ANNUAL REPORT

OF THE

DIRECTOR

KODAIKANAL AND MADRAS OBSERVATORIES

FOR 1913.

MADRAS:
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1914.

KODAIKANAL AND MADRAS OBSERVATORIES.

REPORT FOR THE YEAR 1913.

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KODAIKANAL AND MADRAS OBSERVATORIES.

I. REPORT OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1913.

Staff.—The staff of the observatory on December 31, 1913, was as follows:—

Director	J. Evershed (on deputation to New Zealand).
	T. Royds, D.Sc. (officiating).
Assistant Director	T. Royds D.Sc.
First Assistant	S. Sitarama Ayyar, B.A.
Second Assistant	G. Nagaraja Ayyar.
Third Assistant	A. A. Narayana Ayyar, B.A.
Fourth Assistant	S. Balasundaram Ayyar (on furlough).
	S.N. Krishna Ayyar (acting).
Writer	L. N. Krishnaswami Ayyar.
Photographic Assistant	R. Krishna Ayyar.

The Director was on privilege leave for three months from August 4, and his services were lent to the New Zealand Government for three months from December 11, to advise relating to a proposed Solar Observatory and to select a site. The Assistant Director officiated as Director on both occasions. The First, Second, and Photographic Assistants were on privilege leave for 32 days, 6 weeks, and 1 month from September 15, July 23, and October 20, respectively. Mr. S. Balasundaram Ayyar is on combined privilege leave and furlough for nine months from July 1.

Mr. A. Y. Subrahmanya Ayyar, B.A., resigned his appointment as Third Assistant on February 8, and Mr. A. A. Narayana Ayyar, B.A., of the Madras Observatory was appointed in his place on probation for six months.

The Subordinate staff consists of a book-binder, an assistant book-binder, a mechanic, five peons, a boy peon for the dark room and two lascars.

2. *Distribution of work.*—The Director and the Assistant Director have charge of the two spectroheliographs and the large grating spectrograph. The First, Second, and Third Assistants are in charge of the work with the Cooke equatorial (spectroscopic), the Lerebour and Secretan equatorial (visual and photographic), and the transit instrument. They have also to do the astronomical computing and the preparation of the observations for the press. The Second and Third Assistants have been trained to measure spectrum plates and the Third Assistant has charge of the seismometer and clock comparisons. The meteorological work of the observatory has been reduced (*vide* section 13) and is done by the Fourth Assistant and the Writer. The Fourth Assistant also assists Mr. C. Michie Smith, C.I.E., retired Director of the Observatory in the preparation of a memoir on the meteorology of Periyakulam and Kodaikanal. The Writer is responsible for the accounts, correspondence, and all office records. The Photographic Assistant has charge of most of the photographic developing, printing, etc.

3. *Buildings and grounds.*—The buildings and grounds have been kept in good repair.

The question has been raised of transferring, either partially or wholly, the work of the observatory to Kashmir where the Director, whilst on leave, found the observing conditions more suitable than at Kodaikanal. Consequently the construction of a building for the Poona 20-inch reflecting telescope is held over for the present. It is expected that the Director will make a three months' expedition to Kashmir with suitable instruments for thoroughly testing the conditions in Kashmir both for solar and stellar work.

The fire lines in the compound have been kept in good order and there has been no trouble from forest fires during the year.

4. *Instruments.*—The following are the principal instruments belonging to the observatory, or in use, at the present time :—

Six-inch Cooke equatorial.
Six-inch Lerebour and Secretan equatorial remounted by Grubb, with a five-inch Grubb portrait lens attached. The Lerebour and Secretan object glass has been replaced by a Cooke photo-visual lens of the same aperture and the instrument has been adapted for direct solar photography in addition to visual work.
Spectrograph I—consisting of slit, collimator lenses of 4 and 7 feet focus, 2-inch parabolic grating, and camera tube without lens. Used in connection with an 11-inch polar siderostat and 6-inch Grubb lens of 40 feet focus.
Spectrograph II—consisting of a collimator of 7 feet focus and camera of 14 feet focus placed at an angle of 60° with the former. Plane gratings of 3¼ inches or 5 inches ruled surface are used, and the slit is provided with various devices for the direct comparison of spectra from different sources, and for rotating the solar image.
Spectroheliograph—with 18-inch siderostat and 12-inch Cooke photo-visual lens of 20 feet focus, by the Cambridge Scientific Instrument Company.
An auxiliary spectroheliograph attached to the above, made in the Observatory workshop.
Six-inch transit instrument and barrel chronograph, formerly the property of the Survey of India.
Theodolite, six-inch—Cooke.
Sextant.
Evershed spectroscope with three prisms, for prominence and sunspot work, by Hilger.
Mean time clock, Kullberg 6326.
Do. Shelton.
Mean time chronometer, Kullberg 6299.
Sidereal chronometer, Kullberg 6134.
Tape chronograph, Fuess.
Two micrometers for measuring spectrum photographs, Hilger.
Hartmann Photometer.
Dividing engine, Cambridge Scientific Instrument Company, Limited.
Milne horizontal pendulum seismograph.
Induction coil with necessary adjuncts.
Small polar siderostat.
Universal instrument.
Complete set of meteorological instruments, including a Richard thermograph and a new Richard weekly barograph.
A high class screw cutting turning lathe by Messrs. Cooke & Sons.
Angström Pyrheliometer.
An 18-inch concave mirror by Henry of Paris belonging to the Director is mounted in the spectroheliograph room for general spectrum work.

The instruments received from the Takhtasinghji Observatory at Poona include the following :—

Twenty-inch reflecting telescope, by Common.
Six-inch Cooke photo-visual telescope with equatorial mounting.
Two prisms of 6 inches aperture for use with the above.
Twelve-inch Cooke siderostat.
Eight-inch horizontal telescope.
Large grating spectroscope, by Hilger.
An ultra-violet spectrograph by Grubb.
Sidereal clock, Cooke.
Mean time chronometer, Frodsham No. 3476.

OBSERVATIONS.

(*a*) Solar Physics.

5. The following table shows for each day the solar observations that were made:—

Table A.

Solar Observations in 1913.

A = Disc examined. B = Spot spectrum observed. C = Prominences observed. D = Photoheliograms taken. E = Spectroheliograms taken

