ANNUAL REPORT

OF THE

DIRECTOR

KODAIKANAL AND MADRAS

OBSERVATORIES

FOR 1917

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KODAIKANAL AND MADRAS OBSERVATORIES.

REPORT FOR THE YEAR 1917.

CONTENTS.

I.—KODAIKANAL OBSERVATORY.

II.—MADRAS OBSERVATORY.

KODAIKANAL AND MADRAS OBSERVATORIES.

I.—REPORT OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1917.

Staff.—The staff of the Observatory on December 31, 1917, was as follows :—

Director	J. Evershed, F.R.S. (on privilege leave).
Assistant Director	T. Royds, D.Sc. (on deputation). S. Sitarama Ayyar, acting sub. *pro tem.*
First Assistant	S. Sitarama Ayyar, B.A. G. Nagaraja Ayyar, acting sub. *pro tem.*
Second Assistant	G. Nagaraja Ayyar. A. A. Narayana Ayyar, acting sub. *pro tem.*
Third Assistant	A. A. Narayana Ayyar, B.A. S. Balasundaram Ayyar, acting sub. *pro tem.*
Fourth Assistant	S. Balasundaram Ayyar.
Writer	L. N. Krishnaswami Ayyar.
Photographic Assistant	R. Krishna Ayyar.

MAGNETIC SECTION.

Magnetic Observer	S. S. Ramaswami Ayyangar, B.A.
Magnetic Recorder	S. S. Ranga Acharya.

The Observatory has temporarily lost the services of Dr. Royds who volunteered for military service in November 1916 but continued his work as Assistant Director until October 1917 when he was appointed Assistant to the Director of Ordnance Factories. He left Kodaikanal on October 23 to take up this appointment at Calcutta. First Assistant S. Sitarama Ayyar has been appointed Assistant Director substantive *pro tempore* from October 24.

The subordinate staff consists of a book-binder, an assistant book-binder, a mechanic, six peons (including the peon of the Magnetic Observatory), a boy peon for the dark room and two lascars.

2. *Instruments.*—The instrumental equipment of the Observatory was the same as in the last report with the exception of some additions and reconstructions mentioned in paragraphs 16 to 19. The Kullberg sidereal chronometer has been lent to the Nizamiah Observatory, Hyderabad.

3. *Weather conditions.*—The weather during the year has been generally unfavourable for all classes of work owing to diffusive skies and bad definition during the dry season, and heavy monsoon conditions from May to October and in November.

Photographic and visual observations.

4. *Photoheliograph.*—Work with this instrument was resumed from February 11 and photographs on a scale of 8 inches to the sun's diameter were obtained on 294 days.

5. *Spectroheliographs.*—Notwithstanding the poor weather conditions there was very little reduction in the number of plates obtained, although the quality of these has suffered.

Monochromatic images of the disc in K light were obtained on 328 days, prominence plates on 262 days, and Hα disc plates on 255 days.

6. *Six-inch Cooke equatorial and spectroscope.*—Work with this instrument has been continued on the same lines as formerly for visual observations of solar phenomena which cannot be readily photographed.

7. *Grating spectrograph.*—This instrument has been greatly improved for work requiring long exposures by surrounding and covering the grating chamber with closely packed sand bags, and by erecting a screen outside the west wall of the building as a protection from heating by the afternoon sun. A telescope with collimating lens has also been added for reading a sensitive thermometer, the bulb of which is inserted in the grating chamber. The diurnal range of temperature now seldom reaches 0°·5 Fahrenheit and a change exceeding 0°·01 Fahrenheit rarely occurs in a two hours exposure. The instrument has been used for researches connected with the general displacement of the lines of the solar spectrum with reference to the arc lines. Two series of photographs have been obtained of the spectrum of Venus with Fe arc comparison lines, and of control plates of sky light and Fe arc. During the monsoon months a large number of plates were obtained of the iron arc spectrum in order to test the stability of the Fe lines under various conditions, and for investigating the "pole effect" in different regions of the arc. The sensitiveness to pole effect has also been determined for all the lines used in the Venus plates.

The Venus spectra are for discovering whether the general shift towards red of the lines at all points on the visible disc of the sun affects also a hemisphere of the sun turned 90° or more from the earth. If there is no difference of wave-length in the light reflected by Venus and ordinary sunlight then the displacements observed cannot be interpreted by motion of the solar gases, whilst if the Venus spectra show a smaller wave-length an earth effect is involved. If the hidden hemisphere of the sun should yield normal wave-lengths then it would follow that the sun's gravitational field is not concerned in the line shifts.

General results of the spectrographic work.

8. *The Venus spectra.*—Measures of the first series of Venus and sky spectra photographed when the planet was a morning star indicate distinctly smaller wave-lengths of the Fe lines in the integrated solar spectra reflected by Venus compared with sky light, when the angle Venus-Sun-Earth was about 140°. The difference of wave-length Sun − Venus for the mean of 12 lines is + 0·007A. This result is possibly vitiated by imperfect control of the pole effect, the arc used had nickel for positive pole and iron for negative, and the integrated light from the entire arc formed the spectrum. It has since been found that under these conditions the Fe lines are slightly unstable in wave-length, and even those which are apparently unaffected at the negative pole are liable to be displaced.

The second series of spectra with the planet an evening star was secured with the iron arc under more carefully controlled conditions and without nickel. Unfortunately during the most favourable presentation of the planet in July, August and September, the evening sky was continuously overcast, and not a single exposure could be obtained until October, when the angle Venus-Sun-Earth had become reduced to about 62°. Five spectra were obtained during October under more or less cloudy conditions, and the measures of these, and of the similar sky spectra, show a small but apparently trustworthy difference, the mean wave-length of 18 Fe lines in Venus being 0·0034A smaller than in the sky spectra. The evidence so far obtained may therefore be said to favour the motion interpretation of the solar displacements involving an Earth effect.

A third series of photographs will be attempted after April 1918 with the planet again a morning star and coming into favourable positions in June and July.

The Venus plates have also been used to determine the relative velocity of Venus and the Earth in the line of sight. With the planet near elongation and a dispersion of 1 mm = 1·4A the linear displacement is about 0·14 mm, and the dispersion could probably be doubled if an

uninterrupted exposure of two hours' duration could be given. It is hoped that in the clearer morning skies this may be possible. It has been found from the October plates that the probable error of a displacement determination averages 1 part in 400 for each plate, measuring 40 lines by the positive on negative method. By combining the results from both east and west elongations the uncertainty due to a possible difference of wave-length in the reflected and direct light is eliminated, and the measures can be used to find a correction to the adopted solar parallax. A preliminary result derived from the first and second series of plates indicates an extremely small correction, but since the quantity measured is several times smaller than the parallax displacement in astrographic plates of Eros this result can only be considered as a guarantee of the reliability of the plates.

9. *Pole effect.*—The investigations relating to pole effect have shown that all the Fe lines suitable for measurement between 4337 and 4494 are subject to slight displacements towards red near the negative pole, even those classified *a*3, *b*1 and *b*3 which are supposed to be symmetrical lines. The positive on negative method has been found to be extremely useful in detecting small displacements of 0·002A or over, without the labour of measurement, and with spectra representing longitudinal sections of the arc from pole to pole this method at once detects and locates the position in the arc of any displacements. In this way it has been discovered that when iron forms the negative pole and nickel or some other metals the positive there is a tendency for the displacement at the negative pole to extend across the arc to the central region. Also it is found that in the central region of a 6-ampere arc of 6 to 8 mm. length most of the lines in the region studied show a tendency to shift towards red with increasing exposure time, showing that under ordinary arc conditions they are unsymmetrically widened towards red to a very slight degree. In lines which easily reverse, such as 4383 and 4404, the reversal is found to have the minimum wave-length, and agrees in position with the emission line when the density of the bright line image is small. This dependence of wave-length on exposure time accounts for many inconsistencies in determinations of Sun – arc displacements.

10. *Sun and arc comparison spectra.*—A considerable number of sun and arc plates have been obtained and measured during the year: these include 2nd, 3rd and 4th order spectra of the region photographed in Venus. These plates show the influence of density of the arc images on the measured shifts of the solar lines, and the effect of using nickel as positive pole, thus confirming the results already described. In addition a series of high dispersion spectra of Fe arc and general sunlight were obtained which appear to give sun – arc shifts practically the same as when the centre of the sun's disc is used, but further measures are needed to settle this point.

