

Kodaikanal Observatory.

BULLETIN No. CXVI.

SUMMARY OF PROMINENCE OBSERVATIONS FOR THE FIRST HALF OF THE YEAR 1938.

This bulletin embodies the results of the observations of prominences made at the Kodaikanal Observatory during the first half of the year 1938, supplemented by the data available from other foreign observatories for the days on which Kodaikanal has imperfect or no photographs. We take this opportunity of thanking these observatories which, under the auspices of the International Astronomical Union, co-operated with this Observatory by supplying copies of their photographs on requisition for our imperfect and missing days. The data from the co-operating observatories which have been thus incorporated in this summary are calcium (K_{852}) prominence plates for 16 days and $H\alpha$ disc plates for 24 days from the Meudon Observatory, calcium (K_{852}) prominence plates for 5 days and $H\alpha$ disc plates for 6 days from the Mount Wilson Observatory, and $H\alpha$ prominence plates for 6 days and $H\alpha$ disc plates for 2 days from Mr. Evershed's Observatory at Ewhurst. The available data are still not complete for all the days of the half-year under review, for calcium prominence photograph for one day and $H\alpha$ disc photographs for three days are not available from any of the co-operating observatories, while the photographs for a number of days are incomplete. As usual, the activity of a day of incomplete or imperfect observation has been assumed to be represented by the best photograph for the day, after weighting it according to its quality, the remaining photographs being ignored.

Calcium Prominences at the limb.—The mean daily areas and numbers of prominences derived from all available photographs in the K line of calcium, secured during the half-year are given below. The means are corrected for incomplete or imperfect observations as indicated above, the total of 180 days for which plates were available being reckoned as 168 effective days.

	Mean daily areas (Square minutes)	Mean daily numbers.
North	4.77	8.29
South	2.85	6.51
Total	7.62	14.80

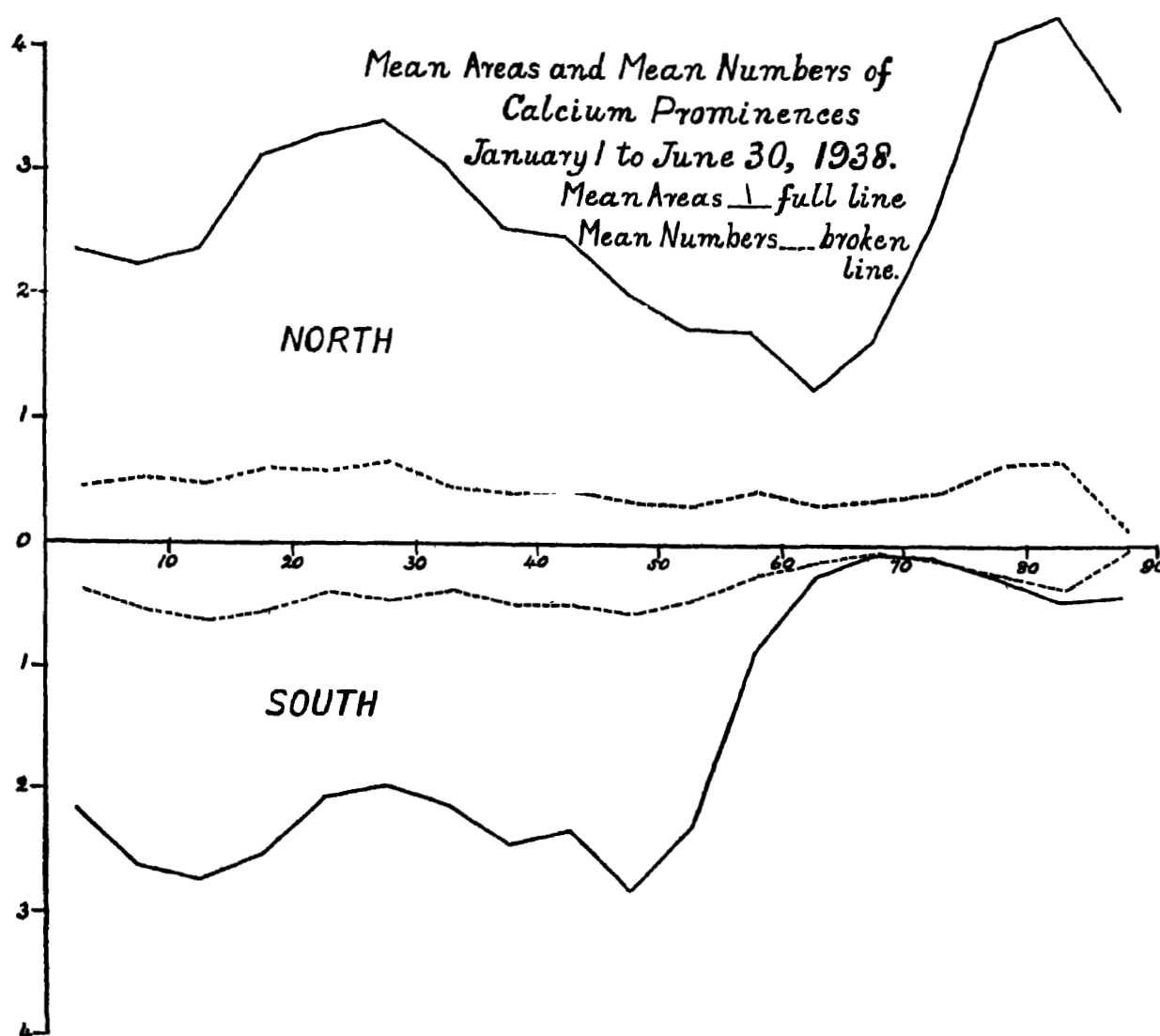
The above figures show that compared to the previous half-year there has been an increase of about 26 per cent in areas and a decrease of about 5 per cent in numbers. The increase in areas has occurred in both the hemispheres being very pronounced in the northern; but the decrease in numbers is confined to the southern hemisphere, there being a slight increase in the northern.

