

Kodaikanal Observatory.

BULLETIN No. CXIII.

SUMMARY OF PROMINENCE OBSERVATIONS FOR THE SECOND HALF OF THE YEAR 1936.

The resumé here presented is based primarily on the observations of prominences made at the Kodaikanal Observatory, but whenever the records of this observatory have been imperfect or lacking, they have been supplemented by the material obtained from other observatories, which, according to an arrangement agreed upon by the International Astronomical Union, co-operate with this observatory. The data from the co-operating observatories which have been made use of in this summary are Calcium (K_{232}) prominence plates for 19 days and $H\alpha$ disc plates for 25 days from Mount Wilson, Calcium (K_3) disc plates for 14 days and $H\alpha$ disc plates for 21 days supplied by the Meudon Observatory, $H\alpha$ prominence plates for 17 days and $H\alpha$ disc plates for 10 days obtained from Mr. Evershed's Observatory at Ewhurst and calcium prominence plates for 4 days from the Solar Physics Observatory, Cambridge. In spite of this International co-operation it has not been possible to collect complete data for all the days of the half-year under review, so that a certain amount of discrimination has been used in estimating the solar activity of those days for which only incomplete photographs are available. For estimating the activity of a day of incomplete observation the procedure adopted is to select the best photograph of the day as the representative one 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 secured during the half-year by means of the K line of Calcium are given below. The means are corrected for incomplete or imperfect observations in the way indicated above, the total of 182 days for which plates were available being reduced to 150 effective days.

	Mean daily areas (square minutes).	Mean daily numbers.
North	3.80	7.97
South	3.44	8.02
Total	<u>7.33</u>	<u>15.99</u>

The above figures show that compared to the previous half-year, there has been an increase both in areas and numbers, the increase being 6 per cent in areas and 14 per cent in numbers. The increase in areas is slightly more in the northern hemisphere than in the southern, while the numbers have increased almost equally in both the hemispheres.

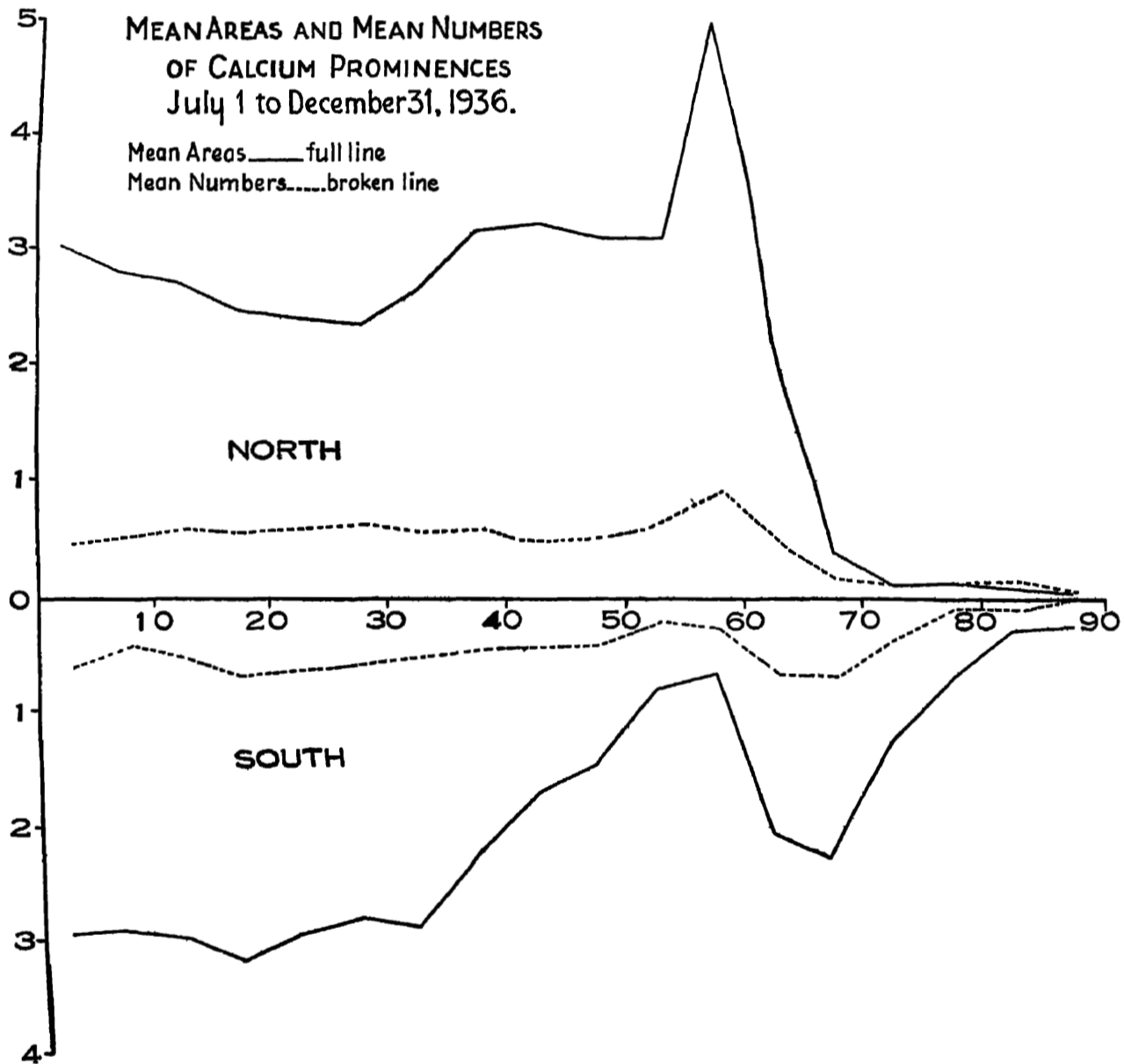
For comparison with bulletins issued prior to 1st January 1923, *i.e.*, before the co-operation of other observatories came into force, the means based on Kodaikanal photographs alone are also given, 149 days of observation being counted as 122 effective days.

