10

KEW OBSERVATORY, 1880.

REPORT

OF THE

KEW COMMITTEE

FOR THE

Year ending October 31, 1880.

[*From the* PROCEEDINGS OF THE ROYAL SOCIETY, No. 207, 1880.]

LONDON:
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1880.

Report of the Kew Committee for the Year ending October 31, 1880.

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

General Sir E. Sabine, K.C.B., *Chairman.*

Mr. De La Rue, *Vice-Chairman.*
Prof. W. G. Adams.
Capt. F. Evans, C.B.
Prof. G. C. Foster.
Mr. F. Galton.
Lieut.-Gen. Sir J. H. Lefroy, K C.M.G.
Vice-Adm. Sir G. H. Richards.
The Earl of Rosse.
Mr. R. H. Scott.
Lieut.-General W. J. Smythe.
Lieut.-Gen. R. Strachey, C.S.I.
Mr. E. Walker.

The work at the Observatory may be considered under seven sections:—

1st. Magnetic observations.
2nd. Meteorological observations.
3rd. Solar observations.
4th. Experimental, in connexion with either of the above departments.
5th. Verification of instruments.
6th. Aid to other Observatories.
7th. Miscellaneous.

I. Magnetic Observations.

No change has been made in the Magnetographs, which have worked continuously during the year. The curves have recently indicated the approach of a more disturbed period than has occurred for some few years, and a magnetic storm of considerable intensity was registered from August 11th to 15th.

Owing to the gradual secular change of declination, the distance between the dots of light upon the cylinder of the magnetometer had become too small for satisfactory registration, and it was found necessary to readjust the instrument by a displacement of its zero. From a similar cause it was also found necessary to readjust the balance of the vertical force magnetometer.

The scale values of all the instruments were re-determined in January, in accordance with the usual practice.

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

The Sub-Committee, appointed to consider the best means of utilising the records of the magnetographs, as mentioned in the Report for 1878, reported that it was unadvisable, in their opinion, to proceed with the regular tabulation of the curves, and suggested that attention should rather be directed to their comparison with synchronous curves, taken at other magnetic Observatories in different parts of the globe, in order to ascertain whether similar disturbances occur at these several stations, and at what time intervals; with a view to the development of the theory of magnetic disturbance.

In order to carry out this scheme, a circular, inviting co-operation on the part of observers provided with magnetographs of the Kew pattern, was issued to the Directors of the following Observatories:— Batavia, Bombay, Brussels, Coimbra, Colaba, Lisbon, Mauritius, Melbourne, Potsdam, St. Petersburg (Pawlowsk), San Fernando, Stonyhurst, Utrecht, Vienna, and Zi-Ka-Wei. Replies favourable to the project were received from all those whose instruments were working under satisfactory circumstances.

An examination of the records for the year 1879 indicated the month of March as that most suitable for the purpose of the comparison. Accordingly, a further request for copies of the declination curves for that month was issued, and, in response, they have at present been received from:—

Coimbra, Colaba, Lisbon, Melbourne, St. Petersburg, Stonyhurst, Vienna, and Utrecht.

The comparison of these magnetic curves has been undertaken by Professor W. Grylls Adams, who has already communicated to the Swansea Meeting of the British Association a preliminary account of the principal facts which have as yet come to light. The discussion, which is still in progress, cannot be completed until data from the more distant stations, as well as the horizontal and vertical force curves from all stations for the same month, have arrived.

The Observatory has also received curves from several of the foreign Observatories, showing the variations recorded by their instruments during the progress of the magnetic storm already referred to.

By the kindness of Professor G. Carey Foster, some experiments were made at the laboratory of University College, London, with a view to determine whether the magnetisation of dip-needles could be conveniently effected by means of a coil of wire conveying an electric current, thereby avoiding certain defects due to their magnetisation by bars, after the ordinary method. The results of these experiments proved that the requisite magnetic intensity could be easily imparted in the way referred to.

At the request of Dr. E. Van Rijckevorsel, observations have been made with dip-needles constructed of nickel, and also with others of steel nickel plated in order to avoid the injurious effects of rust. The nickel plating proved successful; but it was found impossible to impart a sufficient degree of magnetism to the nickel needles to allow of their giving reliable results.

The magnetic instruments have been studied, and a knowledge of their manipulation obtained by Dr. Chistoni and Dr. Harris.

Information on matters relating to terrestrial magnetism and various data have been supplied to Professor W. G. Adams, Mr. Adie, Professor Barrett, Messrs. Barker and Son, Mr. Casella, Professor G. C. Foster, Mr. J. E. H. Gordon, Mons. Marié-Davy, Dr. Rijckevorsel, and Professor Balfour Stewart.

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

Determinations of	Horizontal Intensity	25
,,	Dip	164
,,	Absolute Declination	37

II. Meteorological Observations.

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

New fume pipes have been fitted over the thermograph and electrograph to carry off the products of combustion of the gas more efficiently than the old ones, which had become much corroded.

The standard eye observations made five times daily, for the control of the automatic records, have been duly registered through the year, together with the additional daily observations at 0 h. 45 m. P.M. in connexion with the Washington synchronous system, and at 6 h. 45 m. P.M., for the second synchronous system organized by M. Mascart, Directeur du Bureau Central Météorologique, Paris.

