

4. *Adjustment for Latitude.*

In most of the instruments which have been made for the United Kingdom, the brackets supporting the bowl have been made to a common pattern suited to a mean latitude of about 53°. Except for stations very nearly in that latitude, the stand will require to be tilted a little in the plane of the meridian, through an angle equal to the difference between 53° and the latitude of the place. At stations north of 53°, the northern edge of the stand will require to be raised, at stations south of 53° the southern. For the moderate differences of latitude with which we are concerned, the elevation of edge required may be taken nearly enough at one-eighth of an inch for each degree of difference between the latitude and 53°.

In some few of the instruments the brackets have been made to suit a different latitude. In such cases the above rule will apply on substituting that latitude for 53°.

The above rule will suffice for making the adjustment for latitude very nearly right. To test, and if need be correct it, the height of the image of the sun should be noted on some day when the sun is shining within an hour or so of noon, and compared with the proper height for that day. This may be obtained from the accompanying woodcut, which represents a section of the

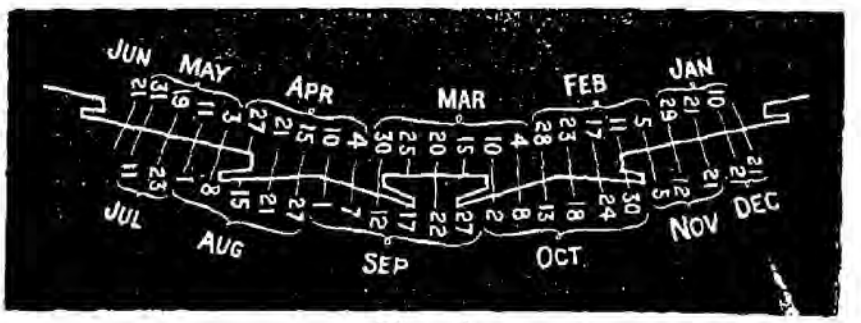


FIG. 4.

inner surface of the bowl by a plane passing through the polar axis of the ball. The figure is graduated for every 2° of the sun's declination, as well as for the maximum declination; and the days in the spring and autumn halves of the year at which the sun has most nearly any one of these declinations are written on the wood cut. Should the day on which it is wished to test the adjustment

be some intermediate day, the proper place of the image may be obtained by estimation, remembering that the declination changes very slowly about each solstice.

5. *Adjustment for the Meridian.*

This adjustment is best made by means of the time, and as fairly correct time can now nearly everywhere be obtained, it seems needless to give methods of adjustment in which the time is supposed unknown.

Supposing then the instrument placed roughly in the plane of the meridian, it may be adjusted, provided the sun is shining about noon, by turning it a little, if necessary, in azimuth, so as to make the image of the sun cast by the ball fall on the meridian mark in the instrument at the moment of *apparent local* noon.

We are not restricted to noon for the adjustment. Any other hour may be taken, supposing the card to have been properly inserted, by taking advantage of the hour lines marked on the card. At the moment when any hour is reached according to apparent local time, the instrument is to be turned so as to cause the image of the sun to fall on the corresponding hour line. Should it be cloudy at noon, it would be well to choose for the adjustment an hour not very far from noon, as in that way defects in the other adjustments would have no appreciable effect* on the adjustment for the meridian.

This supposes the correct time to be at least fairly well known. The time got from a railway clock will probably be Greenwich or Dublin, &c. time, and to get the local mean time we must first add or subtract a time proportional to the difference of longitude between the station of observation and the place the time of which is given by the clock, at the rate of 4 minutes per degree, adding or subtracting according as the station of observation lies east or west of the place for which the time is given by the clock. Having thus got the local mean time, the local apparent time will be obtained by adding or subtracting the equation of time, as given in the accompanying table.

TABLE giving for every THIRD DAY in LEAP YEAR the EQUATION of TIME to the NEAREST HALF MINUTE, to be ADDED TO or SUBTRACTED FROM LOCAL MEAN TIME, according as the Sign is + or —, in order to get Local Apparent Time.

Day.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	− 3½	−14	−12½	−4	+3	+2⅔	−3½	−6	+ ½	+10½	+16½	+10½
4	− 5	−14	−12	− 3	+3½	+2	− 4	−6	+ 1½	+11¼	+16½	+ 9½
7	− 6½	−14½	−11	−2	+3½	+1¼	−4½	−5½	+ 2½	+12½	+16	+ 8
10	− 7½	−14½	−10½	−1	+4	+1	−5	−5	+ 3½	+13	+16	+ 7
13	− 9	−14½	− 9½	− ½	+4	0	−5½	−4½	+ 4½	+14	+15½	+ 5½
16	−10	−14½	− 8½	+ ½	+4	− ½	−6	−4	+ 5½	+14½	+15	+4
19	−11	−14	− 8	+1	+3½	−1	−6	−3½	+ 6½	+15	+14½	+ 2½
22	−11½	−14	− 7	+1½	+3½	−2	−6	−2½	+ 7½	+15½	+13½	+ 1
25	−12½	−13½	− 6	+2	+3½	−2½	−6	−2	+ 8½	+16	+12½	− ¼
28	−13	−13	− 5	+2½	+3	−3	−6	−1	+ 9½	+16	+11¼	− 2
31	−13½	−12	− 4	+3	+2½	−3½	−6	0	+10½	+16½	+10½	− 3½

* See however paragraphs 2, 3, and 7 of § 6.

6. *Confirmation of Adjustments.*

In order that each of the adjustments mentioned above should be sufficiently exact the other adjustments would have to be nearly right. Hence, when the adjustments are deemed to be right, they should be tested, which may be easily done when the sun shines, even though not quite continuously.

The adjustment for the meridian and the adjustment for level east and west are tested together by seeing whether at *apparent local* noon (or at 11 a.m., 1 p.m., &c.) the image falls on the noon hour line, (or on the 11 a.m., 1 p.m., &c., hour line), and whether the line scored by the sun on a card runs parallel to the nearest edge of a flange confining the card. Theoretically, it should not be *quite* parallel, on account of the change of declination of the sun during the day ; but even near the equinoxes this is too small to come under notice.

If reasonable care has been taking in levelling the top of the bowl in an east and west direction, no material error of level is to be feared ; and a defect of parallelism of the score to the flange, though such as might be produced by an error of level, should lead the observer rather to question and to re-examine the adjustment for the meridian. It may be that when the adjustment was made incorrect time was used, or the correction for the equation of time was forgotten, or applied with a wrong sign.

The adjustment for latitude is tested by seeing whether the image of the sun falls at the proper height on the card corresponding to the day of the year.

Once well adjusted, the instrument need not be disturbed, and it may be fixed in its place by cement or otherwise. It is possible, however, that at some stations, from the positions of buildings, &c., one place might be best for the instrument in summer, and another in winter. In such cases there is no objection to making the change. Of course the instrument will have to be re-adjusted after each change of position.

For the sake of those who wish to make use of the mathematical expressions for the errors of time and parallelism produced by given small errors of level and azimuth, the expressions are here subjoined.

Let l be the latitude, δ the sun's declination, both reckoned positive when north, α the small error of azimuth, λ that of level east and west, h the error of hour angle entailed, p the error of parallelism, α, λ, h, p being respectively reckoned positive when in the direction of the hands of a watch to an observer looking vertically downwards for the first, horizontally northwards for the second, downwards in the direction of the earth's axis for the third, downwards in the direction of the sun's rays at apparent noon for the fourth ; then—

$$h = \left\{ \alpha \sin (l - \delta) - \lambda \cos (l - \delta) \right\} \sec \delta,$$

$$p = (\alpha \cos l + \lambda \sin l) \sec \delta,$$

and

$$\alpha = p \cos (l - \delta) + h \sin l,$$

$$\lambda = p \sin (l - \delta) - h \cos l.$$

7. *Choice and Insertion of the Cards.*

Cards are provided of three patterns, rectangular for the equinoxes, and curved for summer and winter. The summer and winter cards are alike except as to length (the summer cards being the longer), and as to having the hour figures printed so as to be seen erect when in the one case the convex, and in the other the concave, edge of the card is held uppermost.

It will be noticed that the bowl is undercut inside so as to leave six grooves roofed in by flanges which are destined to confine the edges of the cards. The grooves or their flanges will here be numbered from the top downwards. The winter cards are inserted, concave upwards, with their edges under flanges Nos. 1, 3, and slid along till the noon hour line is against the line marked on the brass. Should the two marks on the brass not exactly agree, that nearest to the equator of the instrument had best be used. Nothing more is required in general till next day, when the card is pulled out and a fresh one put in. In time of snow, however, when there is any chance of sunshine, the snow should be removed from between the ball and the card.

If the sun should be shining when a fresh card is being put in, the observer should stand on the south side of the instrument, or otherwise shade the ball, lest a false score should be made on the card before it gets into the proper position.

The equinoctial cards are similarly inserted, with the hour figures erect, under flanges Nos. 2, 5, and the summer cards, convex uppermost, under flanges Nos. 4, 6.

The equinoctial cards are to be used during March and the first 12 days of April, and again during September and the first 12 days of October; the summer or winter cards, as the case may be, are to be used during the remainder of the year.

8. *Shortening of the Equinoctial Cards.*

If the ends of the equinoctial cards were left projecting above the brass frame, they would intercept the sun's rays near sunrise and sunset. The parts projecting above the horizonal top of the frame should therefore be cut off. If the observer chooses, he may cut off the ends before inserting the cards, by cutting one in the instrument, and using it as a pattern by which to cut the others. It would be unnecessary to remove the ends of the summer and winter cards, as they are not in the way.

NOTE C.

On the Methods available for the Determination of the Humidity of the Atmosphere, by Mr. W. N. Shaw.

Preliminary Report.

Taking the actual tension of aqueous vapour in the atmosphere at a definite point of time as the quantity sought to be determined by observations with hygrometers of all classes, the first point noticeable is that the determination by instruments of every kind is indirect, and therefore each instrument requires a formula of reduction by which the tension may be obtained from the obtaining observations made.

In the appended table, p. 45, the hygrometers which I have undertaken to compare are arranged in classes according to the quantities which are actually observed in each case, and I have thought it well to add a column showing the most advantageous state of the air in the neighbourhood of the instrument for reliable applications of the formulæ of reduction.

It will be seen that these conditions for some of the classes taken together are incompatible, and I therefore think it advisable that in comparing hygrometers of the same class, in order to form an idea of the value of each different method, I should endeavour in the first instance to obtain the air in the neighbourhood in its most advantageous state for that method. At the same time I think it should be kept in view that an instrument, to be practically useful and reliable, must be to a large extent capable of adapting itself to the changes to be expected in the external atmosphere, and that therefore a hygrometer which will determine under favourable conditions with great accuracy what it is intended to indicate may still be a comparatively useless instrument in practical meteorology, and I accordingly wish to compare the result of more or less rapid variation of atmospheric conditions upon instruments of different classes as well as their capacities for giving a concordant series of readings when the conditions are maintained constant and favourable.

Some of the rooms in the Cavendish laboratory are particularly well adapted to maintaining the air at a very nearly constant temperature for days, so that I expect but little difficulty in producing any atmospheric conditions that I wish. It will also be advisable, probably, to obtain small quantities of air in a known hygrometric state by means of evaporation from saline solutions in a closed space, more especially in order to test the hair hygrometers.

With regard to the psychrometer:—All psychrometer readings are reduced by the same tables, although from my own and the published experienced of others the readings of two instruments are seldom identical. This may be due to the three following causes:—

(1.) The difference in shape and dimensions of the bulbs.
(2.) The method of moistening the bulb.
(3.) The currents of air in the neighbourhood of the instrument.

I propose, then, before comparing the pyschrometers with other instruments, to endeavour to determine what influence on the reading of the wet bulb the three causes above-mentioned exercise.

The first two causes have been investigated by Cantoni, but I think it will be necessary to repeat some of his observations with regard to the moistening, since, so far as I know, the method of moistening the bulb by a Mariotte's bottle has not been employed here, and was not employed by the authorities from whose observations the reduction tables are compiled.

With regard to the third cause, besides experimenting with the blowing apparatus (which I conclude to be that made by the Technical Institution at Milan, known as the Tecnomasio), I have made an arrangement, in which a current of air due to a gas jet passes over the bulbs of a series of thermometers on a screen in front of a chimney, where, by opening and closing holes behind the bulbs and placing the moistening apparatus on one side or other of the screen, I can ascertain with tolerable completeness the effects due to the possible disturbing causes, which, according to a considerable amount of evidence render the psychrometer at present an imperfect instrument.

My general line of investigation will then be—

(1.) To compare instruments of the same class under the most favourable conditions, and determine their sensitiveness to variation of condition.

(2.) To compare instruments of different classes which require similar conditions.

(3.) To compare the whole range of instruments, accepting as the most reliable the result obtained from Schwackhöfer's instrument*, if (*a*) on comparing that instrument with the ordinary chemical hygrometer, and (*b*) on determining by its means the moisture in an atmosphere artificially maintained in a known state, it shows itself worthy of the credit to which it seems to me at present entitled.

Emmanuel College, May 11, 1880. W. N. Shaw.

* Described. Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, Vol. xiii. p. 211.

Table of Hygrometers to be compared.

Class of Instrument.	Name of Instrument.	By whom supplied.	Quantity which the Instrument is designed to measure.	Reduction Formula by which the tension of Aqueous Vapour e is obtained from the Quantity measured.	State of the Air surrounding the Instrument calculated to give the most reliable determination of e.
Chemical Hygrometers.	1. Chemical Aspiration apparatus.	Constructed by the Observer.	Mass m of aqueous vapour which was combined with a volume v of dry air.	$e = \frac{h\, m\, (1 + \cdot 003665t)}{v\, d + m\, (1 + \cdot 003665t)}$ where t is the temperature of the air at the time of observation, h the barometric height, d the density of water vapour at 0° C. & 760mm.	Moisture and temperature uniform or uniformly varying during the observation. Best obtained by drawing the air from a closed space at a uniform temperature.
	2. Schwackhofer's apparatus	From Schneider of Vienna, by Meteorological Office.	Percentage diminution of volume n of a given quantity of air when the aqueous vapour is removed, the pressure and temperature being maintained constant.	$e = \frac{n}{100} h$	Moisture uniform throughout the space in the neighbourhood at the moment when the air is taken into the apparatus for experiment.
Dewpoint Hygrometers.	3. Regnault's - - -	Committee of Kew Observatory.	The temperature t_o to which a metallic surface must be cooled to cause a deposition of moisture upon itself; temperature reduced by evaporation of ether.	$e = e\, t_o \left\{ \frac{1 + a\, t}{1 + a\, t_o} \right\}$ where $e\, t_o$ is the vapour tension at t_o° C., and $a = \cdot 003665$. t is the temperature of the air.	The pressure of the same mass of air remaining the same, the temperature of the dewpoint will always be the same. The air for these observations should therefore be still, and the two thermometers screened from each other.
	4. Alluard's - - -	Meteorological Office			
	5. Dines's - - -	Cavendish Laboratory.	The same as above, the metallic surface replaced by blackened glass, and the cooling effected by iced water.		
Psychrometers.	6. Psychrometer of usual construction by Casella.	Cavendish Laboratory.	The cooling of a thermometer $t - t'$ due to enclosing its bulb in moist muslin.	(1.) Jelinek's tables calculated from the formulæ— $e = e' - \frac{\cdot 480\, (t - t')\, h}{689 - t}$ if $t' < 0$°C. $e = e' - \frac{\cdot 480\, (t - t')\, h}{610 - t'}$ if $t' > 0$°C. (2.) Empirical tables by Glaisher.	The air should be in motion, and some arrangement made to prevent the water evaporated from the wet bulb affecting the indication of the instrument.
	7. Psychrometer with apparatus for blowing a current of air past the bulb. Supposed to be made by the Tecnomasio at Milan.	Meteorological Office	Ditto - - - -		
Hair Hygrometers.	8. Saussure's modified -	Meteorological Office	Extension of a hair by its absorbing nature.	Graduated by an empirical scale of comparison with other hygrometers.	Constant relative humidity or nearly so; slow motion of the air.
	9. Klinkerfues's - -	Ditto - - -	Ditto of bundle of hairs - -		

NOTE D.

I. MEMORANDUM as to the EMPLOYMENT of the HARMONIC ANALYSER in the METEOROLOGICAL OFFICE, by Professor STOKES.

It will facilitate the explanation of what is to follow if we take a particular example; but it is to be understood that the remarks to be made are of general application. Let us confine ourselves, therefore, in the first instance to the consideration of the daily fluctuation of atmospheric temperature at a particular place.

The main object of the harmonic analysis is the determination and representation of periodic inequalities; in the example chosen, the diurnal inequality of temperature. For this we should subject the records extending over a considerable time, such as a year, to the analysis, and thereby determine the constants in the expression. But it is obvious that if nothing of the record were preserved for publication except this final result, the information communicated would be extremely meagre. Not only would stated fluctuations of the variation, such as the seasonal inequality, be passed over, but it would be impossible for a meteorologist seeking after some hitherto unknown inequality (such as an inequality with a period of 24 days or thereabouts, which Professor Balfour Stewart thinks there is evidence of) to make any use of the result. Again, though the harmonic analysis is useless for following the history of the weather in all its details, it is not without use as presenting a succinct representation of the leading features; but this would not be presented if nothing but the final result were given.

The temperature for a single day is not a strictly periodic function. Even if we leave out of consideration those rapid and apparently casual fluctuations that appear to depend on alternations of cloud and sunshine, or on passing showers, the end does not fit on to the beginning. If, treating it as periodic, we were to repeat it day after day, we should be dealing with a function which, graphically represented, would exhibit a succession of curves all alike, but presenting breaches of continuity where the end of one curve joined on to the beginning of the next. At the place of junction there would in general be a sudden change in the ordinate, another in the direction of the tangent, another in the radius of curvature, and so on. Nevertheless, in anything of settled weather the discontinuity would be much smaller than the changes due to the normal diurnal change, especially if the record for the 24 hours began at midnight, or at some other hour when the sun is below the horizon.

The temperature for the day, regarded as a function of the time, may conveniently be divided into two parts, which we may call the *progressive part* and the *residual part* or *residue*, where the progressive part is a simple algebraic function of t (the time), linear, quadratic, cubic, ... according to the order we please

to go to, the constants being so chosen as to give to the residue, or the residue and its first derivative, or the residue and its first two derivatives, ... the same values at the beginning and end of the day. The function will thus be cleared as far as may be of the effect of progressive change, and the residue will represent, more nearly than the function itself, the normal diurnal fluctuation.

Let the time-scale be so chosen that a day is represented by a period, or 2π, and let $f(t)$ be the temperature. The development of $f(t)$ in harmonic series will be, going to three orders after the mean,

$$A_0 + A_1 \cos t + A_2 \cos 2t + A_3 \cos 3t + B_1 \sin t + B_2 \sin 2t + B_3 \sin 3t,$$

where

$$A_0 = \frac{1}{2\pi}\int_0^{2\pi} f(t)\,dt,\ A_i = \frac{1}{\pi}\int_0^{2\pi} f(t)\cos it\,dt,\ B_i = \frac{1}{\pi}\int^{2\pi} f(t)\sin it\,dt,$$

i being 1, 2, or 3, as the case may be.

The several integrals will be given by the machine. To get the development of the residue we must deduct the development of the progressive part. According to the theory of these series this will be got from the above by integrating by parts, and retaining only the terms which are free from the integral sign, provided we assign, as we may, the mean term wholly to the residue. Denoting by Δ, the increment of $f(t)$ or its derivatives in passing from $t = 0$ to $t = 2\pi$, it will accordingly be—

$a_1 \cos t + a_2 \cos 2t + a_3 \cos 3t + b_1 \sin t + b_2 \sin 2t + b_3 \sin 3t$,

where

$$a_i = \frac{1}{\pi i^2}\Delta f'(t) - \frac{1}{\pi i^4}\Delta f'''(t) + \ldots$$

$$b_i = -\frac{1}{\pi i}\Delta f(t) + \frac{1}{\pi i^3}\Delta f''(t) - \ldots$$

In correcting the constants A_0, A_1, B_1, ... so as to get the expansion of the residue, it does not seem desirable to go beyond the function $f(t)$ itself. This comes to taking as the residue a function which would be represented graphically by the excess of the actual ordinate over that of a straight line drawn parallel to the line joining the extremities of the curve, and passing through the middle point in the axis of abscissæ. To this degree of accuracy the development of the residue would accordingly be (writing Δf for $\Delta f(t)$),—

$$A_0 + A_1 \cos t + A_2 \cos 2t + A_3 \cos 3t + \left(B_1 + \frac{1}{\pi}\Delta f\right)\sin t + \left(B_2 + \frac{1}{2\pi}\Delta f\right)\sin 2t + \left(B_3 + \frac{1}{3\pi}\Delta f\right)\sin 3t.$$

The constants A_0, A_1, B_1, &c. are given by the increments of the numbers on the cylinders of the machine, and the corrections are similarly given by the increments of the function itself, supposed tabulated for the commencement of each day.

If, instead of applying the analysis to a single day, we apply it to n consecutive days, the increments of the numbers on the cylinders, and also the correction for reducing the development of the function to that of the residue, will each have to be divided by n, Δ now denoting the increment of the function in passing from the beginning of the first to the end of the last day in the group. Supposing the days on the average much alike, the increments of the numbers on the cylinders will increase nearly in proportion to n, and the quotient will tend to a limit in which irregular changes from day to day disappear. The increment of the function $f(t)$, however, instead of increasing nearly as n, will fluctuate in a casual manner, and when it is divided by n, the quotient will tend to vanish as n is taken greater. It is only therefore when days are considered individually, or grouped in some manner other than that of natural sequence, that the correction for reducing the actual function to the residue need be taken into account.

The seasonal inequality of mean diurnal temperature, or of diurnal fluctuations of temperature, may conveniently be got by subjecting the coefficients, obtained as above, again to harmonic analysis, the period being now a year. For this it would not be necessary to take the increments of the numbers on the cylinders for each day. It would be amply sufficient to take the days in groups of 5, 10, or even more.

