14

THE KEW OBSERVATORY,

RICHMOND, SURREY.

1884.

REPORT

OF THE

KEW COMMITTEE

FOR THE

Year ending October 31, 1884,

WITH APPENDICES CONTAINING RESULTS OF MAGNETICAL, METEOROLOGICAL, AND SOLAR OBSERVATIONS MADE AT THE OBSERVATORY.

[*From the* PROCEEDINGS OF THE ROYAL SOCIETY, 1884.]

LONDON:
HARRISON AND SONS, ST. MARTIN'S LANE,
Printers in Ordinary to Her Majesty.
1884.

Report of the Kew Committee for the Year ending October 31, 1884.

The operations of The Kew Observatory, in the Old Deer Park, Richmond, Surrey, are controlled by the Kew Committee, which is constituted as follows:

Mr. Warren De La Rue, *Chairman.*

Captain W. de W. Abney, R.E.	Vice-Adm. Sir G. H. Richards. C.B.
Prof. W. G. Adams.	The Earl of Rosse.
Capt. Sir F. Evans, K.C.B.	Mr. R. H. Scott.
Prof. G. C. Foster.	Lieut.-General W. J. Smythe.
Mr. F. Galton.	Lieut.-Gen. R. Strachey, C.S.I.

Mr. E. Walker.

The work at the Observatory may be considered under the following heads:—

1st. Magnetic observations.
2nd. Meteorological observations.
3rd. Solar observations.
4th. Experimental, in connexion with any of the above departments.
5th. Verification of instruments.
6th. Rating of Watches.
7th. Miscellaneous.

I. Magnetic Observations.

The Magnetographs have worked uninterruptedly throughout the year.

The curves have been quite free from any large fluctuations, and indeed no unusual disturbance has been registered for a long time past. The most notable perturbations recorded took place on July 3, September 18, and October 2, but the extreme oscillation of the Declination Magnet on any of these days did not exceed 30′, while the change of Horizontal Force was less than 0·02, Gaussian unit.

The values of the ordinates of the different photographic curves determined in January were as follows :—

Declination : 1 inch=0° 22′·04. 1 mm.=0° 0′·87.

Bifilar, January 4, 1884, for 1 inch δH=0·0276 foot grain unit.
,, 1 mm. ,, =0·0005 mm. mgr. unit.
Balance, January 4, 1884 ,, 1 inch δV=0·0251 foot grain unit.
,, 1 mm. ,, =0·0005 mm. mgr. unit.

The distance between the dots of light upon the cylinders of both the Bifilar and Vertical Force Magnetometers having become too small for satisfactory registration, it was found necessary to readjust each instrument, after which the scale values were again determined on January 11th, with the following results :—

Bifilar for 1 inch δH=0·0267 foot grain unit.
,, 1 mm. ,, =0·0005 mm. mgr. unit.
Balance ,, 1 inch δV=0·0296 foot grain unit.
,, 1 mm. ,, =0·0005 mm. mgr. unit.

The tabulation referred to in last year's Report of the traces of the three magnetic elements for the International Polar Commission, is now completed, and the conversion of the results into absolute units is in an advanced stage.

The difficulty experienced in adapting ordinary unprotected gas burners to the Bifilar and Balance Magnetometers, owing to the extremely sensitive nature of the gelatino-bromide paper, has now been overcome by the use of a small screen of blue glass interposed between the flame and mirror. This diminishes the intensity of the light, so that the traces are now well defined instead of being blurred.

Information on matters relating to terrestrial magnetism, and various data, have been supplied to Dr. Wild, General Tillo, Dr. Frolich, Admiral Sir G. Richards, and Dr. Balfour Stewart.

The various magnetic instruments returned by Captain Dawson, R.A., on his arrival in this country from the Fort Rae Circumpolar Expedition, were lent, with the exception of the Balance Magnetometer, one Bifilar, and one Declinometer, to Lieutenant A. Gordon, R.N., of the Meteorological Office, Canada.

Professors Rücker and Thorpe visited the Observatory on July 17, 18, and 19, for the purpose of taking a series of absolute magnetic observations preparatory to surveying the western coast of Scotland, as a preliminary operation towards the proposed repetition of the Survey of Great Britain and Ireland mentioned in last Report.

The monthly observations with the absolute instruments have been made as usual, and the results are given in the tables forming Appendix I of this Report.

The following is a summary of the number of magnetic observations made during the year:—

Determinations of	Horizontal Intensity	35
,,	Dip	164
,,	Absolute Declination	63

Soon after the needles of Dip Circle Barrow 33 had been repolished, as mentioned in last Report, it was found that No. 1 worked somewhat indifferently, and on examining its axle slight marks of scoring were discovered. It was therefore deemed advisable to have a new axle substituted. This was accordingly done by Mr. Dover, in December last, and since then the performance of the needle has been satisfactory.

II. Meteorological Observations.

The several self-recording instruments for the continuous registration respectively of atmospheric pressure, temperature, and humidity, wind (direction and velocity), bright sunshine, and rain, have been maintained in regular operation throughout the year.

The standard eye observations for the control of the automatic records have been duly registered during the year, together with the daily observations at 0 h. 8 m. P.M. in connexion with the U.S. Signal Service synchronous system. A summary of these observations is given in Appendix II.

The tabulation of the meteorological traces has been regularly carried on, and copies of these, as well as of the eye observations, with notes of weather, cloud, and sunshine have been transmitted weekly to the Meteorological Office.

