ANNUAL REPORT

OF THE

DIRECTOR

KODAIKANAL AND MADRAS

OBSERVATORIES

FOR 1920

MADRAS:
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KODAIKANAL AND MADRAS OBSERVATORIES.

REPORT FOR THE YEAR 1920.

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KODAIKANAL AND MADRAS OBSERVATORIES.

I.—REPORT OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1920.

Staff.—The staff of the Observatory on December 31, 1920, as reorganised by the Government of India, was as follows:—

Director	J. Evershed, F.R.S.
Assistant Director	T. Royds, D.Sc.
Assistants	A. A. Narayana Ayyar, B.A. P. R. Chidambara Ayyar, B.A. S. S. Ramaswami Ayyangar, B.A. S. Balasundaram Ayyar.
Recorders	L. N. Krishnaswami Ayyar. R. Krishna Ayyar. S. N. Krishna Ayyar.
Temporary Recorder	K. R. Viswanatha Ayyar.

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

The Director was absent on combined leave from 26th May to 15th December 1920, Dr. Royds acting as Director and Mr. A. A. Narayana Ayyar as Assistant Director.

2. *Buildings and grounds.*—The Magnetic Observatory and the two domes in the main building were painted during the year and the Department of Public Works was engaged at the end of the year in extending the motor house in order to make it suitable for a new pump. Repairs to the wire fencing of the Observatory compound referred to in the last report have not yet been completed.

3. *Instruments.*—The 15-inch lens borrowed from the Nizamiah Observatory has been in constant use during the year for spectrographic research work. A 30° reflecting prism of 4-inch effective aperture has been received from Messrs. Hilger, Limited. It is intended to use this prism in combination with two 45° prisms for the Hα spectroheliograph, replacing the Michelson grating at present in use. Some preliminary tests of the performance of the combination encourage the hope of getting improved results with much shorter exposures.

4. *Weather conditions.*—The rainfall for the year was again in excess of the average, and the conditions in some months were very unfavourable for astronomical work. This applies especially to the month of November when there were twelve consecutive days when no solar observations were possible. The mean definition in the north dome before 10 a.m. was 2·9 on a scale in which 1 is the worst and 5 the best. There were thirty-four days only when the morning definition was estimated as 4 or over.

5. *Photoheliograph.*—Photographs on a scale of 8 inches to the Sun's diameter were taken on 321 days, using the 6-inch visual achromatic object glass and a green colour screen.

6. *Spectroheliographs.*—Monochromatic images of the Sun's disc in K light were obtained on 331 days, prominence plates on 286 days and Hα disc plates on 273 days.

7. *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.

8. *Grating spectrograph.*—Photographs of sunlight and iron arc spectra were obtained during every month of the year, and spectra of sunlight reflected by Venus were photographed on fifty mornings during January, February and March, and on eight evenings in December. Spectrum photographs were also obtained of sections of the Sun's disc including sunspots when the definition was good and other conditions favourable.

Measures of the sunlight and Fe arc spectra by Mr. Narayana Ayyar, indicate a rather large range of variation in the shifts of the solar lines, and his mean values for the year are in excess of those for 1919 by about 0·002 A. Measures of the Venus spectra taken early in the year when the angle Venus-Sun-Earth exceeded 90° give mean shifts about 0·005 A. smaller than those measured in the control plates of direct sunlight. The December plates so far as they have been measured give nearly normal values, the angle at the Sun being then about 70°.

Trials of the effect of altitude gave negative results, the wave-lengths measured when the planet was at a mean altitude of 20° being the same as those observed at a mean altitude of 40°.

By the use of Barnet "Ultra Rapid" plates hypersensitised with ammonia it has been possible to photograph Venus spectra with a very narrow slit, and these are the finest plates hitherto obtained. They give no evidence of an inclination of the lines due to a rotation of the planet when the terminator is placed normal to the slit.

A special ultra-violet spectrograph was erected temporarily, using a parabolic grating and a quartz collimating lens. Spectra were obtained of the east and west limbs of the Sun in the region of the ammonia band at λ 3360, and it was demonstrated by the displacements due to the solar rotation that this band is of solar and not telluric origin.

Some comparison spectra of Venus, and of sunlight reflected from white paper, have been obtained with the prism spectrograph and parabolic mirror, to get evidence on the absorbing effect of Venus' atmosphere.

Measures of the displacements, Sun — arc, of some of the cyanogen bands in the first head near λ 3883 have been completed and published in Kodaikanal Observatory Bulletin No. 64.

Summary of sunspot and prominence observations.

9. *Sunspots.*—The following table shows the monthly numbers of new groups observed at Kodaikanal, 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	11	19	13	10	18	12	9	9	9	12	7	12	141
North	6	9	6	5	12	6	4	5	4	7	4	4	72
South	5	10	7	5	6	6	5	4	5	5	3	8	69
Daily numbers ...	2·9	4·4	2·9	1·4	2·7	2·7	2·3	1·8	2·0	3·5	1·9	2·8	2·6

Compared with the year 1919 there was a decrease of 40 per cent in the case of new groups. The decrease is much greater in the southern hemisphere than in the northern.

The approximate mean latitude of the spots was 11°·1 in both hemispheres.

An extensive group of spots, which during its first apparition crossed the central meridian on January 1-2, returned no less than five times,

and finally disappeared in May. It is noteworthy that the meridian passsages were on all occasions associated with magnetic storms. The very great storm of March 22nd and 23rd was one of these and occurred during the fourth meridian passage of the group.

The number of bright reversals of the Hα line in the neighbourhood of spots was 298 whilst the number of displacements of this line observed near spots was 169. There were 129 dark reversals of D_3 observed, whilst only 57 were seen in 1919. The increase is probably connected with the increase in number and area of the Hα absorption markings, indicating increased density in the prominences both of hydrogen and helium.

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

	North.	South.	Total.
1920—January to June	1·99	2·34	4·33
July to December ...	2·10	2·17	4·27

These figures show a slight increase over those of the previous year. The mean numbers increase from 13·2 for the first half year to 15·9 for the second.

The general distribution in latitude has remained essentially the same as in 1919 notwithstanding some fluctuations in the different zones of activity, and between the northern and southern hemispheres. No large prominences have been observed in the polar regions above latitude 60°.

Metallic prominences were fairly numerous in the sunspot zones, and displacements of the hydrogen lines were also frequent. The displacements towards red again slightly exceed those towards violet at the limb, and on the disc near spots 73 per cent of the whole number were towards red.

Prominences photographed on the disc as absorption markings show an increase in area of 38 per cent compared with 1919 ; their distribution in latitude was identical with that of the limb prominences.

A striking change has occurred in the distribution between east and west. In previous years up to 1919 there has always been an excess of absorption markings on the eastern hemisphere of the Sun, but in 1919 this excess was negligibly small and in 1920 there is a marked excess west of the meridian, the areas of those on the east side being only 47·5 per cent of the whole. About the same western preponderance is shown also by the prominences at the limb, and the western prominences were also about 14 per cent brighter than those on the east limb.

A great eruptive prominence was photographed on December 31, on the west limb. It bore a striking resemblance to the prominence of 1919 May 29 and occupied the same region of latitude, extending from + 5° to − 42° as an immense arch. Between 8^h and 10^h I.S.T. the prominence reared up to a great height and rapidly faded, the highest parts ascending to 16′ above the limb.

In a detailed study of the Hα plates Dr. Royds has brought out several new features regarding the absorption markings (see Kodaikanal Observatory Bulletin, No. 63) and in studying the prominence data for the interval 1913—1920 for periodicities he finds that periods of 13 and $7\frac{1}{2}$ months are the principal features of the periodogram, as was the case also during the interval 1905—1912.

11. *Magnetic observations.*—Continuous magnetograph records are obtained of declination, vertical force, and horizontal force. Absolute observations for dip are made daily excepting Sundays, declination and horizontal force on three days per week alternately. All the records are

made over to the Magnetic Survey Office, Dehra Dun, and the results are published by the Survey annually.

