KODAIKĀNAL AND MADRAS OBSERVATORIES.

REPORT FOR THE YEAR 1911.

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KODAIKĀNAL AND MADRAS OBSERVATORIES.

I.—REPORT OF THE KODAIKĀNAL OBSERVATORY FOR THE YEAR 1911.

Staff.—The staff of the Observatory on December 31, 1911, was as follows :—

Director	J. Evershed.
Assistant Director	T. Royds, D.Sc.
First Assistant	S. Sitarama Aiyar, B.A.
Second Assistant	G. Nagaraja Aiyar.
Third Assistant	A. Y. Subrahmanya Aiyar, B.A.
Fourth Assistant	S. Balasundaram Aiyar.
Writer	L. N. Krishnaswamy Aiyar.
Photographic Assistant	R. Krishna Aiyar.

Mr. C. Michie Smith, C.I.E., retired from service as Director on January 14 (forenoon), 1911, but was appointed to special duty from that date to March 31, 1911, in connection with the electric installation work. Dr. Royds was appointed as Assistant Director and joined duty on February 28 afternoon. The First Assistant was on privilege leave for 41 days from August 14 and the Third Assistant for 20 days from July 3.

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 of 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), the photoheliograph, the transit instrument and the seismometer. They have also to do the astronomical computing and the preparation of the observations for the press. The Fourth Assistant has charge of the clock comparisons and, with the help of the writer, is responsible for the whole of the meteorological work. 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.**—Work was begun early in the year on the electric power house and by the end of December the building was practically finished and most of the machinery installed. Much delay was caused by the difficulty in getting the heavier parts of the generating plant carried up the ghaut. A new fly wheel for the gas engine had to be cast as the one originally sent was too heavy to be carried up. It is expected that the installation will be completed and ready for work very soon after the new fly wheel has been received.

Plans and estimates for the house of the photographic assistant have been sanctioned by Government, and work was commenced on it towards the end of the year.

The pines planted in the compound in recent years are growing well and 500 more seedlings were planted during the year. The fire lines have been kept in good condition and extended so as to afford ample protection to the new plantations. The area planted with short grass has also been extended thus diminishing the risk of fire spreading if it should enter the compound.

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 of 36 inches focus attached.

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.

A rhomb with ends cut at 45° mounted on a graduated circle can be placed in front of the slit so as to enable any part of the limb to be brought on to the slit.

Spectrograph II.—consisting of slit provided with vertical and horizontal millimetre scales for measuring position angles, and a reflecting device for rotating the sun's image, collimator lens of 210 c.m focus, 6-inch Michelson grating, and camera lens of about 4 metres focus. The spectrograph is used with the 18-inch concave mirror.

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.

Six-prism table spectroscope—Hilger.

Photoheliograph Dallmeyer No. 4.

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.

Micrometer for measuring spectrum photographs. Hilger.

Dividing engine, Cambridge Scientific Instrument Company, Limited.

Two Balfour Stewart actinometers.

Milne horizontal pendulum seismograph.

Induction coil with necessary adjuncts.

Small polar siderostat.

Universal instrument.

Complete set of meteorological instruments, including Richard barograph and thermograph, and wind recorders.

A high class screw cutting turning lathe by Messrs. Cooke & Sons.

Ångström Pyrheliometer.

An 18-inch concave mirror by Henry of Paris belonging to the Director is mounted in the spectroheliograph room for general spectrum work.

OBSERVATIONS.

(*a*) Solar Physics.

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

Table A.

Solar Observations in 1911.

A = Spots observed. B = Spot spectra. C = Prominences. D = Photoheliograms. E = Spectroheliograms.

Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1 ..	—	A— C D E	A— C D E	A B 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
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— 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 B C D E	A— — D *E*	A— C D E	A— *C* D E	A— *C* D *E*	—	A— — — —
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— —D E	A— C D E	A— C D E
5 ..	A— C D E	A— C D E	A— *C* D E	A B *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*
6 ..	A— C D E	A— C D E	A— C D E	A B *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— — — 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	A— C D E	A— — — —
8 ..	—	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
9 ..	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— C D E	—	A— C D E
10 ..	A— C D E	A— *C* D E	A— C D E	A B 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*
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— —D E	A— *C* D E	—	A— C 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— C D E	—	A— C D E
13 ..	A— *C* D E	A— C D E	A— C D E	A B 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	—
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— C D E	A— C D E	A— C D E	A— C D E	A— — — *E*
15 ..	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	A— — D 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
17 ..	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
18 ..	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— —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
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— C D E	A— C D E	A— *C* D *E*	A— C D —	A— —D *E*
21 ..	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	—	—
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*	—	—
23 ..	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— — — —	A— *C* D *E*	A— — — —
24 ..	A— C D E	A— C D E	A— C D E	A B C D E	A— C D E	A— C D E	—	—	A— *C* D E	A— —D *E*	—	A— *C* D E
25 ..	A— C D E	A— C D E	A— C D E	A B 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*	—
26 ..	A— C D E	A— C D E	A— C D E	A B 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 B C D E	A— —D *E*
27 ..	A— C D E	A— *C* D E	A— *C* D E	A B 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
28 ..	A— *C* D E	A— C D E	A— C D E	A B C D E	A— — 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
29 ..	A— C D E		A— C D E	A B C D E	A— —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
30 ..	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	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— C D E		A— — D *E*		A— — C D E

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

SOLAR Observations—Abstract.

—	1911.												
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
A	28	28	31	30	31	24	23	30	28	30	23	27	333
B	..	..	..	10	..	1	.	..	..	..	2	..	13
C	28	28	31	29	28	24	15	26	24	25	22	18	298
D	28	28	31	30	31	24	21	30	28	29	23	21	324
E	28	28	31	30	31	24	21	30	28	29	22	24	326

There was a fall in the number of observations made as compared with 1910 due to less favourable atmospheric conditions, the number of days on which no observations were possible having risen from 10 to 32. On 26 days there was no sunshine recorded.

6. **Photographs of the sun** with the Dallmeyer photoheliograph were taken on 324 days as against 345 in 1910. Double exposures are taken twice a month for determining the error of orientation of the photographs. Six solar negatives were sent during the year to the Greenwich Observatory to complete its series out of the 7 which were asked for.

7. **Work with the Spectroheliograph.**—Monochromatic photographs of the sun's disc in "K" light were taken on 326 days and prominence plates on 281 days. The best disc plate of each day has been copied on an enlarged scale on bromide paper as heretofore, the prints being oriented and pasted in order on card sheets for convenience of reference. The prominence plates have been measured and the position angles and heights of all the prominences recorded. Duplicates of the disc plates have been sent to South Kensington for measurement as in former years, and in exchange prominence plates have been received from South Kensington.

A new autocollimating spectroheliograph constructed in the observatory workshop has been completed, and this was brought into regular use on April 1st. With this instrument photographs of the sun's disc in Hα light were obtained on 165 days. The principal features shown on these plates are drawn by projection on the 8-inch charts used for recording sunspots and prominences, and the heliographic positions are read off from the ruled lines on the charts. The Hα absorption markings are found to be very closely associated with the prominences and the distribution of the prominences on the disc as well as at the limb is now being studied.

8. **Grating Spectrograph.**—High dispersion solar spectra have been photographed whenever the conditions permitted, and the special lines of research which have been prosecuted include the following:—

(*a*) Radial and other movements in spots.

(*b*) Pressure in spots.

(*c*) Motion of calcium vapour in spots, in flocculi, and in undisturbed regions of the photosphere.

(*d*) Motion in the line of sight of prominences for determining the angular speed of the sun's rotation at different heights above the photosphere.

Large spots were too few in number to admit of much progress in regard to radial motion effects, but a few plates have been obtained and measured. It has been found that whilst the outward radial motion appears to be an invariable and necessary accompaniment of spot formation, the inward movement of the higher levels is absent in the case of some spots showing very intense calcium emission.