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	1934
,,	dry and wet thermometers	6546
,,	maximum and minimum thermometers	2196

Readings of radiation thermometers	848
,, rain and evaporation gauges	1184
Cloud and weather observations	2300
Measurements of barograph curves	9477
,, dry bulb thermograph curves..	9513
,, wet bulb thermograph curves..	9405
,, wind (direction and velocity)..	18940
,, rainfall curves	639
,, sunshine traces	2094

In compliance with a request made by the Meteorological Council to the Kew Committee, the Observatories at Aberdeen, Armagh, Falmouth, Glasgow, Oxford (Radcliffe), Stonyhurst, and Valencia, have been visited as usual and their instruments inspected by Mr. Whipple during his vacation.

With the concurrence of the Meteorological Council, weekly abstracts of the meteorological results have been regularly forwarded to, and published by "The Times," "The Illustrated London News," and "The Torquay Directory," and meteorological data have been supplied to the editor of "Symons' Monthly Meteorological Magazine," the Secretary of the Institute of Mining Engineers, Messrs. Anderson, Buchan, Eaton, Greaves, McDonald, Rowland, Wragge, and others.

Electrograph.—This instrument has been in continuous action through the year.

During the severe frost of last winter it was found necessary to heat the water flowing through the discharge pipe by means of a spirit lamp, suspended from the collector. This precaution enabled the records to be maintained throughout the year, with very few interruptions due to frost.

In August the instrument was dismounted, and a fresh supply of acid placed in the jar, the charge-keeping properties of which had become slightly deteriorated.

Some experiments have been made with a view of determining the effect of the interposition of an air condenser between the collector and the electrometer, in reducing the extent and rapidity of the electrical changes registered by the instrument under certain atmospheric conditions. These experiments are still in progress.

No steps have yet been taken as to the discussion of the seven years' curves now in store, but suggestions as to the means of dealing with them are under consideration.

The self-recording instruments, with their attendant photographic processes and methods of tabulation, have been studied by Professor C. Niven, who has succeeded the late Professor D. Thomson in the charge of the Aberdeen Observatory; by Dr. Chistoni, of the Roman Observatory; and by M. Perrotint, Director of the Nice Observatory.

The spare barograph, thermograph, and Beckley rain gauge, the property of the Meteorological Council, formerly deposited at the Observatory, having been lent by the Council to the Radcliffe Trustees, were set up at their Observatory in Oxford at the beginning of the year.

With a view to prevent certain failures occasionally taking place in the photographic system of registration, which are attributed to chemical action in the wax used in the preparation of the paper, it has been considered desirable to introduce in part of the work, by way of experiment, a new process devised by Captain Abney, R.E., F.R.S., in which unwaxed paper is employed.

At the request of Admiral Mouchez, Directeur de l'Observatoire National, Paris, a set of copies of the autographic records, together with descriptions of the instruments and other particulars respecting the Observatory, has been forwarded to the Museum recently established in that Institution.

III. Solar Observations.

The preliminary reductions of the measurements of the Kew solar negatives having been completed in January last, a re-examination of the pictures was made with the object of classifying the spots according to a scale of figure and magnitude; this being now terminated, Mr. McLaughlin is engaged assisting Mr. Marth in the reduction to heliocentric elements of the pictures from January, 1864, to April, 1872.

These operations have all been conducted under the direction and at the expense of Mr. De La Rue.

The eye observations of the sun, after the method of Hofrath Schwabe, as described in the Report for 1872, have been made on 246 days, in order to maintain for the present the continuity of the Kew records of sun-spots. The sun's surface was observed to be free from spots on 27 of those days.

A catalogue of the whole of the solar photographs taken at Kew during a decade 1862 to 1872, has been prepared and forwarded to the Solar Committee of the Science and Art Department.

At the request of the Council of the Royal Astronomical Society, the valuable collection of MSS. containing the memorable series of sun-spot observations made by Hofrath Schwabe, of Dessau, during the years 1825 to 1867, which had been deposited in the Library of the Observatory, the first volumes since 1865, was transferred to the Society's Library at Burlington House, London. In order, however, to render the collection of sun-spot observations at Kew as complete as possible, and to prevent the total loss of the observations in case of fire, the Committee voted the sum of £90 to defray the cost of making a complete copy of the solar drawings.

This was accordingly done, and accurate tracings made of every one of Schwabe's drawings. These were pasted into blank books, and any important notes were transcribed at the same time.

The Observatory, therefore, now possesses a complete record of the condition of the sun's surface, extending from November, 1825, to the present date.

The work was performed by the members of the Observatory staff, in extra hours.

Transit Observations.—Ninety observations have been made of sun-transits, for the purpose of obtaining correct local time at the Observatory: 102 clock and chronometer comparisons have also been made.

Sunshine Recorder.—The Campbell sunshine recorder, described in the Report for 1875, continues in action, and the improved form of the instrument, giving a separate record for every day of the duration of sunshine, has been regularly worked throughout the year, and its curves tabulated. In April last, the new pattern of card-holder, devised by Professor Stokes ("Quarterly Journal Met. Soc.," vol. vi, p. 83) was substituted for that previously employed, in order that the records produced by the instrument might be in conformity with those obtained from the other stations of the Meteorological Council. Since that date both cards and tabulations have been transmitted regularly to the Meteorological Office, copies, however, being retained in the Observatory for reference.

A similar sunshine recorder has been constructed for the Melbourne Observatory, and, after trial and adjustment at Kew, was transmitted together with a set of pattern-cards, through the Crown Agents to Mr. Ellery.

IV. Experimental Work.

Winstanley's Recording Radiograph.—This instrument, designed by Mr. D. Winstanley, as described in "Engineering," vol. xxx, p. 316, for the purpose of registering continuously the amount of radiation from the sky, by mechanical means, upon a sheet of blackened paper, has been erected on the roof of the Observatory since the beginning of August.