The following is a summary of the number of meteorological observations made during the past year:—

Readings of	standard barometer	1726
,,	dry and wet thermometers	3452
,,	maximum and minimum thermometers	732
,,	radiation thermometers	1923
,,	rain gauges	732
Cloud and weather observations		1882
Measurements of	barograph curves	8784
,,	dry bulb thermograph curves	9516
,,	wet bulb thermograph curves	8784
,,	wind (direction and velocity)	17568
,,	rainfall curves	576
,,	sunshine traces	2073

In compliance with a request made by the Meteorological Council

to the Committee, the Meteorological instruments at the Observatories of Armagh, Falmouth, Oxford (Radcliffe), and Valencia have been inspected by Mr. Whipple, and those at Aberdeen and Stonyhurst by Mr. Baker, during their respective vacations.

Assistance has also been given in arranging the plans, designs, &c., for the New Observatory, now in progress of erection at Falmouth.

With the concurrence of the Meteorological Council, weekly abstracts of the meteorological results have been regularly forwarded to, and published by "The Times" and "The Torquay Directory." Data have also been supplied to the Council of the Royal Meteorological Society, the editor of "Symons's Monthly Meteorological Magazine," the Secretary of the Institute of Mining Engineers, Messrs. Gwilliam, Mawley, Rowland, and others. The cost of these abstracts is borne by the recipients.

The weekly abstracts of meteorological results, which have been published by the "Illustrated London News" without interruption since 1856, were discontinued in July last, at the request of the proprietors, owing to changes being introduced in the form of publication of the paper.

Electrograph.—This instrument was temporarily dismounted in May, whilst some repairs and painting of the instrument room were in progress, and recently some trouble has been experienced in keeping the potential of the charge constant, otherwise it has been maintained in continuous action.

The tabulation of the curves is at present in arrear, not having been completed beyond February 28, 1882.

Its scale value has been redetermined on two occasions by means of the Portable Electrometer, White No. 53, such determinations being necessary after every readjustment of the instrument.

III. Solar Observations.

The sketches of Sun-spots, as seen projected on the photoheliograph screen, have been made on 185 days, in order to continue Schwabe's enumeration, the results being given in Appendix II, Table IV.

A few experiments were made in June with the Photoheliograph, with a view of testing the suitability of certain plates prepared by Messrs. Morgan and Kidd for solar photography. With this exception nothing has been done in that branch during the year.

Transit Observations.—Frequent observations of both solar and sidereal transits have been made, for the purpose of keeping correct local time at the Observatory.

Numerous clock and chronometer comparisons have been also made. The Observatory Chronometers, Parkinson and Frodsham No. 2408, and Molyneux No. 2125, have been cleaned and readjusted,

and the following clocks are kept carefully rated in addition as time-keepers of the Observatory:—French; Shelton K. O.; Shelton No. 35; and Dent 2011. By the courtesy of Mr. Preece, Superintendent of Telegraphs, the Richmond Chief Post Office was placed in direct communication with the Royal Observatory, Greenwich, on January 22, and enabled to receive the time signal at 10 A.M., when a period of cloudy weather had rendered the true time a little uncertain. Two chronometers conveyed to the Post Office, showed, on comparison with the signal, a satisfactory agreement between the times as kept at the two Observatories.

IV. Experimental Work.

Actinometry.—A report on the Balfour Stewart actinometer observations made last year, was submitted in December to the Meteorological Council, at whose expense the observations were carried on, and it was resolved to discontinue them. The instrument has since been returned to Professor Balfour Stewart at his request.

Fog Gauge.—In conformity with a suggestion contained in an article in "Symons's Meteorological Magazine," vol. xviii, p. 58, a painted board has been set up to the north of the Observatory, to serve as a gauge for measuring the intensity of fogs.

Since its erection in January last no fog, however, has been observed of intensity 1 on its scale.

Magnetic Survey of Great Britain and Ireland.—With reference to this, the Sub-Committee appointed last year has now under consideration the details necessary for the early prosecution of the survey.

Professors Rücker and Thorpe have during the past summer made preliminary observations at a number of stations along the West Coast of Scotland, their base observations being made at the Observatory as above stated.

Nocturnal Radiation.—Experiments have been made with a new pattern thermometer, designed by Messrs. Negretti and Zambra for observations of nocturnal terrestrial radiation, with a view to the avoidance of several serious defects in the Rutherford Minimum, now generally used. Very favourable results were obtained until the instrument was damaged, and had to be sent back to the makers. It has not yet been returned to the Observatory.

Photo-nephograph.—Various experiments have been made with this apparatus during the year, but in consequence of the short base line obtainable with the small amount of connecting wire available for working the pair of cameras, very few satisfactory determinations of cloud altitudes have been made.

A report having, however, been submitted to the Meteorological Council, that body has granted a sum of 40*l.* to the Committee

for the purpose of purchasing a half-mile of double wire telegraphic cable and reel, together with switches and keys, in order that the two cameras may be worked at a distance of 800 yards apart.

A stand has been erected on the roof of the Observatory, where camera A will be permanently placed, and camera B will be similarly supported by another permanent stand at the other end of the cable. Both cameras being oriented with reference to the same point of the horizon, the distant observer will be instructed as to the direction and elevation of his instrument by means of a telephone switched on to the line for the purpose.

Some difficulties having been met with in working the electrical instantaneous shutters, part of the apparatus was returned to the makers, the Philosophical Instrument Construction Society, Cambridge, and rectified.

Experiments with the new arrangement are now being made, and should they prove successful it is intended to bury the cable in the ground across the park beside the Observatory gas main, thereby obviating the present necessity of laying out and winding it in again every time it is desirable to make cloud altitude and air-current motion determinations.