Mr. Royds has obtained and measured about 50 plates of the H and K lines at the centre of the disc in undisturbed regions for estimating the vertical movements of circulation of calcium vapour. His results in general confirm those of St. John at Mount Wilson in showing a general ascending movement of the emitting gas, and a descending movement of the high-level absorbing gas; but the values obtained in kilometers per second are considerably smaller than the Mount Wilson determinations.

The measures of wave-length of K_2 in flocculi do not indicate any ascending motion, as was anticipated, but on the contrary give evidence of a slight descending movement relative to the iron vapour of the reversing layer. A sharp distinction must therefore be recognized between the larger masses of emitting vapour known as flocculi, and the small bright points all over the disc which show an ascending movement.

The H and K lines in the prominences have been measured in over 60 plates, and the average angular velocities obtained show a large excess over the corresponding velocities found by Adams for the chromosphere, which itself rotates faster than the general body of the sun. The excess is greater for the east limb than for the west.

9. **Visual Observations.**—Sunspots and prominences have been observed and recorded as in former years using paper charts with 5° lines of heliographic latitude and longitude impressed upon them by the cyanotype process. The solar phenomena observed are marked on these charts which are subsequently bound up in half-yearly volumes.

The visual work includes detailed observations of affected lines in spot spectra and bright lines in metallic prominences. In accordance with the suggestion of the International Union for Solar Research special attention has been given to the behaviour of certain "arc" and "arc flame" lines in spot spectra and to the "enhanced" lines which occur in the region of spectrum examined. Owing to the great falling off in the solar activity only 6 spots have been studied in this way during the year and in 14 spots the behaviour of the C line and D_3 have been noted. Prominences were recorded visually on 298 days as against 313 in 1910 the difference being accounted for by the fact that there were 26 absolutely cloudy days in 1911 and only 10 in 1910. A somewhat unusual feature was that in December this work was possible on only 18 days. The visual record is compared with the spectro-heliograms and all prominences shown on the photographs but not in the drawings are added in blue pencil.

The visual and photographic records of prominences extending over eight years have been studied with reference to their relative frequency on the east and west limbs. The preliminary results show a marked preponderance of eastern over western prominences for each year with the possible exception of 1904, indicating an apparent influence of the earth tending to reduce prominence formation.

10. **Solar Radiation.**—No observations have been made with the Ångström pyrheliometer. The instrument was taken away by the Director-General of Observatories in February to be standardised and had not been returned at the end of the year.

No progress has been made in the method of estimating changes in the solar radiation by photographic comparisons between moonlight and first type stars on account of the difficulty in obtaining suitable apparatus for measuring the plates. It is hoped however that satisfactory results will be obtained with a Hartmann photographic photometer which the Director has obtained privately and which is expected shortly from Germany.

A new photographic telescope specially designed for the work is under construction in the observatory workshop.

Summary of Results.

11. **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	4	6	7	8	8	4	4	5	2	2	3	3	56
Daily number	0·5	0·8	1·0	1·7	1·1	0·5	0·6	0·6	0·4	0·4	0·6	0·3	0·7
North	..	..	..	3	2	2	1	3	1	2	..	1	15
South	4	6	7	5	6	2	3	2	1	..	3	2	41
Equator	..	..	..	..	..	..	..	..	..	..	..	..	..

The very rapid decline in spot activity noted in the last report in comparing the years 1909 and 1910 has continued as is shown by the following figures :—

	1910.	1911.
Number of new groups	152	56
Mean daily numbers	1·8	0·7
Large spot groups	15	7
Spot returns	6	*Nil*
Number of days on which no spots were seen	56	158

The proportion of the southern spots to northern was higher than in 1910. The mean and extreme latitudes were not very different from what they were in 1910. A very faint dot was recorded at—37° on November 17, 1911. Excluding that, the mean latitudes were 7°·2 north and 9°·8 south and the extremes 2° and 12° in the northern hemisphere and 1° and 19° in the southern.

The following were the most important spot groups seen during the year :—

January—
No. 1951 A single spot of moderate size with a round and regular outline.

February—
No. 1958 A train of spots occupying 11° of longitude when the group was near the central meridian. C was reversed and D_3 was slightly dark on one day. A metallic prominence was observed on the limb of the sun before the day of its appearance.
No. 1960 contained spots of moderate size. C was occasionally observed to be reversed and D_3 dark. This group was also preceded by a metallic prominence.

March—
No. 1966 First appeared on the 29th as a group of small dots, but rapidly developed into two fairly large spots with smaller ones between.

April—
Nos. 1970, 1972, 1973 } contained fairly large spots.

May—
No. 1983 contained a fairly large spot. C was slightly reversed near it on one day.

August—
No. 1993 contained a moderate sized spot. On the 8th at $8^h\ 34^m$ C was reversed and dark C was slightly displaced to violet to the east of the spot, but the displacement had disappeared at $8^h\ 35^m$.

September—
No. 1997 a fairly large spot.

October—
No. 1999 a fairly large spot.

November—
No. 2003 a fairly large spot.

Disturbances in C and D_3 were very rare during the year. Those mentioned above are almost all that were observed.

12. **Prominences.**—The mean areas of prominences for each hemisphere of the sun are shown in the following table in which the figures for the previous year are given for comparison :—

Mean daily profile Areas of Prominences.

	1910. Square minutes.	1911. Square minutes.
North	2·03	1·27
South	2·07	1·64
Total ..	4·10	2·91

The reduction of area of only 28 per cent. compared with 1910 shows that the solar activity as regards prominences is to a large extent independent of the spot activity, which has fallen during 1911 to about one-third of its value in 1910.

The distribution of the prominences in latitude differs from that in 1910 in the development of a zone of great activity in the southern hemisphere between the parallels of 35° and 50°. This has caused a marked excess of southern prominences over northern. The parallels of 60° north and south as in 1910 mark the approximate limits of prominence formation towards the poles, but small and transient jets have been frequently recorded within the polar areas.

Metallic prominences were very infrequent only 24 being recorded during the year. Most of them were found in the sun-spot zones but, as in the previous year, a few were observed in high latitudes. The mean and extreme latitudes are given in the following table :—

Metallic Prominences.

—	Number observed.	Mean latitude.	Extreme latitudes.
North	9	21°·5	0°·5 86°·5
South	15	28°·8	2°·0 71°·5

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	47	1	5
February	25	2	5
March	27	3	6
April	44	3	12
May	33	2	5
June	23	2	2
July	14	..	3
August	43	3	6
September	42	1	12
October	51	..	4
November	49	4	6
December	40	3	2

The following were the more noteworthy prominences observed during the year :—

January.—The highest prominence, 200″, was observed at latitude—35° east on the 29th. For three successive days from the 28th to the 30th tall prominences were seen in this region.

February.—An eruptive, rapidly changing prominence was recorded at latitude—32° west on the 24th. This attained to a height of 165″.

April.—One of the highest prominences ever recorded here was observed on the 2nd. It first appeared on the photographs as a long wide streamer issuing from a point in latitude—34° east in a northerly direction and nearly tangent to the limb. It was immediately found to be rising and a series of photographs was taken. These showed that the prominence ascended with an accelerating velocity and finally broke into fragments which quickly faded. The highest fragment was over 10′ above the limb at $11^h\ 24^m$.

September.—There was a prominence 200″ high recorded at + 32° east on the 8th.

October.—Prominences were observed at latitude—45° east continuously from the 6th to the 16th.

November.—The tallest prominence of the month was photographed on the 28th at latitude—50° west. It was 240″ in height at 10^h 35^m.

December.—An eruptive prominence recorded at + 38° west on the 27th reached to a height of 145″ at 11^h 44^m.

(*b*) Other Observations.