Its indications, which were procured for some weeks, showed it to be a much more delicate appliance than the sunshine recorder or the black bulb thermometer, being affected by changes of radiation from the sky, which take place both at night and when the sky is clouded, as well as when the sun is shining. No use has, however, yet been made of its curves, mainly on account of the difficulty of determining a scale value for them.

Wind Component Integrator.—This instrument, owing to the causes referred to in last Report, was not kept in action after that date, and in December it was dismounted. It has since been deposited again in

the Loan Collection of Scientific Apparatus at South Kensington, the costs attendant on its trial at Kew having been defrayed by the Meteorological Council.

Photo-nephoscope.—This instrument is still in the hands of Captain Abney, R.E., but experiments have been made with several other forms of nephoscope, and also with a new cloud-camera, designed by the Superintendent.

Exposure of Thermometers.—Experiments have been continued throughout the year at the Observatory, with the view of determining the relative merits of different patterns of thermometer screens. For this purpose, there have been erected on the lawn a Stevenson's screen, of the ordinary pattern, and a large wooden cage, containing a Wild's screen, of the pattern employed in Russia. Each of these screens contains a dry and a wet bulb thermometer, and a maximum and minimum, all of which are read daily, at 9 A.M. and 9 P.M., their indications being compared with those of the thermograph at the same hours. A third portable metal screen, designed by Mr. De La Rue for use on board Light-ships, which contains a dry bulb thermometer only, is also carried into the open air by the observer, and read at the same time as the fixed instruments.

The cost of these experiments is borne by the Meteorological Council.

Glycerine Barometer.—This instrument, devised and erected by Mr. Jordan, as mentioned in last year's Report, has been in successful operation throughout the year, and, in compliance with the request of the inventor, has been continuously observed in conjunction with the mercurial barometer five times daily. In April last, with a view to the more complete removal of the minute quantity of air which had adhered to the sides of the tube at the time of filling, and had since risen at intervals into the vacuum, air pressure was applied to the lower surface of the column by means of a force pump, and the glycerine driven up to the top of the tube. The small bubble of air was then expelled through the stoppered aperture, its place being filled by a drop of the glycerine from the cup.

A complete description of the instrument, by Mr. Jordan, was read before the Royal Society, on January 22nd, and has been printed in their "Proceedings," vol. xxx, p. 105. As a preparatory step towards the discussion of the observations made with the instrument, Mr. Jordan has computed a table for the reduction of its readings to a temperature of 32° F., the mean coefficient of expansion of glycerine having been determined by Professor A. W. Reinold to be ·000303 for 1° F. between 32° and 212°. The value of the glycerine barometer as an instrument of precision cannot be determined until the observations now in process of reduction by Mr. Jordan have been completed. Meanwhile the Committee have decided to continue the periodical readings, and to make several separate series of readings, at frequent

intervals, during periods of atmospheric disturbance, so as to determine its relative degree of sensibility as compared with ordinary mercurial instruments.

De La Rue Evaporation Gauge.—The Vice-Chairman of the Committee has devised a small evaporation gauge, by means of which the water given off from a continually-wetted sheet of vegetable parchment is measured daily. Two of these instruments, constructed by Messrs. Negretti and Zambra, were set up at Kew, and their indications noted every day, at 10 A.M., together with those of a Piché Evaporimètre, until the end of July, when, at the request of the Meteorological Council, they were transferred to the care of Mr. Shaw, who is at present engaged at Cambridge in an experimental investigation on hygrometry.

De La Rue Anemograph.—The electrical attachment to this instrument having been successfully completed after a somewhat lengthy series of experiments, its registrations were discontinued and the instrument was partially dismounted, in order to allow of its vane being used for certain experiments now in progress with regard to the working of air-meters.

Air Thermometer.—The construction of the Standard Air Thermometer is still delayed, Professors Thorpe and Rücker not having yet completed their comparisons between the mercurial and air thermometers.

By the kindness of Professor H. A. Rowland, of the Johns Hopkins University, Baltimore, U.S.A., the Committee has had the opportunity afforded it of comparing with a number of Kew standards, one of the thermometers which Professor Rowland has employed in his researches on the deviation of the mercurial from the air thermometer. The instrument is that—Baudin, No. 6166—which Dr. Joule ("Proc. Amer. Acad. Arts and Sciences, 1880") compared with the instrument he used in his determination of the mechanical equivalent of heat ("Phil. Trans., 1878"). Professor Rowland has kindly promised to present the Committee with another of his standards, which has been compared with his air thermometer throughout a greater range of scale than the present instrument.

V. Verification of Instruments.

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

A Unifilar, by Gibson, for Elliott Brothers.
Four Dip-circles, by Casella.
A pair of Dipping-needles for Elliott Brothers.
Three Dipping-needles for Dr. E. Van Rijckevorsel.
Two Magnetograph-needles for M. Dechevrens, Zi-Ka-Wei.
An Azimuth Compass for Barker and Son.

There have also been purchased on commission and verified:—

A Dip-circle for Dr. Mielberg, Tiflis.

A Dip-circle for the Russian Expedition to the Mouth of the Lena.

Two Magnetograph-needles for Dr. Wild, St. Petersburg.