For comparison with bulletins issued prior to 1st January 1923, *i.e.*, before the co-operation of other observatories came into force, the means based on Kodaikanal photographs only are also given, 160 days of observation being reckoned as 151 effective days.

	Mean daily areas (square minutes).	Mean daily numbers.
North (Kodaikanal photographs only)	4.91	8.35
South (Do. Do.)	2.93	6.65
Total	7.84	15.00

The distribution of prominences in latitude is represented in the following diagram, in which the full line gives the mean daily areas and the broken line the mean daily numbers, for each zone of 5° of latitude. The

ordinates represent tenths of a square minute of arc for the full line and numbers for the broken line. Compared with the previous half-year, the high latitude peak in the northern hemisphere has advanced 15° towards the pole but that in the southern hemisphere has disappeared. The low latitude activity near 30° shows an increase in the northern hemisphere, but the distribution is nearly uniform from the equator to latitude 50° in the southern hemisphere.



The monthly, quarterly and half-yearly areas and numbers and the mean height and the mean extent of the prominences on photographs from all the co-operating observatories are given in table I. The unit of area is one square minute of arc. The mean height is derived by adding together the greatest heights reached by individual prominences and dividing by the total number of prominences observed and the mean extent is derived by adding together the lengths of the base on the chromosphere of individual prominences and dividing by the total number of prominences.

TABLE I.—ABSTRACT FOR THE FIRST HALF OF 1938.

Months.	Number of days (effective).	Areas.	Numbers.	Daily means.		Mean height.	Mean extent.
				Areas.	Numbers.		
1938.							
January	30	284.5	428	7.82	14.10	41.45	8.78
February	26	292.5	331	11.25	12.73	50.77	10.30
March	29	188.7	451	6.51	15.55	40.12	7.25
April	28	178.6	452	6.38	16.14	43.79	6.59
May	29½	218.5	471	7.41	15.97	42.32	7.50
June	25½	166.2	359	6.52	14.08	42.16	6.86
First quarter	85	715.7	1205	8.42	14.18	43.51	8.62
Second quarter	83	563.3	1282	6.79	15.45	42.79	7.00
First half-year	168	1279.0	2487	7.61	14.80	43.13	7.79

Distribution East and West of the Sun's Axis.

The areas show a slight decrease at the east limb and numbers a slight increase, as is seen from the following table :—

January to June 1938.	East.	West.	Percentage East.
Total number observed	1263	1223	50.08
Total areas in square minutes	633.3	645.7	49.51

Metallic Prominences.