13. **Comets.**—Photographs were obtained of the spectra of comets 1911b (Kiess) and 1911c (Brooks) with an objective prism spectrograph attached to the South Dome Equatorial. Direct photographs of these objects were also obtained at the same times as the spectrum plates. Kiess' comet was photographed on five days between August 14th and 20th and Brooks' comet on seven days between August 25th and September 22nd, and again after conjunction with the sun on October 28th and 29th.

Excepting for the greater amount of detail shown on the spectrum plates of Brooks' comet obtained at the end of October no essential change occurred in the spectrum as the comet approached perihelion and the best plate of the series (October 28th) appears to be identical with the best spectrum of Halley's comet obtained with the same instrument in 1910. The spectrum of Kiess' comet although much fainter appears to be the same as the others.

14. **Time.**—The error of the standard clock is usually determined by reference to the 16^h 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. Time determinations are made with the transit instrument, when necessary, as a check.

15. **Meteorology.**—Meteorological observations were carried on as in former years. Eye observations are made at 8^h, 10^h, and 16^h local mean time. Temperatures and pressures are recorded continuously by a Richard thermograph (wet and dry bulb) and barograph, and the mean temperatures and pressures are obtained from the traces, corrected by reference to the eye observations. The wind direction and velocity shown in appendix tables II and III are obtained from a Beckley anemograph, and the 8^h values for the Daily Weather Reports of Simla and Madras from a Robinson anemometer and a wind vane.

Comparative observations of the standard barometer were taken early in the year with a barometer brought by the Director-General of Observatories and the instrumental correction was determined to be + 0·009 inch instead of — 0·002 inch. The new correction has been used in the annual report since the beginning of 1910.

Pressure.—The mean pressure for the year was practically the same as the normal—there was an excess of 0·003 inch. Only in four months was the deviation more than 0·010 inch—the greatest amounts being a defect of 0·015 inch in January and an excess of 0·026 inch in October. The pressure was below normal in January, March and November and above in the other months.

Temperature.—The mean temperature of the year was 0°·3 above normal. In seven months it was above and in the other five months below normal. The greatest deviation was 1°·3 either way. The mean grass minimum temperature in February was only 31°·3 as against the normal of 38°·4.

Humidity.—The mean humidity for the year was 2% below normal. It was above in March, June, July and December and below in the other months. The greatest excess was 13% in December and the greatest defect 13% in August.

Rain.—The rainfall for the year exceeded the normal by 4·51 inches. In January, February, March, August, and September there was a total defect of 15·50 inches and in May, June, July, October, November and December a total excess of 19·92 inches.

Wind.—The average daily velocity for the year exceeded the normal by 19 miles. The average velocity was in defect only in three months February, March and September. The excess in November was 113 miles and the mean direction in that month was east by south against north by west which is the normal direction for November. The highest daily movement was 883 miles on November 22 and the lowest 120 miles on October 7.

Transparency of the atmosphere.—The transparency of the lower atmosphere as judged by the visibility of the Nilgiris, about 100 miles distant, was much below the average.

Cloud and sunshine.—On 26 days the sky was completely overcast, but the average "clear sky" for the whole year was practically the same as the normal. There were 2,114 hours of bright sunshine against an average of 2,028.

16. **Seismology.**—The Milne horizontal pendulum recorded 95 earthquakes during the year as against 81 in 1910. There were between 10 and 12 earthquakes in each of the months January, April, October, November and December The largest and longest record continued for 4^h 48^m on January 3 and had its origin in Turkestan.

17. **Library.**—One hundred and ninety-two volumes were bound during the year.

18. **Publications.**—Bulletins Nos. XXIII and XXIV were published during the year and Bulletin No. XXV was in the press at the end of the year. The first two deal with prominence observations in 1910 and the last with the same observations in the first half of 1911. In addition to these the following papers were published :—

"On the Angular speed of rotation of a long enduring prominence" by J. Evershed (A.P.J. Vol. XXXIII, No. 1).

"The Autocollimating Spectroheliograph of the Kodaikānal Observatory" by J. Evershed (M.N., R.A.S., Vol. LXXI, No. 9).

"The Absorption markings in H_a spectroheliograms" by T. Royds (M.N., R.A.S., Vol. LXXI, No. 9.)

19. **General.**—The Director-General of Observatories inspected the Kodaikānal Observatory in February and the Director inspected the Madras Observatory in December.

The staff of the observatory worked well during the year. In the reduction of the prominence observations and the preparation of the bulletins for the press the Third Assistant Mr. Subrahmania Aiyar deserves special mention for his zeal in keeping the work well up-to-date.

THE OBSERVATORY, KODAIKANAL,
7th February 1912.

J. EVERSHED,
Director, Kodaikanal and Madras Observatories.

II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1911.

Staff.—The computer was on privilege leave for one month and eleven days and the Frst Assistant for two months.

2. **Time Service.**—No change was made in the programme of Astronomical observations, which have been restricted, as usual, to meridian observations for time determinations. The system of time signals distributed from the Observatory also remains unchanged. The time gun at the Fort failed on 9 occasions and was fired correctly on 721 occasions out of 730, giving 98·8 as the percentage of successes. The gunner was absent on one occasion, the gun failed twice owing to defect in firing apparatus, on three occasions owing to bad tube, twice owing to faults on the line and lastly the gun was not fired on the occasion of the Coronation Durbar of Their Imperial Majesties at Delhi. The semaphore at the Port Office was dropped correctly at 1 P.M. on every day except 3, when it was dropped correctly at 2 P.M.

3. **Meteorological observations.**—In addition to the ordinary meteorological observations, extra observations were taken and special telegrams sent to Simla on 2 occasions and on 41 occasions to Calcutta.

4. **Buildings.**—Electric light and fans were fitted in the offices and in the quarters of the Deputy Director during the year.

5. **Instruments.**—The following is a list of the instruments at the Madras Observatory on the 31st December 1911 :—

(*a*) *Astronomical.*

Eight-inch Equatorial Telescope—Troughton & Simms.
Sidereal Clock—Haswall.
" Dent, No. 1408.
" S. Reifler, No. 61.
Mean Time Clock—J. H. Agar Baugh, No. 105.
" with galvanometer—Shepherd & Sons.
Meridian Circle—Troughton & Simms.
Mean Time Clock—J. Monk.
Mean Time Chronometer—V. Kullberg, No. 5394.
" " No. 6544.
" Parkinson and Frodsham, No. 2352.
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.
" Thermograph—No. 3618, L. Casella.
Beckley's Anemograph—Adie.
Sunshine Recorder—No. 149, L. Casella.
Anemoscope—P. Orr & Sons.
Nephoscope—Mons Jules Daboseq & Ph. Pellin.
Barometer, Fortin's—No. 1771, L. Casella.
" No. 725, L. Casella (spare).
" No. 1420, L. Casella (spare).
Dry Bulb Thermometer—No. 94221, L. Casella.
" No. 38037, Negretti & Zambra (spare).
Wet Bulb Thermometer—No. 94219, L. Casella.
" No. 38037, Negretti & Zambra (spare).
Dry Maximum Thermometer—No. 8581, Negretti & Zambra.
Dry Minimum Thermometer—No. 69047, L. Casella.
Wet Minimum Thermometer—No. 91753, Negretti & Zambra.
Sun Maximum Thermometer—No. 10479, 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 year was an abnormally dry one and very little rain fell till November 19th. During this time the level of the transit changed slowly and steadily in the same direction. After the heavy rain on 21st November it underwent a sudden

change in the opposite direction accompanied by some change in azimuth. At present the level error is very small and is almost steady. The rates of the Riefler and Dent Clocks have been very satisfactory. A new mean time clock by Mr. J. H. Agar Baugh was received towards the end of the year and has been mounted in the room to the west of the transit room. The electrical contacts with which it is fitted have not yet been connected and brought into use. It is proposed to divert the telegraph lines into this room from the Clock room in the Deputy Director's quarters.