There has been a satisfactory increase in the number of meteorological instruments verified, which was as follows:—

Barometers, Standard	47
,, Marine and Station	156
Aneroids	21
Total	224
Thermometers, ordinary Meteorological	1487
,, Standard	94
,, Mountain	68
,, Clinical	3638
,, Solar radiation	57
Total	5344

Besides these, 22 Deep-sea Thermometers have been tested, 14 of which were subjected in the hydraulic press, without injury, to strains exceeding three and a half tons on the square inch, and 165 Thermometers have been compared at the freezing-point of mercury, making a total of 5,531 for the year.

Duplicate copies of corrections have been supplied in 20 cases.

A special set of Standard Thermometers has been constructed for the Bureau International des Poids et Mesures, at Paris.

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

Three Metre Scales have been divided on glass for the University College Laboratory.

The following miscellaneous instruments have also been verified:—

Hydrometers	10
Anemometers	12
Rain Gauges	13
Sextants	5
Theodolites	4
Cathetometer Scales	2

There are at present in the Observatory undergoing verification, 40 Barometers, 50 Thermometers, 1 Hydrometer, and 2 Anemometers.

Anemometer Testing.—The Committee have had before them the question of the desirability of erecting a suitable apparatus for the

testing of Anemometers and Air-meters; but in the opinion of Dr. Robinson it will be better to postpone its erection for a time. Meanwhile these instruments, temporarily erected on the roof, are compared directly with the Standard Anemograph, and tables of corrections supplied to reduce their readings to the same scale of velocities as that indicated by the latter instrument.

The experiments made in 1874, and described in the Report for that year, to determine by means of a "steam-circus" at the Crystal Palace, the true value of Robinson's factors for Anemometers at different velocities, are under discussion by Professor G. G. Stokes, F.R.S., and have been found to afford valuable results. A paper, which he intends to communicate on the subject to the Royal Society, is nearly ready.

Experiments have been made with one of M. Hagemann's Anemometers ("Quart. Jour. Met. Soc.," vol. v, p. 203), designed for use at sea, the results being submitted to the Meteorological Council.

A Bridled Anemometer, designed by Mr. F. Galton, has also been tried.

The Galton Thermometer-tester has had a new water-heater fitted to it, and has besides undergone thorough repair and renovation.

The Winchester Observatory of the Yale College, U.S.A., having recently established a department on the Kew system, for the verification of thermometers, Professor Newton, Secretary of the Institution, visited our Observatory, studied the methods employed for comparing thermometers, and procured copies of the various forms and certificates used in the work.

The Sextant-testing apparatus has been improved during the year by the substitution of reticules, photographed on glass, for the glass threads in the focus of the collimators. The latter, by their breakage, rendered frequent re-adjustment of the instrument necessary.

Standard Barometers.—Numerous comparisons have been made during the year between the two Welsh Standard Barometers, the old Royal Society Standard (which it is found cannot without risk of derangement be returned to Burlington House), and Newman, No. 34, the working Standard of the Observatory.

Arrangements have been made by means of which the latter may, when desired, be read by the cathetometer, as well as by its own scale, the correct value of which has also been re-determined.

VI. Aid to Observatories.

Waxed Papers, &c., supplied.—Waxed paper has been supplied to the following Observatories:—

Batavia, Colaba, Glasgow, Lisbon, Montsouris (Paris), Mauritius, Oxford (Radcliffe), and Utrecht.

Anemograph Sheets have also been sent to the Madras Observatory, and Mauritius, and

Blank Forms for the entry of magnetic observations to Professor Young, Princetown, U.S.A.

VII. Miscellaneous.

Loan Exhibition.—With the exception of the Hodgkinson's Actinometer and the three instruments mentioned in the 1878 Report, the instruments specified in the Report for 1876 still remain in charge of the Science and Art Department, South Kensington.

At the request of the Secretary of the Royal Society several sets of comparisons have been made between the Hodgkinson's Actinometers, the property of the Royal Society, and a similar instrument sent home from India by Mr. Hennessey, F.R.S., who has observed with it in that country.

International Comparison of Standards.—The Committee received an application from the Secretaries of the Comité International de Météorologie inviting them to assist in the suggested scheme of an international comparison of standard barometers, thermometers, and anemometers. This idea has since been abandoned, but M. Hooremann, Chef de Service of the Brussels Observatory, has visited Kew, with several standard instruments, in order to make a direct comparison between the Observatories of Brussels and Kew.

At the request of Miss Ormerod, F.M.S., experiments were made on the occasion of testing some thermometers at very low temperatures to determine the effect of great cold upon the vitality of certain grubs and insects selected by her for trial.

The Superintendent has, with the consent of the Committee, submitted a paper to the Royal Society on "The Results of an Inquiry into the Periodicity of Rainfall," which was printed in the "Proceedings," vol. xxx, p. 200.

He has also read a paper before the Meteorological Society "On the Rate at which Barometric Changes traverse the British Isles," published in the "Quarterly Journal," vol. vi, p. 136.

The Committee, having memorialised the Under Secretary of State for the Colonies with reference to the establishment of an Observatory for magnetical and meteorological purposes at Hong Kong, has been gratified by the receipt of an announcement to the effect that the Governor of Hong Kong has been authorised to propose a vote for the establishment of an Observatory in that colony.

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,

and many of them are in constant, and others in occasional use at the Observatory, but the funds of the Committee do not at present allow of the employment of a mechanical assistant, although one is much needed.

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

14 English Scientific Societies and Institutions, and

47 Foreign and Colonial Scientific Societies and Institutions.

Ventilation Experiments. — The Sub-Committee of the Sanitary Institute of Great Britain is still engaged in experiments on the ventilating power of cowls of different form, for which purpose space has been placed at its disposal in the experimental house. In addition to this, the Institute has recently erected a wooden hut with an elevated wooden platform over it in the park, at a sufficient distance from the Observatory to avoid the eddies in the wind caused by it and the adjacent buildings.