Thirty-three metallic prominences were observed during this half-year and their details are given below :—

TABLE II.—LIST OF METALLIC PROMINENCES. JANUARY TO JUNE 1938.

Date.	Time I. S. T.	Base.	Latitude.		Limb.	Height.	Lines.
			North.	South.			
1938.	H. M.	°	°	°			
January 1	10 00	..	15.5		W	15	4 and 10.
6	9 50	4		11	E	30	4 and 10.
11	9 54	4	29		E	20	4 and 10.
13	9 15	2	24		E	15	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12.
18	9 02	1	17.5		W	10	4 and 10.
21	9 25	6		16	E	20	1, 2, 3, 4, 5, 6, 8, 9, 10, 11 and 12.
25	9 40	—		27	E	10	4 and 10.
	9 20	9	18.5		W	10	1, 2, 3, 4, 5, 6, 8, 9, 10, 11 and 12.

TABLE II.—LIST OF METALLIC PROMINENCES. JANUARY TO JUNE 1938—*contd.*

Date.	Time I. S. T.	Base.	Latitude.		Limb.	Height.	Lines.
			North.	South.			
1938.	H. M.	°	°	°		'	
February	2	10 58	1	14.5	W	25	4 and 10.
	5	8 59	2		W	15	4 and 10.
	11	8 59 10 15	1 2		W E	10 15	4 and 10. 1, 2, 3, 4, 5, 6, 8, 9, 10, 11 and 12.
	15	9 57	4		W	15	4 and 10.
	17	9 23	4		E	15	4 and 10.
		9 20	3		W	20	1, 2, 3, 4, 5, 6, 8, 9, 10, 11 and 12.
	18	9 07	2		W	20	4 and 10.
	20	9 05	1	10.5	W	10	1, 2, 3, 4, 5, 6, 8, 9, 10, 11 and 12.
	24	9 00	4	7	W	20	1, 2, 3, 4, 9, 10, 11 and 12.
	25	9 45	1		W	15	1, 2, 3, 4, 9, 10, 11 and 12.
March	2	11 00	3		W	10	1, 2, 3, 4, 5, 6, 8, 9, 10, 11 and 12.
	7	9 07	5	19.5	E	15	4 and 10.
	9	10 00	15	29.5	E	30	4 and 10.
	10	9 57	2		E	10	4 and 10.
	11	9 04	—		E	25	1, 2, 3, 4, 5, 6, 8, 9, 10, 11 and 12.
	29	9 10	2		W	20	1, 2, 3, 4, 6, 9, 10, 11 and 12.
April	7	9 14	8	26	E	30	1, 2, 3, 4, 5, 6, 8, 9, 10, 11 and 12.
	15	9 10	4		E	10	1, 2, 3, 4, 5, 6, 8, 9, 10, 11 and 12.
	26	9 05	3		E	20	1, 2, 3, 4, 5, 6, 8, 9, 10, 11 and 12.
	28	10 08	2		E	15	4 and 10.
May	10	9 35	15		E	20	4 and 10.
	14	9 27	5		W	25	4 and 10.
	17	9 25	—		W	15	4 and 10.
June	26	9 27	7		E	15	1, 2, 3, 4, 5, 9, 10 and 11.

NOTE.—The key to the wavelengths of the metallic lines is given below:—

No.	Wavelength.	Element.	No.	Wavelength.	Element.
1	4924.1	Fe+	7	5276.2	Fe+
2	5016.0	He	8	5316.8	Fe+
3	5018.6	Fe	9	5363.0	Fe+
4	b ₁ , b ₂ , b ₃ , b ₄	Mg, Fe+	10	D ₁ , D ₂	Na
5	5234.8	Fe	11	6877	He
6	5276.0	Cr	12	7065	He

The distribution of metallic prominences was as follows :—

	1°—10°.	11°—20°.	21°—30°.	31°—40°.	Mean latitude.	Extreme latitudes.
North	1	6	4	..	19°·2	7° and 29°·5
South	4	7	10	1	18°·9	6° and 35°·5

Seventeen were on the east limb and 16 on the west limb.

Displacements of the Hydrogen line.

Particulars of displacements observed in the chromosphere and prominences with the spectroscopie are given in the following table :—

TABLE III.—DISPLACEMENTS OF THE HYDROGEN LINE. JANUARY TO JUNE 1938.