Twenty-eight "Great" and 126 "Moderate" magnetic storms were registered during the year. The storm commencing March 22, 9^h 14^m was one of the greatest recorded at Kodaikanal, and during the more violent fluctuations there was considerable disturbance of the Indian Telegraph service. This storm occurred during the meridian passage of a great spot group, and, as mentioned on page 3, magnetic storms were recorded at every meridian passage of the group, that is, during five solar rotations from January 1st to April 18th, at 27 day intervals. Subsequent records show that while the spot disturbance had subsided in May, magnetic storms continued to recur at 27 day intervals during 7 more solar rotations. The storms of April 18th and May 14th were recorded as "Great," those of June 11th, July 8th, August 4th and August 30th as "Moderate," September 27th as "Great," October 24th and November 21st as "Moderate."

12. *Pyrheliometer.*—Measures of the solar radiation were made by Dr. Royds with the Angstrom pyrheliometer No. 73 on cloudless days whenever opportunity offered, 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 centimeter per minute and a is the transmissive power of the earth's atmosphere. The instrumental constant supplied by the makers has been used to determine E but the values require to be multiplied by an undetermined factor in order to compensate for the absorptive power of the pyrheliometer being less than its assumed value.

Date.	E.	a.	Remarks.	Date.	E.	a.	Remarks.
1920.				1920.			
January 21 ...	1·820	0·878	Forenoon.	February 16 ...	1·732	0·884	
,, 21 ...	1·902	0·867	Afternoon.	,, 17 ..	1·710	0·878	
,, 27 ..	1·856	0·848		,, 23 ...	1·749	0·901	
,, 28 ...	1·766	0·863		,, 24 ...	1·778	0·900	
February 4 ...	1·692	0·909		,, 25 ...	1·783	0·903	
,, 9 ...	1·778	0·865		March 1	1·738	0·908	
,, 11 ...	1·830	0·881		,, 8 ...	1·740	0·869	

13. *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.

14. *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. The meteorological means for 21 years have been worked out and are printed as appendix VI with this report. There is little change in the adopted mean values excepting rainfall which is now 61·89 inches instead of 59·55, and the mean temperature has increased from 56°·3 to 57°·0. In the following paragraphs "mean" values refer to the new 21 year averages.

Pressure.—The mean pressure for the year was normal. The monthly means show that it was below normal in January, March, April and November and above normal in February, May, June and July. The highest pressure recorded was 22·946 inches on January 8, and the lowest 22·671 on October 5.

Temperature.—The monthly mean temperature in the shade was above normal in all months except January. The highest temperature

recorded during the year was 75°·5 on May 8, and the lowest was 39°·6 on December 23. The maximum temperature in the sun was below normal by 16° in September and November. In the remaining months it was not far from normal. The lowest minimum on grass was 24°·1 on December 28.

Humidity.—The mean humidity for the year was 1 cent below normal. The driest days in the year were January 18 and March 25 when the humidity was 7 cents only.

Rainfall.—The total rainfall was 65·46 inches or 3·57 inches above normal. There was an excess of 5·89, 5·58 and 7·71 inches in January, September and November, respectively. The greatest defect was 4·68 and 4·02 inches in the months of October and December respectively. The driest month was March with only 0·10 inch.

Wind.—The wind directions were nearly normal in all months except May, October, November and December. The air movement was below normal in January, and from April to September inclusive and in December. It was above normal in February.

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.—The percentage of clear sky was above normal in February and December, and below normal in April and November. During the other months it was normal. The total number of hours of bright sunshine was 2258 which is 5 per cent above normal. The total number of hours of sunshine in November was 59·2 only, the average being 132·8.

15. *Seismology.*—The Milne horizontal pendulum recorded eighty-five earthquakes, as against ninety during the previous year. Details of the records are given in Appendix I.

16. *Library.*—Eighty volumes were bound during the year.

17. *Publications.*—Four bulletins with the following titles were published during the year:—

No. LXII. Summary of prominence observations for the second half of the year 1919, by J. Evershed, F.R.S.

No. LXIII. Some features of H*α* dark markings on the sun, by T. Royds, D.Sc.

No. LXIV. On the displacements of the triplet bands near λ 3883 in the solar spectrum, by J. Evershed, F.R.S.

No. LXV. Summary of prominence observations for the first half of the year 1920, by T. Royds, D.Sc.

In addition the Director has contributed an article with the following title "The displacement of the lines in the solar spectrum and Einstein's prediction"—Observatory 43, 153.

KODAIKANAL,
1*st February* 1921.

J. EVERSHED,
Director, Kodaikanal and Madras Observatories.

II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1920.

Staff.—The staff of the Observatory during the year 1920 was as follows :—

Deputy Director	Edward Barnes (January 1 to April 30) C. Chengalvaraya Mudaliyar (May 1 to June 30). Edward Barnes (July 1 to December 31).
Time Assistant	S. Solomon Pillai (January 1 to October 24).
Observers	C. Chengalvaraya Mudaliyar (January 1 to July 2). P. Jayaram Mudaliyar (January 1 to December 31). S. S. Ranga Acharya (July 3 to December 31).

A revised scale of pay was sanctioned by the Government of India for the non-gazetted staff of the Madras Observatory with effect from 1st July 1920 and the designations "Computer" and "Assistants" were changed to "Time Assistant" and "Observers", respectively.

Mr. S. Solomon Pillai was absent on privilege leave from 1st to 27th May and on leave on private affairs from 28th May to 30th June. He retired from service on the evening of 24th October.

Mr. C. Chengalvaraya Mudaliyar was transferred to the Meteorological office as Weather Assistant on July 2. Mr. S. S. Ranga Acharya was transferred from Kodaikanal to Madras and took up his duties as Observer on July 3.

2. *Time service.*—The time gun at Fort St. George failed on 27 occasions out of 732 giving a percentage of success of 96·3. Although most of the failures were due to faults outside the Observatory, yet it would appear to be desirable that the apparatus and instruments both at the Observatory and at the Fort be completely renewed. These have been in use for many years and have become much worn. The gun was fired at 8 hrs and 11 hrs instead of at 12 hrs on November 11 on account of the anniversary of the armistice. The time ball at the Harbour failed altogether on one day. On four other days it failed at 13 hrs but dropped correctly at 14 hrs. The 16 hr roll of signals was sent to the Central Telegraph Office on every day.

3. *Meteorological observations.*—Eye observations were made daily at 8 hrs, 10 hrs, 16 hrs and 20 hrs local mean time as in former years, and the records of self-registering instruments were maintained as usual. Extra observations were taken for storm warning purposes and telegrams were sent to Calcutta on 36 occasions and to Simla on three occasions.

4. *Buildings.*—The usual annual repairs to the office and quarters were carried out during the year.

5. *Instruments.*—The following is a list of instruments at the Observatory on 31st December 1920 :—

(*a*) *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 & Sons.

Meridian circle—Troughton and Simms.
Portable transit instrument—Dollond.
Tape chronograph—R. Fuess.
Relay for use with the chronograph—Siemens.

(*b*) *Meteorological.*

Richard's barograph—No. 10, L. Casella.
Do. thermograph—No. 29637, L. Casella.
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 and Ph. Pellin.
Barometer, Fortin's—No. 1771, L. Casella.
Do. do. No. 725, L. Casella (spare).
Do. do. No. 1420, L. Casella (spare).
Dry bulb thermometer—No. 94221, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Wet bulb thermometer—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 do. No. 127618, Negretti and Zambra.
Grass minimum do. 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 level error of the Transit Circle at the beginning of the year was $0^{s}\cdot23$. It changed gradually till it reached its maximum negative value $-10^{s}\cdot19$ in the third week of October. As a result of continued and heavy rain during the remainder of the month it went through a rapid change in the reverse direction. This change continued during November, by the end of which a value of $-2^{s}\cdot18$ had been attained. After a slight rise, it remained fairly steady at about $-2^{s}\cdot56$ during December. The rate of the Riefler clock has varied considerably during the year. This may be due partly to the somewhat abnormal meteorological conditions, but this would not appear to entirely account for the behaviour.

6. *Weather summary.*—The following is a summary of the meteorological conditions at Madras during 1920 :—

Pressure.—The mean monthly pressure was normal in February, April, May and October, above normal in August and below normal during the other months. The greatest excess was 0·013 inch in August while the greatest deficiency was 0·048 inch in November. The highest pressure recorded was 30·116 inches on January 8.

