

REPORT

OF THE

THIRTY-SEVENTH MEETING

OF THE

BRITISH ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE;

HELD AT

DUNDEE IN SEPTEMBER 1867.



LONDON:

JOHN MURRAY, ALBEMARLE STREET.

1868.

selves into a voluntary association for the pursuit of science. This Scientific Society, which numbers upwards of thirty members, meets every ten days at the house and under the presidency of one or other of the masters. Objects of scientific interest are exhibited by the members, and papers are read generally on some subject connected with natural history. Under the auspices of this Society the nucleus of a future museum has already been formed; and among other advantages the Society has had the honour of numbering among its visitors more than one eminent representative of literature and science. We cannot too highly recommend the encouragement of such associations for intellectual self-culture among the boys of our public schools.

*Report of the Kew Committee of the British Association for the
Advancement of Science for 1866-67.*

The Committee of the Kew Observatory submit to the Council of the British Association the following statement of their proceedings during the past year:—

At the Nottingham Meeting it was resolved, "That the Kew Committee be authorized to discuss and make the necessary arrangements with the Board of Trade, should any proposal be made respecting the superintendence, reduction, and publication of Meteorological observations, in accordance with the recommendations of the Report of the Committee appointed to consider certain questions relating to the Meteorological Department of the Board of Trade."

On the 18th of October last, a joint Meeting of the Kew Committee, and of the President, Vice-Presidents, and other Officers of the Royal Society, took place, to take into consideration a communication which had been received by the President of the Royal Society from the Board of Trade relative to the Meteorological Department, and to consider what reply should be sent.

At this joint Meeting it was recommended that the Department under whose care the Meteorological observations, reductions, and tabulations are to be made should be under the direction and control of a Superintending Scientific Committee, who should (subject to the approval of the Board of Trade) have the nomination to all appointments, as well as the power of dismissing the usual officials receiving salaries or remuneration. It was also understood that while the services of the Committee were to be gratuitous, they would yet necessarily require the services and assistance of a competent paid Secretary.

Finally, the draft of a reply to the above-mentioned communication from the Board of Trade was agreed to at this Meeting, for consideration of the Council of the Royal Society.

The Council of the Royal Society, on 13th Dec. 1866, nominated the following Fellows of the Society as the Superintending Meteorological Committee:—General Sabine, Pres. R.S., Mr. De la Rue, Mr. Francis Galton, Mr. Gassiot, Dr. W. A. Miller, Captain Richards (Hydrographer of the Admiralty), Colonel Smythe, and Mr. Spottiswoode; and on the 3rd of January this Committee appointed Mr. Balfour Stewart as its Secretary, on the understanding that he should, with the concurrence of the Kew Committee of the British Association, retain his present office of Superintendent of the Kew Observatory.

It was also proposed that Kew Observatory should become the Central Observatory, at which all instruments used by or prepared for the several observatories or stations connected with the Meteorological Department should

be verified,—the entire expense attendant thereon, or any future expense arising through the connexion of the Observatory with the Meteorological Department being paid from the funds supplied by the latter, and not in any way from money subscribed by the British Association. These proposals having been submitted to the Kew Committee, they approved of the Kew Observatory being regarded as the Central Observatory of the Meteorological Department, and of Mr. Stewart's holding the office of Secretary to the Scientific Committee superintending that Department.

When the Meteorological Department was placed under the superintendence of a Scientific Committee, one of the main objects contemplated was the establishment of a series of meteorological observatories, working in unison with the Kew Observatory, provided with similar self-recording instruments, and distributed throughout the country in such a manner that by their means the progress of meteorological phenomena over the British Isles might be recorded with great exactness.

For this purpose it was proposed to have observatories in the following places:—

Kew (Central Observatory).	Aberdeen (probably).
Falmouth.	Armagh.
Stonyhurst.	Valencia.
Glasgow.	

Such a plan of course involves an additional annual expenditure; but, the appointment of a Committee having been sanctioned in the first instance by the Government, and the estimates attendant thereon afterwards by the House of Commons, the arrangement may now be regarded as established, without involving any additional expense to the British Association. The consequence will be a considerable access of work to Kew Observatory, and the duties now undertaken by that establishment may, for clearness' sake, be considered under the two following heads:—

- (A) The work done by Kew Observatory under the Direction of the British Association.
- (B) That done at Kew as the Central Observatory of the Meteorological Committee.

This system of division will be adopted in what follows of this Report.

(A) WORK DONE BY KEW OBSERVATORY UNDER THE DIRECTION OF THE BRITISH ASSOCIATION.