Solar Radiation Thermometers.—The experiments with a view to determining the causes of variation in the readings of similarly constructed and exposed black bulb thermometers, *in vacuo*, have been continued during the year.

The first series of observations having been concluded, and the results communicated to the Royal Meteorological Society and published in their "Quarterly Journal," vol. x, p. 45, the six thermometers were returned to Messrs. Negretti and Zambra, in order that all might have their bulbs coated with three coats of lampblack and their jackets altered: one pair is now enclosed in small bulbs, a second pair in medium, and the third pair in large bulbs.

With the exception of one which was accidentally broken in July, they have been read daily since May 3. The results have not yet been fully discussed, but a cursory inspection appears to indicate that the larger the containing bulb the lower is the reading of the enclosed blackened bulb thermometer.

Ventilation Experiments.—Assistance has been given to a Sub-Committee of the Sanitary Institute in their experiments on the motion of air in ventilating tubes, which have been carried on during the summer under the charge of Mr. R. Rymer Jones, C.E., in a hut erected for the purpose, adjacent to the Observatory.

The experiments are in continuation of those prosecuted in the Experimental House in 1880.

Wind Integrator.—At the request of Mr. Walter Baily, M.A., a wind-component integrator of his invention, described in the "Phil. Mag.,"

Vol. xvii, p. 482, has been erected in the Experimental House, being attached by permission of the Meteorological Council to their spare Beckley Anemograph.

Some difficulties were experienced on account of the unsuitability of the electrical counters fitted to it for registration of light winds, but these have now been overcome, and the instrument is working satisfactorily.

V. Verification of Instruments.

The following magnetic instruments have been verified, and their constants determined :—

3 Unifilar Magnetometers for Elliott Brothers, London.
3 Dip Circles for Elliott Brothers, London.
1 Unifilar Magnetometer for Negretti and Zambra, London.
1 Dip Circle for Negretti and Zambra, London.

There have also been purchased on commission and verified :—

A Unifilar Magnetometer and a Dip Circle for Professor Rücker, Leeds College of Science.
A small Robinson's Pattern Dip Circle for Senhor Capello, Lisbon.
2 Fox Circles with Gimbal Tables complete, for the United States Government.
6 small Collimating Magnets for Professor Tacchini, Rome.
One Pair of Dip Needles for the Greely Relief Expedition.
A Dip Circle for Dr. Wild, St. Petersburg.
A set of self-recording Magnetometers for the United States Government.
A Unifilar and a Pair of Dip Needles are at present undergoing examination.

The General Verification Department a continues in full activity, a considerable increase having taken place in the number of Sikes' Hydrometers and Sextants examined.

The total number of instruments tested in the past year was as follows :—

Barometers, Standard	44
,, Marine and Station	80
Aneroids	84
Total	208

Thermometers, ordinary Meteorological	1225
„ Standard	83
„ Mountain	164
„ Clinical	8726
„ Solar radiation	42
Total	10240

Hydrometers	1161
Anemometers	2
Rain Gauges	3
Sextants	64
Index and Horizon Glasses, unmounted	87
Dark Glasses, unmounted	254

Besides these, 13 Deep-sea Thermometers have been tested, 4 of which were subjected, in the hydraulic press, without injury, to pressures exceeding two tons on the square inch. 142 Thermometers have been compared at the freezing-point of mercury, making a total of 10395 for the year.

Duplicate copies of corrections have been supplied in 30 cases.

The number of instruments rejected on account of excessive error, or which from other causes did not record with sufficient accuracy, was as follows:—

Thermometers, clinical	40
„ ordinary meteorological	2
Various	27

10 Standard Thermometers have also been calibrated, and supplied to societies and individuals during the year.

A Thermograph has been examined, and had its scale values determined for the Japanese Government. A Richard Temperature Recorder, a Self-registering Aneroid, an Electrograph, and a Richard Humidity Recorder, have also been tried.

There are at present in the Observatory undergoing verification, 32 Barometers, 742 Thermometers, 14 Hydrometers and 10 Sextants.

VI. Rating of Watches.

The arrangements for rating watches mentioned in last year's Report have been completed and brought into operation successfully, at a cost of £193.

A second safe having been purchased by the Committee, an apparatus was fitted to it which enables the enclosed watches to be maintained continuously at either high temperatures, without being subjected to injury by fumes of gas, or at low temperatures.

Two additional Mean Time Clocks have been obtained, one of them, a Transit of Venus Expedition Clock, Dent 2011, has been lent to the Committee by the Astronomer Royal; the other has been purchased. Mr. T. Mercer, watch manufacturer, of Coventry, having obligingly placed a number of watches at the disposal of the Superintendent, two dozen were obtained on loan from him, and were daily compared, tested, and rated by the assistants for three months. This enabled them to become familiarized with the work of rating before watches were received from the public.

The Superintendent, after communicating with the Directors of the Geneva and the Yale Observatories, prepared a circular specifying the conditions watches must fulfil in order to obtain certificates of the various classes, A, B, and C, which are issued, and the nature of the test to which they will be subjected. This circular, together with the forms of certificates, &c., after revision and approval by the Committee, was printed, and copies forwarded to all the leading watch manufacturers of this country, as well as to the principal journals, many of which very favourably noticed the scheme.

Rating commenced on May 13, and up to the present 42 watches have been tried, of which 22 were submitted by the owners, and 20 by the manufacturers, or by dealers.

Certificates have been awarded to 17 of these watches, 7 are now on trial.