Dates.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1 ...	A—*C* D E	A—C D E	A—C D E	A—C D E	A—C D E	A—C D E	A—*C* D E	A—*C* D E	A *C* D E	A— —D E	— — —	A—C D E
2 ...	A—*C* D E	A—*C* D E	A—*C* D E	A—C D E	A—C D E	A—*C* D E	A— —D E	A C D E	A—C D E	A—*C* D E	A—C D E	A—*C* D E
3 ...	A—C D E	A—C D E	A—C D E	A—*C* D E	A—*C* D E	A— D—	A—C D E	A—*C* D E	A—C D E	A— —D E	A— — —	A— —D E
4 ...	A—C D E	A—C D E	A—*C* D E	A—C D E	A—C D E	— — —	A—*C* D E	A—*C* D E	A—C D E	A—*C* D E	A—C D E	A— —D—
5 ...	A—C D E	A—C D E	A—C D E	A—C D E	— — — *E*	A—C D *E*	A— — D	A—*C* D E	A—C D E	A—C D E	A—C D E	A *C* D E
6 ...	A—C D E	A—C D E	A—*C* D E	A—C D E	A—C D E	A— D—	A—*C* D E	A—*C* D E	A *C* D E	A C D E	A—C D E	A C D E
7 ...	A—C D E	A—C D E	A—*C* D E	A—C D E	A—C D E	— — —	A—*C* D E	A—*C* D E	A—*C* D E	A—C D E	— — —	— — —
8 ...	A—C D E	A—C D E	A—C D E	A—C D E	A—C D E	A—C D E	A—*C* D E	A—C D E	A—*C* D E	A *C* D E	A — —	A — — —
9 ...	A— —D—	A—C D E	A—C D E	A—C D E	A—C D E	A—C D E	A—*C* D E	A—C D E	A—C D E	A— D *E*	— — —	A—*C* D E
10 ...	A — — —	A—C D E	A—*C* D E	A—C D E	A C D E	A—C D E	A—*C* D E	A—*C* D E	A—C D E	A—*C* D E	— — —	A—*C* D E
11 ...	A—*C* D E	A—C D E	A—*C* D E	A—C D E	A—*C* D E	A—*C* D E	A—*C* D E	A—C D E	A—*C* D E	A— — E	A—*C* D *E*	A— —D E
12 ...	A—C D E	A—*C* D E	A—*C* D E	A—C D E	A—C D E	A—*C* D E	A—*C* D E	A—*C* D E	A D E	A—*C* D E	A—C D E	A *C* D E
13 ...	A—C D E	A—C D E	A—*C* D E	A—C D E	A—C D E	A—*C* D E	A— —D E	A— —D E	A— — *E*	A—C D E	A— —D E	A—C D E
14 ...	A—C D E	A—*C* D *E*	A—C D E	A—*C* D E	A—C D E	A—C D E	A— —D E	A—*C* D E	A— D *E*	A—*C* D E	A—C D E	A—*C* D E
15 ...	A— —D *E*	A—*C* D E	A—C D E	A—C D E	A—C D E	A—*C* D E	A—*C* D E	A—*C* D E	A C D E	A—C D E	A—C E E	A—C D E
16 ...	A—C D E	A—*C* D E	A—C D E	A—*C* D E	A—C D E	A—*C* D E	— — —	A *C* D E	A—C D E	A—C D E	A—*C* D E	— — —
17 ...	— — —	A—C D E	A C D E	— — —	A—*C* D E	A—*C* D E	A — — —	A—*C* D E	A C D E	A—C D E	A—C D E	— —
18 ...	— — —	A—C D E	A—C D E	A—*C* D E	A—C D E	A— D *E*	A— —D *E*	A — D *E*	A *C* D E	A—C D E	A C D E	—
19 ...	A—*C* D E	A—C D E	A—C D E	A—*C* D E	A—C D E	A— D *E*	A—*C* D E	A— D *E*	A—C D E	A—*C* D E	A C D E	A C D E
20 ...	A C D E	A C D E	A—*C* D E	A—C D E	A—*C* D E	A—*C* D E	A— —D *E*	A—C D E	A—*C* D E	— — —	A—C D E	A—C D E
21 ...	A—C D E	A—C D E	A—C D E	A—*C* D E	A— D E	A— D—	A—*C* D E	— — —	A—C D E	A—C D E	— E	— — —
22 ...	A—C D E	A—*C* D E	A—C D E	A—*C* D E	A—C D E	A—*C* D E	A—*C* D E	A—*C* D E	A—C D E	A—C D E	A—C D E	A—*C* D E
23 ...	A—C D E	A — — E	A—*C* D E	A—C D E	A—C D E	A—C D E	A—*C* D *E*	A—*C* D E	A—*C* D E	A— D—	A C D E	A C D E
24 ...	A— —D *E*	A—*C* D E	A—C D E	A—*C* D E	— — — *E*	A—*C* D E	A—C D E	A—*C* D E	A— —D *E*	A *C* D E	A C D E	A C D E
25 ...	A—*C* D E	A— —D E	A—C D E	A—*C* D E	A—*C* D E	A—*C* D E	A—C D E	A—C D E	A—*C* D E	— — —	A *C* D E	A—C D E
26 ...	A—C D E	A—*C* D E	A—C D E	A—C D E	A—C D E	A—*C* D E	A—C D E	A—C D E	A— D E	A — — —	— — —	A—C D E
27 ...	A— —D E	A—C D E	A—C D E	A—*C* D E	A *C* D E	A—*C* D *E*	A C D E	— — —	A—*C* D E	A— D—	A — — —	A—C D E
28 ...	A—C D E	A—*C* D E	A—C D E	A—C D E	A—*C* D E	A—*C* D E	A—C D *E*	A—*C* D E	A—*C* D E	A—C D E	— — —	A—C D E
29 ...	A—C D E		A—*C* D E	A—*C* D E	A—*C* D E	A—*C* D E	A— — —	A—*C* D E	A—C D E	A— —D *E*	— — —	A C D E
30 ...	A—C D E		A—C D E	A—*C* D E	A—*C* D *E*	A—C D E	A— —D *E*	A—*C* D E	A—*C* D *E*	A C D E	A—*C* D E	A—*C* D *E*
31 ...	A—C D E		A—C D E		A—*C* D E		— — —	A C D E		A— —D—		A—*C* D E

Note.—When a letter is in italics, it means that on that day the observation was not complete.

Solar Observations—Abstract.

—	1913.												Total.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
A	29	28	31	29	29	28	29	29	30	29	22	26	339
B	..	...	...	...	...	...	...	...	..	...	...	...	..
C	24	26	31	29	28	23	20	26	25	20	18	22	292
D	28	27	31	29	29	28	27	29	29	27	19	25	328
E	27	28	31	29	31	26	26	29	30	25	19	24	325

The partial failure of the monsoon in this locality in 1913 shows itself as an increase in the number of days of observation in the above table. During the months June to October the sun was examined for spots and faculæ on 145 days against 135 in 1911 and 120 in 1912 ; but the number of days for the whole year is not very high.

6. *Photoheliograph.*—Photographs of the sun were obtained on 328 days as against 329 in 1912. The number of possible days was very low in November. The photographs are, as stated in the last report, taken with the photo-visual telescope in the north dome. Double exposures are taken twice a month for determining the error of orientation of the photographs. Six solar negatives asked for by the Greenwich Observatory to complete their series for the period January to June 1913 were all sent.

7. *Spectroheliograph.*—Monochromatic photographs of the sun's disc in "K" light were taken on 325 days, and prominence plates on 300 days. With the autocollimating spectroheliograph Hα images were secured on 202 days. The prominence plates are measured as soon as obtained, and the results tabulated. Duplicates of the disc plates have been sent to the Cambridge Observatory for measurement since the South Kensington Observatory was transferred there.

The Michelson grating in the Hα spectroheliograph was removed on November 20 for use in the spectrograph.

8. *Grating Spectrograph.*—The work with the spectrograph has been mainly along the following lines :—(1) comparison of the centre and the limbs of the sun ; (2) comparison of the sun's centre and the iron arc in air and *in vacuo* ; (3) comparison of the sun's limb and the iron arc. These comparisons were used to investigate the equatorial velocity of rotation of the sun, and the study of the displacements of the lines of the sun's centre and limb. Mr. Evershed has now put forward the view that these displacements can be best explained as due to velocities in the line of sight rather than to pressure which has been hitherto the commonly accepted explanation (*see* Bulletin No. XXXVI). These investigations are being continued, special regard being paid to those lines of which we know the effective levels, as well as their behaviour under pressure.

A new method of measuring spectrum plates has been worked out by the Director.

9. *6-inch Cooke Equatorial and Spectroscope.*—As stated in section 9 of the last report the old Cooke equatorial telescope with its mounting and also the Evershed spectroscope were removed from the south dome and re-erected in the photoheliograph dome in October 1912. Visual spectroscopic observations were made there from October 15, 1912, to March 26, 1913. On March 27 the Evershed Spectroscope was replaced by a new grating spectroscope constructed by the Director. Meanwhile the 6-inch

Cooke Equatorial with the Hilger Solar Spectroscope, both from Poona, were erected in the south dome and a series of comparative observations with this combination and that of the old Cooke telescope with the new grating spectroscope showed the former combination to be a better instrument; it was accordingly adopted for regular observations from April 4, 1913. A careful examination of the sun's limb is made for displacements of hydrogen lines and for metallic prominences. A fairly large number of the former have been recorded.

Prominences were recorded visually on 292 days. There was no spot large enough to have its spectrum observed in detail, except perhaps one which was seen early in December, but the weather was unfavourable on the only two days on which the spot was fairly large. Disturbances in the C line were recorded on about half-a-dozen days and D_3 was observed as an absorption line on one day.

Summary of Sunspot and Prominence Observations.

10. *Sunspots.*—The following table shows the monthly numbers of new groups observed, the mean daily numbers of spots visible, and the distribution between the northern and southern hemispheres :—

—	January.	February.	March.	April.	May.	June.	July.	August.	September	October.	November.	December.	Year.
New groups	3	1	2	1	...	...	1	...	1	2	1	4	16
Daily number ...	0·3	0·4	0·1	0·1	...	...	0·2	...	0·1	0·3	0·1	0·5	0·2
North	1	1	...	...	...	...	1	...	1	2	...	1	7
South	2	...	2	1	...	...	...	...	...	...	1	3	9
Equator	...	...	...	...	...	...	...	...	...	...	...	...	...

It was stated in the last report that the new cycle of spot activity could probably be considered to have begun about the end of 1912. There seemed to be some confirmation of this in the early months of 1913, especially as the spot of February which was a high latitude one, 32° north, lived long enough to pass across the whole disc of the sun; but the activity was not kept up as the year advanced. In fact there were three months—May, June, and August—without a single spot recorded as against two months in 1912; also only 16 spot groups were recorded in the whole year, which is six less than in 1912. On the other hand the average latitude was high (19°·9 north and 16°·9 south) in 1913 as compared with previous years, which is an indication of the commencement of a new cycle. Further, on December 13, 1913, three separate spot groups were seen on the disc, for the first time since May 1911. The distribution of spots between the two hemispheres was more even than in former years, there having been seven northern spots and nine southern.

The following particulars may be useful for comparing the spot activity of recent years :—

—	1910.	1911.	1912.	1913.
Number of new groups ...	152	56	22	16
Mean daily numbers ...	1·8	0·7	0·3	0·2
Number of days on which no spot was seen.	56	158	240	288

Only two spots, one in February and the other in December, reached a fair size, but neither of them could be called large.

11. *Prominences.*—The mean prominence areas in the years 1912 and 1913 are given below :—

Mean daily Profile areas of Prominences in square minutes of arc.

—	1912.	1913.
North	0·95	1·08
South	1·51	1·11
Total ...	2·46	2·19

The mean area for 1913 was 93·1 per cent. of that of the previous year, the figures for 1912 and 1911 being 84·5 and 71·0 per cent., respectively, showing that the decrease in prominence activity is now becoming slower.