Some plates obtained by Dr. Royds of the centre of the disc and Fe arc in the region including the telluric oxygen lines of the *a* group have been measured in order to test the observation reported by Perot that the telluric oxygen lines of the group B indicate a motion shift amounting to 3 km/sec in a vertical direction. The result of measures of plates taken with high and low sun gives an entirely negative result: the lines of the *a* group show no measurable shift depending on altitude.

11. *Spectrographic determination of the solar rotation.*—A new scheme of work was developed in the favourable atmospheric conditions in Kashmir in 1916, but owing to persistent diffusive and cloudy skies throughout the past year at Kodaikānal no progress was possible. The method is to photograph the east and west limb spectra in the red region near to and including the H*a* line, and to measure these by the positive on negative method, confining attention to the strongest Fe and Ca lines and the hydrogen line. These lines can be measured in this way with far greater accuracy and greater freedom from systematic errors than

by the usual method, and the lines chosen are less affected by atmospheric diffusion than weaker lines or lines in the more refrangible regions. Variations in the solar rotation of 1 per cent could, it is believed, be detected with certainty by this method, and with a minimum of labour in measurement.

Work with the 8-inch horizontal telescope.

12. *Star photography in daylight.*—At the request of Mr. Lindemann an effort was made to observe the conjunction of Regulus and the Sun on August 22 by the photographic method initiated by him. Light from the siderostat was passed through two large prisms each of 6 inch aperture and 45° angle but placed 35 feet apart and in reversed positions, the second prism taking up and recombining only the red and infra red rays which then enter the 8-inch telescope. The more refrangible red rays were cut out by an absorbing screen of cobalt glass placed near the focus. As the sun would be in the field of the telescope together with the star an arrangement was constructed whereby the sun's image could be reflected out of the tube during the exposure on the star but yet admitting of an instantaneous exposure, so that a record might be obtained of both sun and star on the same plate. Measures of the distance of the star from the sun's limb would then be used to discover whether there was any displacement of the star due to the gravitational field of the sun.

The day of conjunction was not clear enough to test the method satisfactorily, and no star image appeared on the plates obtained, nor could the star be seen visually during fairly clear intervals. The definition of the sun appeared very good and the spots seemed darker than with ordinary light.

Summary of sunspot and prominence observations.

13. *Sunspots.*—The following table shows the monthly numbers of new groups observed at Kodaikānal and their distribution between the northern and southern hemispheres. The mean daily numbers of spots visible are also given :—

—	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
New groups	32	28	24	26	30	21	31	45	37	28	24	39	365
North	17	13	16	12	17	12	23	20	19	13	13	18	193
South	15	15	8	14	13	9	8	25	18	15	11	21	172
Daily numbers ...	6·0	5·0	5·6	5·1	6·7	6·9	6·7	8·8	7·6	4·9	5·4	9·3	6·5

There is an increase in the number of new groups recorded of 31 per cent and of mean daily numbers visible of 67 per cent compared with the previous year. There was no day in 1917 on which no spots were recorded.

The preponderance of activity in the northern hemisphere is somewhat less marked than in 1916. The approximate mean latitude was 14°·1 in the northern and 17°·1 in the southern hemisphere, a decrease of 1°·9 and 1°·3 respectively compared wth the previous year. Judging by the mean latitudes it would appear that the maximum of the sunspot cycle had not yet been reached, although the northern hemisphere alone may possibly have attained its greatest activity. There were 483 reversals of the hydrogen lines, 40 darkenings of D_3, and 133 displacements of H*a* recorded during the year.

The largest spots observed during the present cycle crossed the sun's disc in February and in August.

14. *Prominences.*—The mean daily areas of prominences in square minutes of arc derived from the Kodaikānal photographic records are as follows :—

—	North.	South.	Total.
1917—January to June	2·94	2·42	5·36
July to December	2·83	2.12	4·95

These figures indicate a considerable increase of activity compared with the previous year and show that the reduction in 1916 was of a temporary character. The mean daily number of prominences recorded during the year was 19·8.

The distribution in latitude indicates a close approach to the climax in prominence development when the high latitude zones of activity reach the polar regions. The northern zone is shown to have a maximum between 75° and 80° and the southern between 70° and 75°: the north is thus slightly ahead of the south in its approach towards the pole, and a complete disappearance of these northern prominences may be anticipated during 1918, whilst the southern zone may be expected to continue active some time longer. The northern hemisphere has continued more active than the south and this applies also to prominences projected on the disc as absorption markings, to metallic prominences, and to displacements of the hydrogen lines indicating violent motion.

The prominence areas east and west of the sun's axis show a slight western excess, the proportion on the east side being 49·6 per cent of the whole. The denser prominences showing as absorption markings on the disc indicate on the other hand the usual eastern excess, the areas east of the meridian being 52·8 per cent of the whole, derived from 4725 markings. D_3 darkenings and bright reversals of hydrogen lines on the disc were also slightly more frequent east of the meridian ; but of 51 metallic prominences observed at the limb only 19 were east. Three hundred and seventy-five displacements of Hα were recorded in the chromosphere and prominences, and of these 52·5 per cent were on the east limb.

The usual preponderance of displacements of the hydrogen lines towards red is shown both in prominences at the limb and near spots on the disc.

Solar radiation.

15. *Pyrheliometer.*—Very few days in 1917 were clear enough for solar radiation measures, but a series of observations was secured by Dr. Royds early in the year with the Angstrom pyrheliometer No. 73, and the results are given in the following table. In this E is the solar constant or the amount of heat which would be received outside the earth's atmosphere, in calories per square centimetre per minute, and a is the transmissive power of the earth's atmosphere.

Date.	E	a	Remarks.	Date.	E	a	Remarks.
February ... 16	1·813	0·903		March ... 13	1·709	0·836	Afternoon observations.
„ 19	1·731	0·856					
„ ... 22	1·730	0·879		„ . 14	1·728	0·858	
„ 23	1·781	0·881		„ .. 15	1·672	0·874	
„ ... 25	1·848?	0·841?		„ .. 16	1·723	0·890	
„ ... 27	1·769	0·875		„ . 17	1·701	0·890	
„ ... 28	1·711	0·860		„ ... 18	1·662	0·896	
March ... 1	1·534?	0·938?		„ ... 23	1·655	0·886	
„ ... 2	1·702	0·888		„ ... 29	1·680	0·897	
„ ... 8	1·687	0·877		April ... 4	1·681	0·901	
„ ... 9	1·687	0·879		„ ... 14	1·602	0·894	
„ ... 10	1·689?	0·873?	Incomplete.	May ... 4	1·665	0·892	
„ ... 11	1·731	0·855		„ ... 12	1·598	0·885	
„ ... 12	1·672	0 873		„ ... 14	1·635	0·887	
„ ... 13	1·671	0·876	Forenoon observations				

Dr. Royds adds the following remarks :—

"The instrumental constant supplied by the makers has been used, although the absorptive power is at any rate much lower than its assumed value. The values of the solar constant therefore require to be multiplied by an undetermined factor before comparing with observations at other stations.

"Whilst the variations from day to day may not be real it would seem from the observations that the value of the solar constant was falling from February to May."

Workshop construction.

16. Dr. Royds has constructed and made experiments with interference standards of the pattern of Fabry and Perot with a view to their use in determining solar displacements with great accuracy. His apparatus is ready for mounting in front of the spectrograph when observing conditions are favourable.

17. A new prism spectrograph for use with the 15-inch Hyderabad lens, or the 20-inch mirror from Poona, was constructed during the year. The prism box is large in order to accommodate any prism train. Two 45° prisms of 6-inch aperture are at present used with collimator of 3-foot and camera 5-foot focal lengths. The spaces surrounding the prisms are filled with small closely packed sand bags. The prism box is mounted on a carriage having 3 flanged wheels running on iron rails in order that the instrument may be run into position in the beam of light from the siderostat which also feeds the spectroheliograph. The immediate purpose of this spectrograph was to obtain Venus and Fe arc spectra when the planet was too near superior conjunction for long exposures with the grating spectrograph, but atmospheric conditions were unfavourable throughout the period when it would have been of use.