Temperature.—The mean temperature of the air was normal in April, May and December and above normal throughout the remainder of the year. The maximum shade temperature was normal in January, March, April, October and November and above normal during the other months. The highest temperature recorded was $108^{\circ}\cdot7$ on the 6th May. The minimum in shade was normal in April and May, below normal in December and above normal during the other months. The lowest temperature recorded was $62^{\circ}\cdot8$ on December 4. The highest sun maximum was $166^{\circ}\cdot7$ on April 19 and the lowest on grass $58^{\circ}\cdot8$ on December 4.

Humidity.—The percentage of humidity was about normal throughout the year. The driest day in the year was June 23.

Wind.—The wind velocity was above the average in November, but it was in defect in all other months. The wind direction was almost normal during the year.

Cloud.—The amount of cloud was above normal in April and November, below normal in February, June and December and about normal during the other months.

Sunshine.—The percentage of sunshine was normal in August, above normal in February, June, September and December and below normal during the other months. The total number of hours of bright sunshine during the year was 2362·2.

Rainfall.—The rainfall was above the average in January, October and November and below in the remaining months. The greatest excess was 16·87 inches in November and the greatest defect 5·27 in December. The total fall for the year was 63·89 inches on 78 days compared with an average of 49·02 inches. The monsoon rainfall from 15th October to the end of the year was 50·22 inches. The heaviest rainfall on one day was 7·61 inches on October 27.

Storm.—A storm passed over the extreme south of the Presidency during the first few days in January and caused heavy rain on the Coromandel Coast. During the year several disturbances approached the Circars Coast but passed away to the north. Towards the end of October a shallow depression formed in the south of the Bay and caused very heavy rain over the south of the Presidency. During the third week of November, conditions were very disturbed in the south-west of the Bay and the exceptionally heavy rains received in the south of the Carnatic caused serious floods and interrupted railway and telegraphic communication with Ceylon and the extreme south for several days. Negapatam received as much as 32·85 inches of rain in 10 days at this period.

THE OBSERVATORY,
MADRAS, 14*th January* 1921.

EDWARD BARNES,
Offg. Deputy Director.

APPENDIX I.

STATION—KODAIKANAL OBSERVATORY.

SEISMIC RECORDS.

$\phi = 10° 13' 50''$ $\lambda = 77° 28' 00''$ $h = 2343$ metres. *Subsoil*—Rock.

Apparatus—Milne's Horizontal Pendulum Seismograph.

1920.	T_o	$\frac{\tau}{T_o^2}$	1920.	T_o	$\frac{\tau}{T_o^2}$
January	17·8	2·8	July	18·0	2·6
February	17·9	2·8	August	18·1	2·6
March	18·0	2·6	September ..	18·3	2·5
April	18·0	2·7	October	18·0	2·5
May	18·2	2·6	November	17·6	2·8
June	18·3	2·5	December	17·7	2·6

No.	Date.	Phase.	Time G.M.T.	Period. (Sec.).	Amplitude (u). An.	Ae.	Az.	Distance Δ (Km.).	Remarks
	1920.		H. M. S.						
1	January 8 ...	eP	9 04 06	...	...	..	...	..	Widening of line.
		F	9 07 06	...	...	...	...	...	
2	9 ...	eP	4 39 12	..	...	...	...	...	Widening of line.
		F	4 43 06	...	...	...	...	...	
3	12 ...	eP	14 17 24	..	...	...	..	...	Widening of line.
		F	14 21 30	...	.	.		...	
4	22 ...	eP	16 44 06	...	..	...	...	...	Widening of line.
		F	16 52 18	...	...	...		...	
5	February 2 ...	eP	11 34 06	...		.	.	...	
		eL	11 45 24	...	..	...		...	
		M	12 17 30	...	..	1310	..	.	
		F	15 45 30	..	...	. .	...	...	
6	8 ...	eP	5 49 12	...	...	...		. .	
		eL	5 55 24	. .	...			...	
		M	5 57 24	..	.	50	...	...	
		F	6 08 12	...	...	..	...	...	
7	10 .	eP	10 03 30	...	...		...	..	
		eL	10 06 30	...	...			..	
		M	10 08 36	.	...	40	..	...	
		F	10 20 48	...	...	...	.	...	
8	10 ...	eP	23 10 36	..	..		...	...	
		eL	23 31 06	...	...	...	...	...	
		M	23 33 12	..	..	60	...		
		F	23 58 18	..	...	...	...	...	
9	27 ...	iP	3 57 24	...	.	...	.	...	Instrument examined at 4h 3m. G.M.T.
		L	?	...	...	..	.	...	
		M	?	...	...	...	..	.	
		F	?	...	...	...	...	...	
10	March 11 .	eP	12 30 00	...	..	...	...	..	Widening of line.
		F	12 36 00	...		...	...	...	
11	12 ...	eP	16 00 00	..	..		...	...	Widening of line.
		F	16 03 18	...	...	...	..	...	
12	15 ...	eP	10 21 36	...	...	...	...	...	Widening of line.
		F	10 23 36	.	..	...	...		
13	15 ..	eP	10 42 06	...	...	...	..	...	Widening of line.
		F	12 49 18	...	..	.	...	...	
14	17 ...	eP	18 45 06		..	...	.	..	
		eL	18 47 36	...	.	..	..	...	
		M	18 50 12	...	...	150	...	...	
		F	19 08 36	...	...	..	...	..	
15	19	eP	10 10 12	...	...	...	...	...	Widening of line.
		F	10 12 00	...	...	...	...	...	
16	20 ...	eP	19 24 24	...		..	...	...	
		eL	19 53 42	...	.		...	.	
		M	20 07 06	...	...	100	...	..	
		F	20 41 54	...	...	..		...	
17	22 ...	eP	21 02 48	...	..	...	...	...	Widening of line.
		F	21 14 06	...	...	...	...	...	
18	30 ...	eP	23 42 18	...	...	...	...	...	Widening of line.
		F	23 44 36	...	..		...	...	
19	31 ...	eP	8 39 12	...	...	..	...	..	Widening of line.
		F	8 41 48	...	..	...	...	...	
20	April 2 ...	eP	1 57 42	...	...	...	...	...	Widening of line.
		F	2 01 48	...	...	...	..	...	