1. *Magnetic*.—The Self-recording Magnetographs ordered by the Victoria Government for Mr. Ellery, of Melbourne, have been verified at Kew, and dispatched to Melbourne, where they have arrived. They will, it is believed, be very shortly in continuous action.

It was mentioned in the last Report that a set of Self-recording Magnetographs ordered by the Stonyhurst Observatory had been verified at Kew and dispatched to their destination. These instruments are now in action at Stonyhurst, under the direction of the Rev. W. Sidgreaves.

Mr. Meldrum, of the Mauritius Observatory, who is now in this country, has received at Kew instruction in the various processes of that establishment. His Self-recording Magnetographs have been verified in his presence, and they are now in the hands of the optician, who is awaiting Mr. Meldrum's instructions regarding them.

It is hoped that very soon a considerable number of Magnetographs after the Kew pattern will be in continuous operation at different parts of the

world; and as during the next two or three years magnetic disturbances may be expected to increase, it will be interesting to institute comparisons between the simultaneous records produced by these various instruments.

The usual monthly absolute determinations of the magnetic elements continue to be made by Mr. Whipple, magnetic assistant; and the Self-recording Magnetographs are in constant operation as heretofore, also under Mr. Whipple, who has displayed much care and assiduity in the discharge of his duties.

The photographic department connected with the self-recording instruments is under the charge of Mr. Page, who performs his duties very satisfactorily.

The observations made for the purpose of determining the temperature coefficients of the horizontal-force and vertical-force magnetographs have been reduced.

In order to obviate the chance of any break in the continuity of the series of absolute magnetic determinations made at Kew which might arise from a change of the magnetic assistant, the Superintendent has commenced taking quarterly observations of the dip and horizontal force, with the view of correcting any change in *personal equation* which might be produced by change of assistant.

The magnetic curves produced at Kew previously to the month of January 1865, have all been measured and reduced under the direction of General Sabine, by the staff of his office at Woolwich, and the results of this reduction have been communicated by General Sabine to the Royal Society in a series of interesting and valuable memoirs. It is now proposed that the task of tabulating and reducing these curves since the above date be performed by the staff at Kew working under the direction of Mr. Stewart.

2. *Meteorological work.*—The meteorological work of the Observatory continues in charge of Mr. Baker, who executes his duties very satisfactorily.

Since the Nottingham Meeting 89 Barometers have been verified; 608 Thermometers have likewise been verified, and two Standard Thermometers have been constructed at the Observatory.

The Self-recording Barograph continues in constant operation, and traces in duplicate are obtained, one set of which is regularly forwarded to the Meteorological Office.

A Self-recording Barograph and Thermograph on the new Kew pattern about to be made for Mr. Ellery of Melbourne, and a Self-recording Barograph for Mr. Smalley of Sydney, will be verified at the observatory before they are dispatched to their destination.

The Anemometer is in constant operation as heretofore.

Dr. R. Coleridge Powles, before he proceeded to Peking, received meteorological instruction at Kew.

The well-known apparatus employed for so long a time by Mr. Robert Addams for liquefying carbonic acid, has been purchased by Mr. Stewart from funds supplied by the Royal Society; and Mr. Addams has kindly undertaken to make a preliminary experiment with his apparatus, as well as to give specific instructions regarding it. As the exact thermometric value of the freezing-point of mercury has been previously determined by Mr. Stewart, it is expected that the apparatus will furnish the means of verifying thermometers at very low temperatures.

At the request of the Meteorological Committee, several Aneroids have been obtained from the best-known makers of these instruments, and, by means of an apparatus constructed by Mr. Beckley for this purpose, they have been compared with a standard Barometer at different pressures, being

meanwhile tapped so as to imitate as well as possible the tapping by the hand which these instruments are usually subjected to previously to the readings being taken.

These experiments show that, while Aneroids cannot be considered equal in accuracy to standard Barometers, yet the best-constructed Aneroids, within certain limits, give reliable results.

3. *Photoheliograph*.—The Kew Heliograph, in charge of Mr. De la Rue, continues to be worked in a satisfactory manner. During the past year 204 negatives have been taken, on 144 days. Pictures of the Pagoda in Kew Gardens are regularly taken by this instrument, in the hope that by this means the angular diameter of the Sun may be satisfactorily determined. Since the last Meeting of the Association, a second series of solar researches, in continuation of the first series, has been published (the expense of printing having been defrayed by Mr. De la Rue), entitled “Researches in Solar Physics, Second Series, Area Measurements of the Sun-spots observed by Mr. Carrington during the seven years 1854–1860 inclusive, and deductions therefrom. By Messrs. De la Rue, Stewart, and Loewy.”