18. A new microscope specially adapted for positive on negative measures was fitted to the usual form of Hilger micrometer. This instrument has been fitted with a new high quality screw and can be used for positive on negative or ordinary filar measures. The eye piece carrying a single thread has also been reconstructed and a screw arrangement provided for rotating the thread through a small angle ; this is an almost indispensable aid in spectrum measures but one which appears never to be provided by instrument makers.

19. The 8-inch telescope from Poona was erected horizontally and fitted with a special form of camera intended for photographing Regulus in red light when near the sun.

Time, meteorology, etc.

20. *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 Postmaster-General, Madras.

21. *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. Cloud observations with the nephoscope are made three times daily.

Pressure.—The mean pressure was below normal in every month of the year, the defect ranging from 0·003 inch in May, to 0·046 inch in October. The mean for the year was 0·023 inch below normal.

Temperature.—The annual mean temperature was 1° above normal, the mean maximum almost normal and the mean minimum 1° below normal.

Humidity.—The annual mean humidity was slightly above normal.

Rainfall.—There was an excess of rain in February, May, June, August, September and November, the total fall for the year exceeding the average by 7·9 inches. The greatest monthly excess and also the

heaviest fall for a day, occurred in February, usually the driest month of the year.

Wind.—The mean wind velocity was in excess of normal in January but in defect in every other month, especially in July, August and September.

Cloud and sunshine.—The mean cloudness was greater than normal but the number of hours of bright sunshine actually exceeded the average by 8 per cent.

22. *Seismology.*—Seventy-two earthquakes were recorded on the Milne horizontal pendulum. Details of the records are given in Appendix I.

23. *Library.*—One hundred and two volumes were bound during the year.

24. *Publications.*—Volume I, part 2 of the Observatory Memoirs and five bulletins were published during the year, but under instructions from Government only a few copies were distributed privately outside India. The titles are—

Memoirs, Volume I, part 2.—Results of Prominence Observations, by J. Evershed, F.R.S., and M. A. Evershed.
Bulletin No. LIII.—The displacement of nickel and titanium lines in the sun and arc, by T. Royds, D.Sc.
„ No. LIV.—The cause of the so-called pole effect in the electric arc, by T. Royds, D.Sc.
„ No. LV.—The solar prominence of 1916, May 26, by J. Evershed, F.R.S.
„ No. LVI.—Summary of prominence observations for the second-half of the year 1916, by T. Royds, D.Sc.
„ No. LVII.—Summary of prominence observations for the first-half of the year 1917, by T. Royds, D.Sc.

In addition the following contributions to "The Observatory" were made by the Director :—

The Einstein Effect and the Eclipse of 1919, May 29, XL, 269.
Day and night "seeing" ... ... XL, 400.

J. EVERSHED,
Director, Kodaikanal and Madras Observatories.

KODAIKANAL,
7th February 1918.

II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1917.

Staff.—The staff at the Observatory during the year 1917 was as follows :—

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

2. *Time service.*—The time gun at Fort St. George failed on 20 occasions out of 730, giving a percentage of success of 97. The semaphore failed both at 1 and 2 p.m. on two occasions, failed at 1 but dropped at 2 p.m. on eleven occasions and dropped correctly at 1 p.m. on all other occasions. The 4 p.m. roll of signals was sent and received at the Central Telegraph Office, for distribution over India, correctly on every day except one. On this occasion—22nd November—the signals were not received at the Central Telegraph Office owing to a fault in the circuit at the Observatory. The circuit arrangements here have since been changed so as to permit easier inspection and detection of such faults in future.

3. *Meteorological observations.*—Eye observations were made at 8^h, 10^h, 16^h, and 20^h, local mean time as in former years. The Richard thermograph and barograph, the Beckley anemograph, the sunshine recorder and self-registering rain-gauge also continue in use. Extra observations were taken for storm warning purposes and telegrams sent to Calcutta on 69 occasions.

4. *Buildings, etc.*—The usual annual repairs to the office and quarters were carried out during the year. The subsoil drain constructed round the observatory was in part effective in stopping the variations in level of the transit instrument and the changes have been smaller during the past year.

5. *Instruments.*—The following is a list of the instruments at the Observatory on 31st December 1917 :—

Astronomical.

Eight-inch Equatorial Telescope—Troughton and 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 and Sons.
Meridian circle—Troughton and Simms.
Portable transit instrument—Dolland.
Portable telescope with stand.
Tape chronograph—R. Fuess.
Relay for use with the chronograph—Siemens.

Meteorological.

Richard's barograph—No. 10, L. Casella.
Do. thermograph—No. 29637, L. Casella.
Peander's self-recording rain-gauge—No. 116, Lawrence and Mayo.
Beckley's anemograph—Adie.
Sunshine recorder—No. 149, L. Casella.
Nephoscope—Mons. Jules Daboseq Ph. and Pellin.
Barometer, Fortins—No. 1771, L. Casella.
Do. No. 725, L. Casella (spare).
Do. No. 1420, L. Casella (spare).

Dry bulb thermometer—No. 94221, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Wet do. No. 94219, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Dry maximum thermometer—No. 8581, Negretti and Zambra.
Dry minimum do. No. 69017, L. Casella.
Wet do. do. No. 91753, Negretti and Zambra.
Sun maximum thermometer—No. 127618, Negretti and Zambra.
Grass minimum thermometer—No. 3377, Negretti and Zambra.
Rain-gauge (8″ diameter)—No. 1042, Negretti and Zambra.
Measure glass for above.
Rain-gauge (5″ diameter).
Measure glass for above.
Stop watch—No. A-3.

The variations in the level of the Transit Circle still continue but have now a much smaller range than in 1915 and previous years before the drain was constructed round the observatory. Further they have now become very nearly periodic, and do not show a net progressive change in one direction for the whole year, as was the case formerly. During the third and fourth week in October there was a rapid recovery in the level but it was only about half of the similar change which occurred in the third week of October in 1916 and one-third of the corresponding sudden change in 1915. The range this year was less than in 1916 and possibly this was due to the better distribution of rainfall this year (see remarks on Rainfall in Weather Summary). The most satisfactory feature however is that the changes are not only smaller but are no longer cumulative. During the first half of January 1917 the mean level error was + 0^{s}·25 and during the last half of December 1917 and first half of January 1918 it was + 0^{s}·19.

The rate of the Riefler clock has been very steady during the year. If it could be placed in a more favourable position where it would not be subjected to such violent fluctuations of temperatures as it undergoes in its present position, no doubt it would be still more satisfactory.

6. *Weather summary.*—The following is a summary of the meteorological conditions at Madras during 1917 :—

Pressure.—The mean monthly pressure was 0·015 inch above normal in January and below normal during the rest of the year, the defect being greatest in the months of October and December—about 0·065 inch. The highest daily mean was 30·150 inches on January 9.

Temperature.—The mean temperature of the air was above normal in January and November, below normal in June and September and about the average during the remaining months of the year. The maximum shade temperature was below normal in June, August, September and December and normal during the rest of the year. The highest temperature was recorded on May 25 (105°·3 F.). The minimum in shade was in defect of the average in May and June and in excess in January, February and November. The lowest temperature recorded was 60°·7 on February 19. The highest sun maximum was 164°·1 on February 28 and the lowest on grass was 57°·3 on February 19.

Humidity.—The percentage of humidity was above normal from July to September and differed little from normal during the rest of the year. The driest day in the year was June 20, when the humidity was only 31.

Wind.—The wind velocity was above normal in January, normal in February and April and below normal throughout the rest of the year. The wind direction was nearly normal in all months except in October when it was 15 points towards west.

Cloud.—The weather was more cloudy than usual in February, September and November and less cloudy during the other months.

Sunshine.—The percentage of bright sunshine was above normal in April, May and July and below in all other months. The total number of hours of bright sunshine during the year was 2190·9 against 2372·1 in the previous year.

Rainfall.—Rainfall was in excess of the average from June to October and in December and in defect during the rest of the year, the greatest excess being 5·48 inches in October and the greatest defect 7·18 inches in November. The total rainfall for the year was 51·06 inches on 101 days. The monsoon rainfall from October 15 to the end of the year was normal and amounted to 26·06 inches. The heaviest rainfall on one day was 6·52 inches on October 20.