No.	Date.	Phase.	Time G.M.T. H.	M.	S.	Period. (Sec.).	Amplitude (u). An.	Ae.	Az	Distance Δ (Km.).	Remarks.
	1920.										
21	April 6 ...	eP	19	48	30	...	...	...	...	...	Widening of line.
		F	19	50	30	...	...	...	...	..	
22	May 2 ...	eP	8	38	42	..	...	...	...	...	
		eL	8	41	48	...	...	...	...	...	
		M	8	43	48	...	...	100	...	...	
		F	9	11	00	...	...	...	...	...	
23	2 ...	eP	14	57	12	...	...	...	...	...	
		eL	15	00	12	...	..	...	...	...	
		M	15	02	48	...	...	80	..	...	
		F	15	28	00	...	...	...	...	...	
24	7 ...	eP	5	42	18	...	...	...	...	...	
		eL	6	11	30	...	...	...	...	...	
		M	6	14	42	...	...	340	...	..	
		F	6	55	00	..	...	...	...	...	
25	7-8 ...	eP	21	53	54	...	...	...	...	..	
		eL	22	19	42	...	...	...	...	..	
		M	22	23	24	...	...	200	...	...	
		F	0	10	00	...	..	...	..	...	
26	10 ...	eP	18	58	42	...	...	...	...	...	
		eL	19	21	48	...	...	..	...	...	
		M	19	23	00	...	...	80	...	...	
		F	19	56	06	...	...	...	...	...	
27	13 ...	eP	2	08	00	...	...	...	..	...	
		eL	2	31	30	...	...	..	...	...	
		M	2	34	06	..	...	80	...	...	
		F	3	12	06	...	..	...		...	
28	19 ...	eP	13	10	00		...	...	...	...	Widening of line.
		F	13	24	24	...	...	..	...	...	
29	20 ...	eP	8	15	06	..	...	...	...	...	
		eL	8	27	24	..	...		...	...	
		M	8	30	00	...	..	100	...	...	
		F	8	52	36	...	...	...	...	...	
30	27 ...	eP	6	03	18	...	...	...	...	..	Widening of line.
		F	6	08	12	...	...	...	...	...	
31	June 5 ...	eP	4	31	18	...	..	...	...	...	
		iL	4	26	54	..	...	...	...	...	
		M	4	52	36	...	...	1250	...	...	
		F	7	21	18	...	...	...	...	...	
32	5 ...	eP	12	18	18		...	...	...	...	Widening of line.
		F	12	20	18	...	...	...	...	.	
33	5 ...	eP	18	31	00	...	...	...	...	...	Widening of line.
		F	18	34	06	..	.	...		...	
34	5 ...	eP	18	41	30	...	...	...	...	...	Widening of line.
		F	19	08	48	...	...	..		..	
35	8 ...	eP	14	09	48	...	...	...	...	.	Widening of line.
		F	14	12	24	..	...	...	...	...	
36	9 ...	eP	11	44	24	...	...	...		..	
		eL	11	55	36	...	...		...	...	
		M	12	01	48	...	...	200	...	...	
		F	12	36	12	...	...	...		...	
37	10 ...	P		?		...	...	...	...	...	Instrument examined at 2h 47m.
		eL	2	56	54	...		...	...	..	
		M	2	58	42	..	...	60	...	...	
		F	3	07	24	...	...	...	.	...	
											Air tremors during high wind were frequent during the month of June.
38	July 1 ...	eP	2	32	06	...	...	...	...	....	Widening of line.
		F	2	34	06	...	...	...	...	...	
39	1 ...	eP	3	19	06	..	...	...	...	...	Widening of line.
		F	3	21	18	...		...	.	...	
40	1 ...	eP	3	41	18	...	...	..	.	...	Widening of line.
		F	3	43	18	...	...	...	...	...	
41	1 ...	eP	14	15	06	...	...	..	...	...	Widening of line.
		F	14	18	42	...	...	...	...	...	
42	1 ...	eP	18	16	12	...	...	..	...	...	Widening of line.
		F	18	20	12	...	...	...	...	...	
43	2 ...	eP	2	58	00	...	.	...	..	...	
		eL	3	13	24	...	...	...	...	...	
		M	3	16	00	...	...	100	...	....	
		F	3	44	12	...	...	...	...	...	
44	4 ...	eP	9	15	06		...	...	...	...	Widening of line.
		F	9	21	12	...	...	...	...	..	
45	6 ...	eP	3	59	24	...	...	...	...	..	Widening of line.
		F	4	05	30	...	..	...	...	...	

No.	Date.	Phase.	Time G.M.T.	Period. (Sec.).	Amplitude (u).			Distance $\triangle$ (Km.).	Remarks.
					An.	Ae.	Az.		
	1920.		H. M. S.						
46	July 6 ...	eP	15 51 30	...	...	...	..	..	Widening of line.
		F	15 54 36	...	..	.	...		
47	7 ...	eP	19 43 18	...	...	...		...	Widening of line.
		F	19 47 24	...	...	..	...	...	
48	8 ...	eP	5 04 18	...	...	...	.	...	Widening of line.
		F	5 06 54	...	...	..	...	..	
49	10 ...	eP	10 19 30	...	...	...	...	...	Widening of line.
		F	10 21 06	...	...	...	...	...	
50	10 ...	eP	16 02 42	..	...	..	...	...	
		eL	16 09 18	...	...	..	...		
		M	16 11 54	...	...	50	...	...	
		F	16 17 00	...	.	...	...	...	
51	August 2 ...	eP	6 36 06	...	...	..	...	..	Widening of line.
		F	6 38 42	...	...	...	...	..	
52	2 ...	eP	7 00 24	...	...	...	...	...	Widening of line.
		F	7 01 48	...	...	...	...	...	
53	15 ...	eP	7 12 36	...	...	...	...	...	Widening of line.
		F	7 16 30	...	...	...	...	...	
54	15 ...	eP	8 34 06	...	...		...	...	
		iL	8 39 42	..	..	...	..		
		M	8 41 00	...	...	90	...	...	
		F	9 45 18	...	.	...	...	...	
55	20 ...	eP	17 24 24	...	...	...	...	..	
		iL	17 35 36		...	...	..	...	
		M	17 38 54	...	...	170	...	...	
		F	18 26 42	..	...	...	...	...	
56	26-27 ...	eP	23 54 48	.	...	..	...	...	
		eL	23 59 00	...	...		...	..	
		M	0 01 18	...	...	40		...	
		F	0 18 00	...		...	...	...	
57	September 4 ...	eP	14 47 06	...	...	...		...	
		eL	14 51 00	...	...	..	...	...	
		M	14 56 36	...	...	130	...	...	
		F	15 41 30	...	...	.	...	...	
58	6 ...	eP	21 35 36	...	...	...	...	...	Widening of line.
		F	21 39 12	.	...		...	...	
59	8 ...	eP	2 05 54	...	..	...	...	..	
		iL	2 11 48	.	...	..	...	...	
		M	2 15 36	. .	...	150	...	...	
		F	3 10 00	...	...	...	...	...	
60	9 ..	eP	19 13 06	.	...	..	...	..	
		eL	19 53 36	..	..	.	...	..	
		M	19 59 12	...	...	140	...		
		F	20 23 18		..	. .		...	
61	20 ...	eP	14 52 36	..	...		..	...	
		iL	14 58 42	..	. .	..	...	...	
		M	15 41 18	...	..	1020		.	
		F	18 32 06	...	...	.	...	..	
62	20 ...	eP	23 52 36	...	..	.		...	Widening of line.
		F	23 54 36	...	...	...	...	..	
63	21 ...	eP	3 31 30	...	...	...	...	...	Widening of line.
		F	3 35 06	...	...	...	...	...	
64	23 ...	eP	6 19 00	...	...	..	...	...	Widening of line.
		F	6 21 06	...	...	...	...	...	
65	24 ...	eP	6 23 06		..	...	...	...	Widening of line.
		F	6 26 42	...	...	...	...	...	
66	October 12 ...	eP	7 07 48	...	...	...	...	...	
		eL	7 17 30	...	...	...	...	...	
		M	7 21 06	...	...	50	...	...	
		F	7 25 12	...	...	...	...	...	
67	18 ...	eP	8 25 24	...	...	...	...	...	
		iL	8 31 48	...	...	...	...	...	
		M	8 33 36	...	...	160	...	...	
		F	9 56 42	...	...	...	...	...	
68	20 ...	eP	10 21 18	...	...	...	...	...	
		eL	10 29 30	...	...	...	...	...	
		M	10 30 30	...	...	50	...	...	Hour signal at 10h 30m.
		F	10 55 36	...	...	...	...	..	
69	22 ...	eP	12 30 48	...	...	...	...	...	
		eL	13 30 30	...	...	...	...	...	
		M	13 32 36	...	...	90	...	...	
		F	14 05 06	...	..	...	...	...	Hour signals at 12h 30m and 13h 30m.
70	28 ...	eP	8 19 12	...	...	...	..	...	
		eL	8 25 24	...	...	...	.	...	
		M	8 30 48	...	...	40	...	...	
		F	8 33 06	...	...	...	...	..	