Observatory and Grounds.—The buildings and grounds have been kept in repair throughout the year, and the rooms in the basement and some of the upper rooms have been painted and whitened by the Board of Works.

No action having been taken by the Commissioners with respect to the footpath across the park, its temporary repair has been carried on at the expense of the Committee.

Personal Establishment.

The staff employed is as follows:—

G. M. Whipple, B.Sc., Superintendent.
T. W. Baker, First Assistant.
J. Foster, Verification Department.
J. W. Hawkesworth, Tabulation of Meteorological Curves.
H. McLaughlin, Solar Computations and care of Accounts.
F. G. Figg, Magnetic Observer.
E. G. Constable, Solar Observations and care of Library.
T. Gunter, C. Taylor, H. Clements } Verification Department.
A. Dawson, Photography.
W. Boxall, Office duties.
J. Dawson, Messenger and Care-taker.

J. Hillier, having been appointed Assistant to the Curator of the Museums in the Royal Gardens, Kew, resigned in December last.

Visitors.—The Observatory has been honoured by the presence, amongst others, of:—

Professor Barrett.
Mr. Campbell.
Dr. C. Chistoni.
Rev. J. E. Cross.
Captain M. Hépites.
Mr. Hartnup.
Professor Libbey.
Professor Niven.
M. Perrotint.
Mr. Baden Pritchard.
Mr. Stone.
M. Steen.
Admiral Stopford.

Abstract. Kew Observatory Receipts and Payments Account from November 1, 1879, to November 3, 1880.

Dr. **RECEIPTS.**

	£	s.	d.
To Balance from 1878–79	512	5	7
Royal Society (Gassiot Trust) £248 17 5			
,, ,, 247 16 3			
	496	13	8
Meteorological Office 100 0 0			
,, ,, 100 0 0			
,, ,, 100 0 0			
,, ,, 100 0 0			
	400	0	0
Meteorological Office, for Postages, &c.	35	12	9
Payment for Instruments on Commission	207	6	11
Sale of Waxed Paper	56	4	0
Verification Fees, Meteorological Office 86 13 0			
,, ,, Observatories and Institutions 23 4 0			
,, ,, Opticians, &c. 337 6 0			
Sale of Standard Thermometers 19 17 8			
Payments for Copying Registers 71 13 10			
	538	14	6
Mr. De La Rue for Sun-work	100	0	0
Solar Committee of Science and Art Department	0	18	0
Sale of Old Magnetometer	5	0	0
,, Photographic Residues	11	14	11
	£2364	10	4

PAYMENTS. *Cr.*

	£	s.	d.
By Salaries £1024 14 0			
Extra Payments 67 3 1			
	1091	17	1
Rent of Enclosure 11 11 0			
Fuel and Gas 74 6 10			
Furniture and Fittings 19 8 9			
Chandlery, &c. 7 7 9			
Painting and Repairs 23 15 0			
Maintenance of Path and Fence 13 2 3			
	149	11	7
Printing and Stationery 52 5 2			
Postages 15 1 5			
Library 11 12 2			
Messenger and Housekeeper 63 12 0			
Advertisements 1 1 3			
Porterage and Contingencies 15 5 7			
	158	17	7
Instruments purchased on Commission	209	6	6
Postages and Payments on behalf of Meteorological Office	8	14	6
Purchase of Waxed Paper, Packing ditto, &c.	81	0	9
,, ,, Chemicals and Materials 26 12 5			
,, ,, Tubes for Standard Thermometers 5 5 0			
Verification Department Expenses (Ice, Carbonic-Acid Gas, &c.) 10 1 0			
Repair of Instruments, and Purchase of New 50 7 6			
Carpenter's Work and Sundries 1 19 7			
	94	5	6
Sun-work expenses	100	0	0
Preparing Reference Catalogue of Schwabe's Sun-spot Drawings	89	19	5
Special Experimental Fund	4	17	6
Balance—Bank of England 294 9 7			
London and County Bank 75 0 0			
Cash in hand 6 10 4			
	375	19	11
	£2364	10	4

November 12 1880. Examined and compared with the Vouchers, and found correct. (Signed) WM. GRYLLS ADAMS, *Auditor.*

ASSETS.

	£	s.	d.
By Balance as per Statement	375	19	11
Meteorological Office, Allowances and Sundries	33	14	1
Commissions	51	5	0
Waxed Paper in stock	54	2	6
Blank Forms	2	10	0
Verification Fees due	82	5	11
Standard Thermometers sold	21	13	6
,, ,, in stock	88	13	6
Sundries	4	2	1
	£714	6	6

LIABILITIES.

	£	s.	d.
To Payments due for Extra Observations	9	2	6
Gas, Fuel, and House Account	11	10	9
Apparatus, Chemicals, &c.	18	13	3
Commissions	36	10	0
Balance	638	10	0
	£714	6	6

November 13, 1880. (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* 1879 *to September* 1880.

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 N D 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 π^2K 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 −0·00109.

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 all been made and reduced by Mr. F. G. Figg.

Observations of Deflection for Absolute Measure of Horizontal Force.