	Mean daily areas (square minutes).	Mean daily numbers.
North (Kodaikanal photographs only)	3.86	7.96
South (do.)	3.50	7.76
Total	<u>7.36</u>	<u>15.72</u>

(1)

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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 zone of maximum activity has advanced towards the pole in the southern hemisphere but has remained stationary in the northern. There has been a fall in activity in the zone 50° — 60° 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 co-operating observatories are given in Table 1. 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 SECOND HALF OF 1936.

Months.	Number of days (effective).	Areas.	Numbers.	Daily means.		Mean height.	Mean extent.
				Areas.	Numbers.		
1936.						"	"
July	22½	122.0	401	5.36	17.03	37.07	5.09
August	22½	132.5	378	5.82	16.66	38.20	6.30
September	27	200.2	446	7.41	16.52	37.98	7.24
October	27½	215.5	301	7.84	14.22	40.68	8.93
November.	24½	246.1	393	10.04	16.04	44.75	8.04
December	25½	183.3	389	7.19	15.25	40.04	7.30
Third quarter	72½	454.7	1226	6.27	16.90	37.75	6.25
Fourth quarter	77½	644.9	1173	8.32	15.13	47.81	8.10
Second half-year	150	1099.6	2398	7.33	15.99	42.67	7.15

Distribution East and West of the Sun's Axis.

The areas show a slight excess and numbers a slight defect at the east limb as will be seen from the following table.

July to December 1936.	East.	West.	Percentage East.
Total number observed	1181	1219	49.19
Total areas in square minutes	553.2	546.5	50.30

Metallic Prominences.

Twenty seven metallic prominences were observed during the half-year and their details are given below :—

TABLE II.—LIST OF METALLIC PROMINENCES—JULY TO DECEMBER 1936.

Date.	Time I. S. T.		Base.	Latitude.		Limb.	Height.	Lines. (See note at end of table.)
	H.	M.		North.	South.			
			°	°	°			
1936.								
July	3	8 59	3	25.5		W	15	4 and 10.
	8	9 25	2	23		W	20	4 and 10.
	22	9 35	3	20.5		W	20	4 and 10.
August	4	9 00	2	19		E	10	4 and 10.
	9	8 58	2		20	W	10	4 and 10.
	10	9 26	1	14.5		W	15	4 and 10.
	24	9 58	6		24	E	15	1, 2, 4, 9, 10, 11 and 12.
September	13	9 30	2		17	E	10	1, 2, 3, 4, 6, 8, 9, 10 and 12.
	14	9 40	5	16.5		W	15	1, 2, 3, 4, 5, 6, 8, 9, 10, 11 and 12.
	18	9 22	3	23.5		W	15	4 and 10.
October	11	9 8	2		16	W	20	1, 2, 3, 4, 5, 9, 10 and 11.
	12	8 55	2		30	W	20	4 and 10.
	13	8 57	2	19		W	15	1, 2, 4, 5, 6, 8, 9, 10, 11 and 12.
	15	10 17	..	..	18	W	15	1, 2, 4, 5, 6, 8, 9, 10, 11 and 12.
	16	9 20	3		16.5	W	10	4 and 10.
	19	10 50	4		31	E	30	4 and 10.
	24	10 38	2		18	W	25	4 and 10.
	25	9 16	3		17.5	W	15	1, 2, 4, 5, 6, 8, 9, 10, 11 and 12.
	26	9 37	1	19.5		E	30	4 and 10.
November	11	10 25	..		17	W	10	4 and 10.
	20	10 40	2	10		W	15	4 and 10.
		10 40	1		19	W	10	4 and 10.
	23	9 15		18		E	10	4 and 10.
	24	9 25	5		18.5	E	30	1, 2, 3, 4, 5, 6, 8, 9, 10, 11 and 12.
	30	9 25	1	21.5		E	15	4 and 10.
December	14	9 40	1	21.5		W	15	4 and 10.
	20	9 02	2		28	W	10	4 and 10.