Storm.—A depression which formed in the Bay about the 15th October, developed and moved in a north-westerly direction, giving heavy rain in the north of the Presidency, and filled up near Nellore about the 22nd October. Another storm which entered the Bay from the east about the middle of November caused squally weather at Madras. Stormy weather was also experienced on the Madras Coast during the beginning of December.

THE OBSERVATORY, MADRAS,
3rd February 1918.

R. LL. JONES,
Deputy Director.

APPENDIX I.

STATION—KODAIKANAL OBSERVATORY.

SEISMIC RECORDS.

$\phi = 10° 13' 50''$ $\lambda = 77° 28' 00'$ $h = 2{,}343$ metres. *Subsoil*—Rock.
Apparatus—Milne's Horizontal Pendulum Seismograph.

1917.	T_o	$\frac{\tau}{T_o^2}$	1917.	T_o	$\frac{\tau}{T_o^2}$
January	17·4	2·6	July	18·1	2·8
February	17·2	2·6	August	18·0	2·7
March	17·0	2·6	September	17·4	2·8
April	17·2	2·6	October	17·4	2·6
May	17·1	2·7	November	17·3	2·7
June	17·2	2·7	December	17·4	2·5

No.	Date.	Phase.	Time G.M.T.	Period. (Sec.)	Amplitude (u).			Distance Δ (Km.).	Remarks.
					An.	Ae.	Az.		
	1917.		H. M. S.						
1	January 4 ...	eP	17 11 42	...	...	...	...	..	No record from 6th to 8th.
		eL	17 18 00	..	...	...	...	...	
		M	17 22 06	...	...	80	...	...	
		F	17 44 00	...	...	.	..	...	
2	17 ...	eP	2 55 24	...	.	...	. .	...	Widening of line.
		F	3 24 54	.	..	. .	...	...	
3	20–21 ..	iP	23 25 48	...	...	...	...	...	
		iL	23 32 18	...	.	.	...	...	
		M	23 38 36	...	..	250	...	...	
		F	0 41 42	...	.	...	...	...	
4	24 ...	eP	1 10 18	.	...	..	...	.	Widening of line.
		F	2 01 00	...	...	...	...	...	
5	26 ...	eP	5 55 24	...	...	..	.	...	Widening of line.
		F	6 12 42	...	...	.	...	...	
6	30 ...	eP	2 57 48	...	...	.	...	...	
		eL	3 07 24	...	...	..	...	...	
		M	3 42 12	...	...	1350	.	..	
		F	7 13 42	..	...	...	...	...	
7	30 ...	eP	8 08 36	...	...	...	...	...	Widening of line.
		F	8 25 54	...	.		...	...	
8	31 ...	eP	4 08 00	...	...	...	...	...	
		iL	4 23 00	...	..	...	...	.	
		M	4 33 54	...	...	190	...	...	
		F	5 37 06	...	.	...	...	...	
9	February 12 ...	eP	9 26 42	...	...	.	...	...	Widening of line.
		F	10 34 18	...	...	...	...	...	
10	15 ...	eP	2 00 00	...	...	...	...	...	
		iL	2 04 48	...	...	..	.	...	
		M	2 34 06	...	...	150	...	...	
		F	3 10 12	...	...	...	...	...	
11	18 ...	eP	1 38 06	...	...	...	...	...	Widening of line.
		F	2 09 18	...	...	...	...	...	
12	20 ...	eP	20 10 30	...	...	...	...	..	
		eL	20 42 24	...	...	..	.	...	
		M	20 58 06	...	...	160	...	...	
		F	22 00 24	.	...	. .	...	...	
13	21 ...	eP	10 57 18	...	..	...	..	...	Widening of line.
		F	11 44 00	...	...	...	...	...	
14	22 ...	eP	10 27 12	...	...	...	...	...	
		eL	10 30 30	...	...	...	...	...	
		M	10 32 00	...	...	70	...	.	
		F	11 13 42	...	...	...	...	..	
15	25 ...	eP	5 39 12	..	...	...	...	...	Widening of line.
		F	6 44 12	...	...	...	...		
16	March 14 ...	eP	1 15 18	...	...	...	...	...	Widening of line.
		F	1 25 24	..	...	..	..	...	
17	15 ...	eP	0 34 06	...	...	...	...	...	
		eL	0 54 12	...	...	..	...	...	
		M	1 01 00	..	...	70	...	...	
		F	2 01 30	...	...	...	. .	...	
18	16 ...	eP	3 30 18	...	...	...	...	...	Widening of line.
		F	4 04 30	...	..	...	..	...	

No.	Date.	Phase.	Time G.M.T.	Period. (Sec.)	Amplitude (u). An.	Ae.	Az.	Distance. △ (Km.)	Remarks.
	1917.		H. M. S.						
19	April 3 ...	eP	12 48 12	...	...	...	...	...	
		iL	12 52 48	...	...	...	...	...	
		M	12 54 00	...	...	100	...	...	
		F	13 38 36	...	..	...	...	..	
20	12 ...	eP	2 59 12	...	...	...	...	.	
		iL	3 04 18	...	...	.	...	..	
		M	3 17 42	...	...	50	...	...	
		F	3 44 12	...	...	...	..	...	
21	17 ...	eP	18 55 42	..	...	...	..	..	
		eL	18 59 00	..	.	..	...	...	
		M	19 02 30	...	..	120	...	..	
		F	19 37 06	...	...	...	...	...	
22	21 ...	P	.....	...	...	...	..	..	No P.Ts.
		iL	0 59 30	..	..	...	..	..	
		M	1 05 06	...	...	190	...	..	
		F	1 34 06	...	...	...	...	...	
23	29 ..	eP	12 13 42	...	...	...	...	...	
		iL	12 25 12	...	...	...	...	...	
		M	12 30 12	...	..	80	...	..	
		F	12 56 24	...	...	...	...	...	
24	May * 1-2 ...	eP	18 40 42	...	...	...	.	...	
		iL	18 54 24	...	...	..	...	...	
		M	19 34 06	..	...	1420	...	...	
		F	0 02 30	...	...	...	..	...	
25	24 ...	eP	20 16 12	..	..	...	...	...	
		eL	20 21 18	...	...	..	...	...	
		M	20 30 30	...	...	70		...	
		F	20 42 48	...	...	...	...	...	
26	29 ...	eP	6 59 12	...	...	...	...	...	
		eL	7 00 18	...	.	...	..	...	
		M	7 06 24	...	...	50	...	...	
		F	7 17 12	...	...	..	...	...	
27	31 ...	eP	9 06 24	...	...	...	...	..	
		iL	9 38 12	...	...	..	...	...	
		M	9 50 48	.	...	620	...	...	
		F	9 52 36	...	...	...	...	...	
28	June 3 ...	eP	14 58 00	...	...	..	...	...	Widening of line
		F	15 19 12	...	...	..	..	...	
29	9 ...	eP	9 46 00	...	...	...	...	...	
		iL	9 48 48	...	...		...	...	
		M	9 49 36	..	...	40	...	...	
		F	10 27 30	...	..	...	...	...	
30	9 ...	eP	17 53 36	.	...	...	...	...	
		eL	18 01 54	...	...	...	...	...	
		M	18 05 24	...	...	70	...	...	
		F	18 23 48	...	..	...	...	...	
31	13 ..	eP	7 01 30	...	...	...	...	...	
		iL	7 07 42	...	...	..	...	...	
		M	7 49 42	...	...	600	.	...	
		F	.....		...	...	...	...	
32	13 ...	P	.....		...	...	...	...	
		eL	9 56 42	...	...	..	...	...	
		M	10 00 12	..	..	50	..	...	
		F	10 21 48	...	...	...	...	...	
33	24 ..	eP	20 08 00	...	..	...	..	..	
		iL	20 17 24	...	...	...	..	...	
		M	20 18 12	...	...	70	...	...	
		F	.....		...	...	...	...	
34	24 ...	P	.....		...	...	...	...	
		iL	20 51 18	...	...	..	..	...	
		M	20 58 12	...	...	50	...	...	
		F	21 13 06	...	...	..	...	..	
35	26 ...	iP	6 04 24	...	...	...	..	...	
		iL	6 08 42	...	...	...	...	...	
		M1	6 19 36	...	...	500	...	.	
		M2	6 55 06	...	...	700	...	...	
		M3	6 56 42	...	..	650	...	...	
		M4	7 02 48	...	...	1080	...	...	
		F	10 48 30	...	...	...	...	...	
36	July 4 ..	eP	0 46 48	...	...	..	...	...	
		iL	0 53 48	...		...	...	...	
		M	1 13 24	...	...	290	.	...	
		F	2 39 12	..	...	..	...	...	
37	4 ...	eP	5 52 12	...	...	...	...	...	
		eL	5 55 12	...	...	...	...	...	
		M	6 11 18	...	...	90	...	...	
		F	6 52 36	...	...	...	...	...	
38	4 ...	eP	22 20 36	...	...	...	...	...	Widening of line.
		F	22 48 06	...	.	...	..	...	
39	15 ...	eP	11 11 54		...	...	...	...	Widening of line.
		F	11 36 24	...	...	.	..	...	