Month.	G. M. T.	Distances of Centres of Magnets.	Temperature.	Observed Deflection.	Log $\frac{m}{X}$. Mean.
1879.	d. h. m.	foot.	°	° ′ ″	
October.....	27 12 32 P.M.	1·0	55·8	15 34 5	
		1·3	....	7 1 14	
	2 30 „	1·0	57·0	15 33 28	9·12936
		1·3	....	7 0 56	
November.....	25 12 28 P.M.	1·0	39·5	15 35 14	
		1·3	....	7 1 40	
	2 36 „	1·0	41·4	15 35 27	9·12899
		1·3	....	7 1 51	
December.....	22 12 22 P.M.	1·0	41·0	15 35 37	
		1·3	....	7 1 58	
	2 23 „	1·0	43·0	15 34 41	9·12904
		1·3	....	7 1 30	
1880.					
January.....	27 12 25 P.M.	1·0	23·6	15 37 10	
		1·3	....	7 2 55	
	2 22 „	1·0	23·5	15 37 18	9·12890
		1·3	....	7 2 46	
February	24 12 29 P.M.	1·0	42·2	15 35 29	
		1·3	....	7 1 53	
	2 36 „	1·0	42·2	15 34 42	9·12902
		1·3	....	7 1 30	
March	25 12 26 P.M.	1·0	54·8	15 33 6	
		1·3	....	7 0 52	
	2 30 „	1·0	60·7	15 32 6	9·12898
		1·3	....	7 0 27	
April.....	27 12 30 P.M.	1·0	52·1	15 32 51	
		1·3	....	7 0 41	
	2 37 „	1·0	54·4	15 31 57	9·12853
		1·3	....	7 0 18	
May	24 12 34 P.M.	1·0	65·6	15 29 51	
		1·3	....	6 59 27	
	2 34 „	1·0	65·0	15 30 17	9·12836
		1·3	....	6 59 42	
June	29 12 34 P.M.	1·0	76·3	15 29 15	
		1·3	....	6 59 6	
	2 24 „	1·0	77·7	15 28 34	9·12861
		1·3	....	6 58 48	
July	26 12 32 P.M.	1·0	71·8	15 29 25	
		1·3	....	6 59 23	
	2 40 „	1·0	67·9	15 29 42	9·12848
		1·3	....	6 59 25	
August	23 12 39 P.M.	1·0	64·6	15 32 45	
		1·3	....	7 0 38	
	3 7 „	1·0	68·1	15 31 15	9·12927
		1·3	....	7 0 3	
September.....	28 12 43 P.M.	1·0	63·3	15 32 3	
		1·3	....	7 0 25	
	2 37 „	1·0	67·2	15 31 18	9·12900
		1·3	....	6 59 49	

Vibration Observations for Absolute Measure of Horizontal Force.

Month.	G. M. T.	Temperature.	Time of one Vibration.*	Log mX. Mean.	Value of m.†
1879.	d. h. m.		secs.		
October.....	27 11 58 A.M.	55°·0	4·6376		
	3 3 P.M.	58·2	4·6380	0·31143	0·52528
November.....	25 11 45 A.M.	36·9	4·6301		
	3 8 P.M.	41·4	4·6335	0·31150	0·52510
December.....	22 11 39 A.M.	39·5	4·6316		
	2 53 P.M.	44·3	4·6292	0·31192	0·52539
1880.					
January.....	27 11 47 A.M.	21·5	4·6285		
	2 57 P.M.	23·0	4·6298	0·31103	0·52476
February	24 11 50 A.M.	40·7	4·6359		
	3 8 P.M.	41·9	4·6350	0·31093	0·52477
March.....	25 11 45 A.M.	52·8	4·6393		
	3 3 P.M.	62·4	4·6403	0·31111	0·52486
April.....	27 11 52 A.M.	50·6	4·6405		
	3 14 P.M.	54·5	4·6405	0·31067	0·52432
May.....	24 11 57 A.M.	63·5	4·6423		
	3 10 P.M.	65·7	4·6418	0·31117	0·52452
June	29 11 46 A.M.	75·8	4·6504		
	3 34 P.M.	79·1	4·6472	0·31067	0·52437
July.....	26 11 53 A.M.	69·3	4·6450		
	3 14 P.M.	70·4	4·6432	0·31102	0·52451
August	23 12 5 P.M.	64·2	4·6483		
	3 35 P.M.	68·7	4·6467	0·31018	0·52447
September.....	28 12 10 P.M.	62·1	4·6476		
	3 16 P.M.	69·1	4·6493	0·30996	0·52418

* 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.

Dip Observations.

Month.	G. M. T.	Needle.	Dip. North.
1879.	d. h. m.	No.	° ′
Oct.	28 3 7 P.M.	1	67 42·87
	3 3 „	2	42·75
	30 2 59 „	1	42·81
	2 59 „	2	42·69
	Mean..	....	67 42·78
Nov.	26 3 10 P.M.	1	67 42·68
	3 6 „	2	41·68
	27 3 4 „	1	42·18
	3 6 „	2	41·62
	Mean..	....	67 42·04
Dec.	23 3 4 P.M.	1	67 42·62
	3 4 „	2	42·12
	24 3 23 „	1	42·56
	3 24 „	2	41·75
	Mean..	....	67 42·26
1880.	28 3 5 P.M.	1	67 41·87
Jan.	3 3 „	2	41·37
	29 3 14 „	1	41·00
	3 11 „	2	41·87
	Mean..	....	67 41·53
Feb.	17 3 16 P.M.	1	67 42·37
	3 20 „	2	42·68
	19 3 10 „	1	42·18
	3 13 „	2	41·37
	23 3 16 „	1	42·00
	3 15 „	2	41·12
	25 3 1 „	1	41·12
	2 58 „	2	41·50
	27 3 18 „	1	42·00
	3 26 „	2	41·00
	Mean..	...	67 41·73
Mar.	24 2 55 P.M.	1	67 42·06
	2 54 „	2	41·62
	30 2 58 „	1	42·06
	2 58 „	2	41·31
	31 3 8 „	1	42·12
	3 7 „	2	41·18
	Mean..	....	67 41·72