The Heliographic latitudes and longitudes of all the spots recorded by the Kew Photoheliograph during the years 1862 and 1863 have been calculated, and it is hoped that the results may soon be published, forming a third series of Solar Researches. It is believed that these results will demonstrate the superiority of photographic pictures over all other methods of observation.

The sum of £60 has been obtained from the Government Grant fund of the Royal Society, to be applied to the discussion of Hofrath Schwabe’s long and valuable series of Sun-spots, at present in the possession of Kew Observatory. These pictures are now being examined with this object.

Sun-spots continued likewise to be numbered after the manner of Hofrath Schwabe, and a table exhibiting the monthly groups observed at Dessau and at Kew for the year 1866 has already appeared in the Monthly Notices of the Astronomical Society, vol. xxvii. No. 3.

4. *Apparatus for verifying Sextants*.—The apparatus constructed by Mr. Cooke, for verifying Sextants, has for some time been erected at the Observatory; and a description of it has been communicated by Mr. Stewart to the Royal Society, and published in their ‘Proceedings,’ vol. xvi. p. 2.

Seven Sextants have been verified during the past year.

5. *Miscellaneous work*.—The preliminary observations with Captain Kater’s pendulum, alluded to in last year’s Report, have been made; but the reductions are not yet quite finished.

An account of certain experiments on the heating of a disk by rapid rotation *in vacuo* has been communicated to the Royal Society by Mr. Stewart in conjunction with Professor Tait, and has been published in the ‘Proceedings’ of that body.

The instrument devised by Mr. Broun for the purpose of estimating the magnetic dip by means of soft iron, remains at present at the Observatory, awaiting Mr. Broun’s return to England.

During the past year two standard yards for opticians have been compared with the Kew standard.

Several instruments, chiefly magnetic, have been sent to Kew by General Sabine from his office at Woolwich.

The Superintendent has received grants from the Royal Society for special experiments; and when these are completed an account will be rendered to that Society.

(B) WORK DONE AT KEW AS THE CENTRAL OBSERVATORY OF THE
METEOROLOGICAL COMMITTEE.

Mr. Stewart, as Director of the Central Meteorological Observatory, having been called upon to arrange the self-recording instruments required by the Meteorological Committee, has obtained the cooperation of Mr. Beckley, mechanical assistant at Kew, from whom he has derived very great aid, and in conjunction with him has arranged the Self-recording Thermograph and Barograph which have been adopted by the Meteorological Committee.

The following are the chief characteristics of these instruments:—

Thermograph.—In this instrument an air-speek, formed by a break in the mercurial column of a thermometer, allows the light of a gas-lamp to pass through it, yielding an image that is obtained on a revolving cylinder covered with photographic paper.

As the cylinder revolves once in forty-eight hours, and as the thermometric column rises and falls, these motions delineate a curve, by means of which the temperature of the thermometer is denoted from moment to moment. There would be but one curve if there were only one thermometer; in practice there are two, the dry and wet bulb, the object of the first being to register the temperature of the air, and of the second to register that of evaporation. In this Thermograph the simultaneous records of these two thermometers are obtained, the one under the other, on the same sheet of paper. We have thus an under curve denoting the readings of the wet-bulb thermometer, and a curve above it denoting those of the dry-bulb thermometer.

An arrangement connected with the clock of this instrument has been proposed and executed by Mr. Beckley, by means of which the light is cut off from the sensitive paper for four minutes every two hours. A small break is thus produced every two hours on each curve, by means of which the time of any phenomenon may be easily ascertained. By drawing lines through the simultaneous breaks of the wet and dry-bulb curves, a series of lines is obtained perpendicular to the direction of motion of the cylinder, which serves the purposes of a zero-line. Lastly, a Kew Standard Thermometer, similar in size and figure to those of the Thermograph, and placed between them (outside the house), is used as the standard of reference, and, as such, is read (by eye) five or six times a day. By this means an independent determination of the temperature of the air may be obtained from time to time.

The Thermograph has been for some time ready to commence continuous registration. Hitherto this has been delayed with the view of making experiments designed to improve the working of the instrument, because up to the present time these improvements could be easily adapted to the other instruments in course of construction. It is intended to commence the regular working of the instrument before the beginning of September.

Barograph.—The arrangement for cutting off the light every two hours, and the precaution of comparing the observations with those of a standard instrument, read five or six times a day, will be introduced in the Barograph as well as in the Thermograph. The correction of the Barograph for temperature is the only thing to which it is necessary to allude. Here the curve denotes an uncorrected Barometer: the zero-line is not a straight line, but is formed by the interception of the light from the cylinder by a stop which, by means of a lever arrangement, rises and falls with temperature as much as the barometric column rises and falls from the same cause; that is to

RECEIPTS.