Date	Hour. I. S. T.	Latitude.		Limb.	Displacement.			Remarks.
		North.	South.		Red.	Violot.	Both ways.	
1938.	H M.	°	°		A	A	A	
January 1	9 32	8		E		Slight		At top.
	9 25		60	E	0·5			In chromosphere.
	9 45		37	W	0·5			At top; from —35° to —39°.
3	10 10		8	W		0·5		At top; from —7°s to —9°.
	10 08	23·5		W		1·5		At top; from +22° to +25°.
5	9 35	Equator		E		1		Do.
6	9 15	79·5		E	0·5			Do.
	9 43	5·5		E			0·5	At base.
	9 50		7·5	E	1			At top.
	9 50		12	E		1		At base; from —11° to —13°.
	9 57		47	E	1			Do.
	9 58		58	E	0·5			In chromosphere.
	9 30	14		W	0·5			At top.
	9 28	24		W	2·5			Do.; from +23° to +25°.
7	9 30		76·5	E	0·5			At base.
8	9 34		12	E	1·5			Do.
	9 34		10·5	E		1		Do.
	9 34		11·5	E	2			At top.
	10 13		15	E		1		Do.
	9 55		57	W		1		At base.
	10 00		7	W		1		Do.

TABLE III.—DISPLACEMENTS OF THE HYDROGEN LINE—JANUARY TO JUNE 1938—*contd.*

Date	Hour. I. S. T.	Latitude		Limb.	Displacement.			Remarks.
		North.	South.		Red.	Violet.	Both ways.	
1938	H. M.	S	S		A	A	A	
January 11	9 53	33.5		E	1			At top; from +31° to +36°.
	9 53	29		E		1		At top; from +28° to +30°.
	9 58		25	E	2			Do.; from -23° to -27°.
	9 28	49		W	1			Do.; from +48° to +50°.
18	9 15	20		E		3		Do.
	9 15	19		E		1		Do.
	9 10	10		E	1			Do.
	9 10	10		E	1			At base.
17	9 28	4.5		W	0.5			At top.
	9 20	19.5		W	1.5			Do.
18	9 00	33		W		1		From +32° to +34°.
20	9 07	54.5		E	0.5			In chromosphere.
	9 12	25.5		E	2.5			At top; from +24° to +27°.
	9 22		65	E	1.5			At base.
	8 58	36.5		W		1		At top; from +35° to +38°.
21	9 25		14	E		1		Do.; from -18° to -15°.
	9 25		14.5	E	2			At base.
24	9 15	15.5		W	2	1		To red at top; to violet at base.
	9 15	22		W	1.5			At top; from +20° to +24°.
	9 15	30		W		2.5		Do.; from +29° to +31°.
	9 26	50.5		W		0.5		In chromosphere.
	9 25	65.5		W	0.5			At top.
25	9 40		27	E	1			At base.
	9 20	10.5		W		1		Do.
	9 20	18.5		W	1.5			At top; from +14° to +23°.
26	9 38	14		E		1.5		Do.
	9 10	12		W		1		Do.
	9 10	17		W	1			Do.; from +15° to +19°.
	9 10	21		W	4	1		At base; from +20° to +22°.
28	9 27	59.5		E	0.5			In chromosphere.
	9 22		12.5	W	0.5			At top.
29	8 50	48.5		W	1			At base.