6. **Weather summary.**—The following is a summary of the meteorological conditions at Madras during the year 1911 :—

Pressure.—Pressure was above normal in February, June, July, October and November and below normal in other months. The greatest excess was 0·043 inch in February and the greatest defect 0·034 inch in January The highest pressure recorded was 30·154 inches on February 12 and the lowest 29·548 inches on September 24.

Temperature.—The mean temperature of air was above normal in all months except February. The highest shade temperature recorded was 106°·4F. on June 1 and the lowest 62°·0F. on February 20. The highest temperature in the sun (150°·5) F. was recorded on July 30 and the lowest on grass was 58°·6F. on February 20.

Humidity.—Humidity was below normal in February and August and above normal during the other months.

Wind.—The wind direction was normal in February and December. It was more easterly than usual in January and November, more southerly than usual in March, April, May and October. The wind velocity was below the average throughout nearly the whole of the year. In November the mean daily velocity was 31 miles below normal.

Cloud.—The percentage of cloud was a little above normal in December and below normal in the remaining months.

Sunshine.—The percentage of bright sunshine was above normal in March, July, September and October and below normal during the rest of the year. The total number of hours of bright sunshine during the year was 2,249.

Rainfall.—The rainfall was above the average in September and December and below during the other months, the greatest excess being 2·93 inches in September and the greatest defect 5·09 inches in October. The total fall for the year was 36·53 inches and the monsoon rainfall from October 15 to the end of the year was 24·59 inches against an average of 26·00 inches. The heaviest fall on any day was 4·74 inches on November 21.

General.—The most noteworthy feature of the weather during the year was the deficient rainfall during the first eight months. From the 1st January up to nearly the middle of September the total rainfall at Madras was about 4 inches.

MADRAS OBSERVATORY,
16*th January* 1912.

R. LL. JONES,
Deputy Director.

Appendix I.

KODAIKÁNAL Observatory Seismological Records in 1911.

No.	Date	P.T. commence G.M.T.	L.W. commence G.M.T.	Maxima G.M.T.	End.	Max. Amp.	Duration.	Remarks.
	1911.	H. M.	H. M.	H. M.	H. M.	MM. "	H. M.	
1	Jan. 1 ..	10 27·4	10 32·6	10 36·2	11 47	4·3 = 2·1	1 20	
2	3 ..	7 31·1	7 54·9	7 56·0	8 35	0·6 = 0·3	1 04	
3	3–4 ..	23 32·0	23 38·5	.. (?)	4 20	18 = 8·0	4 28	Beyond range from 23 h. 41m. to 23 h. 54m. Turkestan.
4	4 ..	8 33·0	..	..	8 57	..	0 24	Widening of line.
5	4 ..	9 48·9	9 54·3	9 55·4	10 17	1·0 = 0·4	0 28	
6	4 ..	21 47·3	21 52·8	21 54·4	22 07	0·4 = 0·2	0 20	
7	7 ..	2 25·7	2 56·6	3 00·6	4 09	0·6 = 0·2	1 43	
8	8 ..	13 19·2	..	..	14 20	..	0 01	Do.
9	9 ..	3 53·6	4 12·9	4 16·0	4 40	0·4 = 0·2	0 46	
10	14 ..	18 10·5	..	..	18 41	..	0 31	Do.
11	16 ..	8 59·2	..	9 25·4	9 54	0·5 = 0·2	0 55	
12	Feb. 13 ..	14 07·6(?)	14 18·8	14 19·8	14 35	..	0 27(?)	Do.
13	18 ..	18 41·3	18 51·5	18 56·1	22 30	9·5 = 5·4	3 49	
14	23 .	11 26·4	..	..	12 18	..	0 52	Do.
15	28 ..	5 28·2	5 47·2	5 48·1	5 59	0·3 = 0·2	0 31	
16	March 11 ..	3 37·7	..	..	4 44	..	1 06	Do.
17	14 ..	21 08·6	..	..	22 12	.	1 04	Do.
18	22 ..	5 43·6	5 54·2	6 16·3	7 09	0·3 = 0·3	1 25	
19	22 ..	7 47·3	7 53·4	8 07·8	8 25	0·2 = 0·2	0 38	
20	27 ..	9 07·1	..	..	9 18	..	0 11	Do.
21	April 4 ..	16 14·1	16 19·2	16 21·2	16 24	0·3 = 0·1	0 10	Lombarda.
22	7 ..	7 01·4	7 06·8	7 41·3	8 07	0·4 = 0·2	1 06	
23	10 ..	19 02·7	..	..	19 38	..	0 36	Widening of line.
24	10 ..	20 08·6	..	..	20 28	..	0 14	Do.
25	11 ..	14 29·5	14 30·5	14 44·9	15 02	0·2 = 0·1	0 32	
26	15 ..	11 23·8	..	..	11 28	..	0 04	Do.
27	15 ..	12 01·2	12 03·8	12 04·4	12 23	0·7 = 0·3	0 22	
28	17 ..	5 20·3	..	..	6 27	..	1 07	Do.
29	18 ..	18 20·8	18 25·8	18 34·4	20 10	6·0 = 2·9	1 49	
30	28 ..	10 32·0	..	..	11 28	..	0 56	Do.
31	29 ..	5 32·2	5 46·0	5 48·6	6 02	0·5 = 0·2	0 30	
32	30 ..	9 50·3	..	..	10 29	..	0 39	Do.
33	May 4 ..	13 34·5	13 43·5	13 46·9	14 11	0·7 = 0·3	0 37	
34	4–5 ..	23 48·0	23 57·9	0 30·6	3 05	2·5 = 1·2	3 17	
35	11 ..	4 19·7	4 24·1	4 26·4	Between 4h. 51 m. and 5 h. 00 m.	0·4 = 0·2	0 40(?)	Instrument adjusted 4 h. 51 m. to 5 h. 00 m.
36	27 ..	20 33·6	..	..	21 26	..	0 52	Widening of line.
37	June 1 ..	14 41·2	..	..	14 55	..	0 14	Do.
38	3 ..	21 12·4	..	..	21 48	..	0 36	Do.
39	7 ..	11 24·4	12 27·4	12 43·3	14 57	4·5 = 2·3	3 33	Do.
40	8 ..	0 12·0	..	..	1 03	..	0 51	Do
41	15 ..	..	14 35·1	14 47·7	18 08	13 = 5·5	3 33	No P. TS.
42	17 ..	5 26·0	..	..	6 01	..	3 35	Widening of line.
43	July 4 ..	13 39·0	13 43·3	13 48 5	15 14	5·0 = 1·9	1 35	
44	5 ..	2 17·2	2 29·0	2 31·8	3 24	0·7 = 0·3	1 07	
45	5 ..	18 51·0	..	..	19 42	..	0 51	Do.
46	8 ..	2 32·0	..	..	3 15	..	0 43	Do.
47	12 ..	4 17·2	4 19·2	4 42·8	9 28	12 = 4·9	5 11	
48	19 ..	10 29·0	10 29·7	..	11 41	..	1 12	Do.
49	Aug.* 8 ..	14 58·6	..	..	15 17	..	0 18	Do.
50	8 ..	18 38·1	..	..	19 01	..	0 23	Do.
51	16–17 ..	22 52·4	22 59·5	23 20·3	2 42	6·8 = 2·6	3 51	
52	18 ..	3 10·7	..	..	3 39	..	0 28	Do.
53	21 ..	16 47·3	..	..	18 15	..	1 28	Do.
54	23 ..	16 45·8	..	..	17 23	..	0 37	Do.
55	Sept. 15 ..	13 40·6	13 53·1	14 46·3	15 29	0·5 = 0·2	1 48	
56	17 ..	3 52·2(?)	4 19·1	4 25·2	6 43	1·6 = 0·6	2 51	Instrument examined at 3h. 43 m.
57	20 ..	5 49·8	..	..	6 13	..	0 23	Widening of line.
58	22 ..	5 54·1	5 55·9	5 58·5	6 35	0·8 = 0·3	1 01	
59	26 ..	14 21·6	..	..	14 44	..	0 22	Do.
60	Oct. 6 ..	9 25·9	9 39·2	9 43·3	10 27	0·6 = 0·2	1 01	
61	10 ..	14 41·0	..	..	15 31	..	0 50	Do.
62	13 ..	2 56·1	3 22·8	3 25·4	4 15	1·0 = 0·4	1 19	
63	14 ..	6 42·2	..	..	7 19	..	0 37	Do.
64	14 ..	12 48·0	13 17·5	13 18·0	14 22	0·7 = 0·2	1 34	
65	14 ..	16 59·0	17 30·0	17 31·0	18 02	0·5 = 0·2	1 03	
66	14–15 ..	23 32·8	23 34·6	23 35·9	0 41	>17·5=>6·2	1 08	
67	16 ..	0 34·1	..	..	0 55	..	0 21	Do.