The distribution in latitude in 1913 was very much the same as in 1912, the only noticeable differences being that the secondary maximum in the southern hemisphere between 15° to 20° found in the latter half of 1912 has disappeared, and the region of greatest activity—between latitude 40° and 50°—shows a tendency to broaden towards the equator.

Metallic Prominences.

—	Number observed.	Mean latitude.	Extreme latitudes.	
North	2	26°	25°·5	26°·0
South	3	44°	41°·5	46°·?

The prominence activity in each month may be estimated from the following table :—

Number of Prominences.

Months.	Prominences one minute or more in height.	Metallic.	Eruptive.
January	55	2	5
February	68	...	4
March	80	3	2
April	62	...	4
May	46	...	1
June	23	...	1
July	23	...	1
August	22	...	...
September	18	...	...
October	17	...	...
November	25	...	...
December	21	...	1

The reduction in the number of "large" prominences since 1912 is about the same as that in the mean profile areas.

Only five metallic prominences were recorded : two of these were observed on the same day within 3° of each other and probably originated in a common disturbance.

(*b*) OTHER OBSERVATIONS.

12. *Time.*—The error of the standard clock is usually determined by reference to the 16-hour signal from the Madras Observatory. This is rendered possible by the courtesy of the Telegraph department which permits the Madras wire to be joined through to this observatory. The signal is received with accuracy on most days and all failures are at once reported to the officer in charge of the Trichinopoly division. Independent time determinations have been made with the transit instrument using the Sidereal chronometer K 6134.

13. *Meteorology.*—Eye observations are made at 8^h, 10^h and 16^h local mean time as in former years. The Richard thermograph (wet and dry bulb) and barograph, the Beckley anemograph, and the sunshine recorder also continue in use. The Beckley anemograph was out of action from March 23 to July 28 during the repairs to the wind tower. The tabulation of the hourly readings from the barograms, thermograms and sunshine records has been stopped since March and the anemograms are now tabulated by the Madras Observatory staff which also prepares the 8^h register from readings taken here. The preparation of the 10^h and 16^h registers is done in the Calcutta Meteorological Office. The wind velocity and direction for the daily weather telegrams to Simla and Madras are obtained as usual from the Robinson anemometer and a wind vane. From the 8th December a weekly Richard barograph has been substituted for the daily one which was formerly in use.

Pressure.—The average pressure for the year was 0·006 inch above the normal ; half of the excess is due to the pressure being 0·035 inch above normal in December. The monthly mean pressure was below normal from March to June and above in the other months ; the greatest defect was 0·017 in June.

Temperature.—The monthly mean temperature was in excess of the normal throughout the year and the mean maximum was in excess in the first ten months of the year. The monthly mean dry minima did not vary much from the normal so that there was a wider range of temperature than usual. The annual mean temperature, the annual mean maximum temperature and the annual mean range were respectively 2°·2, 1°·4 and 1°·5 above normal. The mean "sun maximum" was also in excess in every month except November.

Humidity.—The annual mean was in defect of the normal by two per cent. and the mean did not vary much from the normals in the individual months but the variations were the reverse of the temperature variations, that is, they were in defect from January to October and in excess in November and December.

Rainfall.—The total annual fall was 3·27 inches below normal and the number of rainy days was less by nine. The distribution was also abnormal. In the eight months January, February, April, May, June, August, September and October there was a total defect of 14·28 inches and in the other four months a total excess of 11·01 inches. The greatest deviation from normal was a defect of 5·23 inches in October.

Transparency of the atmosphere.—The transparency of the lower atmosphere as judged by the visibility of the Nilgiris, about 100 miles distant, was again much below normal being even worse than in the years 1911 and 1912.

Cloud and Sunshine.—The annual mean clear sky was practically the same as the normal but there was the great excess of 327·5 hours above normal in the total duration of bright sunshine.

14. *Seismology.*—The Milne horizontal pendulum recorded only 61 earthquakes as against 81 in 1912. The number of large shocks was also smaller but the largest, recorded on January 19, had a greater amplitude than any in 1912.

15. *Library.*—One hundred and fifty volumes were bound during the year. A new catalogue of the library is in preparation.

16. *Publications.*—Seven Bulletins, Nos. XXVII to XXXIII were published during the year, and Nos. XXXIV to XXXVI were in the press at the end of the year. Their titles are as follows :—

No. XXVII.—On the Presence of Radium and the elements of the inactive group in the Chromosphere, by J. Evershed.

No. XXVIII.—On the relative numbers of Prominences observed on the Eastern and Western limbs, by J. Evershed.

No. XXIX.—Summary of Prominence observations for the first half of the year 1912, by J. Evershed.

No. XXX.—Summary of Prominence observations for the second half of the year 1912, by J. Evershed.

No. XXXI.—Summary of Prominence observations for the first half of the year 1913, by J. Evershed.

No. XXXII.—A new method of measuring small displacements of spectrum lines, by J. Evershed.

No. XXXIII.—Prominence Periodicities, by T. Royds.

No. XXXIV.—A comparison of the Periodicities in Prominences and Sunspots, by T. Royds.

No. XXXV.—The apparent effect of planets on the distribution of Prominences, by T. Royds and S. Sitarama Ayyar.

No. XXXVI.—A new Interpretation of the general displacement of the lines of the solar spectrum towards the red, by J. Evershed.

The following contributions were made in addition to the above :—

The Determination of Ancient dates from Astronomical data, by T. Royds and S. Sitarama Ayyar. *Astronomical Society of India.*

The distribution in latitude of dark $H\alpha$ markings, by T. Royds. *Monthly Notices of the Royal Astronomical Society.*

Some spectrographic measures of the Solar Rotation made at the Kodaikanal Observatory, by J. Evershed and T. Royds. *Monthly Notices of the Royal Astronomical Society.*

A new method of estimating changes in the general radiation of the sun, by J. Evershed. Read at the *International Solar Union*, at Bonn in August 1913.

Report on sunspot spectra (a summary of the visual and photographic work done at Kodaikanal during the years 1910, 1911 and 1912), by J. Evershed. Read at the *International Solar Union* at Bonn in August 1913.

17. *General.*—The Director-General of Observatories inspected the Kodaikanal Observatory in February and the Director inspected the Madras Observatory in November.

The staff of the Observatory has worked well during the year ; Messrs. S. Sitarama Ayyar, First Assistant, and R. Krishna Ayyar, Photographic Assistant, deserve special mention for their zeal and industry.

T. ROYDS,

THE OBSERVATORY, KODAIKANAL,
19*th February* 1914.

Offg. Director, Kodaikanal and Madras Observatories.

II. REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1913.

Staff.—The Staff at the Observatory on December 31, 1913, was as follows :—

Deputy Director	...	R. Ll. Jones.
Computer ...	...	S. Solomon Pillai.
First Assistant	...	C. Chengalvaraya Mudaliyar.
Second Assistant	...	E. Ramanujam Pillai.

Two peons and two lascars form the subordinate staff. The Deputy Director was absent on leave from 4th April to 30th November 1913. Mr. J. L. Simonsen was in charge from 4th April to 27th June 1913 and Mr. R. Littlehailes from 28th June to 30th November 1913. Mr. A. A. Narayana Ayyar, First Assistant, was transferred to the Kodaikanal Observatory and his place was filled by Mr. C. Chengalvaraya Mudaliyar of the Madras Meteorological office. Mr. E. Ramanujam Pillai was absent on privilege leave for three months from 23rd June 1913.

2. *Time Service.*—No change has been made in the methods for determining time or in the time service. The firing of the 8 P.M. gun at the Fort was resumed from 1st January 1913. The Fort gun failed on nine occasions and fired correctly on 721 occasions out of 730, giving 98·8 as the percentage of success. The failures were due to faults outside the Observatory.

The Semaphore at the Port office failed on three occasions and was dropped correctly at 1 P.M. every other day ; on two of the occasions on which it failed at 1 P.M., it was dropped correctly at 2 P.M.

The Post office clock, which has hitherto been under the control of the Observatory, was handed over to the Telegraph Department at their request, on 1st April 1913. It was electrically connected with the Observatory Standard clock on 8th May 1913.

3. *Meteorological Observations.*—In addition to the ordinary meteorological observations, extra observations were taken for storm warning purposes and telegrams sent to Simla on one occasion and to Calcutta on 49 occasions. The solar radiation thermometer in use was broken by accident on 20th December 1913 and a new one has been applied for.

4. *Buildings.*—The usual annual repairs to the office and quarters were carried out during the year. No examination of the foundations of the transit instrument was made during the year, owing to the absence of the Deputy Director on leave.

5. *Instruments.*—The following is a list of the instruments at the Observatory on the 31st December 1913 :—

(a) *Astronomical.*

Eight-inch Equatorial Telescope—Troughton & Simms.
Sidereal Clock—Haswall.
Do. Dent, No. 1408.
Do. S. Riefler, No. 61.
Mean Time Clock—J. H. Agar Baugh, No. 105.
Do. with galvanometer—Shepherd & Sons.
Meridian Circle—Troughton & Simms.
Mean Time Chronometer—V. Kullberg, No. 5394.
Do. do. No. 6544.
Portable Transit Instrument—Dolland.
Portable Telescope with stand.
Tape Chronograph—R. Fuess.
Relay for use with the Chronograph—Siemens.