	£	s.	d.
Balance from last account	22	9	9
Received from the General Treasurer	600	0	0
" for the verification of Meteorological Instruments from the Meteorological Office	22	19	0
" " from Opticians	31	9	2
" for Barograph Curves sent to the Meteorological Office, London	26	0	0
" for the verification of self-recording Magnetographs	60	0	0
" from Prof. Roscoe for time employed in making actinic observations	24	0	0
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			164 8 2

PAYMENTS.

	£	s.	d.
Salaries, &c. :—			
To B. Stewart, four quarters, ending 1st October, 1867	200	0	0
Ditto, allowed for petty travelling expenses	10	0	0
G. Whipple, four quarters, ending 15th September, 1867	100	0	0
T. Baker, four quarters, ending 29th September, 1867	75	0	0
F. Page, two quarters at £40 per annum	20	0	0
Ditto, two quarters, ending 2nd October, 1867, at £50 per annum	25	0	0
R. Beckley, 54 weeks, ending 2nd September 1867, at 40s. per week	108	0	0
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Apparatus, Materials, Tools, &c.	538	0	0
Ironmonger, Carpenter, and Mason	51	14	8
Printing, Stationery, Books, and Postage	13	18	3
Coals and Gas	56	19	2
House Expenses, Chandlery, &c.	49	7	0
Porterage and petty expenses	27	16	8
Rent of Land to 10th October, 1867	26	14	10
Brushwood for ditch	11	0	0
Balance	1	5	0
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			£786 17 11

I have examined the above account and compared it with the vouchers presented to me.

The Balance from the last year	£ 22	9	9
Received from the Treasurer of the British Association	600	0	0
From Sundries, for the construction and verification of instruments	164	8	2
			<hr/>
			786 17 11
The total Expenditure for the year	776	15	7
Leaving a balance in hand amounting to	£ 10	2	4

15th August, 1867.

R. HUTTON.

say, in order to find the true height of the barometer, we measure between the zero-line and the line denoting the top of the uncorrected column, since, when the top of the column rises or falls through temperature, the zero-line rises or falls just as much. This mode of correction, although sufficient for most purposes, cannot yet be absolutely perfect; a little reflection will, however, show that the curved zero-line may not only be used as the means of correcting the readings of the instrument, but also as giving the actual temperature of the mercurial column from moment to moment, so that the true temperature-correction may with very little trouble be obtained and applied.

A comparison of the curves of the old Kew Barograph at present in operation, with those of the Oxford Barograph, has shown that there is probably a slight adhesion of the mercury to the sides of the tube of the former instrument; moreover the instrument is not in all respects the same as those about to be supplied to the other observatories. It has therefore been resolved that one of the new instruments shall be substituted for it.

Anemometer.—This instrument is a modification of Dr. Robinson's. Its time-scale corresponds in length with those of the Thermograph and Barograph,—the object of having all the time-scales of the same length being to obtain the means of accurately placing the simultaneous records of the different instruments, one under the other, on the same sheet of paper. The present Anemometer will have to be altered, as it is not self-recording for direction; and it is then intended to support it above the moveable dome of the Observatory so as to be independent of it.

In order to fit the Observatory for the purposes of the Meteorological Committee, one of the outhouses, at present only occasionally used for the verification of Magnetographs, has been altered so as to make it also available for the verification of meteorological self-recording instruments; this, together with the addition of a small brick building outside, will be sufficient for the purposes of the Meteorological Committee. When this building is completed it will receive all the moveable iron at present in the Observatory; this arrangement will at the same time set free the present workshop, additional room being required for the increasing work of the Observatory.

J. P. GASSIOT, *Chairman.*

Kew Observatory, 22nd August 1867.

Report of the Parliamentary Committee to the Meeting of the British Association at Dundee, September 1867.

The Parliamentary Committee have the honour to report as follows:—

Your Committee have to express their regret that the Public Schools Bill has again failed to obtain the sanction of the Legislature; but it is a subject for congratulation that the discussions in Parliament and elsewhere, which have followed its introduction, have already borne fruit. The attention of the public appears to have been awakened to the necessity for introducing scientific teaching into our Schools, if we are not willing to sink into a condition of inferiority as regards both intellectual culture and skill in art when compared with foreign nations. The voluntary efforts of the Masters of two of our great schools to add instruction in Natural Science to the ordinary Classical course are deserving of all praise; and some evidence of their suc-