The following table will indicate the nature of the trials to which the certificates refer:—

Position of watch during test.	For certificate of Class		
	A.	B.	C.
Vertical, with pendant up	10 days	14 days	8 days
" " " right	5 "	—	—
" " " left	5 "	—	—
Horizontal, with dial up	5 "	14 days	8 days
" " " down	5 "	—	—
" at temp. 85° F.	5 "	1 day	—
" " 35° F.	5 "	1 "	—
Not rated	5 "	1 "	—
Total duration of test	45 days	31 days	16 days

VI. Miscellaneous.

Photographic Paper, &c.—This has been supplied to the Observatories at Batavia, Coimbra, Colaba, Mauritius, Stonyhurst, and St. Petersburg, and to the Meteorological Office.

Blank Magnetic Observation Forms have been supplied to Professors Brioschi and Rücker, also to Messrs. Negretti and Zambra.

A glass scale for measuring anemograph curves was constructed for the Royal Alfred Observatory, Mauritius.

Two glass scales graduated in millimeters for the purpose of tabulating magnetic curves were constructed for the Toronto Observatory, and also twelve paper scales were supplied for the magnetometers.

A level with spare bubbles has been supplied to Dr. E. van Rijckevorsel, and a hemi-cylindrical lens to Dr. Wild, St. Petersburg.

Exhibition.—A number of instruments of interest were exhibited at the Fifth Annual Exhibition of the Royal Meteorological Society, which was devoted to thermometers and thermometry, and held in the rooms of the Institution of Civil Engineers in March last.

International Health Exhibition.—The Committee exhibited specimens of the certificates issued with instruments verified at the Observatory, as well as diagrams showing the number of thermometers tested annually since 1870, and also indicating the improvement in quality of such instruments.

Workshop.—The several pieces of Mechanical Apparatus, such as the Whitworth Lathe and Planing Machine, procured by Grants from either the Government Grant Funds or the Donation Fund for the use of the Kew Observatory, have been kept in thorough order.

Library.—During the year the Library has received, as presents, the publications of—

31 English Scientific Societies and Institutions, and

76 Foreign and Colonial Scientific Societies and Institutions.

Several volumes of duplicates of works on Astronomy, Terrestrial Magnetism, and Meteorology, have been presented to the Electrical Library of the Franklin Institute, Philadelphia. Others have also been disposed of to various individuals.

Additional shelves have been provided to afford more room, which was urgently required.

House, Grounds, and Footpath.—These have all been kept in order during the year. The iron fencing round the building has been painted, a wall on each side of the entrance steps has been erected, and the necessary external repairs have been effected by Her Majesty's Commissioners of Works.

Personal Establishment.

The staff employed is as follows:—

G. M. Whipple, B.Sc., Superintendent.
T. W. Baker, Chief Assistant and Magnetic Observer.
J. Foster, Verification Department.

H. McLaughlin, Librarian and Accountant.
E. G. Constable, Solar Observations and Watch Rating
T. Gunter, Verification Department.
W. Boxall, Photography, and Tabulation.
E. Dagwell, Watch Rating „ „
C. Henley
H. A. Widdowson } Verification Department.
H. Barton
M. Baker, Messenger and Care-taker.

E. Coates resigned his duties in September.

C. Bell was temporarily employed in December as additional assistant in Verification Department.

Abstract. Kew Observatory Receipts and Payments Account from November 1, 1883, to November 1, 1884.

Dr. RECEIPTS.

	£	s.	d.
To Balance from 1882–83	547	4	11
Royal Society (Gassiot Trust)	494	4	10
Meteorological Office	400	0	0
Meteorological Office, for Postages, &c.	8	3	4
Verification Fees, Meteorological Office £86 19 6			
,, ,, Observatories and Institutions 57 18 6			
,, ,, Instrument Makers and others 614 6 11			
	759	4	11
Instruments on Commission	686	5	5
Sale of Waxed Paper	33	8	0
Standard Thermometers 18 19 6			
,, Forms, &c. 9 1 1			
Copying Registers 56 0 0			
	84	0	7
Experimental Work for Meteorological Office	19	0	7
International Circumpolar Committee	25	0	0
Watch Rating Fees, &c.	18	13	6
	£3075	6	1

PAYMENTS. *Cr.*

	£	s.	d.
By Salaries £1071 4 6			
Extra Payments 155 0 9			
	1226	5	3
Fuel and Gas 65 0 2			
Furniture and Fittings 11 19 4			
Chandlery, &c. 9 5 2			
Painting and Repairs 108 2 2			
Rent and Incidentals (Enclosure and Path) 24 2 1			
	218	8	11
Printing and Stationery (General) 25 2 9			
,, ,, (Verification Department) 14 15 0			
Postages 18 11 10			
Library 13 15 8			
Messenger and Housekeeper 57 4 0			
Porterage and Contingencies 22 7 5			
	151	16	8
Purchase of Chemicals and Materials 37 17 6			
,, ,, Tubes for Standard Thermometers 3 3 0			
,, ,, Anemograph Sheets 1 1 0			
Verification Department Expenses (Ice, Carbonic-Acid Gas, &c.) 20 10 9			
Repair of Instruments, and Purchase of New 14 12 4			
Carpenter's Work and Sundries 13 7 9			
	90	12	4
Postages and Payments on behalf of Meteorological Office	10	4	3
Instruments purchased on Commission	741	18	8
Purchase of Waxed Paper, Packing ditto, &c.	20	0	5
Payments on behalf of Experimental Work	7	10	3
,, ,, International Circumpolar Committee	16	0	3
,, ,, Watch Rating	110	2	1
Balance—Bank of England 411 8 6			
London and County Bank 55 0 0			
Cash in hand 15 18 6			
	482	7	0
	£3075	6	1

November 13, 1884. Examined and compared with the Vouchers, and found correct. (Signed) FRANCIS GALTON, *Auditor.*

ASSETS.