* Driving clock removed for repairs May 5 to 19.

No.	Date.	Phase.	Time G.M.T.	Period. (Sec.).	Amplitude (u). An.	Ae.	Az.	Distance △ (Km.).	Remarks.
	1917.		H. M. S.						
40	July 15 ...	eP	18 16 48	...	..	.	..	...	Widening of line.
		F	18 41 42				..		
41	27 ...	eP	1 24 24	.	...	...	..	...	
		eL	2 23 24	...	...	..	.	...	
		M	2 33 06	...	. .	100	.		
		F	...	...	...	...	...		
42	27 ...	P	.	...	...	.	...	...	Overlapping.
		iL	4 00 54	..	...	...	...	...	
		M	4 12 36	...	...	340	..	...	
		F	5 10 00	...	...	...	...	..	Instrument examined at $5^h\ 2^m$.
43	29 ...	iP	14 52 18	..	..	...	...	...	
		iL	15 13 18	...	...		...	...	
		M	15 15 06	...	..	110	...	...	
		F	16 17 12	...	. .	...	...	...	
44	29-30 ...	iP	22 02 42	...	...	...	...	...	
		iL	22 11 24	...	...		. .	..	
		M	22 45 36	...	...	520	...	...	
		F	1 38 12	..	.	.		...	
45	31 ...	eP	0 05 30	...	...		...	...	
		iL	0 13 24	..	...	...	...	...	
		M	0 19 18	...	...	290		. .	
		F	1 37 42	...	.	...	...	..	
46	August 3 ..	eP	21 49 24	...	...	...	...	...	
		iL	21 53 30	...	...		..	..	
		M	21 54 30	...	...	80	...	...	
		F	22 05 12	...	...	...	...	...	
47	5 ...	eP	16 36 36	...	...	..	...	...	
		eL	16 47 06		...	...	...	...	
		M	16 54 48	...	...	130	...	...	
		F	18 06 48	...		..	.	...	
48	30 .	P	..	...	...	...	...	...	No P.Ts.
		iL	4 16 30	...	...	...	...	...	
		M	4 42 18	...		...	...	...	
		F	6 32 30	...	...	...	...	...	
49	31 ...	eP	11 56 42	..	..	...		..	
		eL	13 01 48	...	..	.		...	
		M	13 05 24	...	...	170	...	...	
		F	14 05 54	...		...	...	...	
50	September 15 ...	eP	10 07 42	...	...	...	..	..	Widening of line.
		F	10 19 30	..	...	..		...	
51	17 ...	P		...	.	...	...	...	No P.Ts.
		eL	20 18 00		...	...	...	...	
		M	20 20 12	...	...	50	...	...	
		F	20 25 54	...	...		..	...	
52	20 ...	eP	3 39 24		...	...	..	...	Widening of line.
		F	4 05 18	...	...		...	...	
53	26 ..	eP	22 13 30	..	...	...	...	...	Widening of line.
		F	22 14 36		..		...	...	
54	October 17 ...	eP	1 17 32	...	..	...	..	...	Widening of line.
		F	1 44 18		...	..	...	...	
55	19 ...	eP	18 12 54	..	...	...	...	...	Widening of line.
		F	18 23 06	...	...	...	...	...	
56	22 ...	P	.	...	...		..	...	No P.Ts.
		eL	8 53 18	..		...	...	...	
		M	8 56 36		...	50	...	...	
		F	9 02 30	...	. .	...	...	...	
57	29 ..	eP	21 34 06	...	...	..	...	...	Widening of line.
		F	21 38 36	...	...	..	...	..	
58	November 4 ...	iP	12 09 30	...	...	...	...	...	
		iL	12 12 54	...	...	...	...	...	
		M	12 18 12	...	...	1320	...	...	
		F	13 29 12	..	...	...	..	...	
59	14 ..	eP	5 36 42		...	...	...	...	Widening of line.
		F	5 38 12	...	...	...	...	...	
60	16 ...	eP	3 38 12	...	...	...	...	...	
		iL	3 47 54	...	...	...	..	.	
		M	4 27 42	..	...	800	...	...	
		F	6 26 42	...	...	...	...	...	
61	16 ...	eP	22 27 12	...	...	...	...	...	
		iL	22 33 06	...	...	...	...	...	
		M	22 47 24	...	...	50	...	...	
		F	23 11 36	...	...	...	...	...	
62	18 ...	eP	3 07 00	...	...	..	...	...	Light stopped from $3^h\ 9^m\cdot5$ to $3\ 11^m\cdot5$ for marking time on sheet.
		L	...	...	...	...	...	...	
		M	3 12 54?	...	...	320	...	...	
		F	4 09 06	...	...	...	...	...	

No.	Date.	Phase.	Time G.M.T.	Period. (Sec.).	Amplitude (u).			Distance Δ (Km.).	Remarks.
					An.	Ae.	Az.		
	1917.		H. M. S.						
63	November 24 ...	eP	11 47 12	...	...	...	..	...	Widening of line.
		F	11 53 30	...	...		...	...	
64	28 ...	eP	15 01 48	...	...		...	..	Widening of line.
		F	15 12 36	...	...	...	..	...	
65	December 1 ...	eP	9 57 48	...	...	..	...	...	
		eL	10 01 12	...	...	.	...	...	
		M	10 02 42	...	...	40		..	
		F	10 08 18	...	...	.	...	...	
66	5 ...	eP	13 07 06	...	...	...	..	...	Widening of line.
		F	13 13 18	...	...	...	..	...	
67	19 ...	eP	10 01 00	...	...	...	...	...	Widening of line.
		F	10 05 06	...	...	...	...		
68	20 ...	P	..	...	...	...	...	...	No P.Ts.
		eL	2 56 00	...	...	.	...	...	
		M	3 00 36	...	...	90	...	...	
		F	3 12 24	...	...	...	...	...	
69	21 ...	eP	18 19 12		...	...	...	..	
		eL	18 50 30	..	...	.	...	...	
		M	19 00 48	...	...	200	...	...	
		F	20 21 18	...	...	...	...	...	
70	21 ...	eP	21 51 06	...	...	...	...	...	Widening of line.
		F	21 54 42	..	...	...	...	.	
71	28 ...	P	...	...	...	.	...	..	No P.Ts.
		eL	22 10 00	...	...	..	...	...	
		M	22 19 24	.	...	90	...	...	
		F	22 43 18	...	.	...	...	...	
72	29–30 ...	eP	23 28 00	...	...		...	...	
		eL	0 25 06	...	...		...	...	
		M	0 43 06	...	...	150	...	...	
		F	1 05 24		...	...	...	...	

APPENDIX II.

Latitude 10° 13′ 50″ N. Height of Barometer cistern above mean sea level 7,688 feet.

Longitude 5h 9m 52s E.

MEAN Monthly and Annual Meteorological Results at the Kodaikanal Observatory in 1917.