Line widened irregularly during

* Driving clock stopped at intervals July 20 and 21.

Kodaikānal Observatory Seismological Records in 1911—*cont.*

No.	Date.	P.T. commence G.M.T.	L.W. commence G.M.T.	Maxima G.M.T.	End.	Max. Amp.	Duration.	Remarks.
	1911.	H. M.	H. M.	H. M.	H. M.	MM.	H. M.	
68	Oct. 17 ..	12 14·9	..	..	13 05	..	0 50	Widening of line.
69	21 ..	0 07·4	..	..	1 02	..	0 56	Do.
70	24 ..	0 45·3	..	..	1 11	..	0 26	Do.
71	29 ..	19 33·6	..	..	20 09	..	0 35	Do.
72	Nov. 1 ..	10 52·0	..	..	11 29	..	0 37	Widening of line. Nov. 3-4 clock not driving.
73	10 ..	..	4 50·3	4 50·3 4 52·1	5 05	0·5 = 0·2 0·6 = 0·2	0 15	No. P. Ts.
74	11 ..	3 16·2	3 18·3	3 18·3	3 27	0·5 = 0·2	0 11	
75	11 ..	3 43·0	3 44·8	3 44·8	3 53	0·4 = 0·2	0 10	
76	13 ..	16 36·1	17 02·3	17 07·8	18 02	1·8 = 0·7	1 26	
77	18 ..	8 54·0	..	..	9 41	..	0 47	Widening of line.
78	20 ..	15 15·0	15 27·2	15 28·7	15 46	0·5 = 0·2	0 30	
79	21 ..	19 41·6	..	..	20 00	..	0 18	Do.
80	22-23 ..	23 18·3	..	..	0 21	..	1 03	Do.
81	28 ..	16 04·9	..	..	16 53	..	0 48	Do.
82	30 ..	11 07·8	..	..	11 53	..	0 45	Do.
83	30 ..	..	23 48·4	23 49·4	24 00	0·4 = 0·2	0 12	No P. Ts.
84	Dec. 2 ..	.. ?	4 31·3	4 32·0	4 42	0·6 = 0·2	0 11	Hour signal at 4h 30m.
85	7 ..	0 22·8	..	0 25·9	1 15	0·4 = 0·2	0 52	
86	7 ..	15 05·2	..	..	15 16	..	0 11	Widening of line.
87	11 ..	11 06·2	11 10·1	11 13·2	13 23	2·2 = 0·8	2 17	
88	13 ..	9 03·2	..	..	9 30	..	0 27	Do.
89	13 ..	23 08·3	..	..	23 44	..	0 36	Do.
90	16 ..	19 38·2	20 41·8	20 42·6 20 46·9	22 11	2·9 = 1·0 2·6 = 0·9	2 33	
91	20	6 14·2	6 47·5	6 52·7	8 29	1·0 = 0·4	2 15	
92	22 ..	14 20·8	..	..	14 46	..	0 25	Do.
93	23 ..	22 33·0	..	..	23 22	..	0 49	Do.
94	29 ..	15 22·9	..	..	16 56	..	0 33	Do.
95	31 ..	6 19·0	6 32·8	6 33·6	7 34	0·6 = 0·2	1 15	

Appendix II.

Mean monthly and annual meteorological results at the Kodaikānal Observatory in 1911.

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	22·830	0·063	54·7	65·2	48·2	17·0	45·7	38·8	0·222	52	114·3	39·0	370	6	E.N.E.	0·21	1	65	249·6
February ..	·859	·067	58·7	66·7	45·2	21·5	44·9	37·5	·214	53	122 3	31·3	265	6	E.N.E.	0·24	1	78	253·9
March	·854	·071	58·2	70·0	50·6	19·4	50·4	43·9	·289	60	130·5	39·2	273	8	E.	0·14	..	70	223·7
April . ..	·840	·067	60·9	71·3	54·9	16·4	53·3	47·6	·330	62	129·7	45·3	288	5	N.E. by E.	4·37	9	60	216·2
May	·808	·067	60·9	70·2	54·8	15·4	55·2	50·3	·380	71	126·5	49·8	259	4	N.E.	9·70	12	49	208·7
June	·778	·056	57·4	63·5	53·7	9·8	54·2	50·4	·391	83	126·0	48·1	377	26	W.N.W.	7·19	17	29	121·6
July	·769	·055	55·5	60·5	52·0	8·5	53·1	49·4	·383	87	121·9	48·4	460	27	N.W. by W.	5·73	15	17	94·5
August	·780	·055	56·4	64·6	50·9	13·7	51·2	45·8	328	72	135·2	43·0	344	28	N.W.	2·08	6	45	214·1
September ..	·793	·075	56·8	64·2	52·1	12·1	53·5	48·8	·378	82	132·3	45·2	272	28	N.W.	2·89	8	33	122·6
October ..	·835	·076	55·4	62·1	50·7	11·4	52·8	48·2	·376	85	127·0	46·6	264	32	N.	13·72	16	30	130·3
November ..	·824	·037	54·6	61·5	49·6	11·9	51·2	45·3	·345	81	115·0	43·9	384	9	E. by S.	11·30	13	37	139·9
December ..	·837	·065	54·1	60·5	50·0	10·5	50·8	46·3	·342	81	111·8	44·9	347	6	E.N.E.	6·49	13	30	139·3
Annual ..	22·816	0·065	56·6	65·0	51·1	14·0	51·4	46·0	0·332	72	124·4	43·7	325	2	N.N.E.	64·06	111	45	2,114·4

Extreme monthly meteorological records at the Kodaikānal Observatory in 1911.

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 . ..	22·912	5	22·730	25	0·182	71·9	14	43·0	26	32·0	15	5	15	120·6	7	19·2	26	603	21	176	3	0·17	17
February ..	·970	21	·770	1	·200	74·2	25	39·8	7	31·3	7	7	21	132·9	10	19·3	18	390	27	149	10	0·15	5
March	·939	18	·765	8	·174	73·4	24	46·0	2	35·2	1	14	28	141·3	19	29·2	1	489	31	146	7	0·06	9
April	·960	21	755	11	·205	74·9	5	51·6	28	41·1	4	26	4,26	138·1	4	39·5	1	421	9	143	11	1·18	7
May	·902	5	·714	22	·188	74·4	4	50·8	28	45·0	11	30	13	137·2	12	37·8	11	456	31	138	20	1·69	20
June	·860	15	·674	10	·186	67·8	26	51·9	14	44·0	17	51	17	147·8	3	44·7	3	733	11	121	3	1·07	6
July	·868	13	·658	5	·210	65·8	31	50·2	15	43·8	31	53	31	142·8	10	42·9	31	716	19	140	3	1·52	2
August	·851	31	·727	5,10	·124	68·4	25	47·4	15	39·2	13	22	13	148·3	1	36·2	15	561	7	138	19	0·55	21
September ..	·882	15	·669	23	·213	68·4	7	50·5	12	43·3	23	40	23	146·9	23	39 0	14	644	23	159	30	0·76	29
October	·916	30	·735	2	·181	67·8	2	45·3	29	39·4	28	48	22	141·5	2	40·3	30	570	4	120	7	3·99	18
November ..	.930	3	·663	23	·267	67·8	14	45·6	28	36·2	26, 27	14	26	135 0	17	31·1	26	883	22	160	8	3·17	23
December ..	·912	25	·759	11	·153	65 3	18, 29	45·2	28	36·4	30	16	30	127·8	8	35·2	16	572	13	162	6	1·51	7

Appendix III.