	£	s.	d.
By Balance as per Statement	482	7	0
Meteorological Office, Allowances and Sundries	38	1	5
Verification Fees due	80	15	0
Watch Rating Fees due	1	6	3
Photographic Paper	44	15	4
Commissions, &c.	12	12	5
Blank Forms	8	10	0
Standard Thermometers	91	4	0
International Circumpolar Committee	8	19	9
	£768	11	2

LIABILITIES.

	£	s.	d.
To Gas, Fuel, and House Account	8	7	8
Apparatus, Chemicals, &c.	3	16	4
Commissions, &c.	11	1	0
Balance	745	6	2
	£768	11	2

November 13, 1884. (Signed) G. M. WHIPPLE.

APPENDIX I.

Magnetic Observations made at the Kew Observatory, Lat. 51° 28′ 6″ *N. Long.* 0^h 1^m 15^s·1 *W., for the year October* 1883 *to September* 1884.

The observations of Deflection and Vibration given in the annexed Tables were all made with the Collimator Magnet marked K C 1, and the Kew 9-inch Unifilar Magnetometer by Jones.

The Declination observations have also been made with the same Magnetometer, Collimator Magnets 101 B and N E being employed for the purpose.

The Dip observations were made with Dip-circle Barrow No. 33, the needles 1 and 2 only being used; these are 3½ inches in length.

The results of the observations of Deflection and Vibration give the values of the Horizontal Force, which, being combined with the Dip observations, furnish the Vertical and Total Forces.

These are expressed in both English and metrical scales—the unit in the first being one foot, one second of mean solar time, and one grain; and in the other one millimetre, one second of time, and one milligramme, the factor for reducing the English to metric values being 0·46108.

By request, the corresponding values in C.G.S. measure are also given.

The value of log $\pi^2 K$ employed in the reduction is 1·64365 at temperature 60° F.

The induction-coefficient μ is 0·000194.

The correction of the magnetic power for temperature t_0 to an adopted standard temperature of 35° F. is

$$0{\cdot}0001194(t_0-35)+0{\cdot}000{,}000{,}213(t_0-35)^2.$$

The true distances between the centres of the deflecting and deflected magnets, when the former is placed at the divisions of the deflection-bar marked 1·0 foot and 1·3 feet, are 1·000075 feet and 1·300097 feet respectively.

The times of vibration given in the Table are each derived from the mean of 12 or 14 observations of the time occupied by the magnet in making 100 vibrations, corrections being applied for the torsion-force of the suspension-thread subsequently.

No corrections have been made for rate of chronometer or arc of vibration, these being always very small.

The value of the constant P, employed in the formula of reduction $\frac{m}{X}=\frac{m'}{X'}\left(1-\frac{P}{r_0^2}\right)$, is −0·00129.

In each observation of absolute Declination the instrumental readings have been referred to marks made upon the stone obelisk erected 1,250 feet north of the Observatory as a meridian mark, the orientation of which, with respect to the Magnetometer, was determined by the late Mr. Welsh, and has since been carefully verified.

The observations have been made and reduced by Mr. T. W. Baker.

Vibration Observations for Absolute Measure of Horizontal Force.

Table I.

Month.	G. M. T.	Temperature. Fahr.	Time of one Vibration.*	Log mX. Mean.	Value of m.†
1883.	d. h. m.	°	secs.		
October.....	26 12 4 P.M.	60·7	4·6518		
	3 3 P.M.	61·0	4·6500	0·30920	0·52128
November.....	27 11 44 A.M.	47·9	4·6480		
	28 12 38 P.M.	60·3	4·6534	0·30880	0·52093
December.....	28 11 22 A.M.	44·3	4·6478		
	2 42 P.M.	47·1	4·6478	0·30882	0·52110
1884.					
January.....	29 11 26 A.M.	49·5	4·6488		
	2 58 P.M.	56·7	4·6477	0·30919	0·52060
February	22 11 8 A.M.	51·8	4·6508		
	3 2 P.M.	55·5	4·6494	0·30887	0·52054
March.....	31 11 47 A.M.	53·0	4·6524		
	3 9 P.M.	58·5	4·6500	0·30877	0·52036
April.....	29 11 10 A.M.	58·3	4·6530		
	3 8 P.M.	69·3	4·6522	0·30900	0·52051
May.....	29 11 35 A.M.	53·8	4·6473		
	3 26 P.M.	59·2	4·6487	0·30934	0·52015
June	30 11 19 A.M.	73·0	4·6567		
	3 6 P.M.	78·6	4·6553	0·30910	0·52015
July	30 11 5 A.M.	72·2	4·6537		
	2 57 P.M.	77·0	4·6563	0·30924	0·52019
August	28 11 37 A.M.	71·3	4·6568		
	3 47 P.M.	75·0	4·6533	0·30912	0·52019
October.....	1 11 44 A.M.	60·9	4·6548		
	3 10 P.M.	66·3	4·6520	0·30886	0·51970

* A vibration is a movement of the magnet from a position of maximum displacement on one side of the meridian to a corresponding position on the other side.

† m = magnetic moment of vibrating magnet.

Observations of Deflection for Absolute Measure of Horizontal Force.

Table II.