Month.	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 Simpson's Tables.				Daily Velocity	Mean Direction.		Amount.	Days.		
	Inches.	Inches.	°	°	°	°	°	°	Inches.	Cents.	°	°	Miles.	Points	Points.	Inches.	No.	Cents.	Hours.
January	22·835	0·059	52·7	60·6	44·9	15·7	46·8	40·8	0·273	71	113·7	39·1	379		E. by S.	1·49	3	48	218·1
February	·823	·063	55·5	64·3	46·7	17·6	48·7	42·6	·285	67	123·9	41·3	276	4	N. E.	6·52	5	59	232·7
March	·823	·063	58·1	67·1	49·0	18·1	50·3	44·6	·299	64	131·3	43·8	267	2	N. N. E.	2·13	5	54	241·6
April	·819	·056	61·3	70·8	51·8	19·0	53·2	47·1	·336	64	135·4	44·9	257	4	N. E.	2·03	4	54	255·6
May	·813	·061	60·3	68·4	52·1	16·3	53·5	48·3	·348	69	133·6	46·1	225	16	South	7·00	7	54	238·7
June	·741	·056	58·8	64·5	53·0	11·5	54·4	50·0	·389	80	124·7	49·7	325	24	West	7·65	12	17	106·3
July	·746	·050	58·5	64·6	52·4	12·2	54·1	49·8	·384	80	125·5	49·1	322	23	W. by S.	3·31	5	23	135·1
August	·757	·063	58·1	63·6	52·6	11·0	55·1	50·9	·412	87	120 8	49·3	196	24	West	11·54	16	21	115·2
September	·754	·074	57·6	63·2	52·1	11·1	54·4	50·6	·401	88	121·7	49·1	214	22	W. S. W.	10·77	22	17	95·0
October	·763	·067	56·8	63·7	49·9	13·8	51·0	45·5	·329	73	121·7	45·6	258	27	N. W. by W.	3·96	7	41	201·9
November	·810	·060	55·2	61·1	49·3	11·8	52·1	47·9	·369	87	111·8	46·0	254	1	N. by E.	10·24	15	27	133·2
December	·792	·066	54·4	62·4	46·3	16·1	48·2	42·2	·288	70	118·9	39·5	248	31	N. by W.	0·81	3	49	215·0
Annual	22·790	0·061	57·3	64·5	50·0	14·5	51·8	46·7	0·343	75	123·6	45·3	268	29	N. W. by N.	67·45	104	39	2188·4

EXTREME Monthly Meteorological Records at the Kodaikanal Observatory in 1917.

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	22·928	11	22·754	29, 30	0·174	71·3	21	**37·1**	**6**	**32·8**	**22**	12	22	139·9	20	**28·1**	**29**	**820**	**31**	114	2	0·64	12
February	**·940**	**13**	·721	26, 28	·219	70·5	20	43·1	15	33·3	16	**9**	**18**	140·9	26	35·1	11, 16	590	1	134	27	**3·13**	**1**
March	·930	29	·719	3	·211	71·3	6	42·3	4	34·2	4	16	4	142·3	20	36·1	4	410	3	155	23	0·63	25
April	·872	26	·733	30	·139	**77·2**	**13**	47·4	8	40·5	28	27	28	148·9	13	38·3	5	422	29	151	20	0·70	23
May	·894	24	·685	1	·209	72·6	12	48·2	5	37·1	5	29	4	141·9	11	38·1	5	340	22	118	3	1·73	30
June	·825	17	·646	14	·179	67·9	13	49·7	20	44·4	22	51	11	**160·9**	**8**	46·0	12	556	27	182	16	1·79	2
July	·812	3	·661	19	·151	67·8	2	50·2	20	44·2	10	45	10	142·6	2	44·0	4	655	19	115	6	1·71	5
August	·866	25	**·645**	**20**	·221	66·7	2	50·5	28	46·9	2	55	26	135 0	9	45·0	3	435	27	129	25	1·58	15
September	·823	20	·678	5	·145	69·5	28	50·2	12	48·1	9	61	18	155·8	28	46·6	23	430	29	**112**	**20**	1·66	20
October	·861	14	·658	18	·203	67·2	14	46·6	29	33·8	31	14	31	138·9	12	36·9	29	410	4	145	11	1·08	19
November	·894	30	·709	12	·185	66·6	3, 4	43·7	30	38·2	1,30	40	1	130·7	3	37·0	1	468	7	130	19	1·51	30
December	·892	1	·712	27	·180	69·5	30	41·8	27	34·8	28	**9**	**17**	129·9	4	28·6	16	356	15	119	4	0·26	14

APPENDIX III.

KODAIKANAL mean hourly wind velocity for the year 1917.

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

APPENDIX IV.

KODAIKANAL mean hourly bright sunshine for the year 1917.

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	0·31	0·61	0·65	0·73	0·76	0·69	0·75	0·64	0·58	0·63	0·50	0·21
February	·50	·76	·82	·87	·86	·79	·73	·72	·67	·61	·57	·41
March	·53	·80	·90	·91	·90	·83	·65	·56	·50	·49	·41	·32
April	·64	·88	·97	·93	·91	·90	·79	·69	·61	·55	·38	·27
May	·56	·77	·92	·94	·90	·78	·65	·56	·48	·38	·43	·32
June	·16	·39	·37	·48	·48	·40	·35	·29	·27	·19	·11	·05
July	·16	·47	·57	·59	·64	·50	·43	·39	·26	·23	·11	·02
August	·24	·49	·58	·66	·58	·41	·32	·25	·10	·05	·02	·01
September	·16	·42	·61	·46	·43	·37	·24	·14	·17	·09	·08	·01
October	·21	·60	·66	·70	·70	·70	·58	·54	·52	·5 4	·48	·27
November	·20	·52	·60	·63	·54	·46	·39	·33	·33	·27	·12	·03
December	·25	·68	·77	·72	·70	·70	·61	·65	·67	·60	·49	·09
Mean	0·33	·062	0·70	0·72	0·70	0·63	0·54	0·48	0·43	0·39	0·31	0·17

APPENDIX V.

NUMBER of days in each month on which the Nilgiris were visible in 1917.

Month.	Very clear.	Visible.	Just visible.	Tops only visible.	Total.
January	.	9	4	1	14
February		9		..	12
March	...	2	4	...	6
April		...	1	...	1
May	2	4	1	...	7
June	8	4	...	...	12
July		1	3	...	4
August	3	10	1	...	14
September	2	4	...	...	6
October	3	7	...	...	10
November	...	5	1	...	6
December	...	10	1	2	13
Total	18	65	19	3	105

APPENDIX VI.

MADRAS OBSERVATORY.—Abnormals from monthly means for the year 1917.

Abnormals of	January.	February.	March.	April.	May.	June.	July.	August.	September	October.	November.	December.	Annual.
Reduced atmospheric pressure	+ 0·015	− 0·032	− 0·020	− 0·026	− 0·041	− 0·016	− 0·033	− 0·027	− 0·040	− 0·066	− 0·047	− 0·067	− 0·026
Temperature of air	+ 1·1	+ 0·7	+ 0·5	+ 0·4	− 0·4	− 2·0	+ 0·4	− 0·2	− 1·1	+ 0·5	+ 1·5	− 0·4	+ 0·1
Do. of evaporation	+ 0·1	+ 0·4	− 0·1	+ 0·5	− 0·9	+ 1·0	+ 1·7	+ 2·0	+ 1·2	+ 0·5	+ 2·1	− 0·2	+ 0·7
Percentage of humidity	− 4	− 1	− 3	same as	− 2	+ 10	+ 6	+ 9	+ 10	+ 1	+ 3	+ 1	+ 3
Greatest solar heat in vacuo	+ 11·1	+ 11·9	+ 14·0	+ 13·6	+ 9·7	− 0·4	+ 5·7	+ 5·0	+ 7·0	+ 9·6	+ 4·9	+ 9·5	+ 8·4
Maximum in shade	− 0·8	− 0·8	+ 0·1	+ 0·2	− 0·8	− 3·8	− 0·5	− 1·6	− 3·2	same as	same as	− 1·0	− 1·0
Minimum in shade	+ 1·7	+ 1·5	− 0·3	+ 0·5	− 1·2	− 1·9	+ 0·2	− 0·2	− 0·5	+ 0·1	+ 2·0	− 0·8	+ 0·1
Do. on grass	+ 2·4	+ 2·9	+ 0·6	+ 1·4	− 1·0	− 1·1	+ 0·8	+ 0·9	+ 0·2	+ 1·0	+ 3·1	− 0·2	+ 1·3
Rainfall in inches	− 0·51	− 0·22	− 0·39	− 0·62	− 1·50	+ 3·42	+ 0·34	+ 1·83	+ 0·61	+ 5·48	− 7·18	+ 0·78	...
Do. since January 1st	...	− 0·73	− 1·12	− 1·74	− 3·24	+ 0·18	+ 0·52	+ 2·35	+ 2·96	+ 8·44	+ 1·26	+ 2·04	+ 2·04
General direction of wind	same as	same as	2 points E.	same as	1 point E.	same as	1 point S.	same as	1 point S.	15 points W.	same as	1 point N.	same as
Daily velocity in miles	+ 24	+ 6	− 24	− 5	− 40	− 85	− 50	− 46	− 54	− 19	− 18	− 24	− 26
Percentage of cloudy sky	− 3	+ 5	same as	− 11	− 13	+ 3	− 3	− 6	+ 5	− 8	+ 3	− 3	− 3
Do. of bright sunshine	− 2·6	− 4·0	− 6·2	+ 5·1	+ 1·0	− 11·1	+ 19·5	− 7·4	− 10·8	− 2·4	− 7·7	− 3·8	− 8·7

\+ means *above* normal ; − means *below* normal.