No.	Date.	Phase.	Time G.M.T. H.	M.	S.	Period. (Sec.).	Amplitude (u). An.	Ae.	Az.	Distance Δ (Km.).	Remarks.
	1920.										
71	October 28 ..	eP	13	10	30	...	...	...	...	...	
		eL	13	23	18	...	...	...	...	...	
		M	13	26	24	...	...	50	...	...	
		F	...		?	...	..	...	...	...	} Overlapping.
72	28 ...	eP	...		?	...	...	..	...	...	
		eL	14	09	00	..	...	...	...	...	
		M	14	20	18	..	...	120	...	...	
		F	14	58	42	...	...	..	..	...	
73	November 3 ...	eP	15	55	30	...	...	...	...	...	
		eL	16	07	48	...	...	..	...	...	
		M	16	08	48	...	...	40	...	...	
		F	16	17	00	...	...	..	...	...	
74	13 ...	eP	19	34	06	...	...	...		..	Widening of line.
		F	19	37	12	...	...	...	...	...	
75	26 ...	eP	9	26	54	...	...	...	...	...	Widening of line.
		F	9	29	00	...	...	...	...	...	
76	December 4 ...	eP	5	25	00	...	...	...	...	...	Widening of line.
		F	5	32	06	..	...	...	...	...	
77	4 ...	eP	23	38	06	...	...	...	...	...	Widening of line.
		F	23	46	18	...	...	...	..	...	
78	5 ...	eP	10	50	18	...	...	...	...	..	
		eL	10	51	36	...	...	..	...	...	
		M	10	56	00	...	...	60	...	...	
		F	11	18	00	...	...	...	...	...	
79	7 ...	eP	21	38	00	...	...	...	...	...	Widening of line.
		F	21	46	12		...	...	...	...	
80	10 ...	eP	5	15	42	...	...	..	...	...	
		eL	5	38	18	...	...		...	...	
		M	5	45	54	...	...	310	..	...	
		F	6	50	06	...	...	...	...	...	
81	16 ...	eP	12	13	06	...	...	...	...	...	
		eL	12	16	36	...	...	...	...	...	
		M	12	34	06	...	...	1500	...	...	The boom struck the stops.
		F	16	25	24	...	...	...	...	...	
82	17 ..	eP	20	16	12	...	...	...	...	.	
		eL	20	19	42	...	...	...	...	...	
		M	20	21	18	...	...	40	...	...	
		F	20	51	30	...	...	...	...	...	
83	18 ...	eP	10	34	06	...	...	...	...	...	Widening of line.
		F	10	45	18	...	...	...	...	...	
84	19 ...	eP	20	50	24	...	...	...	...	...	Widening of line.
		F	20	59	24	...	...	...	...	...	
85	25 ...	eP	11	29	18	...	...	...	...	..	
		eL	11	45	12	...	...	...	...	...	
		M	11	59	18	...	...	140	...	...	
		F	13	02	12	...	...	...	...	...	

APPENDIX II.

Latitude 10° 13′ 50″ N. Height of Barometer cistern above mean sea level 7688 feet.

Longitude 5h 9m 52s E.

MEAN Monthly and Annual Meteorological Results at the Kodaikanal Observatory in 1920.

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 Simpson's Tables.				Daily Velocity	Mean Direction.		Amount.	Days.		
	Inches.	Inches.	°	°	°	°	°	°	Inches.	Cents.	°	°	Miles.	Points	Points.	Inches.	No.	Cents.	Hours.
January	22·837	0·067	53·8	61·6	45·9	15·7	48·2	42·3	0·288	71	116·0	35·0	289	4	N.E.	8·77	6	59	230·1
February	·871	·062	56·8	67·8	45·8	22·0	48·1	40·9	·255	56	129·0	34·7	290	5	N.E. by E.	0·38	2	81	288·0
March	·846	·062	61·4	72·9	49·8	23·1	49·3	42·0	·237	45	135·8	38·8	292	4	N.E.	0·10	0	68	299·9
April	·823	·066	61·0	70·0	52·0	18·0	53·6	47·7	·348	68	133·8	43·9	244	9	E. by E.	6·35	10	42	217·5
May	·821	·059	62·2	70·0	54·5	15·5	55·2	50·1	·375	70	131·6	46·5	197	17	S. by W.	3·68	7	43	217·2
June	·766	·054	59·7	65·9	53·5	12·4	54·8	50·6	·393	80	123·3	48·1	300	22	W.S.W.	2·70	10	22	139·6
July	·771	·047	58·3	64·0	52·5	11·5	53·9	49·5	·381	81	119·1	47·8	364	24	W.	3·23	9	17	125·3
August	·791	·056	57·2	63·1	51·4	11·7	53·4	48·9	·379	83	121·8	46·0	255	25	W. by N.	6·52	11	22	121·4
September	·785	·068	57·9	63·7	52·1	11·6	54·7	50·5	·406	88	110·0	47·5	217	23	W. by S.	12·39	17	25	130·8
October	·815	·071	57·7	64·3	51·2	13·1	53·8	49·6	·385	83	121·7	45·3	255	18	S.S.W.	5·24	12	31	163·8
November	·803	·069	55·2	59·4	51·1	8·3	53·3	50·1	·398	94	99·7	47·7	273	17	S. by W.	15·52	22	10	59·2
December	·829	·059	56·0	65·0	47·1	17·9	46·6	39·2	·230	52	120·7	34·9	196	15	S. by E.	0·58	3	68	264·7
Annual	22·813	0·062	58·1	65·6	50·6	15·1	52·1	46·8	0·340	73	121·9	43·0	264	18	S.S.W.	65·46	109	41	2257·5

EXTREME Monthly Meteorological Records at the Kodaikanal Observatory in 1920.

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	**22·946**	**8**	22·755	1	0·191	67·7	26	40·3	23	33·4	31	**7**	**18**	135·0	25	24·7	31	**722**	**3**	123	18	**3·03**	**2**
February	·936	19	·788	28	·148	73·2	29	42·1	27	32·0	27	8	28	136·2	16	28 7	28	489	25	120	3	0·22	3
March	·937	6	·759	27	·178	75·3	31	44·2	1	34·9	1	**7**	**25**	147·1	10	29 1	1	427	16	169	22	0·08	16
April	·891	4	·747	27	·144	74·7	7	48·7	3	39·4	7	23	7	**148·9**	**4**	34·3	3	400	15	154	10	1·40	18
May	·907	9, 17	·711	1	·196	**75·5**	**8**	50·2	27	45·2	5	29	6	142·9	8	42·0	12	370	3	121	16	1·59	27
June	·842	28	·697	12, 20	·145	72·4	7, 10	50·6	30	47·2	9	52	6	141·0	7	42·4	14	469	30	140	27	0·80	28
July	·840	19	·677	23	·163	68·1	21	50·3	22	43·9	11	52	22	146·9	5	43 2	6	481	24	178	28	0·60	28
August	·862	31	·708	25	·154	66·4	27	49·6	13, 27	44·2	28	58	27	135·1	21	40·5	28	506	23	130	29	1·82	11
September	·864	18, 21	·711	7	·153	66·6	26	48·8	9	46·0	9	70	25, 29	133·5	25	43·8	10	490	7	102	15	2·12	16
October	·920	13	**·671**	**5**	·249	69·0	23	48·1	23	44·9	17	41	11, 12	142·0	23	38·3	17	435	27	117	31	0·97	3
November	·892	9	·695	22	·197	66·4	7	49·1	19	42·2	7	51	7	131·9	8	42·4	6	495	22	105	9	1·95	18
December	·906	19	·752	8	·154	70·3	10	**39·6**	**23**	**31·5**	**4**	8	4	129·7	19	**24·1**	**28**	370	11	**75**	**24**	0·28	18

APPENDIX III.

KODAIKANAL mean hourly wind velocity for the year 1920.

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	13	13	13	12	12	13	13	12	13	14	14	13	12	11	11	11	10	10	10	11	12	12	12	12
February	13	14	14	14	14	14	14	14	15	17	15	14	12	11	9	8	7	7	7	8	9	11	13	15
March	11	12	13	13	14	13	13	14	15	18	16	16	16	13	12	10	9	8	7	8	8	9	7	11
April	10	10	10	9	10	10	12	11	12	13	13	11	11	10	10	10	9	9	8	8	8	9	10	11
May	9	9	8	8	7	7	6	6	8	9	10	9	9	8	9	8	8	7	8	8	9	9	9	9
June	14	14	14	13	13	13	12	12	12	12	12	11	10	10	11	11	12	13	13	14	14	13	14	13
July	17	17	17	17	16	17	16	14	14	14	13	13	13	12	13	14	14	14	16	17	16	17	17	16
August	13	13	13	13	13	12	12	10	9	8	9	10	8	8	9	8	8	9	11	11	12	11	13	12
September	10	10	10	10	10	10	10	9	8	8	9	8	8	9	8	9	8	8	8	9	9	10	9	10
October	12	12	13	12	13	12	12	11	12	11	11	11	10	10	9	8	8	8	9	10	9	10	11	11
November	11	10	11	12	10	11	12	13	13	12	12	12	11	13	11	10	10	9	12	12	11	12	13	10
December	9	9	9	9	8	8	8	9	10	10	10	9	9	8	7	7	5	6	6	7	7	8	9	9
Mean	12	12	12	12	12	12	12	11	12	12	12	11	11	10	10	10	9	9	10	10	10	11	11	12

APPENDIX IV.