NOTE.—The key to the wave-lengths of metallic lines is as follows :—

No.	λ	Element.	No.	λ	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_4, b_3, b_2, b_1	Mg. Fe+	10	D_2, D_1	Na
5	5234.8	Fe	11	6677	He
6	5276.0	Cr	12	7065	He

The distribution of metallic prominences was as follows :—

	1°—10°.	11°—20°.	21°—30°.	31°—40°.	41°—50°.	51°—60°.	Mean latitude.	Extreme latitudes.
North .	1	6	6	..	..	..	19.4	10° and 25°.5
South .	..	10	3	1	..	..	20.4	16° and 31°

Thirteen were on the east limb and fourteen on the west limb.

Displacements of the Hydrogen Line.

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

TABLE III.—DISPLACEMENTS OF THE HYDROGEN LINE—JULY TO DECEMBER 1936.

Date.	Hour I. S. T.		Latitude.		Limb.	Displacement.			Remarks.
			North.	South.		Red.	Violet.	Both ways.	
	h.	m.	°	°		A	A	A	
1936.									
July	3	8 59	26.5		W		1		At base; from +24° to +29°.
	8	9 5	26		E				At base.
	9	9 7	78		E	1			At base.
	10	9 18		4	E	Slight			At base; from -3° to -5°.
	22	9 22	40		E		Slight		At the bottom of the floating prominence.
	24	9 18		73.5	W			0.5	In chromosphere.
		9 14		21	W		0.5		At base.
		9 7	52.5		W	0.5			At top.
August	9	8 58		19	W	0.5			At top.
		8 58		20.5	W		0.5		Do.
	10	9 26	14.5		W			0.5	At base.
	15	10 50	39		E	Slight			In chromosphere.
		10 45		11	E	2			Do.
		10 45		25	E		1		At top; from -21° to -29°.
		11 7		22	W	1			At top.
	23	10 7		30.5	E			1	At base; from -29° to -32°.
		9 51		11.5	W	1			At base.
	24	9 55		16	E	1			At top; from -15° to -17°.
		9 58		24	E			0.5	At base; from -21° to -27°.
	25	8 53	27		W			2	At top; from +25° to +29°.
		8 53	28		W				At base; from +21° to +25°.
	26	10 49	14		E	1			At base.