If the numbers on the mean cylinder and on the pair of cylinders of the first order, or what perhaps would be better, the increments of those numbers, as likewise the initial temperatures, were published for each day, and the numbers on the cylinders of higher orders for somewhat wide intervals, the tables would pack into small compass, and would nevertheless present a tolerably complete and partially digested record of the march of temperature throughout a year; and if curves were drawn representing, one the mean temperature, and the other the coefficient of the resultant of the pair of terms of the first order, the whole could be represented to the eye, in its leading features, in a very small space.

The details of the mode of treatment and publication of records to which the harmonic analysis is applied can hardly be fixed till some substantial experience has been gained in the regular use of the instrument, as distinguished from trials having for object to test whether the instrument was in thoroughly good working order. The above is given as indicating the general direction which the changes in the mode of reducing and publishing the records seem likely to take in consequence of the introduction of the instrument. The same general principles which apply to the discussion of temperatures will apply of course to the other elements, but each element must be considered by itself as to the features which it may be most desirable to bring into prominence.

II.—Suggested First Application of the Harmonic Analyser, and Rules for the Use of the same.

I think the first application had best be to temperature for some year, say, in the first instance, to the records of the dry bulb thermometer, but the same remarks will apply to the wet bulb, which perhaps might be taken up next.

The civil reckoning of time should be followed each day, commencing at midnight. As the sheets commence at 10 a.m. and go on for two days, the record of every second day will be divided, part being on one sheet and part on another. The readings on the cylinders need not be attended to when the sheets are changed, further than to see that they are not accidentally disturbed in the process of changing.

The cylinders being set to zero for the midnight with which the work is commenced, should at first all be read for every midnight, and the readings registered. The mean cylinder and (in the case of the thermometer) the pair of the first order should continue to be read for each day, but, for the others, readings at intervals of several days will probably be sufficient, as may be determined by subsequent orders.

Should a record exhibit a small or moderate gap, which can be filled in by the eye with tolerable certainty, it should be so filled in pencil before the sheet is put on.

Should the gap be more serious, so that in the judgment of operator it would be better to reject the day altogether and interpolate, the process should be as follows:—

Suppose that the record for the 7th of a month is rejected, those for the 6th and 8th being good. Let A, B, C, D be the hour readings concerned as they would have been if the records of the three days had been perfect, these readings being those of any one of the cylinders. The readings are those for the midnights of the 5th, 6th, 7th, and 8th, so that $B-A$ gives the increment for the 6th, and so in the other cases. Then A and B are read on the cylinders, but as the record for the 7th is missing we start with the number B in commencing the paying off of the record for the 8th, and at the end of the day arrive at a provisional reading, say P. Then in default of the record for the 7th we may take the increment for that day of the number on the cylinder as the mean of the increments for the 6th and 8th. This gives $B+\frac{1}{2}(P-A)$, $P+\frac{1}{2}(P-A)$ as the numbers which are to be taken for C, D, respectively. These numbers are to be entered in the register, and the cylinder set by hand to the last of them before paying out the record for the 9th. If the gap should extend over two days, the records should be supplied by a process founded on similar principles.

If the readings of the records of the subordinate cylinders for every day should have been discontinued, the cylinders should be read for the purpose of making the interpolation even though the reading might not have been otherwise demanded.

The preservation of the records on the cylinders not only supplies information as to the element analysed, which would be lost if nothing but the final results were retained, but also affords the means of re-examining any step of the process where an error might be suspected.

A blank column should be left in the register for the subsequent entry of the midnight values of the element analysed.

In what precedes the applicability of the harmonic method with a limited number of terms in the expansion is assumed. The mean hourly value of any meteorological element is of course a periodic function of the time of day. We know that any periodic function may be expressed by a harmonic series, and the only question is what number of terms it may be practically necessary to employ. The publication of the "Reduction of Greenwich Meteorological Observations" seemed to afford a good opportunity of testing this question in what appeared likely to be a specially crucial case. The result of the examination will be seen from the following letters to the Astronomer Royal:—

Lensfield Cottage, Cambridge,
April 30, 1879.

DEAR SIR GEORGE AIRY,

I WAS greatly struck with the enormous amount of work of which the outcome is embodied in the "Reduction of Greenwich Meteorological Observations" which I lately received, and with the very definite character of the results arrived at. My admiration was not unmixed with some anxiety, lest after all the Thomson's harmonic analyser, which we have ordered for the Meteorological Office, should be capable only of giving results which by comparison must be regarded as of the "cheap and nasty" class.

I thought, therefore, that I would test its applicability in a severe case; I mean of course the applicability of the principle, the machine being supposed to be properly constructed, and to work satisfactorily.

I chose the observations of temperature rather than those of the barometer, because the manifest discontinuity introduced by sunrise and sunset seemed to render temperature a more severe test than height of the barometer. As I explained in a former letter, the greater the number of observations of which the mean is taken, the greater the superiority, if any, of the method of hourly means over the harmonic method is likely to prove.

These motives led me to select for trial the last column of Table 50, page 38. I did my work pretty carefully, but I have not revised it, so that it is possible that there may be an arithmetical error, but I do not think it at all likely that the general conclusions would be affected. I went as far as the sixth order. I had contemplated going further, but it did not seem necessary.

I determined the coefficients in the usual way. I may remark in passing that this does not give them correctly in the high

orders. Each is, by rights, given by an integral, which is only approximately represented by a sum, and in the high orders the difference would be very sensible. I had some thoughts of working them out correctly, but the high orders proved to be so small as to render this unnecessary.

Denoting by t an angle proportional to the time measured from midnight, and going through its period in 24 hours, I found temperature = 49·69

$-4{\cdot}280 \cos t$	$-2{\cdot}722 \sin t$
$+0{\cdot}883 \cos 2t$	$+0{\cdot}563 \sin 2t$
$+0{\cdot}063 \cos 3t$	$+0{\cdot}119 \sin 3t$
$-0{\cdot}043 \cos 4t$	$-0{\cdot}014 \sin 4t$
$-0{\cdot}001 \cos 5t$	$-0{\cdot}026 \sin 5t$
$-0{\cdot}003 \cos 6t$	$-0{\cdot}008 \sin 6t$

For the coefficients in the different orders when the two terms are combined into one we get—

	5·072	1·047	0·135	0·045	0·026	0·009
Orders	1	2	3	4	5	6

It appears then that the first three orders give the result within about 1 per cent. of the whole diurnal variation. The error would be only a few hundredths of a degree.

I made an attempt to estimate the errors of the published numbers, by which I mean the difference between the published numbers which represent what I called, in a former letter, the mean of fact, and what I there called the mean of law; in other words, what would be the mean of an infinite series.

For this I chose two months, January and July, and two hours, midnight and noon. In Tables 38 and 44 I took the differences between the numbers in the midnight and noon columns and the means at the feet of the columns, and regarding those as errors I took their mean. The means were 2·475 and 2·500 for January; 1·610 and 1·710 for July; mean 2·074. As Table 50 gives the means for 240 months, I divided the result by the square root of 240, giving 0·134. This, then, we may take as a sort of estimate of the residual errors in the last column of Table 50 arising from the finiteness of the series, great though it was. It is about equal to the greatest value of the terms of the Order 3 in the periodic series.

I noticed, however, in working these figures that on the whole midnight and noon went together, so that the "errors" that I have spoken of arose more from variations of temperature from day to day, or week to week, than from variations within the same day. I therefore took the differences between the midnight or noon column and the last column but one, which gives the monthly mean of the mean temperature of the day. I meaned each vertical column, and took the differences between the mean and the individual numbers, and regarded these as the errors. The means came 0·28 and 0·33 for January; 0·78 and 1·20 for July; mean 0·65; same divided by the square root of 240, 0·042. This is almost exactly the coefficient of the fourth order.

It appears that the harmonic method has come very well out of its trial in a case purposely selected as being likely to be the most severe. It appears, too, that we need not trouble ourselves to go beyond the third order. The third order itself hardly emerges from casual fluctuations.

Of course the harmonic method would not *by itself alone* give such non-periodic results as those represented in Plate 4, but the modification required to introduce these is very simple.

Yours, &c.

G. G. STOKES.

Lensfield Cottage, Cambridge,
May 10, 1879.

DEAR SIR GEORGE AIRY,

I HAVE made some further calculations in pursuance of the subject mentioned in my letter of April 30, the results of which you might perhaps like to know.

From the numerical trials described in that letter, I was led to infer that the uncertainty of the diurnal inequality of temperature expressed by the differences between the numbers in the last column of Table 50 and the number at the foot of the column was something like 0·04, and accordingly of about the same magnitude as the term of the fourth order in the harmonic reduction. The uncertainty I contemplate as arising from the uneliminated residue of casual fluctuations, whereby the actual temperature at any observation differs from the mean really belonging to that day and hour.

If we can only regard the differences between the means in the last column of Table 50 and the ideal means for an infinite series as casual, it is clear that the harmonic reduction when carried to the third order will represent the result as nearly as the latter represents the ideal mean that we are seeking for. But it occurred to me that the fluctuations indicated in my former letter might be fluctuations arising rather from the coefficient than from the law of diurnal variation, in which case though the absolute mean of fact for any hour might deviate from the ideal mean to an extent comparable with 0·04, the law of variation might possibly be a good deal more correctly given. In this case the harmonic reduction, as compared with the other, would show a minute inferiority, unless at least it were carried to orders beyond the third, though the error is so small that it is hard to imagine that any scientific conclusion that could be drawn from the observations would be interfered with. Still, I was desirous of ascertaining whether even a minute error of the harmonic reduction taken to the third order, large enough to emerge from casual fluctuations, could be discovered.

It occurred to me that this point could be decided by taking separate years or groups of years instead of the whole series of 20 years, expressing the means for the separate years or groups in a harmonic series, and comparing the coefficients with those got from the whole 20 years series. If the fluctuations indicated in my former letter depended mainly on fluctuations in the coefficient

of diurnal variation, the law being but little departed from, the changes in the coefficients of the several terms in the series should bear some sort of proportion in magnitude to the coefficients themselves, so that the leading terms should be those chiefly affected, a variation like one per cent. being insensible in the small terms; whereas if the fluctuations affected the law as much as the mere amount of diurnal variation, no such subordination of the higher to the lower orders in regard to the changes of the coefficients was to be expected.

The published volume does not contain a table for air temperature analogous to Table 19, or better, to Table 20 for the barometer. Of course it could be formed from the published numbers by meaning Tables 38 to 49 as if they had been superposed, and the means taken of the numbers that lay one over the other. But this would involve more labour than I was disposed to go through. So I had recourse to a plan which practically, I think, suffices for determining the question, and which permits of utilising an existing table.

I took Table 51 and made three groups of the months, the months of each group being equidistant. I meaned the numbers in each group or rather added them, reserving the division to the end. In this way the seasonal inequality would be pretty completely eliminated, and the results would not much differ in character from those got from dividing the 20 years into three groups, and seeing how far each group agreed with its fellows. Instead of working with the actual numbers of the table, I preferred taking the difference between the number for each group, and the mean of the three. Subjecting these differences to harmonic reduction, I obtained:—

$+0{\cdot}006 \cos t$	$+0{\cdot}022 \sin t$
$+0{\cdot}019 \cos t$	$-0{\cdot}009 \sin t$
$-0{\cdot}025 \cos t$	$-0{\cdot}015 \sin t$
$+0{\cdot}014 \cos 2t$	$-0{\cdot}004 \sin 2t$
$-0{\cdot}026 \cos 2t$	$+0{\cdot}025 \sin 2t$
$+0{\cdot}011 \cos 2t$	$-0{\cdot}021 \sin 2t$
$-0{\cdot}000 \cos 3t$	$-0{\cdot}007 \sin 3t$
$+0{\cdot}006 \cos 3t$	$-0{\cdot}004 \sin 3t$
$-0{\cdot}006 \cos 3t$	$+0{\cdot}011 \sin 3t$
$-0{\cdot}008 \cos 4t$	$+0{\cdot}008 \sin 4t$
$+0{\cdot}016 \cos 4t$	$+0{\cdot}030 \sin 4t$
$-0{\cdot}007 \cos 4t$	$-0{\cdot}042 \sin 4t$

I have written the numbers according to orders, and the groups in the several orders on consecutive lines, so that the development of the first group, for instance, is made up of the first lines in the several orders. For the coefficients of the different orders when the two terms of the same order are combined into one I get:

Order -	1	2	3	4	
Coefficient -	0·023	0·015	0·007	0·011	G. 1
	0·021	0·036	0·007	0·034	G. 2
	0·029	0·024	0·013	0·043	G. 3

There is no such subordination of magnitude of the coefficients in the higher orders to those in the lower as must have taken place on the supposition that the deviations from the ideal mean arose chiefly from deviations from the mean coefficient, not from the law, of diurnal variation. The inference is that the small deviations in question, amounting to a few units in the second place of decimals, can only be treated as casual; and as they are comparable with the coefficient of the fourth order given in my former letter, it follows that the harmonic series taken to the third order will represent the results of observation within their limits of error. The small coefficient of the third order itself can only be deemed to be determined from the observations, subject to an error amounting to 30 or 40 per cent of the whole.

I noticed in taking the difference of the group numbers from the mean of the three that the differences ran very much in series of *plus* and *minus*. They exhibited considerable regularity. I rather expected from this that the harmonic series would have been most significant in the leading terms, but such proved not to be the case. However, the regularity of the fluctuations indicates that the uneliminated errors are not such as would be got by the throwing of dice for the different hours independently of each other, but that the fluctuations from which they arise are such as extend their influence over several hours at a time. This character, even had their amount been larger, would have prevented them from interfering much with the smoothness of the mean curve obtained, so that smoothness of curve is not by itself alone a proof that we have got very near the ideal mean.

I should mention that my Group 1 is made up of January, April, July, and October, and 2, 3 are similarly formed beginning with February and March respectively.

Yours sincerely,

Sir George B. Airy, K.C.B.,
Astronomer Royal.

G. G. Stokes.

Additional Memorandum on Harmonic Reductions, by Professor Stokes.

In the "Reduction of Greenwich Meteorological Observations" there is no table of mean hourly temperatures given in which the months are combined but the years kept distinct, though the materials for forming such a table are published, as the hourly means are given for the separate years and months.

Sir George Airy has subsequently had these means taken, and has been so kind as to furnish me with a copy of the results. I have now subjected these to harmonic reduction, proceeding as far as the fourth order. The first term, giving the mean, was not calculated, as it is given in the last column but one of Table LII., on page 39 of the Greenwich Reductions. The values of the eight remaining coefficients in the series,—

$$A_0 + A_1 \cos T + B_1 \sin T + \cdots + A_4 \cos 4T + B_4 \sin 4T,$$

are given in the following table:—

Coefficients in the Harmonic Reduction of the Mean Hourly Temperatures in the individual years 1849–1868.

Year.	A_1.	B_1.	A_2.	B_2.	A_3.	B_3.	A_4.	B_4.
1849	−4·105	−2·454	+0·822	+0·498	+·134	+·138	−·008	−·018
1850	−4·316	−2·753	+0·817	+0·524	+·101	+·136	−·060	−·038
1851	−4·287	−2·728	+0·907	+0·512	+·064	+·117	−·053	−·005
1852	−4·367	−2·717	+0·936	+0·643	+·046	+·106	−·060	−·049
1853	−3·822	−2·225	+0·753	+0·494	+·107	+·125	−·067	+·040
1854	−4·693	−3·194	+1·049	+0·670	+·034	+·143	−·078	−·058
1855	−4·281	−2·698	+0·918	+0·597	+·022	+·195	−·029	−·036
1856	−4·024	−2·633	+0·963	+0·501	+·065	+·096	−·065	−·014
1857	−4·624	−2·882	+1·004	+0·589	+·073	+·167	−·088	+·003
1858	−4·036	−2·017	+0·993	+0·571	+·006	+·102	−·045	−·002
1859	−4·152	−2·793	+0·891	+0·680	+·051	+·102	−·030	−·024
1860	−3·720	−2·324	+0·794	+0·567	+·045	+·079	−·027	+·003
1861	−4·256	−2·261	+0·820	+0·621	+·054	+·057	−·038	+·013
1862	−3·550	−2·295	+0·645	+0·475	+·029	+·099	−·014	·000
1863	−4·381	−2·701	+0·885	+0·565	+·077	+·049	−·067	−·052
1864	−4·394	−3·021	+0·948	+0·571	+·050	+·089	−·065	−·025
1865	−4·689	−3·171	+0·971	+0·672	+·025	+·146	+·029	−·048
1866	−4·086	−2·512	+0·783	+0·516	+·077	+·166	+·006	−·014
1867	−3·986	−2·479	+0·759	+0·492	+·089	+·119	−·023	+·002
1868	−4·900	−3·106	+0·918	+0·488	+·100	+·184	−·027	−·029
Mean	−4·278	−2·718	+0·879	+0·562	+·062	+·122	−·043	−·016

Differences of the Coefficients from the Mean, in thousandths of a Degree.

Year.	A_0.	$-A_1$.	$-B_1$.	A_2.	B_2.	A_3.	B_3.	$-A_4$.	$-B_4$.
1849	+ 630	−173	−264	− 57	− 64	+72	+16	+25	− 3
1850	− 170	+ 88	+ 35	− 62	− 38	+39	+14	+17	+22
1851	− 510	+ 9	+ 10	+ 28	− 50	+ 2	− 5	+10	−11
1852	+ 910	+ 89	− 1	+ 57	+ 81	−16	−16	+17	+33
1853	−2150	−456	−493	−126	− 68	+45	+ 3	+24	−56
1854	− 400	+415	+476	+170	+108	−28	+21	+35	+42
1855	−2520	+ 3	− 20	+ 39	+ 35	−40	+73	−14	+10
1856	− 550	−254	− 80	+ 84	− 61	+ 5	−26	+22	− 2
1857	+1550	−346	+164	+125	+ 27	+11	+45	+35	−19
1858	− 190	+358	+299	+114	+ 9	−56	−20	+ 2	−14
1859	+1180	+374	+ 75	+ 12	+118	−11	−20	−13	+ 8
1860	−2120	−558	−394	− 85	+ 5	−17	−43	−16	−19
1861	+ 310	− 22	− 47	− 59	+ 59	− 8	−65	− 5	−29
1862	+ 250	−728	−423	−234	− 87	−33	−23	−29	−16
1863	+ 970	+165	− 47	+ 6	+ 3	+15	−75	+24	+36
1864	− 750	+116	+308	+ 69	+ 9	−12	−33	+22	+ 9
1865	+1189	+411	+153	+ 92	+110	−37	+24	−72	+32
1866	+ 710	−192	−206	− 96	− 46	+15	+44	−49	− 2
1867	− 890	−292	−339	−120	− 70	+27	− 3	−20	−18
1868	+2530	+622	+388	+ 39	− 74	+38	+62	−16	+13
Mean	1085	278	220	120	56	26	31	23	20
Do, ÷ $\sqrt{20}$	242	62	49	31	12	6	7	5	4

The calculations were pretty carefully checked. In the steps of the calculations I never went beyond the third decimal of a degree, and therefore this figure is liable to an error amounting to a few units. With this understanding, the mean of the reductions agrees with the reduction of the mean previously given (p. 51), which was calculated quite independently, so that the two check each other.

The last line is given as allowing an estimate to be formed of the mean errors of the coefficients derived from different groups of 20 independent years compared with the coefficients which would be obtained from an infinite number of years.

The general conclusions obtained in my former memorandum in an indirect way are borne out by the direct comparison between different years which is here made. As before observed, the minute fourth order is swallowed up, even in the mean of a 20 years' series, by the uncertainty in the amount of fluctuation, not to speak of the much larger uncertainty in the mean temperature for a day. Nevertheless, it appears from the figures that though this order is so minute, and though its effect on the mean temperature at any particular hour is trifling compared with the average variation from year to year of the mean for that same hour, it still emerges roughly with tolerable certainty from the mean for a good number of years.

If we were in possession of a theory by which mean temperatures could be calculated with the same precision as the planetary motions, there would then be some interest in working out from observation this fourth order, though so minute. But as there appears to be no prospect of such a theory, and as it seems hardly conceivable that so minute a feature of the diurnal fluctuation could assist us in the endeavour to connect observed meteorological effects with their causes, it does not seem advisable to incur the additional labour and expense that would be involved in the endeavour to elicit from observation such very small fluctuations.

APPENDIX.

APPENDIX I.

METHOD followed by the OFFICE in the EXTRACTION of DATA from SHIP'S LOGS.

THE method which has been followed by the Office, since its first establishment in 1854 up to the present date, in the collection of information on Ocean Meteorology, has been to supply observers with a complete outfit of verified instruments, on the condition of their returning the instruments, and the log of observations made with them, to the Office at the completion of the voyage.

Every instrument supplied has been originally verified at Kew Observatory, and on the completion of the voyage it is compared with standard instruments by a duly authorised observer. Under ordinary circumstances it is not requisite to send the instruments to Kew for re-verification after every voyage, as the changes in their errors are generally slight.

The regular outfit of a ship consists of :—

1 Barometer (Kew pattern).
6 Thermometers, with a thermometer screen.
4 Hydrometers.

The first record of observations is made in a Rough Book supplied for the purpose, which is retained by the captain, who copies the observations into a regular form of log kept for the Office.

As regards the Royal Navy, Her Majesty's ships have been supplied by the Office, since its foundation in 1854, with the meteorological instruments used in the service, and for this provision is annually made in the Estimates furnished by the Office to the Treasury upon which the vote for the Meteorological Council is based. The records of observations made by naval officers are in due course deposited at the Admiralty, where they are available. It is optional with the observers to keep the Meteorological Log of the Office in addition to the regular record of observations required by the rules of the service. The Council are glad to say that they receive from time to time Meteorological Logs of high value from Her Majesty's ships.

In order to facilitate the communications between the Office and the observers, agencies are established at some of the principal ports, and instruments are supplied directly from such agencies to the ships.

The following is a list of the agents at present in connexion with the Office :—

Aberdeen	J. R. Jones	Navigation School.
Cardiff	H. Thatcher	Bute Docks.
Dundee	P. A. Feathers	40, Dock St.
Glasgow	Messrs. D. M'Gregor & Co	44, Clyde Place.
Greenock	Do. do.	32, Cathcart St.
Hull	Z. Scaping	Trinity House.
Liverpool	J. Gill	Sailors' Home.
London	Capt. T. M. Almond, F.R.A.S.	131, Fenchurch Street, E.C.
Southampton	Messrs. King, Seymour, & Co.	South-western Terminus.