KODAIKANAL mean hourly bright sunshine for the year 1920.

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	0·42	0·85	0·94	0·92	0·85	0·86	0·71	0·75	0·66	0·72	0·61	0·16
February	·39	·97	1·00	1·00	·99	·95	·90	·85	·79	·78	·77	·54
March	·80	·91	0·95	0·98	1·00	·99	·92	·76	·63	·63	·64	·47
April	·28	·66	·81	·93	0·93	·86	·68	·60	·49	·52	·36	·14
May	·23	·81	·91	·94	·91	·77	·66	·56	·47	·35	·29	·09
June	·17	·46	·63	·68	·62	·63	·59	·50	·35	·28	·18	·07
July	·08	·37	·46	·57	·50	·55	·52	·37	·30	·29	·15	·03
August	·10	·41	·57	·63	·61	·47	·37	·31	·24	·16	·14	·04
September	·08	·53	·70	·77	·70	·57	·47	·33	·22	·19	·10	·02
October	·19	·54	·68	·74	·61	·57	·59	·46	·43	·31	·26	·08
November	·04	·33	·54	·61	·53	·49	·28	·31	·21	·08	·07	·00
December	·24	·79	·86	·91	·91	·89	·88	·87	·81	·77	·59	·01
Mean	0·25	0·64	0·75	0·81	0·76	0·72	0·63	0·56	0·47	0·42	0·35	0·14

APPENDIX V.

NUMBER of days in each month on which the Nilgiris were visible in 1920.

Month.	Very clear.	Visible.	Just visible.	Tops only visible.	Total.
January	1	10	...	1	12
February	...	7	...	...	7
March		3	...	1	4
April	6	1	...	1	8
May	1	2	2	...	5
June	1	8	1	...	10
July	..	...	...	...	.
August	4	2	...	...	6
September	1	8	...	1	10
October	3	6	...	3	12
November	1	3	...	...	4
December	16	7	1	...	24
Total	34	57	4	7	102

APPENDIX VI.

METEOROLOGICAL Means, Kodaikanal.

Month.	Barometer.		Dry bulb.				Wet Bulb.		Vapour tension.	Humidity.	Sun Max.	Grass Min.	Wind.		Rain.		Clear sky.	Bright sunshine.
	Reduced to 32°	Range.	Mean.	Max.	Min.	Range.	Mean.	Min.					Velocity.	Direction.				
	Inches.	Inches.	°	°	°	°	°	°	Inches.	Cents.	°	°	Miles.	Points.	Inches.	Days.	Cents.	Hours.
January	22·848	0·067	54·3	63·7	46·9	16·8	47·0	40 3	0·257	62	119·1	37·5	305	5	2·88	4	63	239·4
February	·855	·067	55·8	66·3	47 5	18 8	47·9	41·2	·263	59	126·5	37·9	278	4	1·41	2	67	237·6
March	·857	·067	58·7	69·2	50·5	18·7	49·6	43·0	·269	55	132·5	41·0	294	6	2·03	3	69	261·5
April	·837	·066	60·7	70·2	53·5	16·7	53·5	47·6	·343	66	134·7	45·3	256	6	4·30	7	56	229·1
May	·811	·066	60·9	69·3	54·6	14·7	55·2	50·2	·382	72	133·1	48·2	247	5	5·95	11	46	209·3
June	·763	·058	58·4	65·1	53·6	11·5	54·2	50·0	·383	79	126·3	49·0	364	25	4·01	10	27	130·4
July	·756	·055	57·0	63·1	52·5	10·6	53·6	49·7	·382	83	123·2	48·7	395	25	4·96	12	23	114·9
August	·773	·062	57·0	63·6	52 3	11·2	53·8	49·5	·387	84	124·8	48·0	313	26	7·01	13	27	133·0
September	·787	·070	57·1	63·8	52·2	11·6	54·0	49·6	·390	84	126·1	47·8	271	25	7·01	13	29	128·5
October	·811	·073	56·2	62·8	51·3	11·5	53·3	49·0	·357	85	122·0	46·4	251	30	9·92	16	30	138·7
November	·820	·069	54·5	61 3	49·3	12·0	51·7	47·0	·361	85	115·8	44·8	268	1	7·81	12	34	132·8
December	·831	·067	54·0	62·3	47·7	14·7	48·4	42·3	·289	70	115·5	42·5	293	5	4·60	7	50	197·2
Annual	22·812	0·066	57·0	65·1	51·0	14·1	51·8	46·6	0·339	74	125·0	44 8	295	N	61·89	110	43	2152·4
Period of means.	1900 January to 1920 December.		1899 May to 1920 April.				1900 January to 1920 December.				1899 May to 1920 April.	1900 January to 1920 December.	1899 May to 1920 April.	1903 January to 1920 December.	1899 May to 1920 April.			1900 January to 1920 December.

APPENDIX VII.

MADRAS OBSERVATORY.—Abnormals from monthly means for the year 1920.

Abnormals of	January.	February.	March.	April.	May.	June.	July.	August.	September	October.	November.	December.	Annual.
Reduced atmospheric pressure	− 0·012	− 0·003	− 0·017	+ 0·006	+ 0·002	− 0·014	− 0·011	+ 0·013	− 0·020	− 0·008	− 0·048	− 0·014	− 0·010
Temperature of air	+ 1·7	+ 2·5	+ 1·9	+ 0·6	+ 0·8	+ 1·6	+ 3·1	+ 1·7	+ 2·4	+ 1·2	+ 1·1	+ 0·3	+ 1·6
Do. of evaporation	+ 2·5	+ 2·4	+ 1·5	+ 0·6	+ 0·7	+ 0·9	+ 1·1	+ 0·2	+ 0·8	+ 1·3	+ 2·1	− 1·2	+ 1·1
Percentage of humidity	+ 4	Normal	− 1	Normal	+ 1	− 1	− 5	− 5	− 5	+ 1	+ 5	− 6	− 1
Greatest solar heat in *vacuo*	+ 7·5	+ 12·2	+ 12·7	+ 13·1	+ 8·3	+ 5·8	+ 8·9	+ 7·7	+ 14·1	+ 0·6	− 4·4	+ 12·2	+ 8·2
Maximum in shade	− 0·4	+ 1·4	+ 0·7	+ 0·1	+ 1·6	+ 1·9	+ 3·9	+ 1·6	+ 2·5	+ 0·5	− 0·5	+ 1·0	+ 1·2
Minimum in shade	+ 2·4	+ 2·9	+ 1·6	+ 0·5	+ 0·1	+ 1·1	+ 2·1	+ 1·2	+ 1·7	+ 1·3	+ 1·9	− 1·5	+ 1·2
Do. on grass	+ 4·3	+ 3·8	+ 2·2	+ 0·7	+ 0·6	+ 1·2	+ 3·0	+ 1·7	+ 2·4	+ 2·5	+ 3·5	− 1·4	+ 2·1
Rainfall in inches	+ 4·77	− 0·28	− 0·39	− 0·56	0·87	− 1·50	− 1·68	− 2·47	− 4·22	+ 10·47	+ 16·87	− 5·27	...
Do. since January 1st	+ 4·77	+ 4·49	+ 4·10	+ 3·54	+ 2·67	+ 1·17	− 0·51	− 2·98	− 7·20	+ 3·27	+ 20·14	+ 14·86	+ 14·86
General direction of wind	1 point N.	3 points S.	1 point S.	Normal	Normal	1 point S.	1 point W.	1 point W.	Normal	3 points S.	3 points E.	2 points E.	1 point S.
Daily velocity in miles	− 39	− 46	− 56	− 95	− 92	− 78	− 55	− 60	− 72	− 49	+ 67	− 105	− 68
Percentage of cloudy sky	+ 2	− 46	− 3	+ 10	− 1	− 17	+ 4	− 55	− 1	+ 3	+ 11	− 25	− 3
Do. of bright sunshine	− 8·3	+ 3·6	− 1·5	− 6·1	− 5·5	+ 11·1	− 6·7	+ 0·9	+ 2·4	− 4·6	− 15·5	+ 16·0	− 4·9

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

APPENDIX VIII.