Month.	G. M. T.	Distances of Centres of Magnets.	Temperature.	Observed Deflection.	$\text{Log}\frac{m}{X}$. Mean.
1883.	d. h. m.	foot.	°	° ′ ″	
October.....	26 12 46 P.M.	1·0	61·4	15 23 8	
		1·3	....	6 56 32	9·12494
	2 19 „	1·0	61·5	15 22 55	
		1·3	....	6 56 39	
November.....	27 12 33 P.M.	1·0	50·0	15 23 7	
		1·3	....	6 57 18	9·12476
	28 12 0 „	1·0	57·7	15 24 1	
		1·3	....	6 56 43	
December.....	28 12 10 P.M.	1·0	44·9	15 25 45	
		1·3	....	6 57 30	9·12502
	2 5 „	1·0	46·1	15 25 37	
		1·3	....	6 57 50	
1884.					
January.....	29 12 15 P.M.	1·0	52·0	15 22 18	
		1·3	....	6 56 20	9·12382
	2 18 „	1·0	55·6	15 20 52	
		1·3	....	6 55 32	
February	22 12 2 P.M.	1·0	53·8	15 22 39	
		1·3	....	6 56 5	9·12402
	2 20 „	1·0	56·2	15 21 36	
		1·3	....	6 55 46	
March	31 12 28 P.M.	1·0	54·8	15 22 3	
		1·3	....	6 56 2	9·12382
	2 30 „	1·0	59·2	15 20 25	
		1·3	....	6 55 20	
April.....	29 12 1 P.M.	1·0	60·1	15 21 20	
		1·3	....	6 56 2	9·12386
	2 19 „	1·0	66·0	15 19 9	
		1·3	....	6 54 46	
May	29 12 26 P.M.	1·0	55·8	15 19 43	
		1·3	....	6 54 49	9·12292
	2 39 „	1·0	58·3	15 19 10	
		1·3	....	6 54 40	
June	30 12 7 P.M.	1·0	72·7	15 18 26	
		1·3	....	6 54 10	9·12315
	2 19 „	1·0	76·7	15 15 55	
		1·3	....	6 53 27	
July	30 11 55 A.M.	1·0	73·8	15 16 24	
		1·3	....	6 54 1	9·12308
	2 5 P.M.	1·0	77·6	15 16 30	
		1·3	....	6 53 42	
August	28 12 11 P.M.	1·0	71·3	15 17 59	
		1·3	....	6 54 24	9·12320
	2 11 „	1·0	74·3	15 16 52	
		1·3	....	6 53 46	
October.....	1 12 30 P.M.	1·0	62·6	15 19 52	
		1·3	....	6 53 1	9·12264
	2 28 „	1·0	65·0	15 18 0	
		1·3	....	6 54 2	

Dip Observations.—Table III.

Month.	G. M. T.	Needle.	Dip.
			North.
1883.	d. h. m.	No.	° ′
Oct.	25 2 37 P.M.	1	67 40·19
	2 38 „	2	39·84
	27 2 34 „	1	39·37
	2 33 „	2	40·60
	Mean..	....	67 40·0
Nov.	26 3 18 P.M.	1	67 40·0
	3 18 „	2	41·19
	27 2 42 „	1	41·09
	2 42 „	2	41·88
	28 3 0 „	1	41·60
	3 0 „	2	41·84
	Mean..	....	67 41·27
Dec.	17 2 40 P.M.	1	67 40·31
	2 38 „	2	40·03
	18 2 31 „	1	40·37
	2 30 „	2	41·50
	19 3 6 „	1	40·25
	3 4 „	2	40·47
	Mean..	....	67 40·49
1884.	23 3 8 P.M.	1	67 39·47
Jan.	3 8 „	2	40·90
	24 2 22 „	1	39·40
	2 21 „	2	40·48
	Mean..	....	67 40·06
Feb.	19 2 58 P.M.	1	67 39·81
	2 59 „	2	39·72
	20 3 3 „	1	39·81
	3 4 „	2	40·28
	Mean..	...	67 39·90
Mar.	26 2 58 P.M.	1	67 38·97
	2 58 „	2	38·22
	27 2 54 „	1	37·72
	2 53 „	2	38·59
	Mean..	....	67 38·37

Month.	G. M. T.	Needle.	Dip.
			North.
1884.	d. h. m.	No.	° ′
April	24 3 4 P.M.	1	67 37·69
	3 6 „	2	39·28
	25 3 8 „	1	39·84
	3 3 „	2	40·18
	Mean..	....	67 39·25
May	24 12 14 P.M.	1	67 38·50
	17 „	2	39·53
	26 2 28 „	1	37·93
	2 28 „	2	38·84
	Mean..	....	67 38·70
June	24 2 57 P.M.	1	67 37·90
	2 56 „	2	38·34
	25 3 0 „	1	36·65
	3 0 „	2	38·50
	Mean..	....	67 37·85
July	28 2 43 P.M.	1	67 39·40
	2 43 „	2	38·81
	31 2 48 „	1	39·31
	2 48 „	2	37·90
	Mean..	....	67 38·85
Aug.	26 2 47 P.M.	1	67 38·81
	2 52 „	2	39·31
	27 2 45 „	1	38·65
	2 44 „	2	39·03
	Mean..	....	67 38·95
Sept.	29 2 42 P.M.	1	67 40·62
	2 42 „	2	67 39·28
	Mean..	....	67 39·95

Table IV.