A set of instruments is kept in working order at the Office in London and at each Agency. A notice to captains is inserted as a standing advertisement in the "Nautical Magazine," and copies of it are supplied to each agent. When a captain expresses himself willing to observe, he is invited to inspect the instruments and learn what will be required of him. If this takes place at one of the agencies, and the captain decides to undertake the work, his name is submitted to the Marine Superintendent, who, if the owners of the ship are British subjects, and she is likely to return to some port in the United Kingdom, sanctions the supply, having due regard to the nature of the proposed voyage and giving preference to captains intending to visit the districts whence the information existing in the Office is scanty.

In a few exceptional cases captains are supplied at ports where there are no agencies, and in these cases the instruments are sent from the Office in London.

Agents receive a fee of 1*l.* 5*s.* for each case of supply and return of instruments, and an additional fee of 1*l.* for the first "excellent" log sent in by any observer whom they may have invited to begin keeping a log.

Captains are requested to give notice of their return to any port in the United Kingdom to the agent at the port, if there be one, or else to the Office in London, and steps are then taken to send for the instruments and log. The latter is sent up to London, and the instruments are at once compared with a standard set, and if received at an agency, the results of such comparison are duly forwarded to London.

The log is tested according to a definite form (the "test sheet," which has been published in the Report of the Maritime Conference of London, 1874, p. 35), and the observations are classified according to their quality.

As soon as this first testing has been effected, a letter is written to the captain, and if any questions arise to which he can probably give an answer, he is requested to do so while the incidents are fresh in his memory. When his reply is received it is noted in the log for future reference when the observations come for discussion.

The first step in the process of discussion is the extraction of the observations (which in the original documents are of course in chronological order, and follow the tracks of the ships for the time being), into forms in which they are grouped for the different months of the year and for definite areas of the sea-surface. These forms are called Data Books, and the actual process of transference of the observations into them is mainly clerical, but the operations "examination" and "preparation," which are preliminary to the transference, are of a different character, and of these the former demands the higher degree of experience in the person to whom it is entrusted.

The examination of a log requires a careful reading of the test sheet, and of any correspondence which may have been conducted with the observer. The hours for which the observations are to be used must be selected. The instrumental corrections must be considered for the whole log, and it must be finally decided whether they shall be applied or not. The observations are then looked over, so as to detect by inspection obvious errors (such as of half-an-inch or an inch in the barometer, or of 5° or 10° in the thermometer); evidence of accidental exposure of the thermometers to the sun is also carefully sought for, and indications of mismanagement of the wet-bulb thermometer. These are all precautionary measures, not peculiar to sea records, but it must not be forgotten that as regards the thermometric observations the instruments at sea are placed under different conditions from those which can be obtained on

land, for it is impossible on board ships to have the screen always in the shade and yet freely exposed to the air, so that any instances of undue heating of the thermometers in the daytime must be noted. The compass entries must be considered in order to see if they are sufficiently exact for extraction. The ship's positions must be examined, and corrected for current when requisite, and the number of the next subsquare into which the ship moves, or the direction of the ship's head for every observation entered for subsequent use as a record of the ship's course when the observation is isolated in the Data Book.

The wind observations are examined in order to ascertain the method employed by each observer, to decide what correction for compass error is to be applied, and to see that the records have been consistently entered.

Finally, the "Remarks" column is to be read, and portions of its contents are to be marked for extraction.

The results of the examination are entered in the log in red ink.

When the examination is complete, the work of preparation begins. This consists in carrying out the instructions entered in red ink in the log, and is always done in pencil. It may be classified under the following heads :—

1. Interpolation of the ship's position at each hour for which the observations are extracted, and notation of the ten-degree square and one-degree subsquare to which each observation belongs.
2. Transference of the Current observations, which are given at intervals of 24 hours, to their midway position.
3. Application of instrumental corrections to each reading.
4. Correction of the observations of Wind, Sea, and Cloud motion for compass error.

When the preparation has been completed the copying into Data Books is undertaken.

The Meteorological Committee having decided in 1867 to sift the data into one-degree squares for each month, the following method was then devised for carrying out that object. Monthly books are prepared for each ten-degree square for the part of the ocean under discussion from time to time. These books are paged so as to represent the *unit* figures of the *degrees* of latitude and longitude of the position in which a given observation was taken. For instance, an observation recorded in 8° 45′ N. or S. and 0° 18′ E. or W. would be entered on page 80 of the Data Book for the month, and for the ten-degree square in which it had been taken, and 80 would be considered to be the number of the subsquare to which it belonged. The same page would receive all observations taken between 8° and 9° N. or S. lat. and between 0° and 1° E. or W. long. The same number 80 would equally represent all observations recorded between 18° and 19° lat. and 10° and 11° long., each ten-degree square having its one-degree subsquares numbered similarly, but every Data Book bears the number of the ten-degree square to which it refers.

The ten-degree squares are numbered on the following system. Square 1 commences with lat. 0° N. and longitude 0° W., and the numbering is carried on with increasing W. longitude until the circuit of the globe is completed with Square 36. The first number in the southern hemisphere is 300 and the last in the zone nearest the equator is 335.

The following diagram shows the way in which the pages in the Data Books are numbered.

All pages having a number *commencing* with the same digit have the same unit figure for their degree of *latitude*, whilst all *ending* with the same digit have the same unit figure for their degree of longitude.

By using the numbers of the subsquares in quoting extracts from a log, the locality of an observation is shown to a degree, but in the Data Book itself the minutes of latitude and longitude are given with each entry.

W. / 10 N.	Square 1. 9	8	7	6	5	4	3	2	1	0	of Greenwich. 0	1	2	3	4	5	6	7	8	9	Square 36. 10 E. / 10 N.
9	99	98	97	96	95	94	93	92	91	90	90	91	92	93	94	95	96	97	98	99	9
8	89	88	87	86	85	84	83	82	81	80	80	81	82	83	84	85	86	87	88	89	8
7	79	78	77	76	75	74	73	72	71	70	70	71	72	73	74	75	76	77	78	79	7
6	69	68	67	66	65	64	63	62	61	60	60	61	62	63	64	65	66	67	68	69	6
5	59	58	57	56	55	54	53	52	51	50	50	51	52	53	54	55	56	57	58	59	5
4	49	48	47	46	45	44	43	42	41	40	40	41	42	43	44	45	46	47	48	49	4
3	39	38	37	36	35	34	33	32	31	30	30	31	32	33	34	35	36	37	38	39	3
2	29	28	27	26	25	24	23	22	21	20	20	21	22	23	24	25	26	27	28	29	2
1	19	18	17	16	15	14	13	12	11	10	10	11	12	13	14	15	16	17	18	19	1
0	09	08	07	06	05	04	03	02	01	00	00	01	02	03	04	05	06	07	08	09	0
Equator.																					Equator.
0	09	08	07	06	05	04	03	02	01	00	00	01	02	03	04	05	06	07	08	09	0
1	19	18	17	16	15	14	13	12	11	10	10	11	12	13	14	15	16	17	18	19	1
2	29	28	27	26	25	24	23	22	21	20	20	21	22	23	24	25	26	27	28	29	2
3	39	38	37	36	35	34	33	32	31	30	30	31	32	33	34	35	36	37	38	39	3
4	49	48	47	46	45	44	43	42	41	40	40	41	42	43	44	45	46	47	48	49	4
5	59	58	57	56	55	54	53	52	51	50	50	51	52	53	54	55	56	57	58	59	5
6	69	68	67	66	65	64	63	62	61	60	60	61	62	63	64	65	66	67	68	69	6
7	79	78	77	76	75	74	73	72	71	70	70	71	72	73	74	75	76	77	78	79	7
8	89	88	87	86	85	84	83	82	81	80	80	81	82	83	84	85	86	87	88	89	8
9	99	98	97	96	95	94	93	92	91	90	90	91	92	93	94	95	96	97	98	99	9
10 S. / 10 W.	9	8	7	6	5	4	3	2	1	0	Meridian	0	1	2	3	4	5	6	7	8	9 / 10 S. / 10 E.
	Square 300.											Square 335.									

APPENDIX II.

LIST of CAPTAINS (and Officers) who have sent in Logs marked "Excellent" during the year ending March 31, 1880. 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.
Almond, Thomas Michael, F.R.A.S.	7	"Decapolis."
Barlow, Arthur Edward -	3	S.S. "Nizam."
Barron, William - -	8	S.S. "Sultan."
Bennett, Edwin Charles -	6	"Thessalus."
Beresford, Lieut. C. W. De La Poer.	1	H.M.S. "Alert."
Blackie, Alexander Hamilton, R.N.R.	4	"Melpomene."
Blake, Edwin John - -	6	"Tilkhurst."
Brown, Alfred John - -	6	"Belleisle."
Buchan, James - -	7	"Commewyne."
Caborne, Warren Frederick, F.M.S.	3	"Oakdale."
Campbell, Archibald - -	7	S.S. "Ethiopia."
Campbell, George - -	1	"Janet Cowan."
Campbell, Hugh - -	5	"Rajmahal."
Cato, William Robert - -	3	S.S. "Scotia."
Chapman, Lieut. E. P., R.N. -	1	H.M.S. "Magpie."
Chatfield, Alfred J., R.N. -	1	H.M.S. "Thunderer."
Chitham, Robert - -	3	"Torrington."
Clayton, Francis S., R.N. -	1	H.M.S. "Rifleman."
Coxwell, Charles Duncan -	2	S.S. "German."
Dobson, Charles Meadows -	7	S.S. "Sunbeam."
Dyke, Harris William - -	1	"Agnes Wilson."
East, St. James H. C., R.N. -	2	H.M.S. "Alert."
Ellery, William - -	9	"Majestic."
Emmett, Henry - -	1	"Sophia Joakim."
Frederick, Lieut. George C., R.N.	7	H.M.S. "Fawn."
Freeden, H. v.- - -	1	"W. v. Freeden."
Freeman, Thomas William -	8	S.S. "Nestor."
Grant, John F. G., R.N. -	1	H.M.S. "Malabar."
Gray, David - - -	7	S.S. "Eclipse."
Gray, John - -	6	S.S. "Hope."
Gray, John McDonald - -	10	"Shun Lee."
Gray, Samuel B. - -	2	"Letterewe."
Greig, J. G. - - -	1	"British Peer."
Heggum, Edward Carl V. -	12	"Blythswood."
Holdich, John Peach, R.N.R. -	5	"Overdale."
Hughes, W. P. - -	1	"Royal Alexandra."
Innes, George - - -	3	"Sir John Lawrence."

Captain's Name.	Number of "Excellent" Logs.	Ship.
Jackson, Staff Com. Robt., R.N.	2	H.M.S. "Thunderer."
Jones, George Henry - -	13	S.S. "Odessa."
Kidder, John - - -	2	S.S. "Fleurs Castle."
Maclear, John F. L. P., R.N. -	2	H.M.S. "Alert."
Manning, Henry - -	2	S.S. "Seine."
Mesnard, Thomas - -	2	"Mistley Hall."
Metcalfe, John - -	2	S.S. "Oceanic."
Morrish, Samuel - -	2	"Pendragon."
Murdoch, Henry - -	3	"Denbighshire."
Murdoch, Peter - -	1	"Sierra Madrona."
Napier, Richard Henry, R.N. -	10	H.M.S. "Magpie."
Nares, Sir George Strong, R.N., F.R.S.	4	H.M.S. "Alert."
Pearson, Charles William -	15	S.S. "Strathleven."
Peebles, Robert - -	4	"Otago."
Pollard, Lieut. G. N. A., R.N.	8	H.M.S. "Malabar."
Raeburn, John, R.N.R. -	3	"Lochee."
Randall, William - -	3	"Iron Cross."
Raymond, Charles Tenzer -	9	"Theophane."
Scott, William - -	5	"Alliance."
Seymour, John - -	1	S.S. "Kangaroo."
Shearer, George - -	2	"Early Morn."
Simpson, Alexander - -	10	"Traveller."
Smith, William Henry, R.N.R.	13	S.S. "Peruvian."
Stiven, John H. - -	1	"Arethusa."
Stuart, George Rennie - -	8	"Oamaru."
Stuart, W. H. - - -	8	Colonial Tender "Richmond.
Symington, William - -	16	S.S. "Hankow."
Tannock, Robert Stewart -	1	"Pomona."
*Thomson, Anthony Standidge -	3	S.S. "Elbe" and S.S. "Don."
Turner, Edward Wrake -	6	"Mertola."
Waring, William - -	4	S.S. "Gordon Castle."
Watson, William, F.M.S. -	21	S.S. "Algeria."
Wharton, William J. L., R.N.	7	H.M.S. "Fawn."
Wight, Henry Potts - -	8	"Taranaki."
Young, Thomas - -	1	"City of Agra."

* Chief Officer.

Names of Officers deceased, *in italics*.

APPENDIX III.—Ships supplied and Documents returned during the year ending 31st March 1880.

The number of merchant ships supplied with standard instruments and meteorological logs during the above period was 105.

The number of meteorological logs and documents received during the same period, and registered in the Office, amounted altogether to 249, of which 156 were returned from ships, 88 from land stations, outside the British Isles, and 5 were miscellaneous documents.

List of Documents received from Land Stations.

Place.	Observer.	No. of Documents.	Nature of Observations.
Abaco (Bahamas) - - -	Thomas Ap Rees, Lightkeeper.	1	"Lighthouse" Register, January to June 1879.
Barbados (Bridgetown) - -	——	2	" " March to December 1879.
" (Commercial Hall) -	T. L. Ince - - -	2	" " January to December 1879.
" (Joe's River House) -	R.B.Walcott,M.D.,F.R.C.S.E.	2	" " " " "
Bermuda - - - - -	Sergt. A. G. Evans - -	7	Anemograms, May 1879 to February 1880.
Beyrout (Lee Observatory) - -	Rev.C.V.Van Dyck,D.D.,M.D.	12	Two observations daily, March 1879 to February 1880.
Breaksea Island (King George's Sound).	G. Turner, Lightkeeper -	3	"Lighthouse" Register, July 1878 to December 1879.
Cape of Good Hope (Royal Observatory).	——	1	Extracts of observations between 1856 and 1878.
Cape Pembroke (Falkland Islands)	G. K. Broom, Lightkeeper -	2	"Lighthouse" Register, July 1878 to June 1879.
Cay Lobos (Bahamas) -	G. L. Nairn, " -	2	" " October 1878 to June 1879.
Cay Sul (Bahamas) - - -	H. J. Fountain and J. G. Mama, Lightkeepers.	1	" " January to June 1879.

LIST of DOCUMENTS—*continued.*

Place.	Observer.	No. of Documents.	Nature of Observations.
Fort Chipewyan (Lake Athabasca)	—	1	Meteorological Register, March and April 1844.
Frances Lake (McKenzie's River)	—	1	„ „ November 1844 to March 1846.
Gibraltar	Sergeant W. Allen, A.H.C., and Corp.S.Cordue,A.H.C.	12	Two observations daily and monthly means, March 1879 to February 1880.
Heligoland	Lightkeepers	12	Eight observations daily, March 1879 to February 1880.
Kerguelen	Rev. S. J. Perry, S.J., F.R.S.	1	Meteorological tables, November 1874 to February 1875.
Manitoba	R. Bourne, M.A.	3	Two observations daily, July 1878 to September 1879.
Norfolk Island	T. Rossiter	9	„ „ „ December 1878 to December 1879.
Point King (King George's Sound, W. Australia.)	S. Mitchell, Lightkeeper	1	"Lighthouse" Register, July to December 1878.
Red River Settlement (Hudson's Bay).	—	1	Meteorological Register, January to May 1845.
Sao Paulo (Brazil)	H. B. Joyner	11	Two observations daily, February 1879 to January 1880.
Sombrero	J. A. Richardson, Lightkeeper	1	"Lighthouse" Register, June to November 1879.
		88	

List of Documents received from Ships.

Captain's Name.	Ship.	Tons.	Owners.	Voyage.	Months of Register.
Almond, T. M., F.R.A.S.	Decapolis - -	632	T. B. Walker, London - -	Brisbane - - - -	8
[1] Balderston, R. J. -	Tenasserim - -	1,419	T. & R. Brocklebank, Liverpool -	Calcutta - - - -	8
Balkwill, W. H. -	Endymion -	251	R. C. Balkwill, West Alvington, Devon.	To Maranham, Mobile, and home -	4
[2] Barlow, A. E. -	S.S. Nizam - -	2,725	The P. & O. Steam Navigation Co., London.	Bombay and China, viâ Suez - -	4
[3] " " -	" - -	"	" " -	Calcutta and Bombay, viâ Suez -	3
Barron, William -	S.S. Sultan - -	1,025	W. Liddell, Hull - -	Between Hull and Hamburg - -	4
" " -	" - -	"	" " - -	" " - -	4
" " -	" - -	"	" " - -	" " - -	4
Becket, Alexander -	Amana - -	1,299	J. Smith, Glasgow - -	To Melbourne, Newcastle (N. S. W.), Negapatam, Bassein, and home -	9
Bennett, E. C. -	Thessalus - -	1,782	J. H. Carmichael, Greenock -	Calcutta - - - -	7
[4] Berridge, H. -	Superb - -	1,451	H. Green, London - -	Melbourne - - - -	6
Blackie, A. H., R.N.R.	Melpomene - -	1,439	H. Fernie, Jun., Liverpool -	To Rangoon - - -	4
Blacklin, R. J. -	S.S. Wyberton -	1,314	Commercial S.S. Co., London -	Batavia, viâ Suez, two voyages -	5
Blake, E. J. - -	Tilkhurst - -	1,527	W. R. Price, London - -	To Bombay, Calcutta, and home -	9
[5] Borges, Bernhard -	S.S. Amanda - -	1,809	O. Trechmann, West Hartlepool	Bombay, viâ Suez - - -	3
Bourke, E. G., R.N.	Gannet - -	1,124	H.M.S. - - - -	To Rio Janeiro, Valparaiso, Callao, and Arica (Peru) - - -	7
Bristow, R. J. W. -	S.S. Otranto - -	1,887	C. H. Wilson, Hull - -	New York, four voyages -	4
	S.S. Sorrento - -	1,778			
Brown, A. J. -	Belleisle - -	388	J. Anderson, London - -	Jamaica - - - -	3
" "	" - -	"	" " - -	" - - - -	3
[6] Browse, Frederick -	Charles Cotesworth -	1,031	J. Lyne, Liverpool - -	From Lat. 27° S., Long. 40° W., to San Francisco and home - - -	6

List of Documents, &c.—*continued.*

	Captain's Name.	Ship.	Tons.	Owners.	Voyage.	Months of Register.
7	Buchan, James -	Commewyne - -	315	J. Grierson, Glasgow -	Surinam - - - -	3
	,, ,, -	,, - -	,,	,, ,, - -	,, - - - -	3
	,, ,, -	,, - -	,,	,, ,, - -	,, - - - -	3
8	Burton, —— -	Loch Katrine - -	1,200	J. P. Kidston, Glasgow - -	From Melbourne - - -	4
	Caborne, W. F., R.N.R., F.M.S.	S.S. Oakdale - -	1,408	W. Young, London - -	To Point de Galle, Rangoon, and back, viâ Suez. One voyage to Cronstadt	3
	Campbell, Archibald	S.S. Ethiopia - -	4,005	Barrow S.S. Co., Lim., Barrow -	New York, five voyages - -	4
	Campbell, George -	Janet Cowan - -	1,278	R. Shankland, Greenock - -	To Bombay, Bassein, and home -	8
	Campbell, Hugh -	Rajmahal - -	1,302	J. Brocklebank, Liverpool -	Calcutta - - - -	7
	Campbell, James -	Hope - - -	250	T. W. Karren, Castletown - -	West Coast of Africa - - -	5
9	Cato, W. R. - -	S.S. Scotia - - -	2,031	Telegraph Construction and Maintenance Co., Lim., London.	Singapore - - - -	3
10	,, ,, - -	,, - - -	,,	,, ,, ,,	To Aden, Zanzibar, and home, viâ Suez	4
11	Chatfield, A. J., R.N.	Thunderer - -	9,190	H.M.S. - - - -	To Malta and Artaki Bay - -	4
11	,, ,, ,,	,, - -	,,	,, - - - -	At Malta - - - -	4
	Chitham, Robert -	S.S. Terrington -	1,946	Commercial S.S. Co., London -	To Batavia, Marseilles, and Rotterdam, viâ Suez - - - -	3
	,, ,, -	,, - -	,,	,, ,, ,,	To Batavia and Rotterdam, viâ Suez -	3
	,, ,, -	,, - -	,,	,, ,, ,,	To Padang, Batavia, and Rotterdam, viâ Suez - - - -	3
	Clayton, F. S., R.N.	Rifleman - -	592	H.M.S. - - - -	In Mozambique Channel - -	4
	Collins, H. - -	Bowfell - -	1,002	R. Brocklebank, Liverpool -	To Lat. 39° S. Long. 92° E. - -	3
12	Coxwell, C. D. -	S.S. German	3,028	Union S.S. Co., Lim., Southampton	Natal - - - - -	2
13	,, ,, -	,,	,,	,, ,, ,, -	Cape Town and Natal - - -	4
13	,, ,, -	,,	,,	,, ,, ,, -	Cape Town - - - -	3
13	,, ,, -	,,	,,	,, ,, ,, -	Cape Town and Algoa Bay - -	3
	Crowell, S. O. -	S.S. Alpha - -	653	W. Cunard, Halifax, N.S. -	Two voyages between Halifax and St. Thomas, viâ Bermuda - -	1