TABLE III.—DISPLACEMENTS OF THE HYDROGEN LINE—JANUARY TO JUNE 1938—*contd.*

Date.	Hour. I. S. T.	Latitude.		Limb.	Displacement.			Remarks.
		North.	South.		Red.	Violet.	Both ways.	
	H. M.	°	°		A	A	A	
1938.								
February	1	9 16	20.5	W		1		At top.
	2	11 10	20.5	E			1	At base; from +19° to +22°.
		11 15		E	0.5			At top.
		10 58	20	W		0.5		At base.
	11	10 15		E	2			Do.; from -5° to -7°.
	12	9 23		E	1.5			Do.
		9 14		E	1			Over whole of prominence.
		9 13		E	1			At top; from -39.5° to -44.5°.
	13	9 42	12	E	1			At base.
		9 42	9	E		0.5		Do.; from +8° to +10°.
	16	9 45	63	E	1			At top.
	17	9 20		W		1.5		At base.
	18	9 07		W	1			At base.
	20	9 00	10.5	W	0.5			At top.
		9 02	15	W	1.5			Do.; from +14° to +16°.
	23	10 45	27.5	W			1	Do.
	24	9 02		W	3	2.5		To red at base; to violet at top.
		9 01	Equator	W	2			At top.
		9 00	7	W			1	At base.
	25	9 25		E		1		
March	2	11 00		W			1	At top.
	4	8 55	20	W		0.5		At base.
	6	8 57		W		1.5		Do.
	7	9 07	20.5	E		1		At top; from +19° to +22°.
		8 55		W		1		At base.
		8 55		W	0.5			At top; from -29.5° to -31.5°.
		8 54		W	1			Do.
	8	8 40	25.5	E	2			Do.; from +24° to +27°.
	9	10 00	30	E		1		Do.
		9 52	Equator	E		1		Do.; from +1° to -1°.
	10	9 57		E		0.5		Do.; from -25° to -27°.
	14	8 55		W	1			Do.; from -23° to -25°.
		8 55		W	1.5			At base.

TABLE III.—DISPLACEMENTS OF THE HYDROGEN LINE—JANUARY TO JUNE 1938—contd.

Date	Hour. I. S. T.	Latitude.		Limb.	Displacement.			Remarks.
		North.	South.		Red.	Violet.	Both ways.	
1931.	16	A	11.5	E	4	A	2	Over whole prominence; maximum displacement.
		A	9.40	W	2			At top.
	17	10.00	28	W	0.5			At base.
		11.41	17.5	W	1			Do.
	18	9.10	28.5	W	0.5			At top.
		9.57	21	W	2			Do; from -18° to -24°.
	23	10.00	3	W	2			Do.
		10.32	5	E	1			At base.
	27	9.23	83	E	0.5			At top.
		9.10	62	E	3			Do.
	28	9.16	28	E	1			At top; from -27° to -29°.
		9.08	24	W	1.5			At base.
29	9.02	7	W	1			At top.	
	9.10	9	W	1.5			To red at top; to violet at base.	
30	9.16	30.5	E				At base.	
	9.26	22	W				Do.	
31	9.04	68	W	1			At top.	
	9.04	18	W	1			At base, from +67° to +69°.	
2	9.43	13	W	1			At top.	
	9.43	17	W	1			Do.	
5	9.38	40	E				Do.	
	9.38	29	E				Do.	
6	9.38	29	E				Do.	
	9.38	29	E				Do.	
7	9.12	29	E				At base; from +28° to +30°.	
	9.36	26	E				Do.	
8	9.35	26	E				To violet at top and to red at base.	
	9.12	28.5	E				At base; from +22° to +25°.	
9	9.12	28.5	E				At top; from +22° to +25°.	
	9.30	23.5	E				At top; from +22° to +25°.	

TABLE III.—DISPLACEMENTS OF THE HYDROGEN LINE—JANUARY TO JUNE 1938—*contd.*

Date.	Hour. I. S. T.	Latitude.		Limb.	Displacement.			Remarks.
		North.	South.		Red.	Violet.	Both ways.	
1938.	H. M.	°	°		A	A	A	
	8 45	68		W	0.5			At base.
April	7 9 15	42		E	1.5			At base.
	9 9 57		26	E		1		At top.
	10 9 10	21		E		1		Do.
	12 8 40	48		E		0.5		At base.
	15 8 56		6	E		1		At top; from -4° to -8° .
	8 56		3	E	1			At top.
	8 55		15	E		0.5		Do.
	9 23		37	W	1			Do.
	9 20		15.5	W		2		At base.
	17 9 35	24.5		W			1	At middle of prominence.
	18 9 25	18		W	1.5			At top; from $+17^{\circ}$ to $+19^{\circ}$.
	25 9 06	25.5		E	2			Do.; from $+24^{\circ}$ to $+27^{\circ}$.
	9 06	18.5		E	1.5			Do.; from $+17^{\circ}$ to $+20^{\circ}$.
	9 22		23.5	E		3		Do.; from -22° to -25° .
	9 22		27	E		4.5		Do.
	8 55		28	W	1			Do.; from -27° to -29° .
	8 45	76.5		W		0.5		In chromosphere.
	26 8 57	28		E	1			At base; from $+18^{\circ}$ to $+28^{\circ}$.
	9 05		28.5	E	1			Do.; from -27° to -30° .
	28 10 00	17		E	1			At base.
	10 08		23	E			1	At base; from -22° to -24° .
	8 53	18.5		W	0.5			At base.
May	2 9 35	27		E		1		At top; from $+26^{\circ}$ to $+28^{\circ}$.
	3 9 00	25		W		1		At base.
	5 9 45	33.5		E	0.5			At top; from $+32^{\circ}$ to $+35^{\circ}$.
	6 9 42		55	E	0.5			At base.
	9 25	44.5		W	1			At top.
	7 9 20		26	E	1			At middle of prominence.
	9 08		6	W		1		In chromosphere.
	9 18	85.5		E	0.5			In chromosphere.
	8 9 35		21	E	1.5			At base.
	9 25		27	W		1		At top.