Month.	G. M. T.	Needle.	Dip. North.
1880.	d. h. m.	No.	° ′
Apl.	26 2 56 P.M.	1	67 42·56
	2 55 „	2	42·12
	28 3 12 „	1	40·43
	3 13 „	2	40·75
	29 3 0 „	1	41·93
	2 59 „	2	41·25
	Mean..	....	67 41·51
May	25 3 14 P.M.	1	67 41·43
	3 13 „	2	41·37
	27 3 11 „	1	42·00
	3 10 „	2	41·43
	Mean..	....	67 41·56
June	24 3 14 P.M.	1	67 41·68
	3 17 „	2	40·75
	30 4 16 „	1	41·81
	4 21 „	2	40·93
	Mean..	....	67 41·29
July	28 3 3 P.M.	1	67 42·37
	3 3 „	2	41·62
	29 3 11 „	1	41·68
	3 14 „	2	40·81
	30 3 4 „	1	41·87
	3 5 „	2	41·06
	Mean..	....	67 41·57
Aug.	27 3 40 P.M.	1	67 43·43
	3 34 „	2	43·37
	31 3 10 „	1	42·68
	3 13 „	2	41·93
	Mean..	....	67 42·85
Sept.	29 2 58 P.M.	1	67 44·81
	3 0 „	2	44·25
	30 3 17 „	1	43·62
	3 14 „	2	42·75
	Mean..	....	67 43·86

Month.	Declination.	Magnetic Intensity.								
		English Units.			Metric Units.			C. G. S. Units.		
	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.									
1879.										
October	19 2 20	3·8997	9·5146	10·2828	1·7981	4·3870	4·7412	0·1798	0·4387	0·4741
November	18 58 10	3·9017	9·5135	10·2825	1·7990	4·3865	4·7411	0·1799	0·4386	0·4741
December	19 0 47	3·9034	9·5194	10·2887	1·7998	4·3892	4·7439	0·1800	0·4389	0·4744
1880.										
January	18 58 24	3·9000	9·5054	10·2742	1·7982	4·3828	4·7373	0·1798	0·4383	0·4737
February.....	18 59 47	3·8990	9·5045	10·2733	1·7978	4·3824	4·7369	0·1798	0·4382	0·4737
March	18 59 26	3·9000	9·5069	10·2757	1·7982	4·3835	4·7379	0·1798	0·4383	0·4738
April	18 58 29	3·9000	9·5054	10·2745	1·7982	4·3828	4·7374	0·1798	0·4383	0·4737
May..	19 0 2	3·9030	9·5131	10·2825	1·7996	4·3863	4·7411	0·1800	0·4386	0·4741
June	19 1 7	3·8997	9·5028	10·2719	1·7981	4·3816	4·7362	0·1798	0·4382	0·4736
July.....	18 58 26	3·9018	9·5102	10·2795	1·7991	4·3850	4·7397	0·1799	0·4385	0·4740
August	18 56 24	3·8945	9·5023	10·2695	1·7957	4·3814	4·7351	0·1796	0·4381	0·4735
September	19 0 41	3·8948	9·5111	10·2776	1·7958	4·3854	4·7388	0·1796	0·4385	0·4739

Meteorological Observations.—Table I.

Kew Observatory.

Longitude $0^h\ 1^m\ 15^s{\cdot}1$ W. Latitude 51° 28′ 6″ N. Height above sea-level =34 feet.
Mean Monthly results from the continuous Records for the Twelve Months ending September 30th, 1880.

Months.	Thermometer.*						Barometer.†					Pressure.	
	Means.	Extreme maximum.		Extreme minimum.		Means.	Extreme maximum.		Extreme minimum.		Means.		
		Date.	Ther.	Date.	Ther.		Date.	Bar.	Date.	Bar.	Vapour-tension.	Dry air.
	°	d. h.	°	d. h.	°	inches.	d. h.	inches.	d. h.	inches.	inch.	inches.
1879. October....	49·4	4 3 P.M.	64·4	26 4 A.M.	32·9	30·132	12 10 A.M.	30·569	20 6 A.M.	29·373	·305	29·827
November..	38·8	18 2 „	54·9	16 7 „	21·9	30·221	7 midt. to 8 1 A.M.	30·642	12 1 „	29·748	·201	30·020
December..	32·7	31 8 „	53·9	7 9 „	13·5‡	30·328	23 3 „	30·822	4 8 P.M. to 11 „	29·520	·167	30·161
1880. January....	33·2	1 1 „	55·0	27 10 P.M. to 28 0.20 A.M.	18·9‡	§30·387	7 10 „	30·687	1 1 A.M.	29·798	·165	30·222
February...	41·9	20 3 „	53·2	2 7 „	25·0	29·813	25 9 „	30·484	17 7 „	28·826	·232	29·581
March.....	44·5	25 3 „	60·6	29 7 „	27·7	30·113	8 10 „	30·513	3 2 „ to 3 „ to 4 „	29·256	·229	29·884
April.....	47·3	19 3 „	64·6	8 5 „	34·7	‖29·879	30 7 „	30·446	6 5 „	29·273	·246	29·633
May	51·9	26 2 „	81·0‡	2 5 „	32·2	30·089	29 8 „	30·487	27 6 „	29·686	·267	29·822
June.....	57·7	29 5 „	76·0	5 4 „	37·4	29·914	27 10 P.M. to 11 „	30·239	7 1 P.M.	29·594	·363	29·551
July.....	61·6	15 6 „	76·9	31 5 „	48·6	29·901	5 8 A.M.	30·195	26 5 „	29·450	·420	29·481
August....	62·6	28 3 „	77·6‡	3 4 „	49·7	29·998	10 8 „ to 10 „	30·314	7 9 „	29·204	·436	29·562
September..	59·5	4 2 „	84·0	20 4 „	44·0	29·985	29 10 „	30·511	15 4 A.M.	29·147	·407	29·578
Means.....	48·4	....	..	....	..	30·063	....	..	....	..	·286	29·777