TABLE III.—DISPLACEMENTS OF THE HYDROGEN LINE—JULY TO DECEMBER 1936—*contd.*

Date.	Hour I. S. T.		Latitude.		Limb.	Displacement.			Remarks.
			North.	South.		Red.	Violet.	Both ways.	
	H.	M.	°	°		A	A	A	
1936.									
	11	05	24		W	1	1		To red at top and to violet at base.
	11	05	17		W	1			At top.
September	1	9 58		47	E		Slight		At top ; from -46° to -48° .
	2	9 35	21.5		E		1		At top.
		9 27		21	E			1	At base.
	4	10 35	54		W		Slight		Do.
	5	9 6	31		E		Slight		At top.
		8 44		35	E		Slight		Do.
	7	9 11		28.5	W	1			At base.
	9	8 56		39	E		1		At top.
	10	9 16		18	E	1			At base ; from -17° to -19° .
		9 16		18.5	E		0.5		At base.
		9 24		36	E		0.5		Do.
		9 25		47.5	E	2			In chromosphere.
		9 3		42.5	W			0.5	At base.
	13	9 7	10		W	1.5			At top.
	14	9 40	16.5		W	1.5	0.5		Both at base ; from $+14^{\circ}$ to $+19^{\circ}$.
	17	9 42		14	E	3			At top ; from -12° to -16° .
		9 42		20	E	1.5			At top ; from -19° to -21° .
		9 25	16		W		1.5		At top.
	18	9 36		27	W		Slight		At base.
	21	9 49		33	E	1	0.5		Both at base.
		9 26		50.5	W		0.5		At base.
		9 25		39.5	W	0.5			At top.
	22	8 55	15		E	Slight			At base.
		8 55	14		E		Slight		At top.
	25	9 22		31	W		0.5		At base.
	26	9 10	15.5		E		2		At top.
		9 10	14		E	2			At base.
	28	10 2		22	E			0.5	
		9 50	21		W	Slight			At base.
October	7	11 24		27	E		1		At top.
		11 43	83		W		2		Do.
	8	11 30	50		W	1			Do. from $+48^{\circ}$ to $+52^{\circ}$.
	9	10 00	43.5		W		0.5		At base.
		10 00	45		W	1			At top.
		9 55	47		W		2		At base.
	11	9 23		13.5	E	2			Do.
		9 7		16	W	1			At top ; from -15° to -17° .
		9 3	24		W	1			At top.
	12	8 55		30	W	1.5			At base ; from -29° to -31° .
		8 51		10	W	Slight			At top.
		8 50	11		W		0.5		At top.
		8 50	14		W	1.5			To red at top and to violet at base.
	13	8 57	19		W		2		At top.
		8 53	37		W		1		Do. ; from $+36^{\circ}$ to $+38^{\circ}$.
	15	10 17		18	W		1		At base.
		10 10	27		W		2		At top.
	18	9 40		13	W	2			Do.
	19	10 47	13.5		E		1		Do.
		10 49		23	E	1			At base.
		10 50		39	E	1.5			At top.
		10 35		34	W		0.5		At base ; from -33° to -35° .
		10 37		19	W	1			At top.
		9 22		2.5	W	2			At top ; from $+5^{\circ}$ to -10° .
	24	9 18	22		W		0.5		At base ; from $+21^{\circ}$ to $+23^{\circ}$.
		10 43	20		E	1			At top.
		10 38		18	W			0.5	Do. ; from -17° to -19° .
	26	9 30	64.5		W		0.5		At base.
		9 25	47.5		E	0.5			Do.
		9 37	19.5		E		2		At top.
		9 39	Equator		E	Slight			In chromosphere.

TABLE III.—DISPLACEMENTS OF THE HYDROGEN LINE—JULY TO DECEMBER 1936—*concl'd.*

Date.	Hour L. S. T.		Latitude.		Limb.	Displacement.			Remarks.
			North.	South.		Red.	Violet.	Both ways.	
1936.	H.	M.	°	°		A	A	A	
	9	40		22	E	3.5			At base.
	9	40		34	E	1.5			At top; from -33° to -35° .
	9	14	22.5		W	1			At top; from $+21^{\circ}$ to $+24^{\circ}$.
	9	10	64.5		W	1			At top.
29	9	7		67	W		0.5		In chromosphere.
31	9	55	40		E	1			At base.
November									
11	9	32		9.5	E		1		At base; from -7° to -12° .
	9	30		15	E	1			At base.
	10	24		17	W		1		Do.
	10	24		12	W	1			At top.
	10	40	51		W	Slight			Do.
12	9	35	Equator		W	2			Do. ; from $+1^{\circ}$ to -1° .
12	9	35	14		W	1			At top; from $+13^{\circ}$ to $+15^{\circ}$.
20	10	40	10		W		2		At base.
21	9	30	22		E		2		Throughout the height of the prominence.
	9	20		50	E	Slight			At base.
	9	40		19	W		Slight		Do.
22	9	15	28		E		Slight		Do.
23	9	6	66.5		E		1		Do. ; from $+65^{\circ}$ to $+68^{\circ}$.
	9	10	46.5		E		2.5		At top; from $+45^{\circ}$ to $+48^{\circ}$.
24	9	25		19	E			2	At the middle of the prominence from -18° to -20° .
	9	25		21	E		1		
29	9	50	16.5		E	1			At top; from $+14^{\circ}$ to $+19^{\circ}$.
30	9	30		15	E	1			At base; from -14° to -16° .
December									
3	10	55	53		E		Slight		At base.
	11	22		24	E		1		At the middle of the prominence.
	11	12		20.5	W		Slight		At base.
5	9	30	5		E		1		At top.
	9	55		21	W			1	Do.
	9	55		18.5	W	1			Do. ; from -17° to -20° .
	10	00		11	W		Slight		At base.
	10	00		8	W	1			At top.
	10	15	13		W	1			Do.
7	9	38		7	E		0.5		Do. ; from -6° to -8° .
	8	52		54	E		0.5		At base.
	9	56		33.5	W	0.5			At top; from -32° to -35° .
	9	57	24		W	0.5			At top.
9	9	33	56		W	1			Do. ; from $+54^{\circ}$ to $+58^{\circ}$.
13	10	14	7		E		1		At top.
	10	32	22		W	Slight			In chromosphere.
14	9	5	8		E		0.5		At base.
20	8	43	84		E		Slight		Do.
21	10	9		15	E	0.5			Do.
	9	8	23		W	1			Do. ; from $+22^{\circ}$ to $+24^{\circ}$.
22	10	7		21	E		0.5		At top.