List of Documents, &c.—*continued.*

Captain's Name.	Ship.	Tons.	Owners.	Voyage.	Months of Register.
Crutchley, W. C., R.N.R.	S.S. African - -	2,019	Union S.S. Co., Lim., Southampton	To and from Natal, and one voyage between Natal and Zanzibar - -	5
" "	" - -	"	" " "	To Cape Town, &c., Zanzibar, back to Cape Town, &c. and home - -	4
Dart, C. - -	Fylde - - -	365	Fylde Shipping Co., Lim., Blackpool.	To Havana, Philadelphia, Oporto, and Baltimore - - - -	4
Davidson, C. W. -	Brilliant - -	1,613	J. Duthie, Aberdeen - -	Sydney - - - - -	6
[14] Dobson, C. M. -	S.S. Sunbeam -	1,784	W. E. Woolf, Hull - -	From Constantinople to Marseilles, Port Said, Odessa, and home; also to Penang, Singapore, Hong Kong, Yokohama, Shanghai, and Gibraltar, viâ Suez, thence to New York and home -	7
Douglas, George -	Rozelle - -	1,286	R. Cuthbert, Greenock - -	From Calcutta - - - -	4
Dow, John - -	Dunselaw - -	1,297	W. Wood, Liverpool - -	To Madras, Diamond Island, Callao, Huanillos, and home - -	13
Draper, H. E. -	S.S. Danube - -	2,039	Union S.S. Co., Lim., Southampton	To Cape Town, Zanzibar, back to Cape Town, and home - - -	4
Dyke, H. W. -	Agnes Wilson - -	349	J. Pritchard, Liverpool - -	To Rio Janeiro, St. Thomas, Belize, and home - - - -	6
Ellery, William -	Majestic - -	1,884	T. & R. Brocklebank, Liverpool -	Calcutta - - - -	7
Emmett, Henry -	Sophia Joakim -	1,007	P. Bennett, London - -	To Gulf of Bothnia, Adelaide, and Tamatave (Madagascar) - -	7
Fleck, Robert -	Bonnie Dundee -	1,027	H. Ewing, Catrine, Ayrshire -	To Rio Janeiro and Pensacola - -	4
Fox, H. L. - -	Fedalma - -	478	T. Scrutton, London - -	Trinidad - - - -	2
" " -	" "	"	" " - -	Demerara - - - -	4
[15] Franklin, E.B.H., R.N.	Conway - -	—	School Frigate - - -	Off Birkenhead - - -	4
Freeden, H. v. -	W. v. Freeden -	330	—	St. Croix, W. Indies - - -	3
Freeman, T. W. -	S.S. Nestor - -	1,869	Ocean S.S. Co., Liverpool -	Shanghai, viâ Suez, and Amsterdam -	5

LIST of DOCUMENTS, &c.—*continued.*

Captain's Name.	Ship.	Tons.	Owners.	Voyage.	Months of Register.
Fursman, N. P.	Stuart	881	J. Hay, Liverpool	To Port Augusta (S. Australia), San Francisco, and home	12
Garden, J. J.	Northern Monarch	1,230	R. Exchange Shipping Co., Lim., London.	Voyage to Madras, Natal, back to Madras, Bimlipitam, and thence to Lat. 20° N., Long. 32° W.	8
[16] Glazebrook, Thomas	Alastor	824	R. H. Penney, Southwick, Sussex	Auckland (N. Z.)	7
[17] Grant, J. F. G., R.N.	Malabar	6,211	H.M.S.	Bombay, viâ Suez	3
Gray, David	S.S. Eclipse	435	D. Gray, Peterhead	Greenland	5
Gray, John	S.S. Hope	452	R. Kidd, Peterhead	"	5
Gray, J. McD.	Shun Lee	669	J. Graham, Whitehaven	To Algoa Bay, Valparaiso, and home	8
Gray, S. B.	Letterewe	798	D. Irwin, Liverpool	To Sydney, San Francisco, and home	10
Greig, J. G.	British Peer	1,428	The British Shipowners Co., Lim., Liverpool	Calcutta	8
Grey, Charles, R.N.R.	Southesk	1,154	D. Bruce, Dundee	From Calcutta, one voyage; and one from Newcastle (N.S.W.) to Galle	6
Heggum, E. C. W.	Blythswood	1,607	R. Cuthbert, Greenock	Calcutta	8
Heggum, Waldemar	Rozelle	1,286	" "	To Calcutta	3
Holdich, J.P., R.N.R.	Overdale	882	J. Hay, Liverpool	To Adelaide, Newcastle (N.S.W.), Yokohama, Manila, and home	9
Hughes, W. P.	Royal Alexandra	1,332	H. Fernie, Liverpool	To Calcutta, New York, and home	8
Innes, George	Sir John Lawrence	879	W. Rose, Aberdeen	Melbourne	7
Johnson, Charles	St. Lawrence	1,073	G. Luckley, Newcastle	To Sydney, San Francisco, and Adelaide	8
Jones, G. H.	S.S. Odessa	1,079	C. M. Norwood, London	To Poti and Antwerp; Cronstadt and Antwerp; and Cronstadt and Dunkerque	4
Jones, S. G.	Victoria Nyanza	1,022	T. H. Jackson, Liverpool	San Francisco	9

LIST of DOCUMENTS, &c.—*continued.*

	Captain's Name.	Ship.	Tons.	Owners.	Voyage.	Months of Register.
	Kidder, John -	S.S. Fleurs Castle -	2,472	T. Skinner, Glasgow - -	China, viâ Suez - - -	4
	Legg, William -	Star of Greece	1,227	J. Corry, Croydon - -	Calcutta - - -	7
18	Leigh, R. A. -	S.S. Teuton - -	2,309	Union S.S. Co., Lim., Southampton	Cape of Good Hope - - -	2
18	" " -	" - -	"	" " "	" " - - -	2
19	Macaulay, R. H. -	S.S. Arno - -	1,038	Royal Mail Steam Packet Co., London.	Cruising in West Indies - -	15 days.
20	Maclear, J. F. L. P., R.N.	Alert - - -	1,331	H.M.S. - - - -	At Coquimbo, Valparaiso, and Talcahuano - - - -	4
21	" "	" - - -	"	" - - - -	Surveying in the Patagonian Channel and Straits of Magellan - -	4
22	Manning, Henry -	S.S. Seine - -	3,579	Telegraph Construction and Maintenance Co., Lim., London.	Mozambique and Delagoa Bay, viâ Suez	5
	McGregor, William -	Shakespeare - -	1,757	W. Adamson, Sunderland -	To Bombay - - - -	4
	McKenzie, Allan -	Candahar - -	1,418	R. Brocklebank, Liverpool -	Calcutta - - - -	8
	McMoutrey, W. R. -	S.S. Wyberton -	1,314	Commercial S.S. Co., London -	Batavia, viâ Suez - - -	3
23	" " -	" - -	"	" " " -	" " - - - -	3
24	" " -	" - -	"	" " " -	" " - - - -	3
	Mesnard, Thomas -	Mistley Hall - -	1,772	W. Herron, Liverpool - -	To Melbourne, Calcutta, New York, and home - - - -	9
	Metcalfe, John -	S.S. Oceanic - -	3,707	The Oceanic Steam Navigation Co., Lim., Liverpool.	Two voyages between Hong Kong and San Francisco, viâ Yokohama, and one between Hong Kong and Yokohama - - - -	4
	" " -	" - -	"	" " " "	Two voyages between Hong Kong and San Francisco, viâ Yokohama; one from Yokohama to San Francisco and back, thence to Hong Kong, Singapore, and home - - -	6

LIST of DOCUMENTS, &c.—*continued.*

Captain's Name.	Ship.	Tons.	Owners.	Voyage.	Months of Register.
Milne, Richard	Nebo	1,383	J. Smith, Glasgow	Bassein	8
Morrish, Samuel	Pendragon	1,278	J. E. Greenshields, Liverpool	Java	7
Murdoch, Henry	Denbighshire	1,367	C. Pierce, Bangor	To Otago, San Francisco, and home	8
Murdoch, Peter	Sierra Madrona	1,430	A. M. Anderson, Liverpool	To Bombay, Chittagong, and home	8
Murray, Alexander	S.S. Windward	321	W. Baxter, Peterhead	Greenland	6
[25] Napier, R. H., R.N.	Magpie	774	H.M.S.	In China Seas	4
" "	"	"	"	" "	4
[30] Nares, Sir G.S., K.C.B.	Alert	1,331	"	To Montevideo, Falkland Islands, and Coquimbo; and surveying on W. Coast of S. America	8
Newell, Frederick	S.S. Abana	2,277	J. M. Wood, Liverpool	To Genoa, New Orleans, Havre, and home	2
Nicholson Malcolm	John Rennie	848	J. L. Devitt, London	Adelaide	6
Parry, Moses	Queen of Cambria	865	W. Thomas, Nevin, Carnarvon	To Melbourne, Newcastle (N.S.W.), and towards Bombay	4
[26] Parry, W. E., R.N., F.R.S.	Hecla	—	H.M.S.	To Melville Island	4
[27] Parson, G. F.	Astarte	910	J. Shepherd, London	Mauritius	6
Patterson, J. E. C.	Kingston	1,208	P. Douglas, Liverpool	To Singapore	4
[28] Pearson, C. W.	S.S. Strathleven	2,436	W. Burrell, Glasgow	Bombay, viâ Suez	3
[28] " "	"	"	" "	To and from Newfoundland; to Sydney, Melbourne, and home	5
Peebles, Robert	Otago	993	Albion Shipping Co., Glasgow	Otago	6
[29] Peel, W., R.N.	Shannon	—	H.M.S.	From Lat. 34° S., Long. 19° E. to Singapore, Hong Kong, and thence to Lat. 13° N., Long. 90° E.	2

LIST of DOCUMENTS, &c.—*continued.*

Captain's Name.	Ship.	Tons.	Owners.	Voyage.	Months of Register.
Pepper, George -	S.S. Tasso - -	608	A. Wilson, Hull - - -	Between Hull and Drontheim - -	1
30 Perriam, J. -	Wave Queen - -	853	J. Park, London - - -	To Wellington (N.Z.) - -	4
Povah, John -	Star of Devon -	340	J. J. Holdsworth, London -	From Lat. 37° N., Long. 14° W. to Santos (Brazil) - - -	2
Raeburn, John, R.N.R.	Lochee - -	1,728	D. Bruce, Dundee - -	Calcutta - - - -	7
Randall William -	Iron Cross - -	1,508	H. Fernie, Liverpool - -	To Calcutta, New York, and home -	7
,, ,, -	,, - -	,,	,, ,, -	New Orleans - - - -	3
Raymond, C. T. -	Theophane - -	1,525	J. M. Heap, Liverpool - -	To Melbourne, and from Madras to Rangoon and home - - -	7
Reed, F. P., R.N.R.	Oithona - -	1,342	J. H. Worthington, Liverpool -	To Lat. 21° N., Long. 24° W. - -	18 days.
Riddell, Francis -	Zuleika - -	1,092	J. A. Simpson, Leith - -	To Point de Galle, Calcutta, and home -	9
Robinson, Thomas -	Burdwan - -	803	T. & R. Brocklebank, Liverpool -	Singapore - - - -	6
Scott, William -	Alliance - -	300	J. Grierson, Glasgow - -	Surinam - - - -	3
,, ,, -	,, - -	,,	,, ,, - -	,, - - - -	4
Seymour, John	S.S. Kangaroo -	1,773	Telegraph Construction and Maintenance Co., Lim., London.	To Natal, Zanzibar, and home, viâ Suez	5
Shaw, Gilbert -	S.S. Beta - -	1,087	W. Cunard, London - -	Five voyages between Halifax and St. Thomas, viâ Bermuda - -	3
Shearer, George -	Early Morn - -	1,057	P. Bicknell, London - -	To Negapatam, and home from Rangoon. Also one voyage between Negapatam and Rangoon, and one between Negapatam and Akyab - - -	10
Simpson, Alexander-	Traveller - -	196	A. Simpson, Peterhead - -	To Ivigtut, thence to and from Philadelphia, back to Philadelphia, and home	7
15 Smith, J. H., R.N.R.	Worcester - -	—	Training Ship - - -	Off Greenhithe - - - -	4
31 ,, W. H., R.N.R.	S.S. Peruvian -	3,038	R. G. Allan, Liverpool - -	Quebec, three voyages; three to, and two from, Baltimore, viâ Halifax -	4
,, ,,	,, - -	,,	,, ,, -	Quebec, five voyages; Baltimore, viâ Halifax, one - - -	4

LIST OF DOCUMENTS, &c.—*continued.*

	Captain's Name.	Ship.	Tons.	Owners.	Voyage.	Months of Register.
	Stiven, H.	Arethusa	1,272	J. Hamilton, Liverpool	Lyttelton (N.Z.)	7
	Stuart, G. R.	Oamaru	1,306	Albion Shipping Co., Lim., Glasgow.	Otago	6
	„ W. H.	Richmond	183	Board of Trade, London	At the Bahamas	12
	„ „	„	„	„ „ „	„ „	4
	Swan, David	Devonshire	1,519	A. Mitchell, Glasgow	Calcutta	7
29	Swan, John	City of Madrid	1,191	G. Smith, Glasgow	To Adelaide, Newcastle, San Francisco, and towards home, as far as Lat. 20° N., Long. 42° W.	8
	Symington, William	S.S. Hankow	3,594	W. Milburn, Newcastle-on-Tyne	Singapore and China, viâ Suez	4
	„ „	„	„	„ „ „	To Australia, viâ Cape of Good Hope, and home, viâ Suez	4
	Thorne, J. W.	British Commodore	1,390	British Shipowners Co., Lim., Liverpool.	Philadelphia	2
	Turner, E. W	Mertola	392	F. T. Barry, London	Pomeron, three voyages	3
	„ „	„	„	„ „	„ „	4
30	Wait, A. McL.	S.S. American	2,485	Union S.S. Co., Lim., Southampton	Cape Town	2
31	„	„	„	„ „ „	„	2
35	„	„	„	„ „ „	„	2
27	Waring, William	S.S. Gordon Castle	2,031	T. Skinner, London	To China, Japan, and back to Gibraltar, viâ Suez, thence to New York, and home	6
	Watson, William, F.R.G.S., F.M.S.	S.S. Algeria	3,428	Cunard S.S. Co., Lim., Liverpool	New York, five voyages	4
	Wayman, Henry	Drumelog	977	W. Hamilton, Glasgow	To Hong Kong, Singapore, Penang, Rangoon, and Bremerhaven	11
	Westergard, J. E. F.	Ferdinand	—	—	Extract from log during voyage from Bangkok to Hong Kong	15 days.

List of Documents, &c.—*continued.*

Captain's Name.	Ship.	Tons.	Owners.	Voyage.	Months of Register.
[36] Wharton, W. J. L., R.N.	Fawn - - -	1,045	H.M.S. - - - -	In Sea of Marmora and at Malta -	3
[36] " " "	" - - -	"	" - - - -	In Sea of Marmora - - -	4
Wight, H. P. -	Taranaki - -	1,126	J. Galbraith, Glasgow - -	New Zealand - - - -	5
Williams, H. H. -	Harvest Home -	547	W. Just, Liverpool - -	Port Victoria (S. Australia) - -	8
Wright Samuel -	Atmosphere - -	1,378	T. A. DeWolf, Halifax, N.S. -	From Hamburg to New York and back to Bremerhaven - -	2
[37] Young, Thomas -	City of Agra - -	1,074	W. B. McGavin, London -	Melbourne - - - -	6

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

[1] Assisted by Messrs. Blower and Janvrier.
[2] Kept by J. R. Lendon, 3rd Officer.
[3] Kept by J. R. Lendon and E. H. Gordon.
[4] Kept by D. W. Barker, 3rd Officer.
[5] Kept by the 1st and 2nd Officers.
[6] Assisted by Chief Officer.
[7] Assisted by J. Lang, Chief Officer.
[8] Kept by R. Wright, a passenger.
[9] Kept by R. A. Allen.
[10] Kept by T. Wickenden.
[11] Kept by Staff-Commander Robert Jackson, R.N.
[12] Kept by F. K. Thimm, 2nd Officer.
[13] Kept by Richard Ladd.
[14] Assisted by H. L. Bone, Chief Officer.
[15] Kept by the Boys.
[16] Assisted by J. Hutchison and A. J. Swann, 1st and 2nd Officers.
[17] Kept by Lieut. George N. A. Pollard, R.N.
[18] Kept by C. H. Bond, 2nd Officer.
[19] Kept by Anthony S. Thomson, Chief Officer.
[20] Kept by Sub-Lieutenant J. H. C. East, R.N.
[21] Kept by Sub-Lieutenant C. W. de la P. Beresford, R.N.
[22] Kept by William Symes, 2nd Officer.
[23] Kept by G. N. Guthrie, Chief Officer.
[24] Kept by R. B. Holland.
[25] Kept by Lieutenant E. P. Chapman, R.N.
[26] Kept by Captain E. Sabine, R.A.
[27] Assisted by Officers.
[28] Assisted by J. Kirkpatrick, 2nd Officer.
[29] Kept by G. A. Waters, Master.
[30] Kept by W. R. Symons.
[31] Kept by W. Roberts, 3rd Officer, and J. Powell, 4th Officer.
[32] Kept by H. G. Story, 3rd Officer.
[33] Kept by Campbell M. W. Hepworth, Chief Officer.
[34] Kept by Campbell M. W. Hepworth, Chief Officer, and Rupert Archibald, 4th Officer.
[35] Kept by C. M. W. Hepworth, Chief Officer, and B. H. Dunn, 4th Officer.
[36] Kept by Lieutenant G. C. Frederick, R.N.
[37] Assisted by W. P. Reade, 2nd Officer.

Miscellaneous Documents.

Sea Temperature Observations recorded by Captain W. Watson, F.R.G.S., F.M.S., during two voyages to and from New York in December 1877 and December 1878.

Comparison of Observations recorded by three Anemometers (Cup, Magnetic, and Hagemann's) on board the S.S. "Algeria," from April 16 to December 5, 1879, by Captain W. Watson.

Extracts from Ships' Logs relating to a Cyclone on the N.W. Coast of Australia, from 27th February to 1st March 1878, by Captain A. Schück.

Extracts from Logs and Chart relating to a Cyclone near the Lacepede Islands in December 1878, by Richard Wynne.

Sea Temperature Observations taken at various Lightships on the Coast of the British Isles during the years 1875–9.

APPENDIX IV.

INSTRUMENTS supplied, &c. to the Royal Navy.

Per Account.	Barometers.	Aneroids.	Thermometers.				Hydrometers.
			Ordinary.	Max.	Min.	Screens.	
April 1st, 1879, afloat	203	401	1,061	158	154	72	134
Issued since	58	94	292	30	28	18	48
	261	495	1,353	188	182	90	182
Returned since	68	89	330	37	42	14	45
April 1st, 1880, afloat	193	406	1,023	151	140	76	137

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

April 1st, 1879, in use	51	102	81	20	14	7	11
Issued since	36	22	182	15	29	—	5
	87	124	263	35	43	7	16
Returned since	10	9	43	12	9	2	—
April 1st, 1880, in use	77	115	220	23	34	5	16

DISPOSITION of ADMIRALTY INSTRUMENTS on April 1st, 1880.

Afloat in Royal Navy	193	406	1,023	151	140	76	137
In use at stations	77	115	220	23	34	5	16
In store at M.O.	115	58	69	87	96	30	82
,, Chatham	10	11	53	8	10	3	8
,, Sheerness	3	6	23	8	6	8	19
,, Portsmouth	6	6	24	3	6	11	22
,, Devonport	1	3	5	2	2	—	20
,, Queenstown	2	2	4	1	1	—	8
,, Gibraltar	1	1	5	—	—	—	4
,, Malta	7	10	29	—	—	4	20
,, Halifax	1	8	26	2	5	—	12
,, Bermuda	2	3	9	4	6	—	15
,, Jamaica	2	4	5	2	3	—	8
,, Cape of Good Hope	4	6	39	9	7	—	31
,, Trincomalee	3	2	4	—	—	—	—
,, Hong Kong	10	8	22	6	7	1	14
,, Coquimbo	6	6	33	4	3	—	23
,, Sydney	4	6	16	2	2	—	—
,, Esquimalt	3	4	2	—	—	—	8
Under repair	9	13	—	—	—	—	—
Total, April 1st, 1880	457	678	1,611	312	328	138	447
Lost, &c. since April 1st, 1879.	1	2	255	17	28	8	13

APPENDIX V.

INSTRUMENTS supplied, &c. to Mercantile Marine.

Per Account.	Barometers.	Compasses.	Thermometers.				Hydrometers.
			Ordinary.	Max.	Min.	Screens.	
April 1st, 1879, afloat	117	1	713	—	7	118	460
Issued since	101	—	627	—	7	98	387
	218	1	1,340	—	—	216	847
Returned since	93	1	606	—	—	86	369
April 1st, 1880, afloat	125	—	734	—	—	130	478

INSTRUMENTS at Stations, viz., Telegraph Offices, Observatories, Navigation Schools, &c.

April 1st, 1879, in use	91	2	220	53	54	41	42
Issued since	18	—	39	11	9	7	4
	109	2	259	64	63	48	46
Returned since	23	—	26	11	11	12	—
April 1st, 1880, in use	86	2	233	53	52	36	46

DISPOSITION of Board of Trade Instruments.

In merchant ships	125	—	734	—	—	130	478
In use at stations	86	2	233	53	52	36	46
In store at M.O.	58	46	145	4	52	20	126
At Liverpool agency	9	8	51	—	—	19	50
„ Aberdeen „	4	—	16	—	—	1	20
„ Glasgow „	5	—	43	—	—	4	21
„ Dundee „	4	—	29	—	1	5	11
„ Hull „	4	—	18	—	—	4	11
„ Southampton* „	6	—	30	—	—	5	22
„ Cardiff „	8	—	24	—	—	5	20
Total, April 1st, 1880	309	56	1,323	57	105	229	805
Lost, &c. since April 1st, 1879	4	—	178	3	8	24	54

* No return since June 30th, 1879.

APPENDIX VI.

List of Stations reporting Meteorological Observations by Telegraph to the Office, with the Names of Observers.