The above Table is extracted from the Quarterly Weather Report of the Meteorological Office, by permission of the Meteorological Council.

* The thermometer-bulbs are 10 feet above the ground.
† Readings reduced to sea-level.
‡ Approximate reading.
§ One of the daily means doubtful.
‖ Three of the daily means doubtful.

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 blew							
		Total.	Maximum.	Date.	Rain.	Snow.	Hail.	Thunderstorms.	Clear sky.	Overcast sky.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
1879.		in.	in.															
October ..	7·5	0·700	0·220	24	14	..	..	..	1	16	2	9	4	..	..	6	6	4
November	6·9	0·765	0·250	21	10	4	..	..	4	14	12	4	1	..	1	3	5	4
December	7·9	0·775	0·300	30	9	4	1	1	2	23	3	7	3	1	5	7	3	2
1880.																		
January..	7·4	0·440	0·210	16	6	2	..	..	3	16	7	3	5	3	3	4	4	2
February .	7·7	2·215	0·400	7	19	..	2	..	2	16	3	..	..	1	10	11	3	1
March ...	5·3	0·730	0·285	31	6	..	..	..	9	12	1	9	8	3	1	5	4	..
April	7·4	1·975	0·430	14	16	..	2	3	..	13	4	6	2	..	5	8	4	1
May.....	6·7	0·280	0·215	31	4	..	..	1	2	13	6	10	4	..	..	5	3	3
June	7·5	2·215	0·440	15	19	..	..	3	..	15	4	5	3	..	3	7	6	2
July.....	7·5	4·890	0·535	25	19	..	..	12	..	18	2	2	1	1	5	14	5	1
August ..	7·5	0·555	0·215	2	8	..	..	1	2	20	6	14	1	..	1	3	4	2
September	6·5	4·395	1·440	11	14	..	1	2	5	13	1	2	3	2	4	8	9	1
Totals..		19·935			144	10	6	23	30	189	51	71	35	11	38	81	56	23

* Measured daily at 10 A.M. by gauge 1·75 feet above surface of ground. † Derived from observations made at 10 A.M., noon, 2, 4, and 10 P.M.
‡ As registered by the anemograph.

Meteorological Observations.—Table III.

Kew Observatory.

Months.	Bright Sunshine.*		Maximum temperature in sun's rays.			Minimum temperature on the ground.			Horizontal movement of the Air.†		
	Total number of hours.	Number of hours Sun was above the horizon.	Mean.	Highest.	Date.	Mean.	Lowest.	Date.	Average daily Velocity.	Greatest Movement in a day.	Date.
1879.	h. m.	h. m.	deg.	deg.		deg.	deg.		miles.	miles.	
October	69 12	329 24	87·7	113·6	4	38·9	26·0	17	204	431	30
November	45 30	264 54	69·8	94·2	30	28·4	12·2	16	180	415	12
December	18 0	243 3	52·3	81·4	30	22·8	8·0	7	186	624	28
1880.											
January	46 30	257 33	54·0	83·1	31	25·6	11·1	28	159	459	1
February.....	67 24	287 43	77·3	99·5	27	32·2	22·0	12	297	581	9
March.....	141 54	367 45	92·0	108·9	14	33·3	22·1	24	330	749	2
April	127 24	415 34	104·7	123·2	24	36·0	27·5	26	311	500	29
May.....	193 30	482 50	117·9	132·0	26	36·9	24·0	1	264	491	16
June	153 24	494 29	119·9	138·7	26	45·1	27·3	5	220	405	7
July.....	191 0	496 30	128·5	138·8	22	50·7	42·4	5	223	398	28
August	138 0	448 38	120·0	138·2	6	52·4	42·2	3	221	363	12
September	140 30	376 42	116·6	131·5	6	45·2	36·2	20	167	360	18

* Registered by the Sunshine-recorder.

† As indicated by a Robinson's anemograph, 70 feet above the general surface of the ground.

Errata in Kew Report, 1878–9.

By error no corrections for height above sea-level were applied to the extreme barometer readings in the Table on page 462.

The following values must therefore be substituted for those printed under extreme maximum and extreme minimum respectively.

		Inches.		Inches.
1878.	October	30·352	.....	29·026
„	November	30·487	.....	29·205
„	December	30·387	.....	29·159
1879.	January.....	30·457	.....	29·349
„	February	30·182	.....	28·834
„	March	30·633	.....	29·566
„	April	30·337	.....	28·934
„	May.....	30·528	.....	29·543
„	June.....	30·165	.....	29·407
„	July.....	30·177	.....	29·303
„	August.....	30·334	.....	29·465
„	September.....	30·497	.....	29·297