The total number of displacements was $\times 133$ as against $274 \times$ in the previous half-year and their distribution was as follows:—

1°—30°	.	.	.	.	.	.	.	.	.	North.	South.
31°—60°	.	.	.	.	.	.	.	.	.	45	47
61°—90°	.	.	.	.	.	.	.	.	.	15	18
										6	2
										Total	66
											67
East limb	.	.	.	.	.	.	.	.	.	..	63
West limb	.	.	.	.	.	.	.	.	.	..	70
										Total	133

Of these displacements, 64 were towards the red, 58 towards the violet and 11 both ways simultaneously.

Reversals and Displacements on the Sun's Disc.

Three hundred and four bright reversals of the $H\alpha$ line, 288 dark reversals of the D_3 line and 27 displacements of the $H\alpha$ line were observed with the spectroscope during the half-year. Their distribution is given below :—

	North.	South.	East.	West.
Bright reversals of $H\alpha$	132	172	148	156
Dark reversals of D_3	121	167	139	149
Displacements of $H\alpha$	15	12	8	19

Twelve displacements were towards the red, 9 towards the violet and 6 both ways simultaneously.

The Hale spectrohelioscope was used daily (except on Sundays and holidays) for observation in $H\alpha$ light of changing phenomena and of displacements which cannot be readily photographed. The observations were made normally at the hours allotted by the International Astronomical Union to this observatory for spectrohelioscope observations, namely 2-30 to 3-00, 4-00 to 4-30, 5-30 to 6-00 and 6-30 to 7-00 G. M. T. or 8-00 to 8-30, 9-30 to 10-00, 11-00 to 11-30 and 12-00 to 12-30 I. S. T., but they were made at other times as well whenever interesting developments were expected. The observations made during the first half of 1936 are summarised below :—

	North.	South.	East limb.		West limb.		Total.
			East.	West.	East.	West.	
Displacements in prominences			43	56	99		
Displacements in $H\alpha$ markings	32	36	34	34	68		
Displacements in $H\alpha$ bright flocculi	5	8	11	2	13		
			Displacements towards				
			Red.	Violet.	Both ways.	Total.	
Prominences			47	52	..	99	
$H\alpha$ dark markings			41	27	..	68	
$H\alpha$ bright flocculi			9	4	..	13	

Prominences Projected on the Disc as Absorption Markings.

Photographs of the sun's disc in $H\alpha$ light were available from Kodaikanal and the co-operating observatories for, in all, 176 days which were counted as 159 effective days. The mean daily areas of $H\alpha$ absorption markings (corrected for fore-shortening) in millionths of the Sun's visible hemisphere and their mean daily numbers are given below :—

	Mean daily areas.	Mean daily numbers.
North	4562	27.56
South	4026	23.28
Total	8588	50.84