Sumburgh Head	Rev. W. Brand	Minister of Dunrossness.
†*Stornoway	J. Sutherland	Schoolmaster.
Wick	J. Sinclair	Watchmaker.
Nairn	W. D. Penny	Schoolmaster.
†*Aberdeen	J. McCormack	Telegraph Clerk.
Leith	J. Turnbull (1)	Do.
†*Shields	J. Irvine	Do.
Scarborough	F. Shaw, F.M.S.	Do. (2)
Spurn Head	J. Sibert	Assistant Lightkeeper.(3)
York	Dr. Purves	Museum.
Nottingham	E. J. Lowe, F.R.S.	Highfield House Observatory.
†*Ardrossan	W. McNeil (4)	Telegraph Clerk.
†*Mullaghmore	K. Kerr	Coastguard Officer.
Donaghadee	J. MacGowan, jr.	Telegraph Clerk.
Kingstown	G. Mitchell	Keeper of Sailors' Home.(5)
Parsonstown	W. Harding	Assistant Observer at Lord Rosse's Observatory. (6)
†*Holyhead	J. Tilston	Keeper of Sailors' Home.
Liverpool	J. Hartnup, junr.	Bidston Observatory.
†*Valencia	J. E. Cullum	Superintendent of the Observatory.
Roche's Point	W. Kennedy	Telegraph Clerk.
Pembroke	J. C. Walker	Do.
†*Scilly	W. Thomas	Signalman.
Prawle Point	W. Blackler	Coastguard Officer.
†Hurst Castle	T. Lanceley	Lightkeeper. (7)
Jersey	J. Fisher	Signalman.
Dover	J. Costello	Telegraph Clerk.
†*London	F. Gaster, F.M.S.	
Oxford	H. E. Bellamy	Radcliffe Observatory.
Cambridge	H. Todd	Observatory.
†*Yarmouth	G. T. Watson	Secretary, Sailors' Home.
†Hawes Junction	G. Wooding	Station Master. (8)

Note.—Those stations marked with an asterisk (*) report also at 0h. 45m. p.m. (in lieu of 2 p.m.); and those with a dagger (†) at 6 p.m.

(1) Died on 5th March 1880; succeeded by Mr. Hutchison. (2) Ceased reporting on June 30, 1879. (3) Spurn Head began reporting on June 1, 1879. (4) Mr. McNeil resigned in July 1879, and was succeeded by Mr. Carrick, telegraph clerk. (5) Ceased reporting January 1880. (6) Commenced reporting January 1880. (7) Mr. Lanceley resigned in December 1879, and was succeeded by Mr. G. G. Appleton, the new lightkeeper at Hurst. (8) High Level Station, 1,135 feet above the sea; began reporting at the end of January 1880.

It will be seen from the above list that the stations have been re-organised. Spurn Head is now working in lieu of Scarborough, which was too much sheltered from northerly, westerly, and southerly winds. Kingstown has ceased reporting, and in lieu thereof a station has been established at Birr Castle, the inland parts of Ireland not having been represented previously.

Summary of Stations in the British Islands reporting at the Close of the Financial year.

England and Wales (with Jersey)	17
Scotland	7
Ireland	5

Arrangements have been made for the establishment of a new station at Barrow-in-Furness. The whole cost of this will be borne by the Barrow-in-Furness Railway Company. The station commenced reporting on April 1, 1880.

The Foreign stations are 23 in number; viz., in SWEDEN and NORWAY, Haparanda, Hernösand, Stockholm, Wisby, Bodö, Christiansund†, Skudenaes*† and Oxö; in DENMARK, the Scaw† and Fanö; in N. GERMANY, Cuxhaven; in HOLLAND, the Helder; in BELGIUM, Brussels; and in FRANCE, Cape Gris Nez, Brest (St. Mathieu), Lorient (Grognon), Rochefort*† (Ile d'Aix), Biarritz, Toulon (Cape Sicié), Charleville, Paris, and Lyons; in SPAIN, Corunna.

It will be observed that one station (Bodö) has been added to this list during the year, and that Christiansund, Skudenaes, the Scaw, and Rochefort now send reports at 6 p.m. daily as well as at 8 a.m.

During the autumn of 1879 reports were received daily from four Swiss stations, as an experiment; and for similar reason, a 6 p.m. report was received for a short time from Paris. For various reasons, however, this service was abandoned, and the present system adopted in its place.

APPENDIX VII.

METHOD of DEALING with TELEGRAPHIC WEATHER INTELLIGENCE.

The principal operations connected with the preparation and issue of the Daily Weather Report and of Storm Warnings are as follow:—

The Office receives, when the telegraphic communications are perfect, fifty-two reports every morning, fifteen every afternoon (except on Sundays), and nineteen each evening. From this it will be evident that the afternoon and evening reports are now more numerous than at the time of the last Report. This increase has been made in order to render the daily forecasts more reliable. The reason of the suspension of the afternoon reports on Sundays is that almost all the telegraphic circuits are closed at the hour at which the messages would be transmitted.

The foreign reporting stations, 23 in number, extend along the entire western coast of the Continent, from Christiansund in lat. 63° N. to Corunna in lat. 43° N., and include four stations on the coast of the Baltic, and one in the Mediterranean. The information is received in accordance with various arrangements made with the Meteorological organisations in France, Holland, Germany, Denmark, Norway, and Sweden.

At the British 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 Office by its private wire, where the majority of them usually arrive between 9 a.m. and 10 a.m.

As fast as the reports come in the information is entered on a chart, which shows 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. From this chart, which is preserved in the Office, other charts are then drawn for publication in the newspapers, as described further on.

If necessary, telegraphic intelligence of storms or of atmospherical disturbance is immediately sent to our own coasts and to foreign countries. A brief telegraphic *resumé* of the weather is despatched shortly after 11 a.m. to the Harbour Authorities in Jersey and also to the Marine Ministry in Paris, by which department it is afterwards transmitted to Florence for the benefit of the Italian Naval Service. 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 for despatch to the provinces. The last of these messages consists of a brief statement of the general condition of the weather in Western Europe, as shown by the reports for the morning.

It is, however, not only at 11 a.m. that storm warnings are issued to the coasts, for a constant watch is 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.

Since April 1st, 1879, there have been prepared each morning, afternoon, and evening, Forecasts of the weather, for one day in advance; these are drawn up for eleven districts in the British Islands, and are issued to subscribers, to certain Clubs, and to many of the London and Provincial newspapers in accordance with the arrangements referred to on p. 81 of this appendix. The districts for which the Forecasts are prepared are those into which the returns for the Weekly Weather Report are divided (*see* p. 99), with the addition of Scotland, N., viz. :—

0. Scotland, N.
1. ,, E.
2. England, N.E.
3. ,, E.
4. Midland Counties.
5. England, S.
6. Scotland, W.
7. England, N.W. (with N. Wales).
8. England, S.W. (with S. Wales).
9. Ireland, N.
10. ,, S.

The demand for these Forecasts is considerable, as will be seen further on, and efforts are being made to increase their accuracy.

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 Forecasts for the London newspapers, so that the MS. copies for the "Times" and other papers are ready for issue soon after 11 a.m.

The Charts prepared daily for newspaper publication are as follows :—

For the "Times," - -	two daily, viz. :	for 8 a.m. and 6 p.m.
For the "Shipping Gazette"	one ,,	for 8 a.m.
For the Patent Type-founding Company, to be distributed to the provincial press - - -	one ,,	for 8 a.m.

The first and second of these charts are sent out at about 10.15 a.m. : third at 11.30 a.m.

The draft of the Daily Weather Report, which is issued as a separate sheet, with four charts attached, is drawn on transfer paper and is ready by noon, when it is at once sent to the lithographer to be printed. The copies for delivery by hand in London are issued by the lithographer 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.

In addition to the charts referred to above, 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 "Observer," "Graphic," "Lloyd's Weekly London Newspaper," and the "Agricultural Gazette," and *monthly* for the "Miller." They are all accompanied by remarks on the phenomena exhibited.

At about 2 p.m. the observations taken at thirteen home stations at 0h. 45m. p.m. are received, and those for two foreign stations (Skudenaes and Rochefort), come in soon after. Copies of these reports are

issued, together with the 8 a.m. report, to several newspapers and subscribers. Nine copies of the "Remarks" (8 a.m. and 0.45 p.m.) are sent to the Type-founding Company for issue to provincial newspapers for publication, in order to explain the 8 a.m. charts. On the information derived from the morning and afternoon reports a second telegram of about 200 words is prepared and transmitted soon after 6 p.m. to the Intelligence Department of the Post Office for the Central News, and a second copy is sent to the Press Association for publication in the next morning's provincial newspapers.

At 7 to 7.30 p.m. the nineteen evening (6 p.m.) reports arrive and are charted and discussed for the "Times," in accordance with the arrangement referred to on p. 77. The chart and remarks are usually ready by 8 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 frequently 8.30 or 9 p.m. before they are issued.

It will be seen that the charts for 0.45 p.m. and for 6 p.m. are less complete than that for 8 a.m. That for 0.45 p.m. is drawn on the information received from thirteen home stations, supplemented by that from two foreign ones, whenever the latter arrive in time to be used, which however is a rare occurrence. The material for the 6 p.m. charts is now supplied by reports from fifteen stations in the United Kingdom, supplemented by four from continental stations, but those from the latter frequently arrive late at the very time when they are most wanted, *i.e.*, during bad weather.

The Sunday duty is conducted as follows:—Two of the clerks attend on Sunday morning 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. They 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 the utmost 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 close for the day, which is usually 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 prompt information of storms to our coasts; but a telegram is sent to Paris and Jersey in the same way as on week days, and there is the ordinary interchange of messages with foreign countries. At 6 p.m. the same clerks attend at the Meteorological Office to receive the evening reports and to prepare the 8 p.m. Forecasts for the "Times," and another opportunity is thus offered for the correction or extension of any warnings which may have been issued in the morning. Forecasts for the Provincial press are prepared at 6.30 p.m. from the 8 a.m. and a few 0.45 p.m. reports only, and the evening message is sent to the Central News and the Press Association for transmission to the provinces.

Weekly Summary.

Soon after the end of each week a copy of the Weekly Weather Report (p. 99), printed on large paper, is issued as a supplement to the Daily Weather Report, giving an account of the changes which have been observed in the weather from day to day, together with a brief general statement showing what have been the more prominent features in the weather conditions during the whole period.

In this manner the main meteorological features of the week are presented as a connected story, and additional facility is afforded for future reference.

Correction and Addition List.

Some further steps are taken to insure accuracy in the Daily Weather Report. At the close of each month a return is received from nearly all of the telegraphic reporting stations, containing a copy of all the observations which have been transmitted to London by wire during the month. These schedules are used for checking the daily telegrams, for the preparation of the average and other values of the different elements, and also as evidence in the case of legal proceedings; and about the middle of every month a lithographic sheet is issued with the Daily Weather Report, containing corrections for all discrepancies which have been discovered and supplying any observations which have been omitted in the published reports.

Weekly Weather Report.

The Weekly Weather Report is a publication which has appeared since the beginning of February 1878. A specimen will be found as Appendix XIII*. It consists of the average and extreme temperatures and the rainfall values in each week for ten districts in Great Britain and Ireland, together with the difference between them and their respective mean values for the corresponding weeks in previous years. These statistics are now given on page 1 of the publication, the corresponding values for *each station* being given on page 4. In addition to the telegraphic reports weekly returns from 26 volunteer observers (nine more than in 1878) are used in preparing this report, the names of the observers at each station being as under—

Names of Stations.		Names of Authorities.
Barnstaple		W. Knill.
Bawtry (Hesley Hall)		B. J. Whitaker, Esq.
Birmingham (Oscott)		Rev. S. Whitty, B.A., St. Mary's College.
Blackpool	ℳ	C. T. Ward, F.M.S.
Brookeborough		Mr. Fergurson for Sir Victor Brooke, F.L.S.
Cirencester		The Royal Agricultural College.
Douglas (Isle of Man)		A. W. Moore, Esq., Cronkbourne.
Dublin		J. W. Moore, M.D.
Durham		G. A. Goldney, the Observatory.
Foynes		T. J. Carey, for Lord Monteagle.
Glenalmond		Rev. W. P. Robinson, D.D., F.M.S., Trinity College.
Hastings (St. Leonards)		A. E. Murray, F.M.S., and H. Colborne, F.M.S.
Hereford	ℳ	T. A. Chapman, M.D., F.M.S.
Kelstern (Lincolnshire)	ℳ	D. G. Briggs, F.M.S.
Laudale (Loch Sunart)		A. Fletcher, for T. H. G. Newton, Esq.
Leicester		W. J. Harrison, F.G.S., the Museum.
Londonderry		J. Conroy, F.M.S.
Loughborough		W. Berridge, F.M.S.
Markree Castle (Sligo)		E. Sallis, for Colonel Cooper, F.R.A.S.
Manchester (Prestwich)		T. R. H. Clunn, Esq., M.D.
Marlborough	ℳ	Rev. T. A. Preston, M.A., F.M.S.
Plymouth		J. Merrifield, Esq., F.R.A.S.
Rothamsted		Rainfall by Messrs. Lawes and Gilbert; temperature by T. Wilson, Esq., F.M.S.
Shrewsbury	ℳ	Rev. E. V. Pigott, F.M.S.
Silloth		Rev. F. Redford, F.R.S.E.
Strathfield Turgis	ℳ	Rev. C. H. Griffith, F.M.S.

The returns marked "ℳ" are supplied through the Meteorological Society (London).

NOTE.—The returns from Audley End and Dunfanaghy have ceased, and Parsonstown is now a Telegraphic Reporting Station.

* The specimen furnished contains two additional columns relating to the prevalence of bright sunshine. These columns were introduced in the first week in April 1880, and have appeared ever since that date.

This report is prepared on Wednesday in every week, and is ready for sale early on Saturday morning, but the summary on its first page appears in the "Times" and "Daily News" on Thursday morning.

Issue of Forecasts.

Descriptions of the actual state of the weather, and forecasts *for not more than one day in advance*, are prepared at the Meteorological Office for issue to the public, 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, not for the general public.

(2.) At 2.30 p.m. (from the morning and afternoon reports), for the day following that of issue. This set of Forecasts is intended for the general public, for the late editions of the evening papers, and for the morning papers next day. Arrangements have been made so that newspapers which are issued daily can have for Monday's issue a set of forecasts drawn up at 6.30 p.m. on Sundays* if desired, in lieu of those issued at 2.30 p.m. on Saturdays. These Sunday Forecasts are not issued to the public generally.

(3.) At 8 p.m. (from the 6 p.m. reports), for the day following that of issue. These are at present supplied, under special arrangements, to the "Times," "Standard," and "Daily News" only. No forecast is prepared at this hour on Saturday, as the papers are not published on Sundays, but attendance is given on Sunday* evening in order to prepare the forecasts for Monday.

The forecasts are made for the following district :—

0. Scotland, North.
1. Scotland, East.
2. England, N.E.
3. England, East.
4. Midland Counties.
5. England, South.
6. Scotland, West (with Isle of Man).
7. England, N.W. (with North Wales).
8. England, S.W. (with South Wales).
9. Ireland, North.
10. Ireland, South.

The descriptions and forecasts are posted at the doors of the Meteorological Office, 116, 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 Newspapers and for Private Subscribers.†—Any person is supplied with a copy of the 2.30 p.m. Forecasts, on each week day, on payment of a subscription of ten shillings per annum, *in addition*

* Good Friday and Christmas Day are reckoned as Sundays.

† The form in which the 2.30 p.m. Forecasts are issued to the general public is that given in Appendix XII., but in the case of 11 a.m. and 8 p.m. forecasts, the "State of the Weather" at the time of observation is omitted.

to the cost of transmission; the total charges are therefore, by *letter* post 9*s.* per quarter, by *book* post 5*s.* 9*d.*

Forecasts for Clubs.—Forecasts, drawn up at 2.30 p.m., for all the districts, are supplied to Clubs, for a subscription of ten shillings per annum. These are delivered free, by hand, to Clubs situated in or near Pall Mall. Special arrangements can be made for delivery at a greater distance either by hand or post.

Subscribers for the Daily Weather Report, whose copies are sent by evening post, may have the 2.30 p.m. Forecast enclosed in the wrapper with their report on each week day, on payment of an additional subscription of five shillings per annum—making the total subscription for the report and 2.30 p.m. Forecasts 1*l.* 5*s.*

N.B.—Subscriptions must be paid in advance, and they end at the usual official quarter day; but should the application not arrive until part of the quarter has passed, allowance is made for the time expired in calculating the cost.

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 6.30 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 two shillings in stamps if the reply (not exceeding twenty words) 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 1*s.*, in addition to 2*s.*, the cost of the message to the Meteorological Office and the reply. The telegram containing the inquiry must not exceed 20 words in length, and must be addressed to the

Meteorological Office,
London.

Checking of Forecasts.

In order to test the accuracy of the forecasts they have been compared carefully with the weather reported in the various districts on the days to which they referred. During the nine months (April to December) of 1879 this checking has been confined to the forecasts issued to the three special newspapers at 8 p.m., but those issued at 4 p.m. were also checked (in a somewhat different manner) for a period of about six weeks during the hay season, and the results of this checking have been already given in the Report (p. 17).

From the commencement of the year 1880 the forecasts issued at 2.30 p.m. (instead of 4 p.m.) and at 8 p.m. have been regularly checked.

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

Checking of Storm Warnings.

The method of testing the warnings is as follows: 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 the several gentlemen who have volunteered to observe for the Office, and whose names will be found at pp. 22 and 23.

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 coasts are subdivided into nine districts, as will be seen in the table on p. 13. Two large tracts of coast are entirely omitted: 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 tracts of 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.

List of Persons, Places, &c. to which the Daily Weather Report has been supplied, free of cost.

Newspapers:

*Echo.
*Globe.
Lloyd's Shipping List.
Mark Lane Express.
Morning Advertiser.
New York Herald.
†Observer.
*Pall Mall Gazette.
Press Association (Plymouth Daily Mercury).
Shipping and Mercantile Gazette (with special daily chart).
Standard (Morning and Evening).
Times (1st and 2nd editions).

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* "Remarks" only. † Saturdays only.

For Exhibition at following Seaports:

Banff.
Barrow-in-Furness.
Belfast.
Blackpool.
Bo'ness.
Boscastle.
Bournemouth.
Brighton.
Briton Ferry.
Broughty Ferry.
Buckie.
Budehaven.
Caernarvon.
Cork.
Cowes.
Cromer.
Cullercoats.
Deptford Yard.
Dover.
Exeter (2 copies).
Falmouth.
Great Grimsby (2 copies).
Hastings.
Hayle.
Holyhead.
Kingstown.
Lancaster.
Leith.
Lowestoft.
Margate.
Nairn.
Newquay.
Penarth.
Plymouth.
" G. W. Docks.
Port Dinorwic.
Porthcawl.
Queenstown.
Scarboro'.
Silloth.
Southport.
Teignmouth.
Ventnor (2 copies).
Weston-super-Mare.
Wick.
Worthing.
Yarmouth.

In exchange for Observations:

Aird, G. H., Seaham.
Barnstaple Meteorological Committee.
Bellingham, J. G., Saffron Walden.
Cambridge Observatory.
Campbell J., R.N., M.D., Chigwell Row.
Chatham, Instructor in Surveying.
Clouston, Rev. C., LL.D., Sandwick, Orkney.
Clunn, T. R. H., M.D., Prestwich, Manchester.
Cooper, Col., F.R.A.S., Markree, nr. Sligo.
Conroy, J., Londonderry.
Cooper, W. F., F.M.S., Sheffield.
Durham, University Observatory.
Fernley Observatory, Southport.
Greenwich Observatory.
Harrison, W. J., F.G.S., Leicester.
Hoskins, Dr. S. E., F.R.S., Guernsey.
Royal Indian C.E. College, Staines.
Liverpool Observatory.
Lowe, E. J., F.R.S., Nottingham.
McCormack, J., Aberdeen.
Mackay, Rev. W. P., M.D., Hull.
Miller, S. H., F.R.A.S., Lowestoft.
Moore, A. W., Isle of Man.
Moore, J. W., M.D., Dublin.
Moyle, M. P., F.R.C.S., Helston.
Mullins, Rev. G. H., Uppingham.
Murray, A. E., F.M.S., Hastings.
Neale, J., Waterford.
Netley, Army Medical School.

In exchange for Observations—cont.

Northumberland, Duke of, Alnwick.
Ordnance Survey Office (Southampton).
Propert, W. P., LL.D., St. David's.
Radcliffe Observatory, Oxford.
Richards, W. H., Penzance.
Robinson, Rev. W. P., D.D., Glenalmond.
Rosse, Earl of, F.R.S., Parsonstown.
Royal Horticultural Society.
Rugby Natural History Society.
Taylor, A. H., Folkestone.
Vibert, J. E., M.A., St. Aubin's, Jersey.
Whitty, Rev. S. J., B.A., Oscott.
Yorkshire Philosophical Society.

Government Offices:

Admiralty: 12 copies.
Aldershot, Garrison Library.
Army Medical Department.
Board of Trade: 3 copies.
"Britannia," H.M.S., Dartmouth.
Commons, House of.
Devonport Dockyard: 2 copies.
" Commander-in-Chief.
" Captain of Steam Reserve.
" Master Attendant.
Greenwich, R.N. College.
"Indus," H.M.S., Devonport.
Ireland, Royal College of Science.
Lords, House of.
Mann, J. R., Osborne.
Medical Department of the Navy.
"Nankin," H.M.S., Milford Haven.
Portland, Senior Naval Officer.
Portsmouth, Commander-in-Chief.
" Dockyard.
" R. N. College Observatory.
Registrar General.
" " of Seamen.
"Resistance," H.M.S., Rock Ferry.
Royal Military Academy.
Sandhurst Staff College.
Science and Art Department: 2 copies.
Sheerness, Commander-in-Chief.
" Dockyard.
War Office, Adjutant General, Horse Guards.
" Commander-in-Chief.

Societies, &c.:

Association of Underwriters, Liverpool.
Do. Lloyd's.
British Museum.
Buchan, A., F.R.S.E., Edinburgh.
Crossley, L. J., Halifax.
Griffith, Rev. C. H., Strathfield Turgiss.

Societies, &c.—cont.

Meteorological Council: 4 copies.
„ Society, London.
Observatories: 7 copies.
Reuter's Telegram Company.
Richards, Vice-Adm., Sir G. H., F.R.S., London.
Royal Society.
Rundell, W. W.
Scottish Meteorological Society.
Trinity House.