ABSTRACT of the Mean Meteorological Condition of Madras in the year 1920 compared with the average of past years.

Mean values of	1920.	Difference from	Average.
Reduced atmospheric pressure	29·854	0·010 below.	29·864
Temperature of air	82·7	1·6 above.	81·1
Do. of evaporation	75·6	1·1 „	74·5
Percentage of humidity	71	1 below.	72
Greatest solar heat in *vacuo*	147·9	8·2 above.	139·7
Maximum in shade	92·0	1·2 „	90·8
Minimum in shade	75·9	1·2 „	74·7
Do. on grass	74·0	2·1 „	71·9
Rainfall since January 1st on 78 days	63·89	14·87 „	49·02
General direction of wind	S.E. by S.	1 point S.	S.E.
Daily velocity in miles	103	68 below.	171
Percentage of cloudy sky	46	3 „	49
Do. of bright sunshine	53·5	4·9 „	58·4

DURATION and quantity of the wind from different points.

From	Hours.	Miles.	From	Hours.	Miles.	From	Hours.	Miles.	From	Hours.	Miles.
North.	54	215	East.	77	387	South.	179	1149	West.	190	1380
N. by E.	265	1549	E. by S.	190	760	S. by W.	198	808	W. by N.	185	1261
N.N.E.	360	1774	E.S.E.	151	668	S.S.W.	188	747	W.N.W.	157	1037
N.E. by N.	341	2250	S.E. by E.	483	2454	S.W. by S.	148	600	N.W. by W.	86	513
N.E.	175	1154	S.E.	524	3036	S.W.	139	740	N.W.	35	176
N.E. by E.	215	1280	S.E. by S.	641	4126	S.W. by W.	193	889	N.W. by N.	41	171
E.N.E.	183	862	S.S.E.	314	1911	W.S.W.	324	1748	N.N.W.	58	279
E. by N.	110	531	S. by E.	182	964	W. by S.	304	1900	N. by W.	100	586

There were 1994 calm hours during the year. The resultant corresponding to the above numbers is represented by a S.E. wind, blowing with a uniform daily velocity of 19 miles.

APPENDIX IX.

MADRAS OBSERVATORY.—Number of hours of wind from each point in the year 1920.

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	41	18	37	137	95	101	56	28	22	10	...	...	...	...	...	...	...	...	..	...	...	...	...	..	...	...	...	...	...	...	...	...	199
February	...	1	3	10	22	10	21	13	9	40	20	52	39	82	52	20	16	8	16	2	3	3	..	...	...	...	..	...	...	...	...	...	254
March	...	...	...	...	...	..	...	...	...	26	22	80	118	138	22	21	47	16	14	7	6	2	1	...	..	...	.	...	...	...	...	...	224
April	...	...	...	...	...	...	..	...	2	15	33	131	134	85	41	14	15	15	8	15	3	6	6	3	...	...	...	...	...	...	.	...	194
May	3	...	4	1	2	...	11	5	2	9	9	38	87	192	68	45	29	38	26	19	12	5	11	13	12	17	8	4	4	4	4	1	61
June	.	...	1	..	...	1	...	1	1	1	2	33	80	72	51	22	28	19	12	15	55	46	42	52	71	38	8	4	6	1	2	...	56
July	1	...	...	...	...	...	1	1	1	4	6	10	3	6	23	22	19	17	17	24	30	54	173	133	72	41	29	6	...	4	...	...	47
August	...	4	3	1	1	...	2	1	3	14	17	57	16	31	34	16	7	40	54	31	13	40	51	59	21	52	57	34	8	8	5	4	60
September	4	8	5	1	1	5	7	8	5	15	18	41	18	23	9	7	9	21	32	20	13	28	28	31	11	33	45	35	12	14	17	14	182
October	2	54	43	45	11	25	13	13	5	20	12	39	25	10	6	14	8	21	9	14	4	8	11	13	2	4	9	3	5	10	30	21	235
November	3	96	115	72	16	47	62	21	7	22	7	1	...	1	..	...	...	...	...	1	...	1	1	...	1	...	1	...	...	...	...	60	185
December	...	84	149	74	27	26	10	19	20	14	5	1	4	1	8	1	1	3	..	...	...	...	...	...	...	..	...	...	..	.	...	...	297
Annual total	54	265	360	341	175	215	183	110	77	190	151	483	524	641	314	182	179	198	188	148	139	193	324	304	190	185	157	86	35	41	58	100	1994

APPENDIX X.

MADRAS OBSERVATORY.—Number of miles of wind from each point in the year 1920.

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	125	260	186	808	711	589	256	183	113	24	...	...	.	...	...	...	...	...	...	...	..	...	...	...	...	...	...	...	...	...	...	...	3255
February	...	5	8	56	113	49	117	43	46	166	66	217	136	439	356	101	94	50	90	19	15	8	...	...	...	...	...	...	...	...	...	...	2194
March	...	...	...	...	...	...	...	...	...	77	91	396	684	823	104	113	430	96	93	19	35	5	4	...	...	...	...	...	...	...	...	...	2970
April	..	...	...	...	...	...	...	...	9	57	156	649	894	577	152	60	88	68	44	62	10	29	21	9	...	...	...	...	...	...	...	...	2885
May	36	...	12	8	12	...	27	29	16	47	51	187	537	1378	467	294	168	182	128	77	58	29	45	71	84	128	43	19	18	15	15	4	4185
June	...	...	6	...	...	6	...	3	9	10	15	234	506	565	400	122	161	75	46	66	341	228	256	366	486	250	58	13	26	3	11	...	4262
July	5	...	...	...	...	...	5	5	1	20	22	65	23	43	128	101	97	55	59	105	151	308	1023	1003	605	348	183	47	...	21	...	...	4423
August	...	19	10	5	6	...	14	6	20	106	106	320	81	145	230	86	45	142	177	108	63	169	227	267	156	327	369	180	49	39	28	27	3527
September	20	25	10	7	3	28	28	36	16	53	68	200	82	107	30	28	27	79	74	81	51	84	131	144	43	190	355	245	73	65	73	74	2530
October	8	240	175	280	73	166	74	75	33	52	60	183	88	41	28	57	36	57	36	60	16	26	36	40	5	18	28	9	10	28	152	112	2302
November	21	555	646	437	101	269	293	82	46	94	17	1	...	7	...	...	...	...	...	3	...	3	5	...	1	...	1	...	..	...	...	369	2951
December	...	445	721	649	135	173	48	69	78	54	16	2	5	1	16	2	3	4	...	...	...	..	...	...	...	...	...	...	...	...	...	...	2421
Annual	215	1549	1774	2250	1154	1280	862	531	387	760	668	2454	3036	4126	1911	964	1149	808	747	600	740	889	1748	1900	1380	1261	1037	513	176	171	279	586	37905

APPENDIX XI.

MADRAS OBSERVATORY.—Number of inches of rain from each point in the year 1920.