KODAIKÂNAL mean hourly wind velocity for the year 1911.

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	17	17	17	17	17	17	18	19	20	19	19	19	17	15	13	12	9	9	12	12	13	15	16	17
February	12	12	12	13	13	13	13	13	13	14	14	13	12	11	10	9	8	6	7	8	9	9	10	11
March	10	10	10	11	12	12	12	12	15	15	16	16	13	13	12	10	9	9	8	9	9	9	10	11
April	12	11	12	12	11	11	10	12	14	15	15	14	14	12	12	12	11	11	11	11	11	10	11	12
May	10	10	10	10	9	9	10	10	10	12	13	12	12	11	12	11	11	11	12	12	10	9	10	10
June	13	13	13	12	16	15	15	16	15	14	15	14	14	13	14	15	13	15	15	15	15	16	16	16
July	21	21	20	20	21	19	20	18	19	17	17	18	17	17	16	17	15	17	18	20	21	20	22	22
August	16	16	17	17	17	16	13	14	14	13	12	13	12	10	11	11	11	12	14	14	15	16	17	17
September	12	13	13	13	13	13	12	11	11	10	10	10	10	11	11	12	12	10	10	11	11	10	12	12
October	11	11	11	11	11	12	11	11	12	11	12	12	12	10	11	11	10	9	9	10	11	11	11	13
November	17	17	17	18	17	17	18	19	18	18	17	17	15	13	13	14	11	12	14	14	15	16	16	17
December	14	15	15	15	16	15	16	15	16	16	15	15	15	14	13	12	11	12	12	14	15	15	15	16
Mean	14	14	14	14	14	14	14	14	15	14	15	14	14	12	12	12	11	11	12	12	13	13	14	14

Appendix IV.

KODAIKĀNAL Mean Hourly Bright Sunshine for the year 1911.

Month.	Hours.												Remarks.
	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	0·08	0·71	0·77	0·84	0·88	0·88	0·91	0·89	0·81	0·68	0·57	0·07	
February	·31	·93	·98	·96	·96	·89	·85	·74	·72	·67	·68	·39	
March	·03	·80	·99	·97	·97	·84	·56	·48	·45	·42	·49	·24	
April	·10	·76	·91	·90	·92	·92	·80	·62	·42	·39	·32	·16	
May	·26	·69	·85	·90	·91	·89	·78	·53	·45	·25	·16	·07	
June	·24	·55	·60	·56	·47	·43	·38	·22	·22	·20	·16	·02	
July	·15	·35	·40	·43	·44	·35	·29	·22	·23	·12	·05	·04	
August	·18	·71	·87	·89	·84	·82	·73	·64	·48	·34	·29	·12	
September	·01	·52	·76	·71	·62	·52	·30	·25	·20	·11	·09	·01	
October	·07	·42	·74	·56	·52	·46	·39	·28	·26	·25	·16	·08	
November	·04	·44	·60	·66	·58	·56	·50	·38	·32	·30	·24	·05	
December	·00	·32	·87	·48	·55	·52	·51	·53	·47	·37	·28	·09	
Mean ..	0·12	0·60	0·74	0·74	0·72	0·67	0·58	0·48	0·42	0·34	0·28	0·11	

Appendix V.

NUMBER of days in each month on which the Nilgiris were visible in 1911.

Month.	Very clear.	Visible.	Just visible.	Tops only visible.	Total.
January	1	14	2	2	19
February	..	3	2	6	11
March	..	..	3	1	4
April	..	..	..	..	..
May	..	1	4	..	5
June	4	1	2	..	7
July	4	3	1	..	8
August	3	9	7	..	19
September	3	9	7	2	21
October	6	7	3	..	16
November	5	8	..	..	13
December	3	7	..	2	12
Total ..	29	62	31	13	135

Appendix VI.

MADRAS OBSERVATORY.—Abnormals from monthly means for the year 1911.

Abnormals of	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Reduced atmospheric pressure	— 0·034	+ 0·043	— 0·010	— 0·026	— 0·013	+ 0·007	+ 0·008	— 0·006	— 0·018	+ 0·037	+ 0·008	— 0·012	— 0·002
Temperature of air	+ 1·3	— 0·4	+ 1·3	+ 0·6	+ 1·1	+ 2·2	+ 2·0	+ 2·3	+ 1·3	+ 1·3	+ 1·7	+ 1·1	+ 1·3
Do. of evaporation	+ 1·9	— 0·8	+ 2·0	+ 1·6	+ 1·4	+ 2·0	+ 1·7	+ 1·6	+ 2·8	+ 1·6	+ 2·5	+ 2·4	+ 1·8
Percentage of humidity	+ 3	— 1	+ 3	+ 4	+ 3	+ 1	+ 1	— 1	+ 6	+ 2	+ 4	+ 6	+ 4
Greatest solar heat *in vacuo*	— 4·7	— 5·3	— 6·2	— 5·6	— 5·3	— 5·5	— 4·0	— 3·8	— 4·1	— 3·5	— 6·6	— 11·3	— 5·5
Maximum in shade	+ 1·2	— 0·3	+ 0·8	+ 0 8	Same as	+ 1·4	+ 2·6	+ 3·4	+ 1·3	+ 1·6	+ 1·0	— 0·9	+ 1·1
Minimum in shade	+ 0·4	— 2·3	+ 0·8	+ 0·9	+ 1·2	+ 2·0	+ 1·2	+ 1·6	+ 0·8	Same as	+ 1·6	+ 2·0	+ 0·8
Do. on grass	+ 1·4	— 1·4	+ 1·9	+ 1·5	+ 1·9	+ 2·9	+ 1·8	+ 2·1	+ 1·8	+ 0·8	+ 2·5	+ 3·7	+ 1·6
Rainfall in inches	— 0·89	— 0·28	— 0·39	— 0·62	— 2·11	— 1·48	— 2·73	— 2·40	+ 2·93	— 5·09	— 0·52	+ 1·09	..
Do. since January	..	— 1·17	— 1·56	— 2·18	— 4·29	— 5·77	— 8·50	— 10·90	— 7·97	— 13·06	— 13·58	— 12·49	— 12·49
General direction of wind	1 point E.	Same as	2 points S.	1 point S.	1 point S.	1 point W.	1 point W.	1 point W.	2 points W.	3 points S.	4 points E.	Same as	1 point S.
Daily velocity in miles	— 12	— 2	+ 12	+ 11	Same as	— 10	— 6	— 12	— 12	+ 2	— 31	+ 1	— 9
Percentage of cloudy sky	— 13	— 9	— 14	— 5	— 18	— 16	— 15	— 8	— 13	— 18	— 13	+ 5	— 12
Do. of bright sunshine	— 4·6	— 2·6	+ 0·6	— 13·3	— 12·4	— 6·4	+ 4·4	— 8·4	+ 1·5	+ 6·8	— 1·5	— 17·0	— 7·4

+ Means above normal, — below normal.

Appendix VII.

ABSTRACT of the mean meteorological condition of Madras in the year 1911 compared with the average of past years.