Foreign Places:

Algiers, Meteorological Service.
Bombay, Observatory.
Brussels, Royal Observatory.
Calcutta, Meteorological Department.
Christiania, Meteorological Institute.
Constantinople, Imperial Meteorological Observatory.
Copenhagen, Meteorological Institute.
Cracow, Observatory.
Florence, Meteorological Office.
Freeden, W. H. v., Bonn.
Hamburg, Seewarte.
Hébert, M., Draguignan.
Leipzig Observatory.
Lisbon, Observatory.
Madrid, Royal Observatory.
Melbourne, Observatory.
Meudon, French Balloon Corps.
Nice, Société de Médecine.
Paris, Meteorological Observatory, Montsouris.
„ Meteorological Society.
„ Ministry of Marine.
„ Observatory.
„ M. Harold Tarry.
Rome, Ministry of Agriculture.
San Fernando, Observatory.
St. Petersburg, Central Physical Observatory.
Stockholm, Meteorological Institute.
Tiflis, Physical Observatory.
Toronto, Meteorological Office.
Upsala, University Observatory.
Utrecht, Royal Meteorological Institute.
Vienna, Imperial Meteorological Institute.
Washington, Smithsonian Institution.
„ United States Naval Observatory.
„ Chief Signal Officer, War Office.
Zürich, Central Meteorological Institute.

APPENDIX IX.

Fishery Barometers.

List of Places supplied with Fishery Barometers.

Shetland Isles.—Sandsair, Lerwick.

Orkney Isles.—Burray. Kirkwall.

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

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

England, south coast.—Bognor, Portsea, Ryde and Ventnor (2) (Isle of Wight), Gorey (Jersey), Haslar Hospital, Poole, Weymouth, Portland, Budleigh-Salterton, Cawsand, Charlestown, Mevagissey, Gorranhaven, Devoran, Portscath, Penryn, Falmouth, Coverack, Newlyn, Mousehole.

England, south-west coast.—St. Ives, Hayle, Padstow, Port Isaac Boscastle, Fremington, Burnham, Highbridge.

Wales.—Briton Ferry, Swansea, Angle, Milford, Abersoch.

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, Strangford, Ardglass, Carlingford, Greenore, Dundalk, Malahide, Howth, Kingstown (2).

Ireland, south coast. — Dungarvan, Kinsale, Castletownsend, Crookhaven.

Ireland, west coast.—Valencia, Dingle, Tralee, Tarbert, Kilcredane, Barna, Ballyglass, Elly Bay, Ballina, Tribane, Killybegs, Teelin, Portnoo, Burton Port, Bunbeg.

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

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

Hebrides, Stornoway, Cromore, Balyle, Obb, Ness.

Summary of Instruments on Service.

England and Wales - - - -	64
Scotland - - - - -	50
Ireland - - - - -	37
	149

APPENDIX X.

Telegraphic Weather Intelligence.

The following stations, having been approved by the Board of Trade, are supplied with telegraphic information of storms free of expense, and "drum" and "cone" signal shapes 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, 81 in England and Wales, 35 in Scotland, 14 in Ireland, 3 in the Isle of Man, and 3 in the Channel Islands.

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

Circular No. 717.

TELEGRAPHIC WEATHER INTELLIGENCE.

Board of Trade, February 14th, 1874.

THE Board of Trade have been informed by the Meteorological Committee that they are now prepared to re-introduce the use of Admiral FitzRoy's signals (cones and drum) with slightly modified significations, and that the change will take effect on and after 15th March 1874.

The signals to be used will 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.

3°. Drum, *with cone*, to indicate the probable approach of a *very heavy gale* from the direction indicated by the cone.

The drum will not be used without the cone.

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, as pointed out in the explanatory pamphlet* sent herewith, copies of which are supplied for gratuitous distribution.

It will be seen from the pamphlet in question that 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 will supply 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., as directed by the Circular No. 278, dated 30th November 1867.

THOMAS GRAY.

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* The "explanatory pamphlet" referred to is a circular entitled "Telegraphic Weather Intelligence," printed in large type on four pages, so as to be posted up on a board.

APPENDIX XI.

REPORT ON THE COMPARISON OF THE FORECASTS, WITH THE WEATHER SUBSEQUENTLY EXPERIENCED, for the 12 Months, April 1879 to March 1880.

The letters used have the following signification:—

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

For the first nine months (April—December 1879), the Forecasts were checked without separating the wind from the weather, and the 8 p.m. Forecast only was taken. The percentages are shown on pp. 90 and 91.

At the beginning of the present year, however, the checking was conducted more strigently; each Forecast was considered under the separate headings of "Wind" and "Weather," and both the 2.30 p.m. and the 8 p.m. Forecasts were checked. The percentages in these cases are shown on pp. 92–94.

In the Summary for the whole year at the end (p. 95), the 8 p.m. Forecasts only have been regarded.

Districts.		April.		May.		June.		July.	
		Percentages.	a + b.	Percentages.	a + b.	Percentages.	a + b.	Percentages.	a + b.
Scotland, N.	a	27	89	19	69	23	73	19	93
,,	b	62		50		50		74	
,,	c	11		31		27		7	
,,	d	—		—		—		—	
Scotland, E.	a	39	85	31	85	19	85	20	85
,,	b	46		54		66		59	
,,	c	15		15		15		11	
,,	d	—		—		—		4	
England, N.E.	a	39	85	23	69	35	89	29	70
,,	b	46		46		54		41	
,,	c	15		23		7		26	
,,	d	—		8		4		4	
England, E.	a	42	88	12	77	27	73	37	85
,,	b	46		65		46		48	
,,	c	4		15		27		11	
,,	d	8		8		—		4	
Midland Cos.	a	35	69	15	61	35	81	22	89
,,	b	34		46		46		67	
,,	c	19		39		15		7	
,,	d	12		—		4		4	
England, S.	a	27	81	23	69	39	81	52	89
,,	b	54		46		42		37	
,,	c	15		27		19		11	
,,	d	4		4		—		—	
Scotland, W.	a	21	67	31	89	31	77	22	85
,,	b	46		58		46		63	
,,	c	29		11		19		11	
,,	d	4		—		4		4	
England, N.W.	a	31	66	—	58	15	77	26	74
,,	b	35		58		62		48	
,,	c	27		38		23		22	
,,	d	7		4		—		4	
England, S.W.	a	19	58	16	58	11	69	26	67
,,	b	39		42		58		41	
,,	c	34		42		27		26	
,,	d	8		—		4		7	
Ireland, N.	a	31	77	23	77	19	77	56	89
,,	b	46		54		58		33	
,,	c	15		19		23		7	
,,	d	8		4		—		4	
Ireland, S.	a	38	69	12	77	23	77	26	71
,,	b	31		65		54		45	
,,	c	23		19		23		22	
,,	d	8		4		—		7	

Summary.

British Isles	a	32	76	19	72	25	78	31	81
,,	b	44		53		53		50	
,,	c	19		25		21		15	
,,	d	5		3		1		4	

Districts.		August.		September.		October.		November.		December.	
		Percentages.	a+b.	Percentages.	a+b.	Percentages.	a+b.	Percentages.	a+b.	Percentages.	a+b.
Scotland, N.	a	39		31		8		8		26	
"	b	42	81	39	70	63	71	68	74	48	74
"	c	19		19		22		24		26	
"	d	—		11		7		—		—	
Scotland, E.	a	31		11		19		12		22	
"	b	50	81	62	73	63	82	52	64	45	67
"	c	15		23		14		28		33	
"	d	4		4		4		8		—	
England, N.E.	a	39		11		15		8		11	
"	b	46	85	58	69	67	82	48	56	41	52
"	c	15		31		14		36		41	
"	d	—		—		4		8		7	
England, E.	a	19		27		26		16		19	
"	b	62	81	50	77	56	82	56	72	45	64
"	c	19		15		11		24		29	
"	d	—		8		7		4		7	
Midland Cos.	a	11		15		11		20		11	
"	b	58	69	46	61	67	78	44	64	52	63
"	c	23		39		18		32		37	
"	d	8		—		4		4		—	
England, S.	a	19		31		11		28		4	
"	b	62	81	54	85	74	85	60	88	71	75
"	c	15		15		11		12		19	
"	d	4		—		4		—		6	
Scotland, W.	a	23		15		7		8		15	
"	b	42	65	50	65	45	52	44	52	44	59
"	c	35		23		37		44		30	
"	d	—		12		11		4		11	
England, N.W.	a	8		15		15		8		15	
"	b	65	73	62	77	45	60	68	76	56	71
"	c	27		15		29		16		29	
"	d	—		8		11		8		—	
England, S.W.	a	27		23		15		20		19	
"	b	54	81	54	77	67	82	56	76	26	45
"	c	15		15		18		24		48	
"	d	4		8		—		—		7	
Ireland, N.	a	27		23		4		12		15	
"	b	54	81	46	69	48	52	36	48	67	82
"	c	15		31		44		44		18	
"	d			—		4		8		—	
Ireland, S.	a	23		19		8		20		26	
"	b	69	92	58	77	52	60	40	60	41	67
"	c	4		19		33		28		26	
"	d	4		4		7		12		7	

Summary.

British Isles	a	24		20		13		15		17	
"	b	55	79	53	73	59	72	52	67	49	66
"	c	18		22		22		28		30	
"	d	3		5		6		5		4	

JANUARY 1880.

DISTRICTS.		2.30 p.m. Per-centages. Wind.	Weather.	Total.	a + b	DISTRICTS.		8 p.m. Per-centages. Wind.	Weather.	Total.	a + b
SCOTLAND, N.	a	40	66	53		SCOTLAND, N	a	42	53	48	
,,	b	46	20	33	86	,,	b	38	35	36	84
,,	c	7	7	7		,,	c	12	12	12	
,,	d	7	7	7		,,	d	8	—	4	
SCOTLAND, E.	a	50	67	58		SCOTLAND, E.	a	50	61	55	
,,	b	33	27	30	88	,,	b	35	27	31	86
,,	c	17	3	10		,,	c	15	12	14	
,,	d	—	3	2		,,	d	—	—	—	
ENGLAND, N.E.	a	43	67	55		ENGLAND, N.E.	a	50	62	56	
,,	b	37	23	30	85	,,	b	38	26	32	88
,,	c	17	7	12		,,	c	8	4	6	
,,	d	3	3	3		,,	d	4	8	6	
ENGLAND, E.	a	50	50	50		ENGLAND, E.	a	77	73	75	
,,	b	30	43	36	86	,,	b	15	11	13	88
,,	c	20	7	14		,,	c	8	12	10	
,,	d	—	—	—		,,	d	—	4	2	
MIDLAND COS.	a	57	50	53		MIDLAND COS.	a	54	61	58	
,,	b	23	37	30	83	,,	b	26	23	24	82
,,	c	13	10	12		,,	c	8	12	10	
,,	d	7	3	5		,,	d	12	4	8	
ENGLAND, S.	a	53	40	46		ENGLAND, S.	a	65	58	62	
,,	b	30	40	35	81	,,	b	27	26	26	88
,,	c	17	20	19		,,	c	4	12	8	
,,	d	—	—	—		,,	d	4	4	4	
SCOTLAND, W.	a	50	63	56		SCOTLAND, W.	a	31	65	48	
,,	b	27	23	25	81	,,	b	42	19	32	80
,,	c	10	14	12		,,	c	23	12	18	
,,	d	13	—	7		,,	d	4	4	4	
ENGLAND, N.W.	a	53	50	51		ENGLAND, N.W.	a	50	61	55	
,,	b	41	27	34	85	,,	b	38	19	29	84
,,	c	3	20	12		,,	c	8	12	10	
,,	d	3	3	3		,,	d	4	8	6	
ENGLAND, S.W.	a	47	77	62		ENGLAND, S.W.	a	31	65	48	
,,	b	40	20	30	92	,,	b	54	23	38	86
,,	c	13	3	8		,,	c	15	4	10	
,,	d	—	—	—		,,	d	—	8	4	
IRELAND, N.	a	63	63	63		IRELAND, N,	a	54	61	58	
,,	b	20	34	26	89	,,	b	23	31	27	85
,,	c	17	4	11		,,	c	23	4	13	
,,	d	—	—	—		,,	d	—	4	2	
IRELAND, S,	a	63	63	63		IRELAND, S.	a	69	54	62	
,,	b	33	30	31	94	,,	b	19	38	28	90
,,	c	4	7	6		,,	c	8	—	4	
,,	d	—	—	—		,,	d	4	8	6	

SUMMARY.

BRITISH ISLES	a	52	60	56		BRITISH ISLES	a	52	61	57	
,,	b	33	29	31	87	,,	b	32	25	29	86
,,	c	12	9	11		,,	c	11	9	10	
,,	d	3	2	2		,,	d	5	5	4	

February 1880.

Districts.		2.30 p.m. Percentages. Wind.	Weather.	Total.	a+b	Districts.		8 p.m. Percentages. Wind.	Weather.	Total.	a+b
Scotland, N.	a	34	69	52		Scotland, N.	a	44	64	54	
"	b	34	14	24	76	"	b	20	24	22	76
"	c	18	14	16		"	c	12	8	10	
"	d	14	3	8		"	d	24	4	14	
Scotland, E.	a	24	34	29		Scotland, E.	a	32	40	36	
"	b	38	45	42	71	"	b	36	36	36	72
"	c	28	14	21		"	c	8	16	12	
"	d	10	7	8		"	d	24	8	16	
England, N.E.	a	31	60	46		England, N.E.	a	24	28	26	
"	b	45	24	35	81	"	b	60	56	58	84
	c	17	14	16		"	c	8	16	12	
	d	7	—	3		"	d	8	—	4	
England, E.	a	62	69	66		England, E.	a	68	68	68	
"	b	28	21	24	90	"	b	20	16	18	86
"	c	3	7	5		"	c	8	16	12	
"	d	7	3	5		"	d	4	—	2	
Midland Cos.	a	31	55	43		Midland Cos.	a	36	44	40	
"	b	52	31	42	85	"	b	40	32	36	76
"	c	3	7	5		"	c	20	20	20	
"	d	14	7	10		"	d	4	4	4	
England, S.	a	35	51	43		England, S.	a	56	44	50	
"	b	48	41	45	88	"	b	32	36	34	84
"	c	7	8	7		"	c	4	20	12	
"	d	10	—	5		"	d	8	—	4	
Scotland, W.	a	7	59	33		Scotland, W.	a	32	48	40	
"	b	48	24	36	69	"	b	32	16	24	64
"	c	21	10	16		"	c	8	16	12	
"	d	24	7	15		"	d	28	20	24	
England, N.W.	a	34	34	34		England, N.W.	a	20	32	26	
"	b	28	10	34	68	"	b	40	36	38	64
"	c	24	13	19		"	c	28	24	26	
"	d	14	13	13		"	d	12	8	10	
England, S.W.	a	21	51	36		England, S.W.	a	32	64	48	
"	b	41	35	38	7	"	b	32	20	26	74
"	c	24	11	18		"	c	24	12	18	
"	d	14	3	8		"	d	12	4	8	
Ireland, N.	a	10	59	35		Ireland, N.	a	24	60	42	
"	b	38	24	31	66	"	b	40	32	36	78
"	c	31	10	20		"	c	20	4	12	
"	d	21	7	14		"	d	16	4	10	
Ireland, S.	a	17	69	43		Ireland, S.	a	24	60	42	
"	b	28	21	25	68	"	b	28	16	22	64
"	c	27	10	18		"	c	24	20	22	
"	d	28	—	14		"	d	24	4	14	

Summary.

British Isles	a	28	55	42		British Isles	a	36	50	43	
"	b	39	29	34	76	"	b	34	29	32	75
"	c	18	11	15		"	c	15	16	15	
"	d	15	5	9		"	d	15	5	10	

March 1880.

Districts.		2.30. p.m. Percentages. Wind.	Weather.	Total.	a+b.	Districts.		8 p.m. Percentages. Wind.	Weather.	Total.	a+b.
Scotland, N.	a	35	35	35	75	Scotland, N.	a	41	55	48	84
,,	b	39	42	40		,,	b	41	30	36	
,,	c	10	13	12		,,	c	7	7	7	
,,	d	16	10	13		,,	d	11	8	9	
Scotland, E.	a	39	42	40	68	Scotland, E.	a	37	44	41	84
,,	b	29	26	28		,,	b	44	41	43	
,,	c	13	16	14		,,	c	8	7	7	
,,	d	19	16	18		,,	d	11	8	9	
England, N.E.	a	36	32	34	73	England, N.E.	a	30	37	34	73
,,	b	32	15	24		,,	b	41	37	39	
,,	c	19	13	16		,,	c	22	11	16	
,,	d	13	10	11		,,	d	7	15	11	
England, E.	a	55	52	53	87	England, E.	a	44	44	44	88
,,	b	32	36	34		,,	b	45	44	44	
,,	c	7	6	7		,,	c	11	8	10	
,,	d	6	6	6		,,	d	—	4	2	
Midland Cos.	a	35	35	35	77	Midland Cos.	a	44	34	39	73
,,	b	45	39	42		,,	b	37	30	34	
,,	c	13	16	14		,,	c	11	25	18	
,,	d	7	10	9		,,	d	8	11	9	
England, S.	a	52	39	46	86	England, S.	a	55	44	50	89
,,	b	35	45	40		,,	b	11	37	24	
,,	c	10	10	10		,,	c	4	15	9	
,,	d	3	6	4		,,	d	—	4	2	
Scotland, W.	a	32	42	37	69	Scotland, W.	a	30	30	30	64
,,	b	33	32	32		,,	b	30	37	34	
,,	c	19	15	16		,,	c	25	22	23	
,,	d	16	13	15		,,	d	15	11	13	
England, N.W.	a	61	35	48	78	England, N.W.	a	44	44	44	77
,,	b	26	33	30		,,	b	37	30	33	
,,	c	3	13	8		,,	c	—	15	8	
,,	d	10	19	14		,,	d	19	11	15	
England, S.W.	a	39	39	39	68	England, S.W.	a	33	48	41	78
,,	b	32	25	29		,,	b	41	33	37	
,,	c	16	26	21		,,	c	11	15	13	
,,	d	13	10	11		,,	d	15	4	9	
Ireland, N.	a	45	42	44	81	Ireland, N.	a	41	41	41	84
,,	b	29	45	37		,,	b	48	37	43	
,,	c	16	13	14		,,	c	8	22	15	
,,	d	10	—	5		,,	d	3	—	1	
Ireland, S.	a	48	39	44	81	Ireland, S.	a	41	37	40	85
,,	b	35	38	37		,,	b	48	37	43	
,,	c	3	10	6		,,	c	3	15	7	
,,	d	13	13	13		,,	d	8	11	10	

Summary.

British Isles	a	43	39	41	76	British Isles	a	39	42	41	80
,,	b	33	37	35		,,	b	41	36	39	
,,	c	12	14	13		,,	c	10	14	12	
,,	d	12	10	11		,,	d	9	8	8	

SUMMARY of the PERCENTAGE of the 8 P.M. FORECASTS for all the Eleven DISTRICTS, and for the BRITISH ISLES as a whole, for the year April 1879 to March 1880.

DISTRICTS.		April 1879 to March 1880. Percentage.	a+b
SCOTLAND, N.	a	29	78
"	b	49	
"	c	18	
"	d	4	
SCOTLAND, E.	a	29	79
"	b	50	
"	c	17	
"	d	4	
ENGLAND, N.E.	a	27	75
"	b	48	
"	c	20	
"	d	5	
ENGLAND, E.	a	34	80
"	b	46	
"	c	16	
"	d	4	
MIDLAND COS.	a	26	72
"	b	46	
"	c	23	
"	d	5	
ENGLAND, S.	a	33	83
"	b	50	
"	c	14	
"	d	3	
SCOTLAND, W.	a	24	68
"	b	44	
"	c	24	
"	d	8	
ENGLAND, N.W.	a	22	72
"	b	50	
"	c	22	
"	d	6	
ENGLAND, S.W.	a	27	71
"	b	44	
"	c	24	
"	d	5	
IRELAND, N.	a	29	75
"	b	46	
"	c	21	
"	d	4	
IRELAND, S.	a	29	74
"	b	45	
"	c	19	
"	d	7	

SUMMARY.

DISTRICTS.		April 1879 to March 1880. Per centage.	a + b.
BRITISH ISLES	a	28	75
"	b	47	
"	c	20	
"	d	5	

APPENDIX XII.

Form in which the 2.30 p.m. Forecasts are issued to the General Public.

Chart showing Districts.

Meteorological Office, 116, Victoria Street, London S.W.

State of Weather, and Forecasts.

(Issued on Thursday, March 18th, 1880, at 2.30 p.m.)

State of Weather on Thursday, March 18th, 1880, at 0.45 p.m.

WEATHER is exceedingly fine and bright over nearly the whole of these Islands, but is cloudy both in the Shetlands and on our south-west coasts. The wind remains easterly in the south, south-easterly in the west, and southerly in the north, and is light or moderate in force, except in the south-west and west. Temperature has risen fast over the North of England and South of Scotland, and readings range from about 52° or 53° on our west and south-west coasts to 44° at Yarmouth. Pressure is increasing everywhere, but the change is very slight.

SEA at Dover is moderate; at Holyhead smooth.

Forecasts for Friday, March 19th, 1880.

DISTRICTS.	
0. Scotland, N. -	Southerly or south-south-westerly breezes, light or moderate; weather fair, mild.
1. Do. E. -	
2. England, N.E. -	South-easterly winds, light; fine, hazy, rather cold.
3. Do. E. -	Light easterly breezes; cold; weather fine.
4. Midland Counties	South-easterly winds, light or moderate; fine, some haze.
5. England, S. - (with London and Channel.)	Light or moderate easterly breezes; cold; weather fine, some haze.
6. Scotland, W. - (and I. of Man.)	South-easterly breezes, light or moderate; fair, milder.
7. England, N.W. - (and N. Wales.)	South-easterly and southerly breezes, light or moderate; fine to cloudy.
8. England, S.W. - (and S. Wales.)	Easterly and south-easterly breezes, light to strong; cloudy, fair.
9. Ireland, N. -	South-easterly and southerly breezes, light to strong; cloudy, mild.
10. Do. S. -	South-easterly winds, light to strong; cloudy, some rain.

By Order,
Robert H. Scott,
Secretary.

APPENDIX XIII.

LIST of STATIONS from which DAILY SYNCHRONOUS OBSERVATIONS (at 0h. 43m. p.m. G. M. T.) have been received in 1879.