(b) *Meteorological.*

Richard's Barograph—No. 10, L. Casella.
Do. Thermograph—No. 29637, L. Casella.
Beckley's Anemograph—Adie.
Sunshine Recorder—No. 149, L. Casella.
Nephoscope—Mons Jules Daboseq & Ph. Pellin.
Barometer, Fortin's—No. 1771, L. Casella.
Do. No. 725, L. Casella (spare).
Do. No. 1420, L. Casella (spare).
Dry Bulb Thermometer—No. 94221, L. Casella.
Do. No. 38037, Negretti & Zambra (spare).
Wet Bulb Thermometer—No. 94219, L. Casella.
Do. No. 38037, Negretti & Zambra (spare).
Dry Maximum Thermometer—No. 8581, Negretti & Zambra.
Dry Minimum Thermometer—No. 69017, L. Casella.
Wet Minimum Thermometer—No. 91753, Negretti & Zambra.
Grass Minimum Thermometer—No. 3377, Negretti & Zambra.
Raingauge (8″ diameter)—No. 1042, Negretti & Zambra.
Measure glass for above.
Raingauge (5″ diameter).
Measure glass for above.

The Chronograph, Chronometer, Kullberg No. 6544, Barograph and the Mean Time clock by Agar Baugh were cleaned during the year.

Large changes still take place in the level of the transit instrument and these changes were, as in previous years, closely associated with the rainfall.

During the visit of the Director in November the transit instrument was overhauled and the north collimator rewired and readjusted.

6. *Weather Summary.*—The following is a summary of the meteorological conditions at Madras during 1913 :—

Pressure.—Pressure was above normal in January, September, November and December and below normal in all the other months. The greatest excess was 0·024 inch in November and December and the greatest defect 0·036 inch in March. The highest pressure recorded was 30·257 inches on December 30 and the lowest 29·499 inches on June 6.

Temperature.—The mean temperature of air was above normal in all months except in October when it was normal. The highest shade temperature recorded was 107°·7 on May 12 and the lowest 63°·1 on January 14. The highest temperature in the sun was 148°·6 on September 10 and the lowest on grass 59°·4 on January 14.

Humidity.—Humidity was normal in January, below normal in March, June and August and above normal in the remaining months.

Wind.—The wind direction was normal in February and April. It was more northerly than usual in January and October, more southerly in March, May, June, July and September, more westerly in August and more easterly in the last two months. The wind velocity was below normal in all months except in January, April, August and November. In December the mean daily velocity was 26 miles below the average.

Cloud.—The percentage of cloud was normal in December, above normal in February and November and below normal in the remaining months.

Sunshine.—The bright sunshine recorded was above normal in March, April, August and September and below normal in the other months.

Rainfall.—The rainfall was above the average for May and the last three months in the year, and below normal for the other months ; the greatest excess was 17·28 inches in October and the greatest defect 3·84 inches in August. The total fall for the year was 65·05 inches against an average of 49·02 inches. The monsoon rainfall from October 15 to the end of the year was 48·16 inches against an average of 26·00 inches. The heaviest fall on any day was 8·19 inches on November 10.

THE OBSERVATORY, MADRAS,
26th January 1914.

R. LL. JONES,
Deputy Director.

APPENDIX I.

SEISMIC RECORDS.

STATION—KODAIKANAL.

$\phi = 10°\ 13'\ 50''$. $\lambda = 77°\ 28'\ 00''$. $h = 2343$ *m*

Subsoil—Rock.
Apparatus.—Milne Horizontal Pendulum.

1913.	To	$\frac{r}{To^2}$	1913.	To	$\frac{r}{To^2}$
January ...	15·9	7·0	July	16·5	2·9
February ...	16·2	4·0	August	16·7	2·8
March	16·3	3·1	September ...	16·7	2·8
April	16·4	2·7	October... ...	16·6	2·9
May	16·3	3·0	November ...	16·5	2·9
June	16·4	2·9	December ...	16·1	3·0

No.	Date.	Phase.	Time G.M.T.	Period. (Sec.)	Amplitude (*u*)			Distance Δ (Km.)	Remarks.
					An.	Ae.	Az.		
			H. M.						
1	Jan. 1 ...	eP	17 18·0	...	...	...	...	...	Widening of line.
		F	15 36·2	...	...	..	...	...	
2	5 ...	iP	17 42·4	...	...	..	...	...	
		eL	17 54·4	...	...	...	..	...	
		M	18 01·7	...		60	...	...	
		F	18 27·0	...	...	...	...	...	
3	7 ...	eP	23 12·4		...	..	...	...	
		iL	23 20·0	...	...	..	...	...	
		M	23 21·8	...	...	80	...	...	
		F	23 41·3	...	...	...	...	...	
4	9 ...	iP	3 09·9	...	...	...	...	...	
		eL	3 23·3	...	...	...	...	...	
		M	3 26·1	...	...	40	...	...	
		F	4 01·5	...	...	...	...	...	
5	11 ...	iP	13 25·6	...	...	...	...	...	
		iL	13 32·0	...	...	...	...	...	
		M	13 54·1	...	...	30	...	..	
		F	15 51·5	...	...	...	...	...	
6	13 ...	eP	19 46·7	...	...	...	...	...	
		eL	19 47·9	...	...	...	...	..	
		M	19 52·0	...	...	60	...	...	
		F	20 07·0	...	...	...	..	..	
7	15 .	P	20 30·0?	...	..	...	...	..	Widening of line
		F	20 54·0	...	...	...	...	..	Hour signal at 20h 30.m.
8	19 ...	eP	17 09·5	...	...	...	...	...	
		iL	17 11·8	...	...	...	...	...	
		M	19 14·6	...	...	1,750	...		
		F	19 54·0	...	...	...	...	...	
9	19—20 ...	eP	23 59·7	...	...	.	...	...	Widening of line.
		F	0 52·6	...	...	...	...	...	
10	Feb. 11—12 ...	eP	23 49·9	...	...	...	...	...	Widening of line.
		F	0 16·5	...	...	...	...	...	
11	20 ...	eP	9 10·0	...	...	...	...	...	Widening of line.
		F	9 56·0	...	...	...	...	...	
12	Mar. 4 ...	eP	7 22·5	...	...	...	...	...	Widening of line.
		F	7 44·0	...	...	...	...	..	
13	6 ...	eP	2 16·9	...	...		...	...	
		eL	2 21·5	...	...	...	...	...	
		M	2 23·6	...	...	40	...	...	
		F	2 38·2	...	...	...	...	...	
14	6 ...	P	...	...	...	..	...	...	No P. Ts.
		iL	11 11·5	...	...	...	...	...	
		M	11 14·3	...	...	50	...	...	
		F	12 03·8	...	...	...	...	...	
15	14 ...	iP	8 54·9	...	...	...	...	...	
		iL	8 56·2	...	...	...	...	...	
		M	9 08·6	...	...	1,000	...	...	
		M_2	22·5	...	...	..	...	...	
		F	12 37·2	...	...	...	...		
16	14 ...	eP	18 11·5	...	...	...	...	...	
		iL	18 12·3	...	...	...	...	...	
		M	18 13·3	...		60	...	...	
		F	18 23·6	...	...	...	...	...	
17	23 ...	eP	20 57·0	...		...	...	...	
		iL	21 06·8	...	...	...		...	
		M	21 25·1	...	..	50	...	...	
		F	22 01·0	...	...	...	...	...	