Mean values of	1911.	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	76·3	1·8 ,,	74·5
Percentage of humidity	76	4 ,,	72
Greatest solar heat *in vacuo*	134·2	5·5 below.	139·7
Maximum in shade	91·9	1·1 above.	90·8
Minimum in shade	75·5	0·8 ,,	74·7
Do. on grass	73·5	1·6 ,,	71·9
Rainfall since January 1st on 76 days	36·53	12·49 below.	49·02
General direction of wind	S.E. by S.	1 point S.	S.E.
Daily velocity in miles	162	9 below.	171
Percentage of cloudy sky	37	12 ,,	49
Do. of bright sunshine	43·6	7·4 ,,	51·0

DURATION and quantity of the wind from different points.

From	Hours.	Miles.	From	Hours.	Miles.	From	Hours.	Miles.	From	Hours.	Miles.
North ..	104	927	East ..	170	1,129	South ..	292	2,337	West ..	283	2,423
N. by E. ..	290	1,806	E. by S ..	165	891	S. by W...	258	1,669	W. by N...	182	1,575
N.N.E. ..	287	1,922	E.S.E. ..	205	1,133	S.S.W. ..	256	1,841	W.N.W. .	166	1,508
N.E. by N.	419	2,446	S.E. by E.	286	1,664	S.W. by S.	230	1,605	N.W. by W.	169	1,155
N.E. ..	317	2,361	S.E. ..	534	3,575	S.W. ..	222	1,688	N.W. .	90	645
N.E. by E.	420	2,731	S.E. by S.	1,064	8,323	S.W. by W.	214	1,439	N.W. by N.	56	314
E.N.E. ..	163	1,259	S.S.E. ..	545	4,290	W.S.W. ..	239	1,816	N.N.W. ..	83	492
E. by N. ..	236	1,235	S. by E. ..	254	1,825	W. by S...	329	2,581	N. by W.	91	493

There were 132 calm hours during the year. The resultant corresponding to the above numbers is represented by a south-south-east wind, blowing with a uniform daily velocity of 42 miles.

Appendix VIII.

MADRAS OBSERVATORY—Number of hours of wind from each point in the year 1911.

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 ..	..	13	18	109	75	168	45	66	28	37	31	56	14	40	12	1	1	1	3	1	6	..	3	2	1	..	..	..	1	..	..	..	12
February ..	6	4	2	19	64	114	45	61	27	19	47	49	64	68	9	1	2	2	3	5	4	2	4	..	..	..	1	1	..	1	2	1	15
March ..	..	..	..	..	..	.	..	..	..	..	..	22	124	366	81	39	25	17	15	23	11	5	1	1	..	1	..	.	..		..	..	6
April ..	..	..		..	2	..	2	4	16	2	4	1	70	206	175	51	64	40	22	25	16	5	5	4	1	..	..	..	..	..	1		4
May	..	..	2	1		2	2	..	..	3	2	7	35	168	104	74	122	58	32	26	21	10	16	11	9	10	16	6	3	1	3	..	..
June .. .	1	2	6	6	4	1	..	2	6	8	13	18	34	30	31	22	16	27	40	40	57	84	67	58	84	27	27	5	10	6	5	2	1
July	..	..	..	..	1	..	3	1	4	6	7	13	28	28	16	21	11	20	28	33	40	81	69	109	79	42	38	49	8	4	3	..	2
August ..	2	1	2	1	4	6	3	4	12	9	26	26	58	33	31	18	13	25	40	34	19	18	34	61	53	55	47	32	37	13	15	3	14
September ..	7	2	2	1	1	3	..	3	11	8	15	45	41	43	51	20	4	34	36	32	26	44	26	37	47	38	35	74	24	15	8	3	14
October ..	23	46	50	22	12	11	21	39	30	44	36	11	39	49	32	11	18	33	35	19	22	15	10	11	8	9	1	1	4	3	4	43	32
November ..	20	64	44	125	101	72	28	39	19	15	20	38	27	33	3	1	6	1	2	1	..	..	2	3	1	..	..	..	.	1	11	14	29
December ..	45	158	161	135	53	46	14	17	17	14	4		..	..	..	..	..	.	..	..	..	..	2	2	..	..	1	1	3	12	31	25	3
Annual total ..	104	290	287	419	317	420	168	236	170	165	205	286	534	1,064	515	254	292	258	256	239	222	214	239	329	283	182	166	169	90	56	83	91	132

Appendix IX.

MADRAS OBSERVATORY.—Number of miles of wind from each point in the year 1911.

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	..	86	61	534	473	962	405	404	211	171	162	193	50	173	80	7	6	3	19	3	39	..	12	7	7	..	..	..	4	..	..	..	4077
February	19	32	12	158	407	715	325	245	182	145	185	214	231	301	21	8	19	6	22	35	25	8	18	..	..	..	6	3	..	2	9	9	3357
March	..	..	..	..	..	..	..	..	..	..	..	113	696	2555	769	182	166	106	149	206	82	29	8	10	..	5	..	..	..	..	..	..	5076
April	..	..	..	..	16	..	8	41	73	5	29	9	687	1877	1511	373	584	316	180	122	130	28	24	25	4	..	..	..	..	..	7	..	6049
May	..	..	20	6	..	15	21	..	..	24	14	66	373	1890	1095	656	992	477	290	242	160	69	119	70	79	100	143	58	24	6	20	..	7029
June	10	14	27	28	44	6	..	12	59	68	105	170	298	266	248	136	94	137	360	331	553	334	616	828	845	285	249	24	81	36	27	25	6311
July	..	..	..	.	9	..	18	9	33	61	64	123	215	220	116	142	104	101	186	160	289	545	608	928	693	421	401	351	80	32	29	..	5938
August	13	7	10	7	25	12	18	9	79	57	159	211	395	201	167	89	110	164	218	163	125	128	231	414	419	436	455	316	252	71	57	14	5032
September	31	14	6	7	9	30	..	23	79	57	105	346	283	324	76	128	79	177	170	191	121	201	125	219	316	284	242	393	159	76	35	16	4322
October	109	250	255	123	66	49	63	169	134	135	154	100	236	352	198	99	146	177	236	144	164	97	41	67	54	44	4	6	18	13	30	157	3890
November	93	250	250	628	762	610	258	189	131	89	131	119	116	164	9	10	37	5	11	3	..	.	4	8	6	..	..	..	..	5	41	85	4014
December	352	1153	1281	955	550	332	143	134	148	79	25	..	..	..	..	..	..	..	..	..	..	.	10	5	.	..	3	4	27	73	237	187	5698
Annual ..	627	1806	1922	2446	2361	2731	1259	1235	1129	891	1133	1664	3575	8323	4280	1825	2337	1669	1841	1605	1688	1439	1816	2581	2423	1575	1503	1155	645	314	492	493	60793

Appendix X.

MADRAS OBSERVATORY.—Number of inches of rain from each point in the year 1911.