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	0·02	...	...	...	2·10	0·72	0·09	2 19	0·10	0·44	...	..	...	...	...	...	...	...	...	...	...	..		..	...	...	...	...	...	...	...	..	...
February	...	...	..	..	..	...	...	...	...	..	..	...	...	...	...	...	...	...	..		.	...	...	...	...	...	...	...	...	...	...	...	...
March	...	...	..	..	...	...	...		...	...	...	...	...	...	...	...	...	..	...	...	...	...	..	...	...	...	...			...	...	...	...
April	...	...	..	...	...	...	...	...	...	..	.	0·06	...	...	..	...	...	...	..	...	...	...	...	...	...	...	...	...	.	...	...	...	.
May	0·84	...	...	..	...	...	...	...	...	...	...	...	...	...	0·22	...	...	..	...	..	...	...	...	...	...	0 08	...	...	0·11	..	...	...	...
June	...	...	..	...	...	...	...	.	...	...	...	...	...	...	0 03	0 09	0·02	...	0·06	...	0·05	...	...	0·15	...	0·01	0·02	...	...	0·02	0·10	..	0·06
July	...	.	...	..	...	.	...	...	...	...	0·04	...	...	...	0·14	...	0·21	0·17	0·47	0·14	0·05	0·23	0·02	0·05	0·32	...	0·13	..	...	0·19	...	...	0·03
August	...	...	...	...	...	..	..	...	...	...	...	...	..	...	...	...	...	0·01	0·17	0·10	0·48	0·25	0·18	0·14	0·38	0·12	0·02	0·03	0 17	0·04		...	...
September	...	0·11	0·01	...	...	...	...	...	...	..	...	...	...	...	...	...	...	...	...	0·07	...	0·14	0·02	.	...	...	..	...	...	..	...	...	0·12
October	...	3·57	0·75	1·27	0·02	0·51	..	2·24	0 09	0·50	0·06	...	...	...	...	...	...	0·12	0·01	0·01	...	...	0·21	0·53	...	...	...	...	..	1·70	3·52	3·24	3·12
November	0·46	4·24	8·11	2·10	0·77	1·40	7·15	1·06	0·86	1·71	0·63	...	...	...	...	.	. .	...	...	...	...	...	...	...	...	...	..	...	...	...	..	0·78	0·81
December	...		...		.	...		...	0·01	...	...	...	...	...	...		...	...	...	...	...	...	..	...	...	...	...	.	...	...	...	...	...
Annual	1·32	7·92	8·87	3·37	2·89	2·63	7·24	5·49	1·06	2·65	0·73	0·06	...	...	0·39	0·09	0·23	0·30	0·71	0·32	0·58	0·62	0·43	0·87	0·70	0·21	0·17	0·03	0·28	1·95	3·62	4·02	4·14

APPENDIX XII.

MADRAS OBSERVATORY.—Wind, cloud and bright sunshine, 1920.

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	98	N.E.	4·1	4·6	4·3	2·5	3·9	6·8	9·5
February	56	S.E.	1·4	2·9	0·5	0·5	1·3	9·4	10·7
March	87	S.E. by S.	2·1	3·6	1·6	1·0	2·1	8·7	10·5
April	87	S.E.	4·7	4·7	3·6	2·3	3·8	7·9	11·1
May	97	E.S.E.	3·2	3·3	3·9	4·4	3·7	7·0	9·5
June	78	S.S.W.	4·1	4·2	5·1	5·3	4·7	6·5	9·6
July	115	W.S.W.	6·5	6·5	8·5	8·5	7·5	4·1	8·6
August	47	S.W.	6·6	5·7	6·9	5·7	6·2	5·0	9·7
September	28	W. by S.	6·1	6·3	6·6	5·1	6·1	5·3	9·9
October	29	N.E.	6·8	7·1	5·5	5·2	6·2	5·4	10·5
November	86	N.E. by N.	7·4	8·0	6·8	5·5	7·0	3·7	10·0
December	68	N.E. by N.	2·9	4·2	1·9	1·6	2·7	7·8	9·3
Annual	19	S.E.	4·7	5·1	4·6	4·0	4·6	6·5	...

APPENDIX XIII.

MEAN Monthly and Annual Meteorological Results at the Madras Observatory in 1920.

Month.	Barometer.		Dry Bulb Thermometer.				Wet Bulb.		Tension of Vapour.	Relative Humidity.	Sun Max. in Vac.	Min. on Grass.	Wind.			Rain.		Cloudy sky.	Bright sunshine.
	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	29·985	0·109	76·8	84·2	69·9	14·3	71·7	68·5	0·711	77	145·9	67·4	105	4	N.E.	5·66	6	39	211·4
February	·961	·127	79·2	88·0	70·9	17·1	73·2	69·7	·734	73	151·9	67·6	76	11	S.E. by E.	...	.	13	273·2
March	·886	·125	81·9	89·9	73·7	16·2	75·4	72·4	·793	73	153·2	70·8	96	13	S.E. by S.	...	..	21	269·2
April	·832	·124	84·6	93·0	77·7	15·3	78·2	75·8	·876	74	154·8	75·4	96	13	S.E. by S.	0·06	1	38	236·0
May	·737	·111	87·5	99·4	80·9	18·5	79·0	76·2	·875	68	151·3	79·5	135	15	S. by E.	1·25	3	37	216·1
June	·689	·117	88·0	100·2	81·4	18·8	77·5	74·4	·798	61	146·3	79·8	142	18	S S W.	0·61	6	47	195·6
July	·710	·134	87·6	99·5	80 6	18·9	77·0	74·2	·785	60	147·6	79·6	143	21	S.W. by W.	2·19	14	75	127·7
August	·762	·128	85·0	95·3	78·5	16·8	76·2	73·7	·781	65	147·7	77·1	114	20	S.W.	2·09	9	62	154·8
September	·759	·134	85·4	95·7	78·8	16·9	77·1	74 2	·817	67	155·4	77·4	84	18	S.S.W.	0·47	5	61	159·3
October	·839	·131	81·8	89·5	76·5	13·0	76·9	74·5	·858	79	139·7	75·3	74	10	E.S.E.	21·47	16	62	166·2
November	·877	·118	78·6	84·5	74·2	10·3	75·0	72·8	·821	84	133·0	73·0	98	5	N.E. by E.	30·08	17	70	110·9
December	·964	·108	75·8	84·6	68·3	16·3	69·4	66·2	·633	71	148·0	65·0	78	4	N.E.	0·01	1	27	241·8
Annual	29·833	0·122	82·7	92·0	75·9	16·0	75·6	72·7	0·790	71	147·9	74·0	103	13	S.E. by S.	63·89	78	46	2362·2

EXTREME Monthly Meteorological Records at the Madras Observatory in 1920.

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	**30·116**	**8**	29·876	23	0·240	86·4	29	65·2	18	63·7	22	41	30	155·5	24	61·8	30	**252**	**1**	29	10	2·89	2
February	·110	25	·812	15	·298	91·8	29	66·6	24	65·7	24	38	29	159·7	8	62·4	24	165	16	26	21	..	...
March	·017	6	·712	30	·305	92·1	30	69·7	21	68·2	21	54	19 & 20	156·6	9	66·9	21	167	31	47	25	...	...
April	29·948	3	·611	30	·337	97·8	24	74·3	15	72·3	15	51	9	**167·7**	**19**	71·9	15	148	25	44	29	0·06	19
May	·885	18	·565	3 & 4	·320	**108·7**	**6**	74·2	26	71·6	16	31	14	160·4	13	73·1	16	207	9 & 10	51	1	0·84	26
June	·817	29	**·525**	**21**	·292	106·1	6	75·1	28 & 29	71·9	6 & 7	**28**	**23**	155·6	23	73·1	28	219	21	28	23	0·22	28
July	·834	31	·528	23	·306	103·5	19	76·2	13	71·8	2	33	19 & 21	161·5	11	74·8	13	217	10	81	9	0·39	12
August	·875	3	·619	25	·256	101·1	28	74·6	2	71·4	27	29	26	166·6	31	73·1	1	161	27	36	15	1·15	1
September	·900	18 & 21	·590	7	·310	102·9	30	73·7	21	71·0	10	31	9	164·7	30	72·7	21	155	8	21	19	0·23	21
October	30·019	24 & 25	·629	5	**·390**	97·8	11	73·4	27	70·9	14	46	18	160·7	1	71·7	17	156	28	**7**	**6**	**7·61**	**27**
November	·007	13	·760	27	·247	92·3	9	69·4	30	68·3	30	57	7	158·6	11	67·2	30	184	25	24	3 & 8	5·95	13
December	·068	29	·864	8	·204	86·4	29	**62·8**	**4**	**60·5**	**4**	45	2	154·5	18	**58·8**	**4**	150	14	8	4	0·01	24