Reversals and Displacements on the Sun's Disc.

Four hundred and ninety-two bright reversals of the H α line, 492 dark reversals of the D $_2$ line and 51 displacements of the H α line were observed with the spectroscope during the half-year. Their distribution is given below :—

	North.	South.	East.	West.
Bright reversals of H α	218	274	248	244
Dark reversals of D $_2$	218	274	248	244
Displacements of H α	30	21	18	33

Thirty-eight displacements were towards the red, 5 towards the violet and 8 both ways simultaneously.

The Hale spectroheliograph was in use daily (except on Sundays and holidays) for observation in the H α line of changing phenomena and displacements on the sun's limb and disc. The observations were made normally at the hours allotted by the International Astronomical Union to this Observatory for the purpose, namely, 2^h—30^m to 3^h—00^m, 4^h—00 to 4^h—30^m, 5^h—30^m to 6^h—00^m G. M. T. i. e. 8^h—00^m to 8^h—30^m, 9^h—30^m to 10^h—00^m, 11^h—00 to 11^h—30 I. S. T., but observations were also made outside of routine hours, whenever there were occasions for following the progress of interesting phenomena.

The observations made * during the first-half of the year 1938 are summarised below :—

	East limb.	West limb.	Total.
Displacements in prominences	48	53	101

	North.	South.	East.	West.	Total.
Displacements in H α dark markings	12	5	9	8	17
Displacements in H α bright flocculi	4	2	2	4	6

	Displacements towards.		
	Red.	Violet.	Total.
Prominences.	50	51	101
H α dark markings	9	8	17
H α bright flocculi	4	2	6

Prominences Projected on the Disc as Absorption Markings.

Photographs of the sun's disc in H α light were available from Kodaikanal and the co-operating observatories for 178 days which were reckoned as 174½ effective days. The mean daily areas of H α absorption markings (corrected for foreshortening) in millionths of the sun's visible hemisphere and their mean daily numbers are given below :—

	Mean daily areas.	Mean daily numbers.
North	5273	25.98
South	4426	26.84
Total	9699	52.32