Kodaikanal Observatory Seismic Records—*cont.*

No.	Date.	Phase.	Time G.M.T.	Period, (Sec.)	Amplitude (u) An.	Amplitude (u) Ae.	Amplitude (u) Az.	Distance △ (Km.)	Remarks.
	1913.		H. M.						
18	Mar. 31 ...	eP	4 05·0	...	..	...	...	...	
		eL	4 32·0	...	...	...	...	...	
		M	4 38·5	...	...	70	...	...	
		F	6 39·9	...	...	...	...	...	
19	Apl. 7 ...	eP	14 27·2	...	...	...	...	...	
		F	14 58·7	...	...	...	...	...	Widening of line.
20	9 ...	eP	18 20·3	...	...	..	...	...	
		F	19 19·7	...	...	...	...	...	Widening of line.
21	13 ..	eP	7 02·0	...	...	...	...	...	
		eL	7 12·8	...	...	...	...	...	
		M	7 22·3	...	...	50	...	...	
		F	7 59·7	...	...	...	...	...	
22	18 ...	eP	13 39·2	...	...	...	...	...	
		iL	13 43·1	...	...	...	...	...	
		M	13 43·6	...	...	20	...	...	
		F	14 00·5	...	...	...	...	...	
23	18 ...	eP	19 10·7	...	...	...	...	...	
		iL	19 28·0	...	..	...	...	...	
		M	19 35·1	...	...	90	...	...	
		F	20 09·2	...	...	...	...	...	
24	24 ...	eP	10 23·1	...	...	...	...	...	
		iL	10 41·2	...	...	...	...	...	
		M	10 50·6	...	...	110	...	...	
		F	11 40·2	...	...	...	...	...	
25	24 ...	iP	12 35·4	...	...	...	...	...	
		eL	12 46·0	...	...	...	...	...	
		M	12 51·1	...	...	40	...	...	
		F	13 26·4	...	...	...	...	...	
26	25 ...	iP	18 06·7	...	...	...	...	...	
		iL	18 14·8	...	...	...	...	...	
		M	18 31·0	...	...	300	...	...	
		F	21 38·7	...	...	...	...	...	
27	26 ...	eP	4 17·8	...	...	..	...	...	
		eL	4 31·3	...	...	...	...	...	
		M	4 52·9	...	...	70	...	...	
		F	5 37·1	...	...	...	...	...	
28	30 ...	eP	11 58·7	...	...	...	...	...	
		iL	12 30·0?	...	...	...	...	...	Hour signal at 12h 30m.
		M	12 34·6	...	...	50	...	...	
		F	13 24·9	...	...	...	...	...	
29	May 7 ...	eP	12·0	...	...	...	...	...	
		F	39·8	...	...	...	...	...	Widening of line.
30	8 ...	eP	18 54·7	...	...	...	...	...	
		eL	19 05·3	...	...	...	...	...	
		M	19 06·5	...	...	50	...	...	
		F	20 37·0	...	...	...	...	...	
31	16 ...	eP	12 40·7	...	...	...	...	...	
		F	12 56·8	...	...	...	...	...	Widening of line.
32	18 ...	eP	2 20·7	...	...	...	...	...	
		F	3 40·2	...	...	...	...	...	Widening of line.
33	30 ...	eP	11 59·7	...	...	...	..	...	
		iL	12 09·2	...	...	...	...	...	
		M	12 39·7	...	...	...	...	...	
			44·9	...	...	100	...	...	
			53·1	...	...	90	...	...	
		F	15 23·3	...	...	90	...	...	
34	June 4 ...	eP	10 17·7	...	...	...	...	...	
		eL	10 25·9	...	...	...	...	...	
		M	10 44·9	...	...	...	...	...	
		M_2	10 57·2	...	...	50	...	...	
		F	11 25·9	...	...	50	...	...	
35	14 ...	eP	9 50·7	...	...	...	...	•	
		iL	10 06·7	...	...	...	...	...	
		M	10 15·4	...	...	...	...	...	
		F	11 24·1	...	...	120	...	...	
36	22 ...	eP	14 14·0	...	...	...	...	...	
		F	16 45·4	...	...	...	...	...	Widening of line.
37	26 ...	eP	5 09·7	...	...	...	...	...	
		iL	5 22·3	...	...	...	...	...	Instrument examined at 5h 11m.
		M	5 27·4	...	...	...	...	...	
		C_1	6 11·5	...	...	250	...	...	
		C_2	6 13·6	...	...	320	...	...	
		C_3	6 19·2	...	...	280	...	...	
		C_4	6 22·8	...	...	260	...	...	
		F	8 56·7	...	...	320	...	...	
38	July 7 ...	eP	17 55·6	...	...	...	...	...	
		iL	17 58·5	...	...	...	...	...	
		M	17 58·7	...	...	40	...	...	
		F	19 03·9	...	...	...	...	...	

Kodaikanal Observatory Seismic Records—*cont.*

No.	Date.	Phase.	Time. G.M.T.	Period. (Sec.)	Amplitude (u) An.	Amplitude (u) Ae.	Amplitude (u) Az.	Distance. △ (Km.)	Remarks.
	1913.		H. M.						
39	July 12 ...	eP	10 47·4	...	...	...	...	...	Widening of line.
*		F	11 53·6	...	...	...	...	...	
40	28 ...	eP	7 00·3	...	...	...	..	..	
		iL	7 07·4	...	...	...	...	...	
		M	7 10·4	...	...	60	...	...	
		F	7 42·2	...	..	...	...	...	
41	Aug. 1 ...	eP	17 22·1	...	...	...	...	...	
		iL	17 31·9	...	...	...	...	...	
		M	17 33·4	...	...	50	...	...	
		F	?	...	...	...	..	...	
42	1 ...	P	?	...	...	...	...	...	
		eL	17 53·2	...	...	...	...	...	
		M	17 59·8	...	...	110	.	...	
		F	18 54·5	...	...	...	...	...	
43	6—7 ...	eP	22 28·8	...	...	...	...	...	
		iL	22 47·7	...	...	...	...	...	
		M	23 46·7	...	...	410	...	...	
		F	1 30·0	...	...	...	...	...	
44	7 ...	eP	14 37·8	...	...	...	...	...	Widening of line.
		F	15 39·3	...	...	...	...	...	
45	13 ...	eP	4 28·8	...	...	...	...	...	
		iL	4 40·8	...	...	...	...	...	
		M	4 48·0	...	...	580	...		
		F	5 44·9	...	...	...	...	...	
46	Sept. 3 ...	eP	22 02·8	...	...	..	...	...	Widening of line.
		F	23 30·0	...	...	...	...	...	
47	13 ...	eP	2 22·6	...	...	...	...	...	Widening of line.
		F	2 56·7	...	...	...	..	.	
48	16 ...	eP	12 17·7	...	...	...	...	...	
		eL	12 19·2	...	...	...	...	...	
		M	12 23·3	...	...	90	...	...	
		F	12 40·3	...	...	...	...	...	
49	Oct. 11 ...	eP	1 45·9	...	...	...	..	...	Widening of line.
		F	3 12·0	...	...	...	...	...	
50	11 ...	eP	4 18·2	...	...	...	...	...	Instrument examined at 3h 54m.
		eL	4 27·4	...	...	...	...	...	
		M	4 52·8	...	...	50	...	...	
		F	?	...	...	...	...		
51	11 ...	P	?	...	...	...	...	..	
		L	9 29·5	...	...	...	...	...	
		M	10 03·6	...	...	50	.	...	
		F	10 49·5	...	...	...	...	...	Widening of line.
52	11 ...	eP	11 01·3	...	...	...	...	...	
		F	12 21·8	...	...	...		...	
53	14 ...	eP	7 59·7	...	...	...	...	...	
		iL	8 32·0	...	...	...	...	...	
		M	9 14·9	...	...	120	...	...	
		F	10 51·0	...	...	...	...	...	Widening of line.
54	Nov. 6—7 ...	eP	21 36·2	...	...	...	...	...	
		F	0 02·0	...	...	...	...	...	
55	14 ...	P		...		...	...	...	
		iL	20 56·9	...	...	...	...	...	
		M	20 59·0	...	...	180	..	...	
		F	21 24·4	...	...	...	...	...	Widening of line.
56	15 ...	eP	6 22·1	...	...	..	...	...	
		F	6 48·4	...	...	...	...	...	
57	19 ...	eP	3 29·2	...	...	...	...	.	
		L	3 40·2	...	...	...	...	...	
		M	3 52·5	...	...	200	...	...	
		M_2	55·3	...	...	200	...	...	
		F	4 35·6	...	...	...	...	...	
58	23 ...	eP	22 02·8	...	...	..	...	...	Widening of line.
		F	22 24·4	...	...	...	...	...	
59	Dec. 2 ...	iP	20 06·6	...	...	...	...	...	
		iL	20 07·6	...	...	...	...	...	
		M	20 08·6	...	...	60	...	...	
		F	20 18·9	...	...	...	...	...	
60	10 ...	eP	6 33·5	...	...	...	...	...	Widening of line.
		F	7 41·9	...	...	..	...	...	
61	21 ...	eP	15 46·5	...	...	...		...	
		iL	15 48·3	...	...	...	...	...	
		M	15 58·3	...	...	300	...	...	
		F	17 33·7	...	...	...	...	...	

* Air tremors during high wind July 16—20.

APPENDIX II.

LATITUDE, 10° 13′ 50″ N.
LONGITUDE, 5h 9m 52s E.

Height of Barometer cistern above mean sea level 7,688 feet.

MEAN monthly and annual meteorological results at the Kodaikanal Observatory in 1913.