APPENDIX VII.

ABSTRACT of the Mean Meteorological Condition of Madras in the year 1917 compared with the average of past years.

Mean values of	1917.	Difference from	Average.
Reduced atmospheric pressure	29·838	0·026 below.	29·864
Temperature of air	81·2	0·1 above.	81·1
Do. of evaporation	75·2	0·7 „	74·5
Percentage of humidity	75	3 „	72
Greatest solar heat in vacuo	148·1	8·4 „	139·7
Maximum in shade	89·8	1·0 below.	90·8
Minimum in shade	74·8	0·1 above.	74·7
Do. on grass	73·2	1·3 „	71·9
Rainfall since January 1st on 101 days	51·06	2·04 „	49·02
General direction of wind	S.E.	same as	S.E.
Daily velocity in miles	145	26 below.	171
Percentage of cloudy sky	46	3 „	49
Do. of bright sunshine	49·7	8·7 „	58·4

DURATION and Quantity of the Wind from different points.

From	Hours.	Miles.	From	Hours.	Miles.	From	Hours.	Miles.	From	Hours.	Miles.
North.	337	2,299	East.	257	1,128	South.	142	933	West.	249	1,570
N. by E.	229	1,434	E. by S.	235	1,206	S. by W.	242	1,707	W. by N.	224	1,252
NNE.	213	1,657	ESE.	348	1,504	SS. W.	211	1,280	W. N. W.	69	396
NE. by N.	413	3,135	SE. by E.	608	3,131	SW. by S.	275	1,595	N. W. by W.	111	515
N.E.	285	2,220	SE.	522	3,094	S. W.	171	1,014	NW.	75	314
NE by E.	233	1,588	SE. by S.	572	4,326	SW. by W.	201	1,093	NW. by N.	143	958
ENE.	165	1,034	SSE.	447	3,596	WSW.	249	1,486	NNW.	171	1,067
E. by N.	251	1,113	S. by E.	323	2,156	W. by S.	340	1,983	N. by W.	165	1,177

There were 234 calm hours during the year. The resultant corresponding to the above numbers is represented by a SE. by E. wind, blowing with a uniform daily velocity of 30 miles.

APPENDIX VIII.

MADRAS OBSERVATORY—Number of hours of wind from each point in the year 1917.

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	...	19	73	154	111	84	38	49	76	57	38	25	...	..	...	...	..	...	..	...	...	...		...	...	...	...	...	..	...	...	...	20
February	4	20	6	46	49	48	49	69	21	33	76	83	76	33	18	2	...	.	1	1	1	3	.	..	...	...	..	...	...	...	...	...	33
March	..	..	..	27	20	18	37	34	91	49	89	127	117	74	9	8	2	4	2	1	...	..	...	..	...	.	.	..	...	...	...	..	35
April	...	..	...	..	...	...	.	2	12	6	25	83	87	179	166	68	26	28	15	6	1	1	...	1	...	...	...	...	...	...	...	..	14
May	4		2	5	8	4	2	2	4	8	24	75	105	119	107	58	32	32	26	25	8	13	17	11	6	6	3	7	9	3	10	2	7
June	1		.	..	1	4	2	1	10	10	3	9	11	23	45	81	24	60	40	65	47	29	38	56	51	38	12	37	7	7	3	1	4
July	4	...	..	...	1	.	6	4	18	6	19	39	35	38	30	33	23	41	37	67	35	35	65	69	46	32	16	11	6	9	6	8	5
August	6	...	...	2	2	1	..	22	4	4	6	33	39	21	43	8	15	84	59	53	37	35	45	65	36	29	23	29	8	23	5	4	3
September	15	...	2	7	2	2	1	9	6	16	50	73	44	47	25	18	8	34	9	47	28	54	43	67	27	18	14	3	12	2		1	36
October	24	1	1	...	1	2	8	13	9	45	18	40	2	2	2	46	11	8	22	10	10	26	38	71	82	93	1	21	13	23	35	16	50
November	105	75	34	85	68	32	8	28	6	1	..	21	6	36	2	1	1	1	..		4	5	3	.	1	8	...	3	20	59	32	50	25
December	174	114	95	87	22	38	14	18	...	..	..		...	.	..	..	. .	...		...	...	...	...	...	...	..	...	...	..	17	80	83	2
Annual total.	337	229	213	413	285	233	165	251	257	235	348	608	522	572	447	323	142	242	211	275	171	201	249	340	249	224	69	111	75	143	171	165	234

APPENDIX IX.

MADRAS OBSERVATORY.—Number of miles of wind from each point in the year 1917.

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	...	202	695	1,330	977	555	316	298	323	336	131	77	..	...	..	..	..	...	...	...	...	..	...	...	...	...	...	..	...	...		..	5,240
February	38	115	21	281	532	365	332	267	124	103	279	425	348	182	127	15	...	...	8	6	8	9	...	...	...	...	...	...	...	...	...		3,585
March	..	..		186	128	151	143	163	369	295	422	703	655	519	85	45	11	28	17	7	...	...	...	...	...	...	...	...	...	..	...	..	..	3,927
April			..	.	..	.	..	13	29	45	125	377	614	1,684	1,402	559	234	283	141	54	9	9	...	7	...	...	...	...	...	...	...	...	5,585
May	31	.	10	40	79	45	25	20	35	53	123	501	719	1,067	1,016	440	194	249	221	219	63	87	106	62	55	48	33	74	75	17	72	12	5,791
June	6	.		.	2	38	15	11	76	80	10	52	95	168	374	486	169	363	259	403	279	193	249	363	406	267	81	117	34	22	26	8	4,652
July	27	...	...	...	6	...	41	25	70	45	111	256	217	266	210	231	124	207	181	352	222	202	425	477	358	259	111	65	38	30	14	11	4,581
August	51	..	...	14	14	4		84	15	28	43	199	259	151	246	86	101	396	291	286	203	163	215	347	208	158	112	109	47	97	21	24	3,972
September	35	...	9	38	16	14	8	21	28	65	187	316	152	190	111	82	47	137	55	219	154	262	267	308	133	97	51	19	27	9	..	4	3,061
October	110	6	4	...	7	7	29	78	31	149	73	162	13	13	13	207	50	40	107	49	63	142	211	419	406	395	8	119	19	142	93	70	3,235
November	785	464	359	616	334	240	43	70	28	7	..	63	22	86	12	5	3	4	...	.	13	26	13	...	4	28	..	12	74	480	205	421	4,417
December	1,216	647	559	630	125	169	82	63	...	..	...	...	..	..	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...	161	636	627	4,915
Annual	2,299	1,434	1,657	3,135	2,220	1,588	1,034	1,113	1,128	1,206	1,504	3,131	3,094	4,326	3,596	2,156	933	1,707	1,280	1,595	1,014	1,063	1,486	1,983	1,570	1,252	396	515	314	958	1,067	1,177	52,961

APPENDIX X.

MADRAS OBSERVATORY.—Number of inches of rain from each point in the year 1917.