Month.	Declination.	Magnetic Intensity.								
		English Units.			Metric Units.			C. G. S. Measure.		
	Mean of Observations.	X, or Horizontal Force.	Y, or Vertical Force.	Total Force.	X, or Horizontal Force.	Y, or Vertical Force.	Total Force.	X, or Horizontal Force.	Y, or Vertical Force.	Total Force.
	West.									
1883.	° ′ ″									
October	18 38 57	3·9096	9·5168	10·2885	1·8026	4·3880	4·7438	0·1803	0·4388	0·4744
November	18 35 18	3·9086	9·5242	10·2951	1·8022	4·3915	4·7469	0·1802	0·4391	0·4747
December	18 34 14	3·9075	9·5155	10·2866	1·8017	4·3874	4·7430	0·1802	0·4387	0·4743
1884.										
January	18 31 24	3·9145	9·5293	10·3020	1·8049	4·3938	4·7501	0·1805	0·4394	0·4750
February.....	18 32 55	3·9122	9·5223	10·2946	1·8038	4·3906	4·7467	0·1804	0·4391	0·4747
March.....	18 37 8	3·9127	9·5115	10·2849	1·8041	4·3856	4·7422	0·1804	0·4386	0·4742
April	18 33 23	3·9135	9·5205	10·2918	1·8045	4·3898	4·7454	0·1805	0·4390	0·4745
May.....	18 33 18	3·9193	9·5302	10·3046	1·8071	4·3942	4·7513	0·1807	0·4394	0·4751
June	18 33 25	3·9171	9·5183	10·2927	1·8061	4·3887	4·7458	0·1806	0·4389	0·4746
July.....	18 30 52	3·9181	9·5286	10·3027	1·8066	4·3935	4·7504	0·1807	0·4394	0·4750
August	18 33 55	3·9171	9·5266	10·3005	1·8061	4·3926	4·7494	0·1806	0·4393	0·4749
September	18 32 4	3·9184	9·5378	10·3115	1·8067	4·3977	4·7544	0·1807	0·4398	0·4754

APPENDIX II.

Meteorological Observations.—Table I.

Mean Monthly results.

Months.	Thermometer.								Barometer.*					Mean vapour-tension.
	Mean.	Means of—			Absolute Extremes.				Mean.	Absolute Extremes.				
		Max.	Min.	Max. and Min.	Max.	Date.	Min.	Date.		Max.	Date.	Min.	Date.	
1883.	°	°	°	°	°	d. h.	°	d. h.	ins.	ins.	d. h.	ins.	d. h.	in.
Oct.....	50·5	56·4	44·8	50·6	62·6	14 1 P.M.	38·4	21 0·25 A.M.	29·983	30·544	8 10 A.M.	29·298	17 6 A.M.	·309
Nov.	43·4	49·1	37·5	43·3	56·0	6 11 A.M.	29·3	13 7 „ / 15 8 „	29·850	·424	28 10 P.M.	28·975	6 8 „	·243
Dec.	40·7	44·3	36·5	40·4	54·0	3 7 P.M. / 13 2 „ / 5 „	29·4	6 5 P.M.	30·175	·605	25 10 A.M.	29·431	11 3 „	·213
1884.														
Jan.....	43·9	47·6	39·8	43·7	54·2	23 4 „	32·1	1 4 A.M.	30·106	·674	16 11 „	28·544	26 7 P.M.	·245
Feb.	42·2	47·0	37·5	42·3	54·8	13 2 „	29·5	3 6 „	29·923	·503	3 8 „	29·377	1 9 P.M.	·223
March..	43·9	50·7	37·7	44·2	65·3	15 3 „	27·2	1 3 „	29·945	·280	5 Midt.	·152	10 6 A.M.	·223
April...	44·7	52·0	37·5	44·8	65·4	2 2 „	28·1	23 5 „	29·831	·113	13 11 P.M.	·281	4 Midt.	·221
May	53·5	62·8	44·5	53·7	76·7	24 2 „	35·5	1 5 „	30·006	·456	22 8 A.M.	·356	3 7 P.M.	·285
June...	58·1	66·7	50·1	58·4	80·0	27 4 „	40·9	1 1 „	30·041	·342	12 Midt.	·522	7 5 A.M.	·349
July	62·8	71·9	54·2	63·1	83·6	4 1 „ / 2 „	43·2	26 5 „	29·960	·217	1 11 A.M.	·614	10 3 P.M.	·423
Aug....	64·1	75·0	53·9	64·5	89·2	11 3 „†	46·6	26 5 „	30·014	·277	5 8 „	·660	29 5 A.M.	·410
Sept....	59·1	66·8	51·8	59·3	80·0	17 2 „	40·6	30 6 „	30·016	30·386	18 9 „ / 10 „	29·410	4 5 „	·401
Means..	50·6	57·5	43·8	50·7	..	....	..	....	29·988	..	....	..	....	·295

The above Table is extracted from the Publications of the Meteorological Office, by permission of the Meteorological Council.

* Reduced to 32° at M.S.L. † Approximate.

Meteorological Observations.—Table II.

Kew Observatory.

Months.	Mean amount of cloud (0=clear, 10=overcast).	Rainfall*.			Weather. Number of days on which were registered							Wind †. Number of days on which it was									
		Total.	Maximum.	Date.	Rain.	Snow.	Hail.	Thunderstorms.	Clear sky.	Overcast sky.	Gales.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Variable.	Calm.
1883.		in.	in.																		
October ..	7·0	1·750	0·420	15	13	..	..	..	..	11	..	5	3	2	1	3	6	5	3	3	10
November	6·0	2·540	0·345	4	19	..	1	..	2	9	..	1	2	..	1	6	6	7	2	5	8
December	8·3	0·660	0·340	10	17	3	..	..	1	19	1	5	2	2	2	..	3	9	5	3	8
1884.																					
January ..	8·2	2·295	0·605	26	15	2	2	..	2	25	4	1	1	1	..	1	12	9	2	4	7
February .	7·1	1·400	0·350	1	13	..	2	1	..	15	1	1	1	6	..	5	8	4	1	3	4
March ...	6·5	1·240	0·460	10	8	..	..	..	3	11	..	2	6	3	..	6	4	4	3	3	5
April	6·7	1·255	0·540	6	10	..	2	2	1	12	..	2	12	3	1	4	2	2	1	3	5
May	5·1	0·635	0·240	5	9	..	3	2	9	10	..	1	4	6	..	1	11	6	1	1	2
June	6·4	2·200	0·890	6	8	..	1	3	4	12	..	6	6	3	..	1	3	2	5	4	7
July	6·7	2·240	0·880	6	16	..	1	2	1	13	..	2	..	..	2	4	13	6	1	3	6
August ..	4·5	0·960	0·300	27	9	..	..	1	9	7	..	3	2	5	1	4	7	3	1	5	9
September	5·4	1·690	0·670	3	15	..	..	..	5	9	..	1	4	5	1	4	8	6	..	1	4
Totals..		18·865			152	5	12	11	37	153	6	30	43	36	9	39	83	63	25	38	75