Month.	Barometer.		Dry bulb thermometer.				Wet bulb.		Tension of vapour.	Relative humidity.	Sun max. in *vac.*	Min. on grass.	Wind.			Rain.		Clear sky.	Bright sunshine.
	Reduced to 32°.	Daily range.	Mean.	Max.	Min.	Range.	Mean.	Min.	By Blanford's tables.				Daily velocity.	Mean direction.		Amount.	Days.		
	INCHES.	INCHES.	°	°	°	°	°	°	INCHES.	CENTS.	°	°	MILES.	POINTS.	POINTS.	INCHES.	NO.	CENTS.	HOURS.
January ...	22·857	0·064	57·0	66·5	47·4	19·1	47·6	40·1	0·262	59	126·4	36·9	278	6	E.N.E.	0·27	2	53	212·3
February ...	·854	·065	57·6	68·2	47·0	21·2	49·1	41·5	·283	60	133·0	37·3	296	8	E.	1·07	2	63	227·2
March	·850	·064	60·8	71·0	50·5	20·5	50·0	42·8	·260	50	138·3	39·8	286	8	E.	5·30	5	68	275·5
April	·830	·060	62·7	71·5	54·0	17·5	54·5	48·9	·355	65	141·0	45·3	...		...	4·18	8	58	240·0
May ..	·805	·065	63·0	71·4	54·6	16·8	55·9	50·5	·391	71	140·0	46·8		...	...	3·52	11	46	232·2
June	·751	·049	59·6	65·9	53·3	12·6	54·3	49·5	·375	75	131·6	49·5	...	...	...	2·30	6	34	192·1
July	·757	·055	58·1	63·5	52·7	10·8	53·7	49·1	·377	80	129·4	48·7	...	.	...	6·08	11	27	162·4
August ...	·781	·055	57·8	64·2	51·4	12·8	53·0	48·1	·364	78	129·6	47·3	322	26	W.N.W.	4·94	11	39	192·7
September ...	·805	·066	58·3	64·8	51·8	13·0	54·1	49·0	·383	80	129·5	47·4	211	26	W.N.W.	6·57	11	34	158·8
October ..	·827	·070	57·3	63·1	51·5	11·6	53·5	48·9	·384	84	123·3	46·7	258	30	N.N.W.	5·57	12	21	134·2
November ...	·844	·068	54·9	60·3	49·4	10·9	51·5	47·3	·357	85	113·6	45·6	283	1	N by E.	9·04	12	29	137·5
December ...	·867	·065	54·7	61·6	47·8	13·8	49·9	44·1	·322	76	115·6	41·5	325	5	N.E. by E.	7·44	13	39	190·8
Annual	22·819	0·062	58·5	66·0	51·0	15·0	52·3	46·7	0·343	72	129·3	44·4	282	2	N.N.E.	56·28	104	43	2355·7

EXTREME monthly meteorological records at the Kodaikanal Observatory in 1913.

Month.	Barometer.					Dry bulb thermometer.				Wet bulb.		Humidity.		Sun th. in *vacuo*.		Grass therm.		Wind.				Rain.	
	Highest.		Lowest.		Range.	Highest.		Lowest.		Lowest.		Lowest.		Highest.		Lowest.		Highest.		Lowest.		Greatest fall.	
	INCHES.	DAY.	INCHES.	DAY.	INCHES.	°	DAY.	°	DAY.	°	DAY.	CENTS.	DAY.	°	DAY.	°	DAY.	MILES.	DAY.	MILES.	DAY.	INCHES.	DAY.
January ...	22·942	27, 31	22·757	7	0·185	73·3	4	43·6	9,28	**31·3**	**4**	**11**	**4**	143·3	19	**19·3**	**3**	412	18	143	10,11	0·10	19,25
February ...	·944	1	·769	28	·175	73·7	23,24	40·6	5	32·0	5	25	8	146·6	24	29·0	24	397	13	164	1	0·89	15
March ...	·942	29	·763	14	·179	75·0	26	45·7	24	36·1	24	13	25	**152·7**	**5**	27·8	24	470	1	190	16	**2·94**	**29**
April	·911	1	·731	25	·180	73·9	14	51·4	10	40·0	12	21	12	150·2	25	37·8	10	...	...	...		1·19	28
May	·901	3	·679	31	·222	**77·4**	**12**	52·0	21	44·0	12	37	12	151·0	27	41·9	12,20	...	...	...	...	0·66	30
June	·858	29	**·587**	**4**	·271	69·5	1	49·8	26	43·8	20	35	26	144·8	1	45·0	18,20	...		..	..	0·60	5
July	·834	13	·635	16	·199	68·4	1	49·7	6	43·4	7	49	19	140·3	26	41·2	29	...	...	...	...	1·85	3
August ...	·892	26	·692	14	·200	69·7	9	47·0	24	43·0	30	52	30	142·9	26	42·1	10	585	6	124	27	0·87	12
September ...	·884	20	·713	1	·171	70·7	10	48·9	10	44·9	8	61	14	148·9	17	40·0	10	453	2	108	13	1·32	20
October ...	·924	21	·713	14	·211	67·7	4	46·1	22	40·5	25	39	1	142·8	8	39·0	22	487	25	98	17	1·20	6
November ...	·938	21	·759	9	·179	68·5	17	43·0	14	33·6	14	35	14	136·4	18	31·2	14	610	8	120	2	1·38	1
December ...	**23·000**	**30**	·747	13	·253	69·3	26	**39·4**	**30**	32·7	27	18	27	133·1	23	24·5	26	742	16	150	3	1·34	8

APPENDIX III.

KODAIKANAL mean hourly wind velocity for the year 1913.

Month.	Hours.																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
January ...	12	12	12	11	11	12	12	13	14	15	14	13	13	12	12	10	9	9	9	10	10	11	11	11
February ...	12	13	12	13	13	13	14	13	17	17	16	15	14	13	11	11	8	8	8	9	10	11	12	13
March ...	12	13	12	13	12	13	13	14	15	18	17	15	13	12	10	10	8	8	8	8	8	9	10	10
April May June July	No record.																							
August ...	15	15	15	15	16	16	14	14	13	14	11	11	11	11	12	12	12	13	13	13	13	15	15	16
September ...	9	10	9	9	10	10	10	9	8	10	9	8	8	8	9	9	8	8	9	8	8	8	9	9
October ...	11	12	12	12	12	11	12	12	10	11	10	11	11	10	10	10	9	11	11	12	12	11	12	11
November ...	13	13	13	14	13	12	13	12	11	12	11	13	11	11	11	11	10	11	11	13	12	14	13	13
December ...	14	14	15	14	14	14	14	14	12	14	15	15	13	13	12	10	11	11	12	13	15	15	15	14
Annual ...	12	13	13	13	13	13	13	13	13	14	13	13	12	11	11	10	9	10	10	11	11	12	12	12

APPENDIX IV.

KODAIKANAL mean hourly bright sunshine for the year 1913.

Month.	Hours.											
	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18
January	0·05	0·61	0·68	0·71	0·78	0·81	0·78	0·73	0·67	0·58	0·39	0·05
February	·30	·82	·89	·91	·86	·87	·83	·75	·74	·60	·42	·12
March	·41	·94	1·00	1·00	1·00	·94	·79	·70	·64	·65	·54	·35
April	·48	·86	0·93	0·94	·89	·87	·80	·65	·58	·53	·29	·18
May	·48	·75	·83	·90	·86	·82	·75	·61	·41	·52	·33	·23
June ...	·14	·54	·73	·77	·79	·75	·58	·64	·54	·48	·32	·11
July	·11	·40	·54	·67	·61	·61	·60	·54	·44	·42	·21	·09
August ...	·32	·60	·76	·79	·71	·63	·56	·50	·47	·37	·34	·16
September ...	·26	·65	·72	·76	·68	·54	·35	·34	·26	·29	·25	·18
October	·19	·39	·50	·59	·56	·51	·47	·40	·28	·22	·17	·05
November	·18	·51	·66	·62	·53	·56	·53	·54	·49	·48	·33	·06
December	·14	·55	·64	·73	·70	·72	·81	·73	·66	·57	·45	·11
Mean ...	0·26	0·64	0·74	0·78	0·75	0·72	0·65	0·59	0·52	0·48	0·34	0·14

APPENDIX V.

NUMBER of days in each month on which the Nilgiris were visible in 1913.

Month.	Very clear.	Visible.	Just visible.	Tops only visible.	Total.
January	...	9	4	1	14
February	...	3	6	5	14
March	...	1	...	...	1
April	...	..	...	...	...
May	4	...	1	...	5
June	...	2	1	.	3
July	2	2	1	...	5
August	...	...	2	...	2
September	6	9	5	...	20
October	4	2	2	...	8
November	1	2	3	3	9
December	3	5	2	2	12
Total ...	20	35	27	11	93

APPENDIX VI.

MADRAS OBSERVATORY.—Abnormals from monthly means for the year 1913.

Abnormals of	January.	February.	March.	April.	May.	June.	July.	August.	September	October.	November.	December.	Annual.
Reduced atmospheric pressure	+ 0·019	— 0·008	— 0·036	— 0·026	— 0·007	— 0·029	— 0·011	— 0·013	+ 0·003	— 0·023	+ 0·024	+ 0·024	— 0 002
Temperature of air	+ 0·4	+ 2·1	+ 1·9	+ 1·4	+ 0·5	+ 2·2	+ 1·1	+ 2·8	+ 1·6	Same as	+ 0 6	+ 0·9	+ 1·3
Do. of evaporation	+ 0·2	+ 3·0	+ 1·2	+ 1·6	+ 1·0	+ 1·6	+ 1·4	+ 0·6	+ 2·0	+ 0·6	+ 1·1	+ 2·0	+ 1·3
Percentage of humidity	Same as	+ 4	— 2	+ 1	+ 2	— 1	+ 3	— 8	+ 3	+ 3	+ 2	+ 6	+ 1
Greatest solar heat in *vacuo*	— 8·0	— 5·6	— 2·6	— 3·9	— 4·1	— 7·6	— 8·0	— 4·3	— 1·7	— 10·0	— 15·2	— 12·6	— 7·0
Maximum in shade	— 0·4	+ 0·4	+ 2·8	+ 1·3	+ 0·5	+ 1·9	+ 0·3	+ 3·9	+ 1·8	— 0·4	— 1·0	— 0·5	+ 0·8
Minimum in shade	+ 0·3	+ 3·2	+ 1·0	+ 1·7	— 0·3	+ 2·4	+ 0·6	+ 2·6	+ 1·1	— 0 6	+ 1·1	+ 1·3	+ 1·2
Do. on grass	+ 1·9	+ 4·9	+ 2·2	— 2·6	+ 0·8	+ 2·7	+ 1·4	+ 3·1	+ 2·1	+ 0·5	+ 2·0	+ 2·4	+ 2·3
Rainfall in inches	— 0·75	— 0·28	— 0·39	— 0·60	+ 0·02	— 1·98	—0·76	— 3·84	— 1·68	+ 17·28	+ 4·78	+ 4·23	...
Do. since January	...	— 1·03	— 1·42	— 2·02	— 2·00	— 3·98	—4·74	— 8·58	—10·26	+ 7·02	+ 11·80	+ 16·03	+ 16·03
General direction of wind	2 points N.	Same as	2 points S.	Same as	1 point S.	2 points S.	2 points S.	1 point W.	1 point S.	5 points N.	1 point E.	3 points E.	1 point E.
Daily velocity in miles	+ 23	— 2	— 8	+ 2	— 19	— 25	—18	+ 7	—10	— 4	+ 17	— 26	— 5
Percentage of cloudy sky	— 6	+ 3	—14	— 7	— 12	— 11	— 3	— 2	—13	— 2	+ 3	Same as	— 6
Do. of bright sunshine	— 13·8	— 5·4	+ 2·6	+ 2·4	— 0·6	— 0·2	— 1·0	+ 3·9	+11·0	— 5·7	— 11·0	— 6·7	— 6·5