Stations.	Observers.	Remarks.
ENGLAND AND WALES.		
Bolton	T. Mackereth.	—
Bradford	J. McLandsborough.	—
Cambridge	H. Todd.	—
Cardington	J. McLaren.	—
Chatham, School of Military Engineering.	M. G. Morris, Lieut., R.E.	—
Dover	J. Costello.	—
Falmouth Observatory	The Staff.	—
Greenwich Observatory	The Staff, for Sir G.B.Airy.	—
Guernsey	Dr. Hoskins, F.R.S.	—
Helston	Dr. Moyle.	—
Holyhead	J. Tilston.	—
Jersey (St. Helier's)	J. Fisher.	—
Kew Observatory	The Staff.	—
Leicester (Museum)	W. J. Harrison, F.G.S.	—
Liverpool Observatory (Bidston).	J. Hartnup, Jun.	—
Nottingham	E. J. Lowe, F.R.S.	—
Oscott (St. Mary's Col.)	Rev. S. Whitty.	—
Oxford, Radcliffe Obs.	H. J. Bellamy.	—
Plymouth	J. Merrifield, LL.D., F.R.A.S.	—
Sheffield	W. F. Cooper, F.M.S.	—
Silloth	Rev. F. Redford, M.A., F.R.S.E.	—
St. Ann's Head (Milford Haven).	J. C. Walker.	—
Stonyhurst Observatory	The Staff.	—
Strathfield Turgiss	Rev. C. H. Griffith, M.A.	—
Truro (Royal Institution)	W. Newcombe.	—
Yarmouth (Norfolk)	G. T. Watson.	—
SCOTLAND.		
Aberdeen Observatory	The Staff.	—
Ardrossan	G. Carrick.	—
Glasgow Observatory	The Staff.	—
Nairn	W. D. Penny.	—
Orkneys, (Sandwick Manse).	Rev. C. Clouston, LL.D.	—
IRELAND.		
Armagh Observatory	S. Call. for Dr. Robinson.	—
Donaghadee	J. McGowan.	—
Galway, Queen's College	M. J. O'Donoghue.	—
Roche's Point	W. Kennedy.	—
Valencia Observatory	The Staff.	—

Stations.	Observers.	Remarks.
British Colonies, Possessions, &c.		
Barbadoes, W. I. -	Surgeon-Maj. Doran.	—
Gibraltar - -	W. Allen, Serg. A.H.C.*	—
Malta - - -	H. J. Beckett, Serg., A.H.C.	—
Nassau (Bahamas) -	C. L. Dunscombe.	—
Natal - - -	Priv. G. Salmon, A.H.C.	—
Scutari, British Cemetery	Serg. W. H. Lyne, R.E.	—
Sierra Leone - -	—	—

Summary.

—	—
England and Wales -	26
Scotland - - -	5
Ireland - - -	5
Colonies and British Possessions - -	7
Total	43

* A.H.C.—Army Hospital Corps.

APPENDIX XIV.

WEEKLY WEATHER REPORT.

ISSUED BY THE METEOROLOGICAL OFFICE, LONDON.

PUBLISHED BY J. D. POTTER, 31 POULTRY, AND 11 KING STREET, TOWER HILL; AND E. STANFORD, 55 CHARING CROSS.

VOL. III. No. 22.] WEEK ENDING MONDAY, MAY 31, 1880. [*Price 2d.*
[*Annual subscription, post paid, 12s. 6d.*

I.—SUMMARY OF TEMPERATURE, RAINFALL, AND DURATION OF SUNSHINE IN THE UNITED KINGDOM, FOR AGRICULTURAL AND SANITARY PURPOSES.

Explanation of the Map.—The United Kingdom has been divided into Meteorological districts, ten of which are included in the following Summary. They are separately numbered and shaded on the Map, and are similarly numbered in the letterpress, where they are also named.

The black dots show the positons of the stations furnishing the reports on which the Summary is based. The names of the Stations are given in the following list under those of the districts to which they severally belong.

1. SCOTLAND, E.—Nairn, Aberdeen, Glenalmond, Leith.
2. ENGLAND, N.E.—Shields, Durham, York, Spurn Head, Kelstern (Lincolnshire).
3. ENGLAND, E.—Hillington, Yarmouth, Cambridge, Rothamsted.
4. MIDLAND COUNTIES.—Bawtry (Hesley Hall), Nottingham, Loughborough, Leicester, Birmingham (Oscott), Shrewsbury, Churchstoke, Hereford, Cirencester, Oxford.
5. ENGLAND, S.—London, Marlborough, Strathfield Turgiss, Dover, Hastings (St. Leonard's), Southampton, Hurst Castle.
6. SCOTLAND, W.—Laudale (Loch Sunart), Glasgow, Ardrossan, Silloth (Cumberland), Douglas (Isle of Man).
7. ENGLAND, N.W.—Barrow-in-Furness, Stonyhurst, Blackpool, Manchester, Liverpool Observatory (Bidston), Llandudno, Holyhead.
8. ENGLAND, S.W.—Pembroke, Barnstaple, Falmouth, Plymouth, Prawle Point.
9. IRELAND, N.—Londonderry, Mullaghmore, Markree Castle, Brookeborough, Armagh, Donaghadee.
10. IRELAND, S.—Dublin, Parsonstown, Roche's Point, Valentia, Foynes.

Explanation of Summary.—The data for mean *Temperature* in the corresponding week of previous years are derived from the 13 years observations (1857-69), as determined by Mr. Buchan. Those for mean *Rainfall* have been obtained from the 10 years observations 1866-75. A Rainy day is one on which at least a hundredth of an inch has fallen.

	Districts.	Temperature. (In Degrees Fahrenheit.) Highest observed.	Lowest observed.	Average for the Week.	Above or below the Mean for the Week.	Rainfall. (Amounts in tenths of an inch.) Number of Rainy Days.	Rainfall for the Week.	More or less than the Mean for the Week.	Bright Sunshine. Number of Hours recorded.	Equivalent percentage of total possible Duration.
Principal Wheat-producing Districts.	1. SCOTLAND, E.	64	34	51	2 below.	3	5	2 less.	48	41
	2. ENGLAND, N.E.	68	36	51	4 below.	4	9	6 more.	47	41
	3. ENGLAND, E.	82	34	55	2 below.	4	4	1 more.	41	37
	4. MID. COUNTIES	73	30	52	4 below.	5	13	7 more.	38	34
	5. ENGLAND, S.	86	33	55	2 below.	3	3	2 less.	51	46
Principal Grazing, &c. Districts.	6. SCOTLAND, W.	61	37	51	3 below.	5	6	1 less.	37	32
	7. ENGLAND, N.W.	62	36	51	4 below.	5	15	11 more.	41	36
	8. ENGLAND, S.W.	71	39	54	4 below.	4	10	7 more.	42	38
	9. IRELAND, N.	63	35	51	4 below.	6	8	3 more.	46	40
	10. IRELAND, S.	64	37	53	3 below.	5	7	3 more.	41	37

General Remarks.

Weather during this period has been of a rather changeable character: on the 25th, 26th, 28th, and 29th the sky was moderately clear, but on the other days the weather was generally cloudy or dull. Thunderstorms, accompanied by heavy rain, occurred at some stations on the 26th and again on the 28th.

Temperature has varied very considerably, but has been on the whole a few degrees below the mean for the time of year in all districts. At the commencement of the period readings were rather high in all parts of the kingdom, and in London and at Cambridge 86° and 82° were recorded, respectively, on the 26th. During the last few days the thermometer stood much lower, and the nights were very cold, the lowest reading of all being 30° in the shade at Shrewsbury during the early morning of the 28th. On this occasion sharp ground frosts occurred in many parts of England.

Rainfall was less than the mean in "England, S.," and over Scotland, but more than the mean in all other districts; over the greater part of England the excess was rather large.

Bright sunshine shows a slight increase over southern and eastern England and in the N. of Ireland, but elsewhere a decrease is reported. The number of hours shows considerable uniformity in all parts of the kingdom, but was rather greater (51 hours) in "England, S.," and less (32 hours) in "Scotland, W.," than elsewhere.

Wind was generally south-westerly during the first two days, very variable on the 27th, westerly on the 28th, between S.W. and N.W. in most places on the 29th, and southerly to south-easterly on the 30th and 31st. In force it was generally moderate in the E. and S., but fresh in the W. and N., and on the 30th blew with the force of a gale at some of the most exposed stations on our western and northern coasts.

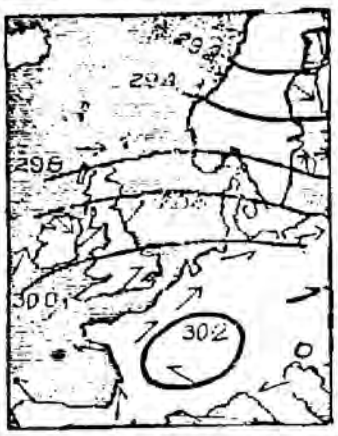
II.—SUMMARY OF WEATHER IN WESTERN EUROPE
during the Week ending May 31, 1880.

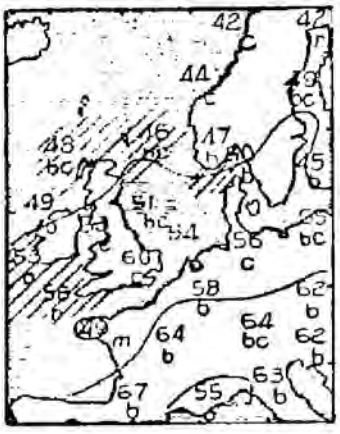
Synoptic Weather Charts.—8 a.m.

BAROMETER AND WIND.

CLOUD, RAIN, SEA, AND TEMPERATURE.

Weather during the 24 hours succeeding the date of the Charts.





Tuesday, May 25.

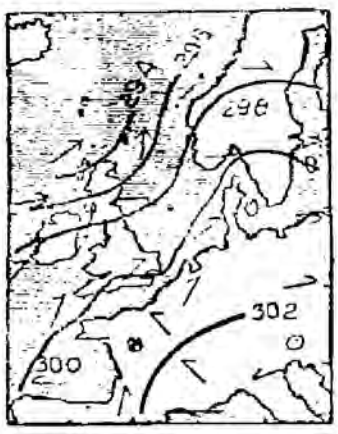
Weather fine at most of our northern and north-eastern stations, and in France and the Netherlands, cloudy or dull in most other places. Fine in the S.E. of England all day, dull elsewhere, with slight rain in W.

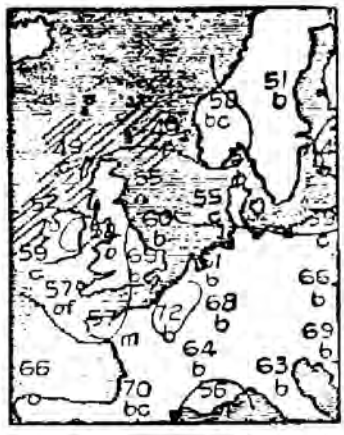
Temperature fallen a little in most places; readings ranging over these Islands from 60° in London to 45° at Wick. Maxima between 55° and 65° generally, but as high as 75° in London and at Cambridge.

Wind easterly over France, but south-westerly and westerly over these Islands and westerly over Scandinavia. Moderate in force on most coasts, but strong in N. Scotland and reaching a gale over Norway and Sweden. Wind backing to S. in the W. later.

Sea rough on our south-western and northern coasts.

Barometer rising briskly in most parts of the United Kingdom and countries to the eastward of the North Sea, but falling slowly in France and on our S.W. coasts. Anticyclone over France, with large depression over Lapland. Fresh depression appearing on our western coasts later.





Wednesday, May 26.

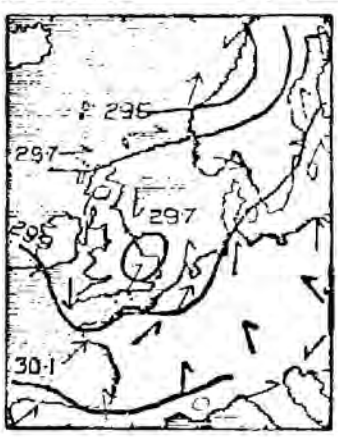
Weather fine at several stations in the E. of England as well as over the greater part of France, the Netherlands, and Sweden, cloudy and unsettled elsewhere. Weather fine all day in the S.E. and at Aberdeen.

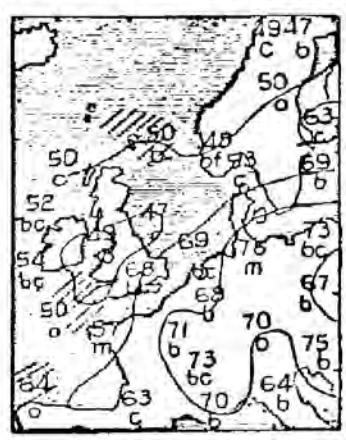
Temperature risen generally; ranging from 69° in London to 49° in the Hebrides; rising quickly in the S.E. during the day and maximum of 86° recorded in London, and of 82° at Cambridge.

Wind easterly over France but south-westerly on all our coasts; blowing lightly or moderately in the S. and S.E., but reaching a fresh gale at Barrow-in-Furness and a moderate gale in Scotland. Wind veering to W. in the W. and N. later. Strong gale felt in the Hebrides.

Sea rough in the N.W. and N.

Barometer rising quickly in Scandinavia and slightly in France, with a slight recovery at Valentia, falling elsewhere. Pressure highest over France, with a large depression to the north-westward of Scotland. Depression travelling away northward, and barometer rising in N. and falling in S.





Thursday, May 27.

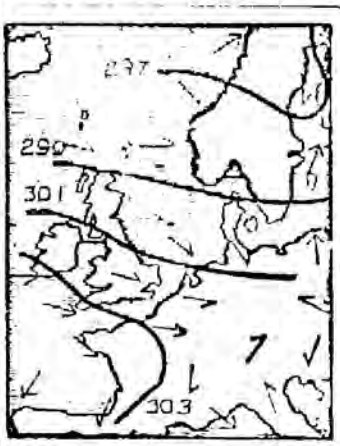
Weather fine at our extreme western, northern, and south-eastern stations, as well as over the Netherlands and E. of France, dull elsewhere, with heavy rain over the northern, central, and western districts of England.

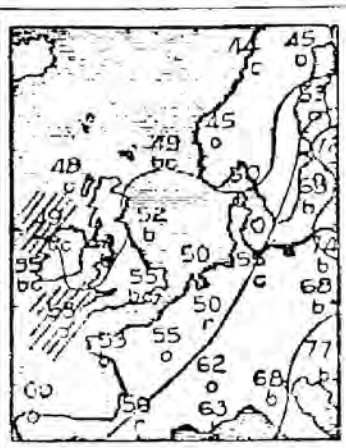
Temperature fallen over these Islands and the W. of France, risen considerably over N. Germany and the Baltic; ranging from 73° at Lyons, 68° in London, and 69° at Stockholm, to 50° in the Hebrides. Maxima exceeding 70° in S.E., between 55° and 65° elsewhere.

Wind between W. and S. on the continent generally, and over the S.E. of England, and westerly at our western stations, but northerly on our other coasts. Moderate in force in most places, but fresh in the S.W.

Sea rough off the Scillys and Hebrides.

Barometer rising briskly in the N. and falling elsewhere. Area of high pressure over the Mediterranean, with large depression near Christiansund and smaller one over eastern England. Pressure increasing slowly all day.





Friday, May 28.

Weather fine in nearly all parts of these Islands and the W. of France, cloudy elsewhere, with rain at Flushing and Brussels. Rain falling on our N.W. coasts during the day, with thunderstorms in the S.E.

Temperature risen in the S.W., fallen elsewhere, very considerably in the S.E. of England and over the Netherlands. Readings uniform, ranging from 55° in the S.W. and S.E. to 48° at Nairn. Maxima lower than on 27th, between 63° and 65° generally.

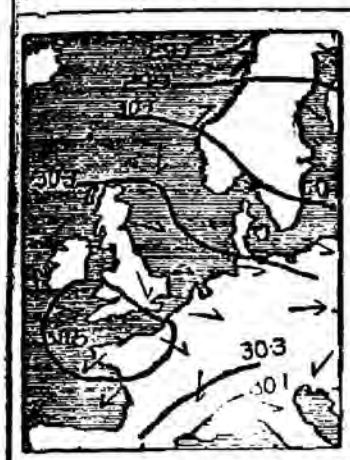
Wind westerly all over these Islands, the North Sea, and the Channel, north-westerly in France, and south-westerly in Sweden. Moderate in force except in the W. Wind veering to W.N.W. later, and freshening a little.

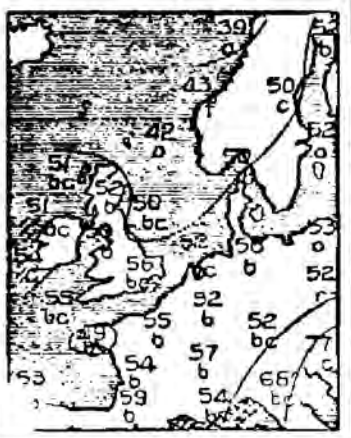
Sea rough at Scilly and Mullaghmore.

Barometer rising over the whole of western Europe, but falling in Sweden. Large area of high pressure off our S.W. coasts and large depression over Sweden. Pressure increasing all day.

Synoptic Weather Charts.—8 a.m.

BAROMETER AND WIND. | CLOUD, RAIN, SEA, AND TEMPERATURE.





Weather during the 24 hours succeeding the date of the Charts.

Saturday, May 29.

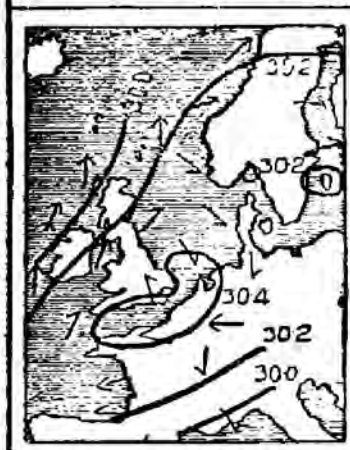
Weather exceedingly fine except in Scandinavia, the extreme N. of Scotland, and at Valentia. Sky clouding over in the W. later, with heavy rain in Ireland, but remaining nearly clear elsewhere.

Temperature fallen a little very generally—most in the N.E.—readings ranging from 57° at Dover to 42° in the Shetlands. Thermometer falling in the E. during the day, and maxima rather low.

Wind moderate south-south-easterly in the S. of Ireland and south-westerly in the N. of that country, westerly to north-westerly over Great Britain and the Channel, north-easterly in France, and south-westerly in Norway. Southerly wind in the W., extending during day, and increasing at Valentia.

Sea rough off the W. of Ireland.

Barometer rising at all stations except Toulon and Valentia. Large anticyclone over our south-western stations and the N.W. of France, with low pressures over the Gulf of Lyons and Lapland. Pressure decreasing briskly in the W. later.



Sunday, May 30.

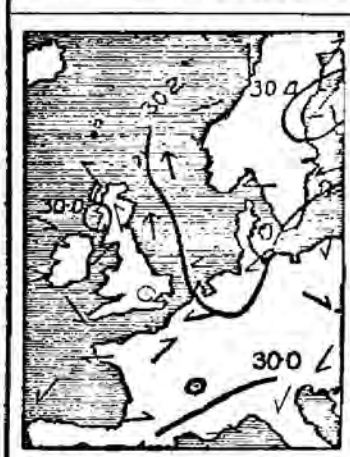
Weather very fine over France, the Netherlands, and the S.E. of England, but dull and unsettled in the W., with rain in Ireland. Sky clear in extreme S.E. all day, but overcast with rain in the W.

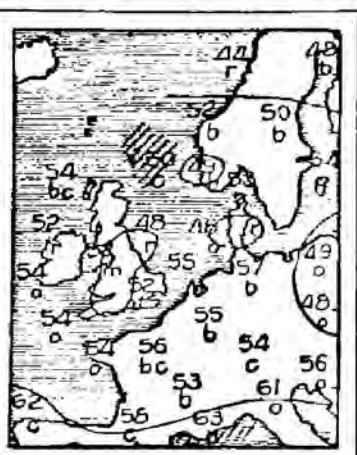
Temperature risen slightly generally; readings ranging from 62° in London to 48° in the Shetlands. Maximum 69° at Nottingham, but between 55° and 65° elsewhere.

Wind easterly over France, and north-westerly in the countries to the eastward of the North Sea, but southerly over the whole of these Islands, blowing strongly in W. Ireland. Wind veering westward in Ireland later, but remaining southerly over Great Britain.

Sea rough in the W. and N.

Barometer risen quickly over Scandinavia, fallen elsewhere. Anticyclone lying over the Channel and N. of France, with large depression off our N.W. coasts. Pressure giving way all day.





Monday, May 31.

Weather fine over the greater part of the continent, on our extreme S.E. coasts, and in N. Scotland, dull and rainy in other parts of these Islands and in W. France. Fine on our N. and E. coasts all day, rainy elsewhere.

Temperature fallen over England, risen slightly in most other places; readings uniform, ranging over these Islands from 47° to 54°. Low all day, only exceeding 60° at Nairn, Oxford, and Cambridge.

Wind varying considerably, north-easterly over the Baltic and the Netherlands, and easterly in France, but westerly in Ireland, and southerly in England and Scotland. Blowing freshly in the N.E. of England, but light generally. Easterly and south-easterly breezes appearing later.

Sea rough round the Shetlands.

Barometer rising slowly over Scandinavia and the N. of these Islands, falling elsewhere,—quickly over France. High pressure over the Baltic, with depressions over our western coasts and the Gulf of Lyons. Barometer rising in the N., and falling in the S. later.

Explanation of Charts.—The two Charts for each day show the general condition of the weather over Western Europe at 8 a.m. In the left-hand Chart the height of the barometer is expressed by "isobars," the value of each line being given in figures. The prevalent winds are shown by arrows, which are drawn flying *with the wind*, the force being indicated thus: ⟫⟶ = a heavy gale; ⟩⟶ = a gale; ⟶ = a fresh to strong breeze; ⟶ = a light to moderate breeze; and ⊙ = a calm. In the right-hand Chart the weather is indicated as follows:—b = blue sky; c = detached clouds; o = overcast; m = misty (hazy); f = foggy; q = squally; r = rain h = hail; s = snow; l = lightning; and t = thunder. The general distribution of temperature is shown by "isotherms," and the readings at certain places are given in figures. Diagonal lines = rough sea, the shading being proportional to the disturbance.

Values for each Station in Scotland, N. and the Channel Islands.