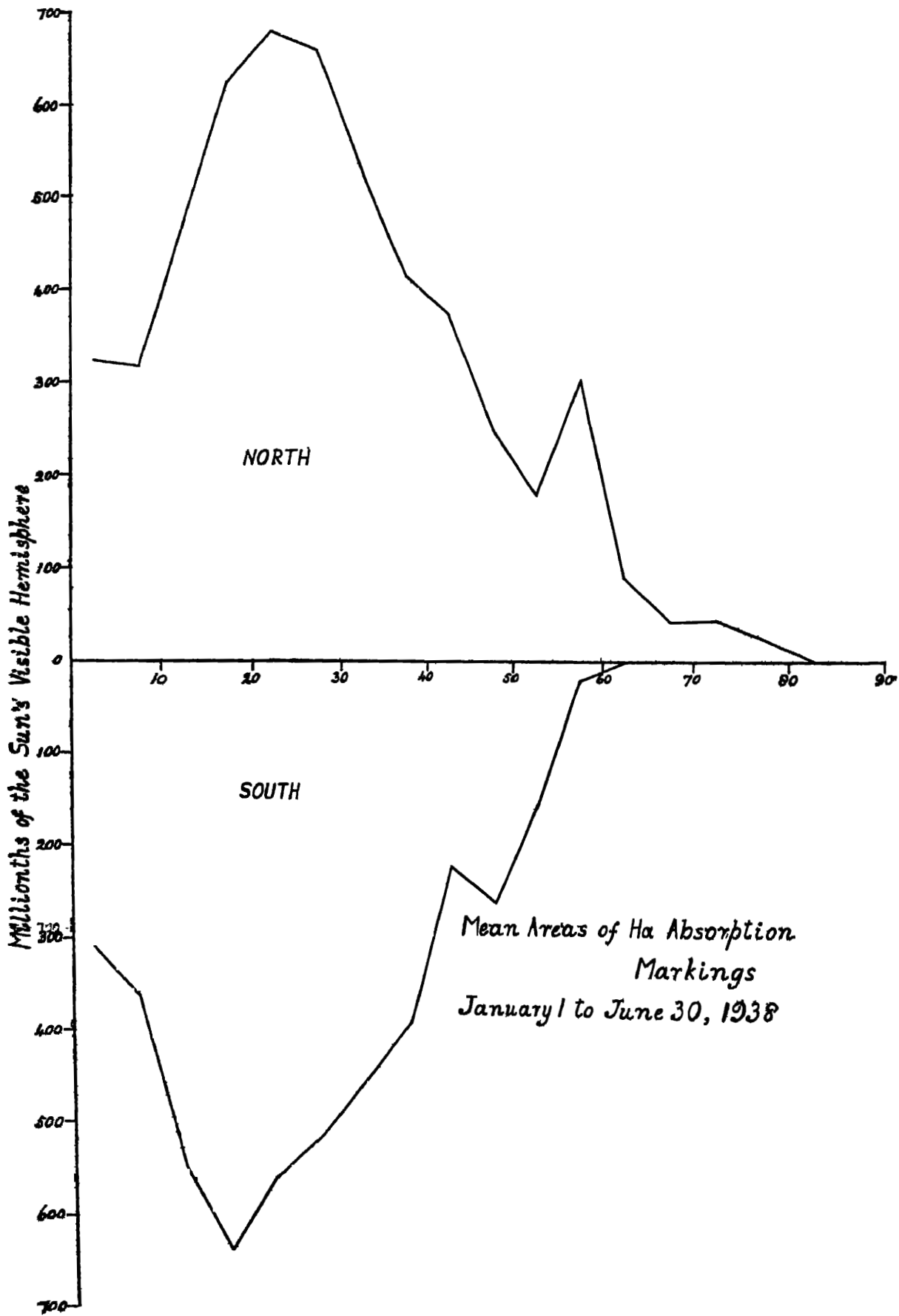
From the above figures it will be seen that there has been an increase of 15 per cent in areas and a decrease of 3 per cent in numbers when compared with those of the previous half-year.

For comparison with bulletins issued prior to the co-operation of other observatories, the means based on Kodaikanal photographs alone are also given, 152 days of observation being counted as 147 effective days.

	Mean daily areas.	Mean daily numbers.
North (Kodaikanal photographs only)	5443	25.89
South (do.)	4418	25.86
Total	9861	51.75

* The data of bright chromospheric eruptions from this observatory are published in the Bulletin for Character Figures of Solar Phenomena, Zurich, together with those from other observatories.

The distribution of mean daily areas in latitude is shown in the following diagram.



Compared with the previous half-year the low latitude zone of maximum activity has receded 5° towards the equator both in the northern and southern hemispheres. The high latitude peak in the northern hemisphere which has now become less prominent has also retreated 10° towards the equator and as in the previous half-year there is no activity at all beyond 60° in the southern hemisphere.

The areas show an eastern defect, the percentage east being 49.87 and the numbers an eastern preponderance, the percentage east being 51.02.

The mean daily areas of H α absorption markings uncorrected for foreshortening are given below :—

	Mean daily areas.
North	2892
South	2638
Total	5530

The uncorrected areas amount to 57 per cent of the corrected ones. The curve of distribution in latitude as usual resembles that of the corrected areas.

KODAIKANAL OBSERVATORY,
The 23rd May 1939.

A. L. NARAYAN,
Director, Kodaikanal Observatory.