+ means above normal ; — below normal.

APPENDIX VII.

ABSTRACT of the mean meteorological condition of Madras in the year 1913 compared with the average of past years.

Mean values of	1913.	Difference from	Average.
Reduced atmospheric pressure	29·862	0·002 below.	29·864
Temperature of air	82·4	1·3 above.	81·1
Do. of evaporation	75·8	1·3 „	74·5
Percentage of humidity	73	1 „	72
Greatest solar heat in *vacuo*	132·7	7·0 below.	139·7
Maximum in shade	91·6	0·8 above.	90·8
Minimum in shade	75·9	1·2 „	74·7
Do. on grass	74·2	2·3 „	71·9
Rainfall in inches since January 1st on 88 days	65·05	16·03 „	49·02
General direction of wind	S.E. by E.	1 point E.	S.E
Daily velocity in miles	166	5 below.	171
Percentage of cloudy sky	43	6 „	49
Do. of bright sunshine	51·9	6·5 „	58·4

DURATION and quantity of the wind from different points.

From	Hours	Miles.	From	Hours	Miles.	From	Hours	Miles.	From	Hours	Miles.
North ...	244	1,474	East ...	259	1,399	South ...	208	1,536	West ...	207	1,643
N. by E. ...	407	2,501	E. by S. ...	289	1,777	S. by W.	185	1,288	W. by N.	153	1,365
N.N.E. ...	509	3,645	E.S.E. ...	298	1,758	S.S.W. ...	247	1,607	W.N.W....	104	941
N.E. by N.	573	4,744	S.E. by E.	399	2,332	S.W. by S.	250	1,847	N.W.by W.	92	692
N.E. ...	314	2.132	S.E. ...	416	2,834	S.W. ...	157	1,073	N.W. ...	61	342
N.E. by E.	270	1,803	S.E. by S.	819	7,037	S.W. by W.	183	1,311	N.W. by N.	38	239
E.N.E. ...	132	820	S.S.E. ...	548	4,634	W.S.W....	230	1,704	N.N.W....	51	277
E. by N.	260	1,280	S. by E. ...	264	2,103	W. by S.	270	1,961	N. by W.	88	590

There were 135 calm hours during the year. The resultant corresponding to the above numbers is represented by a S.E. by E. wind, blowing with a uniform daily velocity of 39 miles.

APPENDIX VIII.

MADRAS OBSERVATORY—Number of hours of wind from each point in the year 1913.

Month.	N.	1	2	3	4	5	6	7	E.	9	10	11	12	13	14	15	S.	17	18	19	20	21	22	23	W.	25	26	27	28	29	30	31	Calm.
January ...	25	174	168	166	80	73	20	31	3	...	...	...	...	...	...	...	...	...	...	...	.	...	...	...	...	...	...	...	...	...	...	4
February ...	...	4	..	40	35	10	39	73	109	114	147	47	19	4	...	...	2	..	3	1	...	...	...	...	...	...	...	..	...	...	...	...	25
March ...	...	...	...	...	..	12	1	36	16	26	7	121	103	207	103	19	12	12	24	25	1	1	...	.	...	..	...	...	...	...	...	...	18
April ...	1	1	1	...	1	...	...	3	2	12	3	39	63	333	135	35	23	23	19	7	1	2	...	..	..	..	...	...		...	2	2	12
May ...	...	...	..	1	5	2	...	2	1	1	12	21	47	153	110	91	71	43	42	36	24	15	13	16	4	6	3	2	11	2	4	3	3
June ...	3	2		.	...			3	5	27	24	56	49	86	63	44	14	19	11	19	14	27	49	60	40	38	20	20	7	6	5	1	8
July ...	...	12	2	...	2	1	11	9	26	22	12	11	35	28	24	34	21	32	72	55	41	59	63	57	50	32	11	14	2	3	...	..	3
August ...	3	1	1	...	...	1	1	1	5	18	19	36	33	33	39	10	13	25	33	34	36	41	57	62	77	50	51	28	15	9	7	4	1
September...	4	2	5	27	2	5	1	24	13	24	21	38	49	50	69	23	22	22	33	40	24	22	26	36	16	19	12	17	9	12	22	20	11
October ...	51	34	44	85	43	24	6	16	59	28	23	3	8	6	4	8	13	5	10	33	16	16	22	39	20	8	7	11	17	6	11	34	24
November...	129	108	124	164	60	45	12	6	17	3	9	17	...	...	...	...	...	...	..	...	...	...	..	...	...		...	..	...	...	...	19	7
December...	28	69	164	90	86	97	41	56	3	14	21	10	10	19	1	...	17	4	...	...	...	...	...	...	..	...	...	.	...	...	...	5	19
Annual total	244	407	509	573	314	270	132	260	259	289	298	399	416	819	548	264	208	185	247	250	157	183	230	270	207	153	104	92	61	38	51	88	135

APPENDIX IX.

MADRAS OBSERVATORY—Number of miles of wind from each point in the year 1913.

Month.	N.	1	2	3	4	5	6	7	E.	9	10	11	12	13	14	15	S.	17	18	19	20	21	22	23	W.	25	26	27	28	29	30	31	Total.
January	218	946	999	1467	669	525	209	126	23	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5182
February	...	29	...	132	120	101	161	411	589	637	716	293	103	30	...	...	19	...	21	10	...	...	...	...	...	...	...	...	...	...	...	...	3372
March...	...	...	...	...	...	59	3	118	112	161	60	569	500	1279	789	143	101	108	222	232	7	4	...	...	...	...	...	...	...	...	...	...	4467
April	7	5	4	...	10	...	..	22	9	59	24	242	502	2659	1188	318	225	222	179	69	6	9	...	...	...	...	...	...	...	...	9	14	5782
May	...	...	...	5	30	23	...	21	10	6	111	171	420	1521	1198	722	614	325	267	322	203	117	66	107	27	41	16	5	48	7	15	26	6444
June	23	13	...	...	...	...	...	27	42	238	225	323	389	673	477	324	95	106	71	128	96	229	440	562	404	357	243	224	63	41	28	6	5847
July	...	28	11	...	15	12	109	102	206	140	107	114	298	205	196	240	155	195	443	441	280	455	488	440	354	311	97	83	19	23	...	...	5567
August	19	5	7	...	...	9	9	8	51	150	161	215	264	254	258	79	68	180	168	242	228	266	427	510	689	462	462	207	85	61	45	35	5624
September	26	17	35	121	13	45	4	80	49	158	155	291	284	370	488	200	147	129	180	226	142	120	144	175	93	152	89	107	67	73	99	115	4394
October	164	209	281	515	220	109	44	91	221	144	94	14	23	41	40	29	91	23	56	177	111	111	139	167	76	42	34	66	60	34	81	174	3681
November	835	713	1067	1630	416	319	73	56	60	15	28	66	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	181	5459
December	182	536	1241	874	639	601	208	218	27	69	77	34	51	5	...	48	21	...	...	...	...	...	...	...	...	...	...	...	...	...	...	39	4870
Annual	1474	2501	3645	4744	2132	1803	820	1280	1399	1777	1758	2332	2834	7037	4634	2103	1536	1288	1607	1847	1073	1311	1704	1961	1643	1365	941	692	342	239	277	590	60689

APPENDIX X.

MADRAS OBSERVATORY—Number of inches of rain from each point in the year 1913.