Districts.	Names of Stations.	Temperature. Highest observed.	Lowest observed.	Average for the Week.	Difference from the Mean.	Rainfall. No. of Days with Rain.	Total fall in the Week.	Difference from the Mean.	Bright Sunshine. No. of Hours recorded.	Percentage of possible Duration.
		°	°	°	°		Inches.	Inches.		
Scotland, N.	Sumburgh Head	54	39	47·5	−1·5	4	0·28	−0·01	*	*
	Stornoway	58	38	48·2	−2·5	5	0·57	−0·04	120	56
	Wick	59	37	49·9	−1·6	3	0·61	+0·35	*	*
Channel Islands	Scilly (St. Mary's)	62	48	54·1	−3·8	5	1·62	+1·30	*	*
	Jersey (Noirmont)	77	45	56·8	−0·2	4	0·38	−0·02	109	67

The above observations made in "Scotland, N." and the "Channel Islands" are not included in the Summary on page 1.

The data from which the summary on page 1 has been calculated, are as follow:

Districts.	Names of Stations.	Temperature. Highest observed.	Lowest observed.	Average for the Week.	Difference from the Mean.	Rainfall. No. of Days with Rain.	Total fall in the Week.	Difference from the Mean.	Bright Sunshine. No. of Hours recorded.	Percentage of possible Duration.
		°	°	°	°		Inches.	Inches.		
1. SCOTLAND, E.	Nairn	64	40	52·9	+1·0	2	0·09	−0·30	*	*
	Aberdeen	64	40	51·5	−1·5	2	0·56	+0·12	52	44
	Glendimond	59	34	48·4	−4·8	3	1·10	?	44	38
	Leith	62	40	52·2	−1·1	3	0·05	−0·34	*	*
2. ENGLAND, N.E.	Shields	64	40	51·0	−3·6	3	0·77	+0·37	*	*
	Durham	65	36	49·8	−4·2	3	0·89	+0·48	53	46
	York	66	40	52·3	−2·9	4	1·72	+1·31	46	40
	Spurn Head	66	45	52·3	−2·7	4	0·55	?	*	*
	Kelstern (Lincolnsh.) ℔	68	38	51·2	−4·4	4	0·61	+0·24	41	36
3. ENGLAND, E.	Hillington ℔	75	37	53·6	−3·4	4	0·73	+0·44	42	37
	Yarmouth	75	40	54·9	−1·2	3	0·26	−0·19	*	*
	Cambridge	82	38	56·7	−0·3	3	0·24	−0·15	40	36
	Rothamsted	79	34	54·0	−3·3	5	0·53	+0·08	*	*
4. MIDLAND COUNTIES	Bawtry (Hesley Hall)	68	35	52·2	−3·3	5	1·48	+1·03	*	*
	Nottingham	73	37	53·8	−2·2	4	1·05	+0·55	*	*
	Loughborough	71	37	53·2	−3·5	5	0·70	+0·17	*	*
	Leicester	69	38	53·5	−3·5	6	0·77	+0·27	?	?
	Birmingham (Oscott)	69	38	52·1	−4·8	5	1·19	+0·64	*	*
	Shrewsbury ℔	66	30	49·7	−7·2	6	2·42	+2·01	*	*
	Church Stoke ℔	62	35	49·7	−7·3	5	2·37	?	34	30
	Hereford ℔	70	36	52·5	−4·4	5	1·88	+1·46	*	*
	Cirencester	70	35	52·4	−4·8	5	0·65	+0·15	41	37
	Oxford	71	41	54·9	−3·4	4	0·63	+0·23	?	?
5. ENGLAND, S.	London	86	40	57·7	+0·7	2	0·21	−0·21	49	44
	Marlborough ℔	71	35	53·2	−4·1	4	0·45	−0·02	*	*
	Strathfield Turgiss ℔	79	33	54·1	−2·9	4	0·27	−0·08	*	*
	Dover	67	44	55·5	−0·3	2	0·29	−0·17	*	*
	Hastings (St Leonard's)	74	45	56·0	0·0	1	0·02	−0·31	*	*
	Southampton	72	39	54·8	−2·5	4	0·25	?	52	47
	Hurst Castle	63	43	53·8	−2·6	4	0·27	?	*	*
6. SCOTLAND, W.	Laudale (Loch Sunart)	61	37	49·4	−3·4	6	1·60	?	*	*
	Glasgow	59	40	50·9	−2·9	4	0·32	−0·28	34	29
	Ardrossan	57	44	51·1	−2·7	5	0·16	−0·05	*	*
	Silloth (Cumberland)	61	37	51·9	−2·1	5	0·38	−0·03	40	34
	Douglas (Isle of Man)	58	41	49·9	−4·5	4	0·27	−0·12	38	33
7. ENGLAND, N.W.	Barrow-in-Furness	59	38	50·8	−4·5	5	1·07	?	*	*
	Stonyhurst	60	37	50·1	−5·2	5	1·56	+0·96	46	40
	Blackpool ℔	59	36	51·5	−3·9	5	1·34	+0·93	*	*
	Manchester	60	39	49·3	−6·9	5	2·01	+1·59	*	*
	Liverpool Obsy (Bidston)	62	45	52·1	−3·9	4	1·81	+1·41	*	*
	Llandudno ℔	60	44	51·9	−3·9	4	1·46	?	36	32
	Holyhead	59	47	52·5	−2·5	4	0·87	+0·51	*	*
8. ENGLAND, S.W.	Pembroke	64	46	51·4	−5·3	4	1·57	+1·15	39	35
	Barnstaple	71	39	56·4	−0·9	4	1·40	+0·95	*	*
	Falmouth	63	46	53·3	−4·7	4	1·09	+0·41	45	41
	Plymouth	66	40	53·8	−3·7	4	0·77	+0·35	*	*
	Prawle Point	68	44	52·8	−4·9	4	0·40	?	*	*
9. IRELAND, N.	Londonderry	63	41	51·4	−3·1	6	0·77	+0·31	*	*
	Mullaghmore	61	43	52·1	−2·4	6	0·68	?	*	*
	Markree Castle	61	35	50·9	−4·1	6	1·10	+0·45	43	37
	Brookeborough	61	37	51·1	−3·6	6	0·70	?	*	*
	Armagh	61	40	51·2	−3·8	7	0·38	+0·05	48	42
	Donaghadee	61	39	50·8	−3·8	5	1·12	?	*	*
10. IRELAND, S.	Dublin	64	42	53·3	−1·7	6	0·59	+0·11	39	35
	Parsonstown	62	37	51·5	−3·7	6	0·49	−0·04	37	33
	Roche's Point	63	43	54·7	−1·3	5	1·07	+0·39	*	*
	Valentia	60	45	52·8	−3·2	5	1·15	+0·53	47	42
	Foynes	64	40	50·6	−4·9	5	0·42	?	*	*

Stations marked ℔ are in connection with the Meteorological Society.

* An asterisk is inserted in all places for which the information is not usually received.

Meteorological Office,
116, Victoria Street, S.W.

(Signed) ROBERT H. SCOTT,
Secretary.

APPENDIX XV.

DONATIONS RECEIVED DURING THE YEAR ENDING 31 MARCH 1880.

Presented by Societies, Institutions, &c.

Adelaide	Observatory - - -	Meteorological Observations, 1878.
Algiers - -	Service météorologique de l'Algérie.	Bulletin Météorologique. Résumé des observations, 1877–9. Saison pluvieuse, 1878–9. Tableau indiquant les quantités de pluie tombées quotidiennement, Sept. and Oct. 1878, Sept. to Dec. 1879, Jan. and Feb. 1880.
Allahabad -	Meteor. Reporter of the N.W. Provinces.	Report on the Rainfall of the N.W. Provinces and Oudh. Variations of Rainfall in Northern India.
Avignon -	Commission Météorologique du Département de Vaucluse.	Le Mont-Ventoux; notice par MM. Bouvier, Giraud et Pamard.
Batavia -	Observatory - -	Magnetic and Meteorological Observations, Vols. II. and III., 1869–75.
Berlin - -	K. Hydrographisches Bureau.	Annalen der Hydrographie und maritimen Meteorologie. Nachrichten für Seefahrer.
	K. Statistisches Bureau -	Preussische Statistik, No. 49: Monatliche Mittel des Jahrganges, 1878.
Bombay -	Colaba Observatory -	Views taken from the Colaba Observatory. Report on the Administration of the Meteorological Department in Western India for the year 1878–9. Report on the condition and proceedings of the Government Observatory for the year ended 30th June 1879. Brief sketch of the Meteorology of the Bombay Presidency in 1878.
Breslau -	K. Universitäts-Sternwarte.	Mittheilungen.
Brisbane -	Government Meteorological Reporter.	Reports for 1877 and 1878.
Brussels - -	Observatoire Royal -	Bulletin Météorologique. Courbes fournies par le météorographe graveur van Rysselberghe, 1879. Annales, 1878, pp. 29–58; 1879, pp. 9–72. Observations météorologiques faites aux stations internationales, 1878, pp. 33–56. Catalogue des ouvrages d'Astronomie et de Météorologie.
Calcutta - -	Meteorological Office -	Daily Weather Report. Abstract of Observations, 1879. Meteorological Telegraphic Reports. Weekly Reports of Rainfall. Results of Observations at Alipore, Feb. 1879—Feb. 1880. Abstract of Results of do. Weekly Weather Reports. Administration Report 1878–9. Report on the Madras Cyclone of May 1877. Report on the Meteorology of India, 1877. Indian Meteorological Memoirs, Vol. I., Part III. Meteorological and Hypsometrical Observations in Western Tibet, recorded by Dr. J. Scully; with a discussion by H. F. Blanford. (See also Blanford.)

Cape of Good Hope.	Meteorological Committee	Reports, 1875–1877.
Carlsruhe -	Meteorologische Central-Station.	Übersicht der Resultate, 1879. Jahresbericht, 1878.
Christiania -	Norske Meteorologiske Institut.	Meteorologisk Aarbog, 1877 and 1878. Norges klima. Oversigt over veir forholdene i Norge, 1878; by K. Hesselberg.
Coimbra -	Observatorio - - -	Observaçoes Meteorologicas e Magneticas, 1878, 1879.
Colombo (Ceylon).	Surveyor General's Office	Results of Meteorological Observations at Ceylon, 1878. Rainfall in Ceylon during 1877; and Means during different periods.
Copenhagen -	Danske Meteorologiske Institut.	Bulletin Météorologique du Nord. Meteorologisk Aarbog, 1877, Part II. 1878, Parts I. and II. Maanedsoversigt over vejr forholdene, March 1879 to February 1880. (See also Hoffmeyer.)
	K. Danske Videnskabernes Selskab.	Forhandlinger, 1878, 2; 1879, 1, 2.
Cork - -	Royal Institution -	Meteorological Observations, 1878.
Cracow -	K.K. Sternwarte - -	Meteorologische Beobachtungen, Mar. 1879 to Feb. 1880. Materyaly do Klimatografii Galicyi, 1878.
Dublin - -	General Register Office -	Weekly and Quarterly Returns.
Eberswalde (Prussia).	K. Förstakademie -	Jahresbericht, 1878. Beobachtungs-Ergebnisse, 1879.
Edinburgh -	Royal Society - -	Proceedings, Session 1878–9.
	Scottish Meteorological Society.	Journal, Nos. 57–59.
Falmouth -	R. Cornwall Polytechnic Society.	Annual Report, 1878.
Fiume - -	I. e R. Accademia di Marina.	Osservazioni delle Statione Meteorologica, 1879.
Frankfort o/M	Physikaliches Verein -	Jahresbericht, 1877–8.
Geneva - -	Bibliothèque Universelle	Archives des Sciences; Troisième Période, Vol I., Nos. 4–6; Vol. II. and Vol. III., Nos. 1–3.
	Société Géographique -	Le Globe, Vol. XVIII.
Gotha -	Geographische Anstalt -	Mittheilungen. Ergänzungsheft, Nos. 57–59.
Greenwich -	Royal Observatory - -	Weekly Returns to the Registrar-General. Daily Weather Report. Magnetical and Meteorological Observations, 1876, 1877. Report to the Board of Visitors, 7th June 1879.
Guatemala -	Observatorio - - -	Observaciones Meteorologicas, March—Dec. 1879.
Hamburg -	Seewarte - - -	Wetterbericht. Monatliche Übersicht der Witterung, March—Dec. 1878. Rapport de la Conférence Polaire Internationale tenue à Hambourg; with Protocols of do. (See also Neumayer.)
Helsingfors -	Société des Sciences -	Observations Météorologiques, 1874–1877. Forhandlingar. Vols. XVIII.–XXI.
Hobarton -	Royal Society of Tasmania	Meteorological Observations, 1879. Results, 1878. Synchronous Observations, Jan. to Oct. 1878. Report, 1877.

Hong Kong -	Government Lock Hospital	Meteorological Observations in Victoria, 1879.
	Harbour Office - -	China Coast Meteorological Register, Feb. 1879 to Feb. 1880. Meteorological observations taken at various stations, Sept. 1878 to Jan. 1880.
Kew - -	Observatory -	Report for year ending 31st Oct. 1879. (See also Whipple.)
Kiel - -	Ministerial-Commission zur Untersuchung der deutschen Meere.	Ergebnisse der Beobachtungs-Stationen, June 1878 to Nov. 1879.
Kremsmünster	Sternwarte - - -	Resultate der meteorologischen Beobachtungen, 1861, 1876, 1877, and M.S. Tables for 1879.
Lahore -	Sanitary Administration of the Punjab.	Report, 1877.
Leicester -	Literary and Philosophical Society.	Transactions, Part V. Report, 1878. Report of the Museum Committee to 31st March 1879.
Leipzig -	Sternwarte - -	Meteorologische Beobachtungen in Deutschland angestellt an 17 Stationen II. Ordnung, 1877. Monatliche Berichte über die Resultate, aus den meteor. Beobachtungen angestellt an 25 k. sächsischen Stationen im Jahre, 1878. Resultate der meteor. Beobachtungen in Leipzig im Jahre 1878. Resultate aus den meteor. Beobachtungen angestellt an 25 k: sächsischen Stationen in den Jahren 1874, 1875. (See also Bruhns.)
Lisbon - -	Observatory - - -	Boletim meteorologico, 1879. Observaçoes das estaçoes internacionaes Portuguezas, 1878, 1879. Annaes, Vol. XV., 1877. Postos Meteorologicos, 1876, Part II. (See also Capello.)
London - -	Admiralty - - -	Hydrographic Notices. Wind and Current Charts for the Pacific, Atlantic, and Indian Oceans. Sun's true bearing or Azimuth Tables. Tide Tables, 1880.
	Army Medical Department	Report, 1878.
	Board of Trade - -	Abstract of the Returns of Sea-Casualties, &c. from July 1877 to June 1878.
	British Association - -	Report 1878, 1879.
	Colonial Office - -	Returns from various Colonies.
	India Office - - -	Returns from various Observers in India.
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Winstanley, D., F.R.A.S. -	The Radiograph.
Woeikof, A. - -	Remarques sur les Isobares de Janvier et de Juillet. (See also Smithsonian Institution.)
Young, Capt. T. - -	Results of meteorological observations at Futuna, New Hebrides, South Pacific, 1867–1876, by J. Copeland, Missionary.
Zenger, Prof. K. W. -	Über den Ursprung und die Periode der Stürme.

APPENDIX XVI.

Meteorological Office: Account of Receipts and Payments for the year ending 31st March 1880.

Receipts.	£	s.	d.
Balance from year 1878–9	1,727	5	1
Parliamentary Vote	14,500	0	0
Repayment of expenses charged under—			
(1.) Incidental expenses	4	18	3
(2.) Special researches (Hoffmeyer's charts and Sun apparatus)	16	15	6
Supply of Information:			
Special reports for "Times," "Standard," and "Daily News" — £ 867 0 8			
D.W. Charts and ordinary Forecasts — 357 8 2			
Telegrams — 308 5 4			
Ordinary weather information for Press Agencies, &c. — 149 6 5			
	1,622	0	7
Subscriptions for "Hourly Observations"	3	0	0
Ocean Statistics (India Office, &c.)	374	15	10
Miscellaneous data	5	7	0
Sale of Instruments, &c.:			
Royal Navy account (A) — 38 5 11			
Mercantile Marine do. (B) — 75 7 8			
	113	13	7
Commissions executed for Colonial and Foreign Institutions, &c. (C)	234	9	1
Commission charged on work done for Colonies, &c.	13	10	9
	£18,615	15	8

Payments.	£	s.	d.	£	s.	d.
Administration:						
Payment of Council	1,000	0	0			
Secretary	800	0	0			
Salaries and wages	712	1	0			
Rent, fuel, and lighting	778	12	8			
Incidental and contingent expenses:-						
Attendance, cleaning, &c.	314	12	4			
Alteration of premises, furniture, and fittings	212	3	1			
Expenses incidental to International Meteorological Congress	104	8	1			
				3,921	17	2
Special Researches and Experiments				1,100	14	5
Land Meteorology:						
Observatories and stations	2,432	15	10			
Discussion and reduction of observations	1,406	17	8			
				3,839	13	6
Weather Information and Forecasts:						
Telegraphic reports and storm warnings	3,368	2	10			
Preparation and issue of reports and forecasts	1,405	13	2			
				4,773	16	0
Inspections:						
Salaries and travelling expenses				523	11	3
Ocean Meteorology:						
Discussion and reduction of observations	1,819	10	5			
Expenses incidental to the supply of instruments:—						
Care and issue of instruments	200	0	0			
Royal Navy	240	4	11			
Mercantile Marine	524	1	11			
Distant island and coast stations	29	0	5			
				2,812	17	8
Commissions executed for Colonial and Foreign Institutions, &c.				311	19	10
				17,284	9	10
Balance:						
Cash in hand	169	8	2			
Bank of England	1,111	17	8			
Advance to Valencia Observatory	50	0	0			
				1,331	5	10
				£18,615	15	8

APPENDIX XVII.

LIST OF PUBLICATIONS, &c. issued by the Meteorological Office.

OFFICIAL.

No. 1. Report for 1867. Presented to Parliament. 1*s.*

2. Instructions for Meteorological Telegraphy. New Edition. (1875.) 6*d.*

3. Fishery Barometer Manual. 6*d.*

4. Charts of Surface Temperature, South Atlantic Ocean. 2*s.* 6*d.*

5. Report for 1868. Presented to Parliament. 5*d.*

6. Report for 1869. Presented to Parliament. 10*d.*

7. Quarterly Weather Report for 1869.—Parts I. to IV. 5*s.* each.

8. The Barometer Manual (out of print, see No. 40).

9. Quarterly Weather Report for 1870.—Parts I. to IV. 5*s.* each.

10. Report for 1870. Presented to Parliament. 10*d.*

11. Contributions to our Knowledge of the Meteorology of Cape Horn and the West Coast of South America. 2*s.* 6*d.*

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. 2*s.* 6*d.*

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, 5*s.*

14. Quarterly Weather Report for 1871.—Parts I. to IV. 5*s.* each.

15. Report for 1871. Presented to Parliament. 10*d.*

16. Quarterly Weather Report for 1872.—Parts I. to IV. 5*s.* each.

17. Report for 1872. Presented to Parliament. 1*s.*

18. Contributions to our Knowledge of the Meteorology of the Antarctic Regions. 2*s.*

19. Quarterly Weather Report, 1873.—Parts I. to IV. 5*s.* 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. 20*s.*

21. Report of the Proceedings of the Meteorological Congress at Vienna. 1*s.*

22. Report for 1873. Presented to Parliament. 4*d.*

23. Report of the Proceedings of the Conference on Maritime Meteorology held in London, 1874. 2*s.*

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

No. 24. Instructions in the Use of Meteorological Instruments. 2*s.* 6*d.*

25. Quarterly Weather Report for 1874.—Parts I., II., and IV. 5*s.* each. Part III., 5*s.* 9*d.*

26. Report for 1874. Presented to Parliament. 6*d.*

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. 24*s.*

28. Contributions to our Knowledge of the Meteorology of Japan. By Staff-Commander Thomas H. Tizard, H.M.S. *Challenger.* 1*s.*

29. Report for 1875. Presented to Parliament. 4*d.*

30. Quarterly Weather Report for 1875.—Parts I., II., III., and IV. 5*s.* each.

31. Report for 1876–7. Presented to Parliament. 3*s.* 5*d.*

32. A Discussion of the Meteorology of the North Atlantic during August 1873, with 31 Synoptic Charts. 15*s.*

33. Quarterly Weather Report for 1876.—Part I. [In the Press.]

34. Contributions to our Knowledge of the Meteorology of the Arctic Regions.—Part I. 2*s.* Part II. 10*s.*

35. Report for 1877–8. 1*s.*

36. Report of the Proceedings of the Meteorological Congress at Rome, 1879. 1*s.* 6*d.*

37. Report on the Meteorology of Kerguelen Island. By the Rev. S. J. Perry, S.J., F.R.S. 3*s.*

38. Report for 1878–9. 5*d.*

39. Meteorological Observations at Stations of the Second Order for the year 1878. 20*s.*

40. Aids to the Study and Forecast of Weather, by the Rev. W. Clement Ley, M.A. 1*s.*

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. 6*d.*

2. Report to the Committee on the Meteorology of the North Atlantic.—By Captain H. Toynbee, Marine Superintendent. 1*s.*

3. Report to the Committee on the Use of Isobaric Curves.—By Captain H. Toynbee, Marine Superintendent. 1*s.*

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. 6*d.*

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

No. 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. 6*d.*

6. Report of the Proceedings of the Meteorological Conference at Leipzig. 1*s.*

7. Notes on the Form of Cyclones in the Southern Indian Ocean.—By C. Meldrum, Esq., M.A., F.R.S. 6*d.*

8. Report on Weather Telegraphy and Storm Warnings. Presented to the Meteorological Congress at Vienna. 6*d.*

9. Report of the Permanent Committee of the Vienna Congress for 1874. 1*s.* 6*d.*

10. On the Physical Geography of the 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. 1*s.* 6*d.*

11. Report of the Permanent Committee of the Vienna Congress for 1876. 2*s.*

12. Reports to the Permanent Committee of the Vienna Congress on Atmospheric Electricity, Maritime Meteorology, and Weather Telegraphy, 1878. 2*s.*

13. Report of the Permanent Committee of the Vienna Congress for 1878. 6*d.*

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