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	...	...	...	...	...	...	0·10	0·28	...	...	...	..	...	...	...	...	...	.	...	...	...	..		...	...	...	...	...	...	..	...	...	...
February	...	...	..	...	...	0·04	0·02	...	...	.	...	...	...	...	...	..	...	...	...	.	.	...	...	...	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	...		...	...	..	..	...	...	...	...	...	..	...	...	...	...	..	..	...	...	...			...	...	...	.
April	...	..	..	...	...	...	...	...	...	..	.	...	...	...	..	...	...	.	..	..	...	...	...	...	...	...	...	...	...	.	...	...	.
May	...	...	...	..	..	...	...	..	...	...		0·03	..	...	0·03	0·37	0·01	...		...	...	...	...	0·04	...	0·07	...	...	0·03	..	0·04	...	.
June	...	...	..	..	0·03	0·23	...	...	0·06	0·07	...	...	0·40	...	...	0·08	0·60	0·12		0·19	.	0·08	0·70	0·78	0·43	0·19	...	0·12	1·05	0·11	0·25	..	0·04
July	...		...	..	...	..	0·32	..	...	..	...	...	0·01	...		0·06	0·06	0·82	0·02	0·07	0·57	0·12	0·32	0·17	1·38	0·29	..	...	..	..	..	..	...
August	0·35	...	...	..	...	..	...	...	...	0·04	0·20	...		...	0·48	0·02	0·29	0·39	0·35	0·34	0·75	0·44	0·46	0·79	.	...	...	1·17	0·06	0·26	...	...	...
September	0·18	..	...	...	...	...		0·05	.	..	...	0·19	0·48	0·37	0·03	0·02	0·02	0·54	...	..	0·09	0·05	0·32	...	0·31	1·93	0·14	0·09	0·27	...	...	...	0·22
October	1·20	...	0·34	0·03	...	...	0·56	...	...		...	...	...	...	...	0·47	0·04	..	0·20	.	0·50	0·73	...	2·13	0·82	0·58	...	1·44	..	6·89	0·41	...	0·14
November	0·32	0·02	0·40	0·19	0·56	.	0·35	..	0·12		...	...	0·02	1·31	...	...	..	...	...	...	0·13	...	...	...	...	0·11	..	...	0·12	1·10	0·03	1·24	0·01
December	2·12	0·12	0·95	0·19	...	0·37	..	0·01	...	...	..	...	...	...	...		...	...	...	...	...	...	..	...	...	...	...	...	...	0·76	0·91	0·63	...
Annual	4·17	0·14	1·69	0·41	0·59	0·64	1·35	0·34	0·18	0·11	0·20	0·22	0·91	1·68	0·54	1·02	1·02	1·87	0·57	0·60	2·04	1·42	1·80	3·91	2·94	3·17	0·14	2·82	1·53	9·12	1·64	1·87	0·41

APPENDIX XI.

MADRAS OBSERVATORY.—Wind, cloud and bright sunshine, 1917.

Month.	Wind resultant.		Cloud (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	142	NE by E.	3·6	4·0	2·8	2·9	3·4	7·5	9·2
February	95	East	2·9	3·4	2·7	2·4	2·9	8·5	11·0
March	103	ESE.	2·9	3·5	1·5	1·8	2·4	8·1	10·2
April	180	SSE.	2·3	2·2	1·5	0·8	1·7	9·2	10·8
May	129	SSE	2·2	1·8	2·8	3·0	2·5	7·8	9·7
June	95	S. by W.	6·1	5·6	8·2	6·7	6·7	7·3	7·5
July	80	SW. by S.	7·1	6·6	7·1	6·4	6·8	3·9	8·6
August	67	SW. by S.	5·7	5·5	7·8	5·1	6·1	4·0	9·1
September	48	SSW.	6·9	7·2	6·4	6·2	6·7	3·7	9·1
October	42	W. by S.	5·0	5·1	5·6	4·4	5·1	5·6	10·4
November	115	N. by E.	6·6	6·8	6·3	5·1	6·2	4·6	9·7
December	143	N. by E.	4·3	4·8	5·7	4·6	4·9	5·6	8·4
Annual	30	SE. by E.	4·6	4·7	4·9	4·1	4·6	6·3	...

APPENDIX XII.

MEAN Monthly and Annual Meteorological Results at the Madras Observatory in 1917.

Month.	Barometer.		Dry Bulb Thermometer.				Wet Bulb.		Tension of Vapour.	Relative Humidity.	Sun Max. in Vac.	Min. on Grass.	Wind.			Rain.		Cloud.	Bright Sunshine.
	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.	Points	Points.	Inches.	No.	Cents.	Hours.
January	30·012	0 111	76·2	83·8	69·1	14·7	69·3	66·1	0·623	69	149·5	65·5	168	5	NE. by E.	0·38	1	34	231·6
February	29·933	·123	77·4	85·8	69·5	16·3	71·2	67·5	·680	72	151·6	66·7	128	8	East.	0·06	2	29	239·2
March	·885	·125	80·5	89·3	71·8	17·5	73·8	70·2	·744	71	154·5	69·2	128	10	ESE.	...	..	24	252·2
April	·799	·132	84·4	93·1	77·7	15·4	78·1	75·5	·874	74	155·3	76·1	186	13	SE. by S.	.	.	17	277·4
May	·775	·131	86·3	97·0	79·6	17·4	77·4	74·5	·816	65	152·7	77·9	187	14	SSE.	0·62	4	25	241·9
June	·686	·113	84·4	94·5	78·5	16·0	77·6	74·8	·852	72	140·1	77·5	155	19	SW. by S.	5·53	10	67	110·2
July	·688	·120	84·9	95·1	78·7	16·4	77·6	74·3	·816	71	144·4	77·4	148	19	SW. by S.	4·21	15	68	120·9
August	·722	·122	83·1	92·1	77·1	15·0	78·0	75·1	·889	79	145·0	76·3	128	19	SW. by S.	6·39	18	61	122·5
September	·738	·128	81·9	90·0	76·6	13·4	77·5	74·7	·885	82	148·3	75·2	102	17	S. by W.	5·30	16	67	111·2
October	·776	·129	81·1	89·0	75·3	13·7	76·1	72·9	·831	79	148·7	73·8	104	22	W. S. W.	16 48	11	51	174·3
November	·877	·106	79·0	85·0	74·3	10·7	75·0	72·6	·814	82	142·3	72·6	147	2	N. N. E.	6·03	17	62	137·3
December	·912	·107	75·1	82·6	69·0	13·6	70·4	67·7	·682	78	145·3	70·4	159	1	N. by E.	6·06	7	49	172·2
Annual	29·817	·121	81·2	89·8	74·8	15·0	75·2	72·2	·792	75	148·1	73·2	145	12	SE.	51·06	101	46	2190·9

EXTREME Monthly Meteorological Records at the Madras Observatory in 1917.

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	**30·150**	**9**	29·898	28	0·252	85·4	15	63·1	25	62·0	25	48	29	156·5	28	59·3	25	**299**	**9**	64	25	0·38	31
February	·113	8	·718	26	**·395**	90·4	26	**60·7**	**19**	**60·2**	**19**	42	19,20	**164·1**	**28**	**57·3**	**19**	260	7	68	12	0·05	8
March	·068	29	·752	5,6	·316	91·4	18	64·5	3	63·2	3	39	16	158·5	11	61·1	3	197	1	78	13	..	...
April	29·943	5	·654	16	·289	101·5	16	73·1	29	71·9	28,30	41	17	161·4	16	71·5	27	268	14	83	26	.	...
May	·946	19	·591	31	·355	**105.3**	**25**	74·3	29	68·8	4	36	26	158·6	24	72·0	29	250	8	118	31	0·38	11
June	·813	16	**·542**	**13**	·271	100·3	21	75·2	. 14	72·4	28	**31**	**20**	159·3	13	69·8	6	208	12	85	7	1·59	3
July	·878	5	**·542**	**19**	·336	101·0	8	73·7	5	72·7	5	37	9	155·2	14	73·2	5	212	22	110	19	0·89	26
August	·878	29	.555	7	·323	98·3	2	73·7	29	73·0	29	46	9	161·5	20	73·1	29	200	7	81	14	1·74	21
September	·864	22	·579	8	·285	94·0	4	72·5	3,30	73·0	15	51	8	161·3	19	73·0	30	159	4	64	24	2·07	30
October	·956	14	·619	4	·337	94·5	9	72 0	2	68·0	6	50	30	162·4	23	68·0	30	184	4	56	23	**6·52**	**20**
November	30·061	30	·676	12	·385	89·5	4	70·2	30	69·2	23	59	1,3	159·5	28	66·6	30	253	11	**54**	**17**	1·31	11
December	·058	19	·760	8	·358	86·9	31	63·7	30	61·6	30	51	30	156·9	27	59·4	30	218	7	85	16	2·62	5