Month.	N.	1	2	3	4	5	6	7	E.	9	10	11	12	13	14	15	S.	17	18	19	20	21	22	23	W.	25	26	27	28	29	30	31	Calm.
January ...	...	...	0·14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
February ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
March ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
April ...	...	...	...	...	0·02	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
May ...	...	...	...	...	...	...	...	...	...	...	0·19	...	...	...	0·12	...	0·45	0·15	0·44	...	0 05	...	...	...	...	0·30	...	...	...	...	...	0·44	...
June ...	0·03	...	...	...	...	...	...	...	...	...	...	0·01	0·01	...	0·07	0·01	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
July ...	...	...	...	...	...	...	0·05	...	0·03	...	...	...	0·01	0·02	...	0·63	0·47	...	...	...	0·30	0·89	0·29	...	0·37	0·05	...	...	...	...	...	...
August ...	...	...	...	...	...	...	...	...	...	...	...	...	...	0·02	0·09	...	...	0·01	0 01	0·20	...	0·18	...	0·15	0·05	0·01	...	...	...	...	...	...
September.	...	0·08	...	0·16	...	...	...	0·03	...	...	...	0·22	...	...	...	0·02	...	0·11	0·01	0·03	0·13	0·33	0·07	0·07	0·47	0·91	0·01	0·06	0·22	...	0·02	0·04	0·02
October ...	2·38	4·31	1·30	1·15	0·52	0·41	0·33	1·93	0·69	...	...	0·02	0·03	...	...	0·96	0·79	0·40	0·12	0·04	0·02	0·67	...	1·99	0·22	0·26	0·02	0·85	1·49	0·90	0·88	5·55	0·05
November.	0·21	5·87	5·01	3·70	1·79	1·00	0·22	0·18	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0·01	...
December ...	0 05	0·49	2·16	0·34	1·41	2·18	0·53	0·45	0·17	0·29	...	1·04	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0·40	...
Annual ...	2·67	10·75	8·61	5·35	3·74	3·59	1·13	2·59	0·89	0·29	0·19	1·29	0·05	0·04	0·28	1·62	1·71	0·67	0·58	0·27	0·50	2·07	0·36	2·21	1·11	1·53	0·03	0·91	1·71	0·90	0·90	6·44	0·07

APPENDIX XI.

MADRAS OBSERVATORY—Wind, cloud and bright sunshine, 1913.

Month.	Wind resultant.		Clouds (0—10).					Bright sunshine.	
	Velocity.	Direction.	8 H.	10 H.	16 H.	20 H.	Mean.	Average per day.	Greatest number of hours in a day.
	MILES.	POINTS.						HOURS.	HOURS.
January	159	N.E. by N.	2·8	3·9	3·4	2·0	3·1	6·2	8·6
February	107	E. by S.	2·9	3·8	2·3	1·8	2·7	8·4	10·3
March	127	S.E. by S.	1·0	1·6	1·1	0·2	1·0	9·2	10·4
April	179	S.S.E.	3·3	2·7	1·7	0·7	2·1	8·9	10·4
May	168	S. by E.	2·4	2·5	2·5	2·6	2·6	7·6	9·1
June	83	S.S.W.	4·8	4·6	6·0	5·8	5·3	5·1	7·7
July	94	S.W. by S.	6·7	6·4	7·4	6·7	6·8	3·9	8·3
August	72	S.W. by W.	6·4	5·6	6·7	7·0	6·5	5·3	10·0
September ...	55	S. by E.	4·7	4·7	5·4	4·8	4·9	6·4	10·7
October	34	N.N.E.	5·5	5·8	6·3	5·2	5·7	5·2	10·5
November ...	168	N.N.E.	6·2	6·7	6·7	5·1	6·2	4·2	9·5
December ...	138	N.E. by N.	5·3	5·8	5·3	4·3	5·2	5·2	8·7
Annual ...	39	S.E. by E.	4·3	4·5	4·6	3·9	4·3	6·3	...

APPENDIX XII.

MEAN Monthly and Annual Meteorological Results at the Madras Observatory in 1913.

Months.	Barometer.		Dry bulb thermometer.				Wet bulb.		Tension of vapour.	Relative humidity.	Sun Max. in *vac.*	Min. on grass.	Wind.			Rain.		Clear sky.	Bright sun shine.
	Reduced to 32°.	Daily range.	Mean.	Max.	Min.	Range.	Mean.	Min.	By Blandford's tables.				Daily velocity.	Mean direction.		Amount.	Days.		
	INCHES.	INCHES.	°	°	°	°	°	°	INCHES.	CENTS.	°	°	MILES.	PTS.		INCHES.	NO.	CENTS.	HOURS.
January ...	30·016	0·114	75·5	84·2	67·8	16·4	69·4	66·2	0·638	73	130·4	65·0	167	3	N.E. by N.	0·14	1	69	191·9
February ...	29·956	·124	78·8	87·0	71·2	15·8	73·8	70·8	·767	77	134·1	68·7	120	8	East.	...	...	73	234·7
March ...	·869	·139	81·9	92·0	73·1	18·9	75·1	71·5	·781	72	137·9	70·8	144	12	S.E.	...	...	90	284·9
April ...	·800	·134	85·4	94·2	78·9	15·3	79·2	76·8	·909	75	137·8	77·3	193	13	S.E. by S.	0·02	1	79	267·5
May ...	·727	·133	87·2	98·3	80·5	17·8	79·3	76·2	·891	69	138·9	79·7	208	16	South	2·14	6	74	235·5
June ...	·674	122	88·6	100·1	82·7	17·4	78·2	75·1	·824	61	132·9	81·3	195	17	S. by W.	0·13	7	47	152·1
July ...	·710	·121	85·6	95·9	79·1	16·8	77·3	74·2	·876	68	130·7	78·0	180	18	S.S.W.	3·11	11	32	119·8
August ...	·737	·122	86·5	97·6	79·9	17·7	76·6	73·9	·775	62	135·7	78·5	181	20	S.W.	0·72	9	35	164·1
September.	·781	·129	84·6	95·0	78·2	16·8	78·3	75·0	·882	75	139·6	77·1	146	17	S. by W.	3·01	11	51	190·5
October ...	·865	·116	80·6	88·5	74·6	13·9	76·2	73·3	·846	81	129·1	73·3	119	4	N.E.	28·28	18	43	162·1
November.	·948	·106	78·1	84·0	73·4	10·6	74·0	71·7	·784	81	122·2	71·5	182	3	N.E. by N.	17·99	12	38	126·4
December ...	30·005	·107	76·4	83·1	71·1	12·0	72·6	69·7	·750	83	123·2	68·8	157	5	N.E. by E.	9·51	12	48	162·0
Annual ...	29·841	0·122	82·4	91·6	75·9	15·7	75·8	72·9	·810	73	132·7	74·2	166	11	S.E. by E.	65·05	88	57	2,291·5

EXTREME Monthly Meteorological Records at the Madras Observatory in 1913.

Months.	Barometer.					Dry bulb thermometer.				Wet bulb.		Humidity.		Sun Th. in *vac uo.*		Grass therm.		Wind.				Rain.	
	Highest.		Lowest.		Range.	Highest		Lowest.		Lowest.		Lowest.		Highest.		Lowest.		Highest.		Lowest.		Greatest fall.	
	INCHES.	DAY.	INCHES.	DAY.	INCHES.	°	DAY.	°	DAY	°	DAY.	CENTS.	DAY	°	DAY.	°	DAY.	MILES.	DAY.	MILES.	DAY.	INCHES.	DAY.
January ...	30·166	27	29·890	7	0·276	86·5	24, 30	**63·1**	**14**	**62 7**	**14, 23**	48	16	136 4	30	**59·4**	**14**	244	16	95	22	0·14	31
February ...	·127	2	·811	23	·316	89·3	24	64·6	10	64·6	10	56	4	138 9	20	61·9	10	185	2	77	7	...	...
March ...	·029	2	·726	17	·303	97·4	21	69·2	26	66·8	21	**27**	**13**	141 5	12	65·3	26	232	31	92	24	...	...
April ...	29·917	1	·648	25	·269	99·1	7	73·5	12	71·2	14	48	9	145·4	15	71·0	12	249	4	113	14	0·02	15
May ...	·864	17	·577	30	·287	**107·7**	**12**	71·9	14	69·4	14	37	13	146·5	14	73·1	19	275	10	116	28	0·86	18
June ...	·868	29	**·499**	**6**	·369	105·3	20	78·9	4	70·5	25	31	12	139 6	1	78·7	11	259	12	85	3	0·04	23
July ...	·836	3	·502	16, 17	·334	103·0	29	70·8	4	70·8	4	33	23	145·1	20	70·7	4	259	17	94	11	1·75	4
August ...	·898	26	·588	13	·310	102·4	3	75·5	20	70·2	24	30	24	145 7	2, 3	74·0	20	249	24	101	18	0·21	13
September.	·900	20	601	1	·299	102·1	1	73·0	25	72 3	25	39	16	**148·6**	**10**	72·0	25	220	18	56	28	1·08	6
October ...	30·050	25	·618	14	**·432**	95·1	16	69·1	31	68·8	31	42	17	142·4	17	67·1	20	239	26	71	8, 19	5·97	31
November ...	·085	21	·800	9	·285	87·6	21	67·3	15	64·1	14	60	16	137·4	19	63·4	15	**367**	**9**	78	18	**8·19**	**10**
December ...	**257**	**30**	·837	13	·420	85·6	9	66·1	25	65·7	25	58	31	133·3	9	63·3	25	346	16	**51**	**24**	3·50	