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 ..	..	..			..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.	..	..	..	..	..	..	..
February ..		..	..	..	..	..	..	..	..	..	..	..	..	.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.	..	..	..	..
March ..	..	.	..	.	..	..		..	..	..	..	..	.	..	.	.	..	..	..	..	..	..	..	..	..	..	..	..		..	..	..	..	..
April ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.	..	..	..	..	..	..	..	..	..	..	..	..	..
May ..	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0·01	..	..	..	..	..	..	..	..	..	..
June ..	..	..	..	..	..	..	..	..	..	..	..	..	..	0·02	..	..	..	0·13	.	..	..	..	0·02	..	0·02	0·06	0 01	..	0·11	..	0·26	..	..
July ..	..	..	..	..	..	0·02	..	.	..	..	0·03	..	0·15	..	..	..	0·07	..	0·09	..	..	0·19	0·03	0·09	0·03	..	..	0·44	..	..	.	..	..
August ..		..	..	..	..	..	0·12	..	..	..	0·08	..	0·01	0·03	0·10	..	0·03	0 10	0·11	0·10	0·12	0·08	0·27	0·39	0·16		0 15	0·02	0·02	0·03	0·13	..	0·11
September ..	0 63	0·92	0·21	..	..	..	..	..	..	..	.	..	0·18	..	0·90	..	0·60	0·03	..	0·11	0·35	0·49	0·84	..	..	0·11	0·30	1·68	0·22	0·03	..	..	0·02
October ..	0·66	..	0·29	..	..	0·07	0·15	0·17	0·60	0·08	1·02	..	0·03	..	0·14	..	..	..	..	..	0·09	..	..	..	0·06	0·01	..	..	0·99	0·41	0·62	0·52	..
November ..	0·17	0·80	0·34	0·12	0·12	1·15	0·52	0·03	0·68	4·25	2·08	0·07	0·47	0·54	..	..		..	0·18	0·02	..	..	0·03	0·02	..		..	..	..	..	0·27	0·62	0·21
December ..	1·42	0·47	0·81	0·36	0·10	0·18	0·23	0·03	0·22	0·77	0·20	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0·17	0·79	0·61	0·01
Annual ..	2·88	2 19	1·65	0·48	0·22	1·42	1·02	0·23	1·50	5·10	3·41	0·07	0·84	0·59	1·14	..	0·70	0·26	0·38	0·23	0·56	0·76	1·20	0·50	0·27	0·18	0 46	2·14	1·34	0·64	2·07	1·75	0·35

Appendix XI.

MADRAS OBSERVATORY.—Wind, cloud and bright sunshine, 1911.

Month.	Wind resultant.		Clouds (0—10).					Bright sunshine.	
	Velocity.	Direction.	8 H.	10 H	16 H.	20 H.	Mean.	Average per day.	Mean number of hours in a day
	MILES.							HOURS.	HOURS.
January	105	E.N.E.	2·5	3·4	2·4	1·3	2·4	7·9	9·2
February	88	E. by N.	1·8	2·3	1·2	0·7	1·5	9·4	10·9
March	151	S.S.E.	1·3	1·7	0·6	0·3	1·0	9·5	10·6
April	180	S.S.E.	2·5	2·0	2·8	2·3	2·4	7·4	10·6
May	180	S. by E.	2·2	1·8	2·2	1·0	1·8	6·1	7·9
June	122	S.W.	4·5	4·6	5·8	4·4	4·8	4·3	8·1
July	122	W.S.W	5·2	4·8	6·2	6·3	5·6	4·6	9·0
August	67	S.W. by W.	5·8	5·3	7·0	5·2	5·9	3·8	8·8
September	51	S. W.	6·0	5·3	4·9	3·5	4·9	5·2	10·7
October	34	S.E.	3·7	4·1	4·6	3·6	4·1	6·7	10·3
November . ..	108	N. E. by E.	4·2	5·7	5·6	2·7	4·6	5·3	8·8
December	164	N.N.E.	5·5	6·3	6·3	4·7	5·7	4·1	8·0
Annual ..	42	S.S E	3·8	3·9	4·1	3·0	3·7	6·2	—

Appendix XII.

Mean Monthly and Annual Meteorological Results at the Madras Observatory in 1911.

	Barometer.		Dry bulb thermometer.				Wet bulb.		Tension of vapour.	Relative humidity.	Sun Max. *in vac.*	Min. on grass.	Wind.			Rain.		Clear sky.	Bright sunshine.	General weather.
	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.	PTS.	POINTS.	INCHES.	NO.	CENTS.	HOURS.	
January ..	29·963	0·118	76·4	85·8	67·9	17·9	71·1	67·0	0·693	76	133·7	64·5	132	6	E.N.E.	..	..	24	245·4	
February ..	30·007	·126	76·3	86·3	65·7	20·6	70·0	64·8	·651	72	134·4	62·4	120	8	E.	..	..	15	261·9	
March ..	29·895	·133	81·3	90·0	72·9	17·1	75·9	72·3	·816	77	134·3	70·5	164	14	S.S.E.	..	..	10	295·6	
April ..	·800	130	84·6	93·7	78·1	15·6	79·2	76·6	·926	78	136·1	76·2	202	14	S.S.E.	..	..	24	220·5	
May ..	·722	·124	87·8	97·8	82·0	15·8	79·7	77·1	·913	70	137·7	80·8	227	16	S.	0·01	1	18	189·2	
June ..	·710	·114	88·6	99·7	82·3	17·4	79·5	75·2	·843	63	135·0	78·6	210	20	S.W.	0·63	5	48	128·0	
July ..	·729	·120	86·5	98·2	79·7	18·5	77·6	74·4	·826	66	134·7	78·4	192	21	S.W. by W.	1·14	11	56	141·3	
August ..	·744	·120	85·6	97·1	78·9	18·2	77·6	74·3	·834	78	136·2	77·5	162	20	S.W.	2·16	16	59	118·6	
September .	·759	·136	84·3	94·5	77·9	16·6	79·1	75·6	·925	78	137·2	76·8	144	20	S.W.	7·62	11	49	155·8	
October ..	·878	·117	81·9	90·6	75·2	15·4	77·2	74·2	·872	80	135·6	73·6	125	10	E.S.E.	5·91	9	41	207·8	
November ..	·932	·111	79·2	86·0	73·9	12·1	75·4	72·8	·827	86	130·8	72 0	134	6	E.N.E.	12·69	12	46	159·0	
December ..	·966	·100	76·6	82·7	71·8	10·9	73·0	70·7	·762	83	124·5	70·1	184	2	N.N.E.	6·37	11	57	135·8	
Annual ..	29·841	0·120	82·4	91·9	75·5	16·3	76·3	72·9	0·824	76	134·2	73·5	162	13	S. E. by S.	36·53	76	37	2,248·9	

Extreme Monthly Meteorological Records at the Madras Observatory in 1911.

	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 ..	30·115	5	29·763	28	0·352	89·5	28	63·1	30	61·9	30	52	13	138·1	4	58·9	13	251	8	70	23	..	..
February ..	·154	12	·784	1	·370	92·1	1	62·0	20	60·6	20	46	18	141·3	2	58·6	20	205	5	78	26	..	..
March ..	·080	1	·746	8	·264	94·9	8	64·6	1	64·5	1	56	23	142·2	14	61·5	1	220	9	120	28	.	..
April ..	29·980	21	·648	29	·332	102·2	18	73·3	2	69·1	1	50	18	144·1	18	70·9	2, 3	260	20	116	15	..	..
May ..	·875	5	·570	28	·305	105·5	25	77·7	30	72·7	16	32	28	144·3	20	76·4	16	281	10	154	21	0·01	29
June ..	·870	15	·550	10	·320	106·4	1	72·6	4	72·6	4	33	1	145·4	1	72·6	4	320	11	128	28	0·26	4
July ..	·862	14	·554	5	·308	103·5	27, 30	74·1	10	72·7	27	39	26	150·5	30	73·4	10	268	17	87	3	0·45	9
August ..	·845	2	·619	9	·226	103·7	15	73·9	11	69·1	6	36	6	148·0	15	71·7	22	258	5	107	25	0·75	30
September ..	·935	15	·548	24	·387	100·2	3	70·6	16	70·6	16	45	23	151·2	13	70·4	16	228	7	61	19	3·12	17
October ..	30·048	30	·671	1	·377	99·5	7	66·7	28	66·7	28	46	7	145·7	10	63·6	6, 7	207	4	67	23	2·98	15
November ..	·084	3	·744	22	·340	88·8	18	69·8	13	69·1	13	60	13	139·1	5	66·6	13	247	17	50	26,28	4·74	21
December ..	·076	25	·760	3	·316	86·4	1	64·4	31	64·4	31	62	16	137·6	4	61·3	31	271	22	105	1	1·44	2