* Measured daily at 10 A.M. by gauge 1·75 feet above surface of ground. † As registered by the anemograph.

Meteorological Observations.—Table III.

Kew Observatory.

Months.	Bright Sunshine.*				Maximum temperature in sun's rays. (Black bulb *in vacuo*.)			Minimum temperature on the ground.			Horizontal movement of the Air.†			
	Total number of hours recorded.	Percentage of possible sunshine.	Greatest daily record.	Date.	Mean.	Highest.	Date.	Mean.	Lowest.	Date.	Average hourly Velocity.	Greatest hourly Velocity.	Date.	Hour.
1883.	h. m.		h. m.		deg.	deg.		deg.	deg.		miles.	miles.		
October	86 0	26	9 36	2	91	117	2	40·2	28·0	23	9	34	4	Noon.
November ..	80 48	30	6 0	10	79	92	9	31·5	19·4	14, 15	9	33	25	10 A.M.
December ..	31 54	13	4 48	4&7	62	84	13	32·6	22·3	5	11	43	12	3 A.M.
1884.														
January	29 24	11	6 36	28	67	82	29	35·0	26·7	13	12	53	26	7 P.M.
February	54 12	19	6 48	18	80	99	20	32·8	21·2	27	13	38	2	Noon.
March	108 0	29	9 6	16	93	113	18	30·9	18·8	3	9	28	31	2 P.M.
April	98 30	24	8 30	9	104	125	8	31·0	16·1	23	9	31	17	5 P.M.
May	208 6	43	13 24	11	117	130	24	39·0	27·7	1	12	30	4	1 P.M.
June	157 0	32	13 24	12	119	130	21	45·2	26·3	1	7	25	2	6 P.M.
July	153 6	30	13 6	2	127	141	8	49·0	35·5	26	8	30	14	4 P.M.
August	227 6	52	12 24	4	126	138	18	47·4	37·3	26	7	22	31	4 P.M.
September ..	129 24	36	11 0	5	111	124	2	46·6	33·5	30	9	27	7	10 A.M.

* Registered by the sunshine-recorder.
† As indicated by a Robinson's anemograph, 70 feet above the general surface of the ground.

Table IV.

Summary of Sun-spot Observations made at the Kew Observatory.

Months.	Days of observation.	Number of new groups enumerated.	Days without spots.
1883.			
October	20	19	0
November	21	18	0
December	12	13	0
1884.			
January	9	20	0
February	17	20	0
March	15	15	0
April	16	15	0
May	20	16	0
June	10	9	0
July	13	13	0
August	18	10	0
September	14	10	0
Totals	185	178	0

APPENDIX III.

List of Instruments, Apparatus, &c., the Property of the Kew Committee, at the present date out of the custody of the Superintendent, on Loan.

To whom lent.	Articles.	Date of loan.
G. J. Symons, F.R.S.	Old Kew Thermometer Screen	1868
	Portable Transit Instrument	1869
The Science and Art Department, South Kensington.	The articles specified in the list in the Annual Report for 1876, with the exception of the Photo-Heliograph, Pendulum Apparatus, Dip-Circle, Unifilar, and Hodgkinson's Actinometer.	1876
Dr. T. Thorpe, F.R.S.	Three Open Scale Standard Thermometers, Nos. 561, 562, and 563.	1879
	Tripod Stand	1883
Major Herschel, R.E., F.R.S.	Invariable Pendulums, Nos. 1821, 4, and 11, Shelton Clock, R.S. No. 34. Stands, and Accessories.	1881
Mr. R. W. Munro ..	Standard Straight-edge.....	1881
Lieutenant A. Gordon, R.N.	Unifilar Magnetometer by Jones, No. 102, complete, with three Magnets and Deflection Bar. Dip-Circle, by Barrow, one Pair of Needles, and Magnetizing Bars. One Bifilar Magnetometer. One Declinometer. Two Tripod Stands.	1883
Major-General Sir H. Kefroy, R.A., F.R.S.	Two parcels Magnetical and Meteorological MSS. from the Sabine Magnetic Office.	1882
Dr. E. van Rijckevorsel	Dip-Circle by Barrow, No. 24, complete, with four Needles, and a Pair of Magnetizing Bars.	1883
Professor W. Grylls Adams, F.R.S.	Unifilar Magnetometer, by Jones, No. 101, complete.	1883
Professor O. J. Lodge	Unifilar Magnetometer, by Jones, No. 106, complete. Barrow Dip-Circle, No. 23, with two Needles, and Magnetizing Bars. Tripod Stand.	1883
Mr. W. F. Harrison .	Condensing lens and copper lamp chimney ..	1883