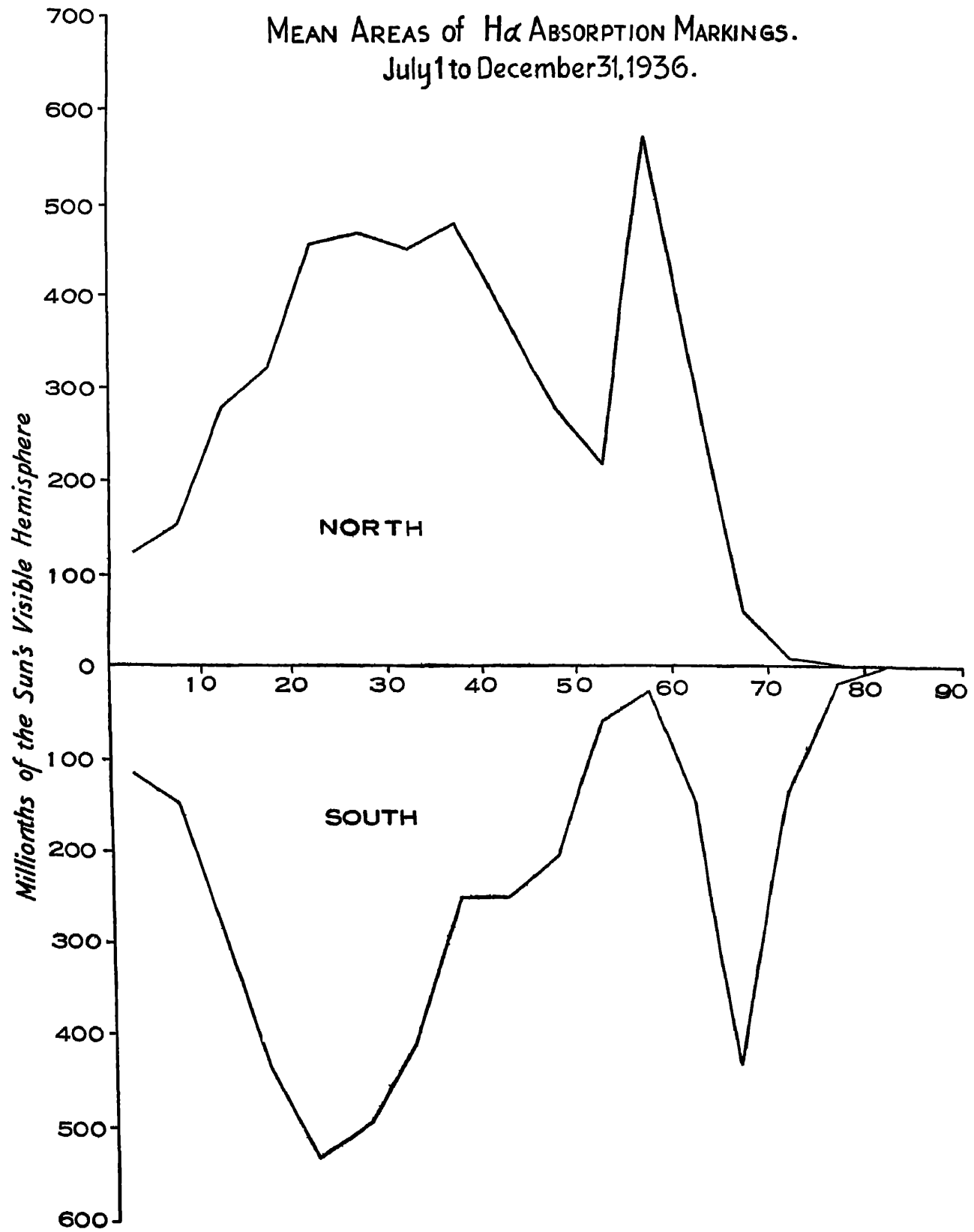
The above figures show that there has been a decrease of 10 per cent in areas but an increase of 14 per cent in numbers since the previous half-year.

For comparison with bulletins issued prior to the co-operation of other observatories the means based on Kodaikanal photographs alone are also given, 126 days of observation being reduced to 120 effective days.

	Mean daily areas.	Mean daily numbers.
North (Kodaikanal photographs only)	4679	27.02
South (do.)	3867	21.72
Total	8546	48.74

The distribution of mean daily areas in latitude is shown in the following diagram. Compared with the previous half-year the high latitude zone of maximum activity has advanced about 10° towards the poles in the southern hemisphere and remains stationary in the northern. The secondary maxima observed in the previous half-year remain almost unchanged in position; the maximum of the northern hemisphere has however become slightly more marked, while the maximum of the southern hemisphere has become slightly less

pronounced, so that in the half-year under review the secondary maxima have very nearly the same amplitude in both the hemispheres.



Compared with the previous half-year numbers show a slight eastern defect, the percentage east being 49.50.

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

	Mean daily areas.
North	2595
South	2094
Total .	<u>4689</u>

The uncorrected areas amount to 54 per cent of the corrected ones. The curve of distribution in latitude is similar to that of the corrected areas as usual.

Thanks are due to the co-operating observatories for the photographs supplied by them.

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Director, Kodaikanal Observatory.

KODAIKANAL ;
The 28th January 1938.