

Publikasjoner fra
DET NORSKE INSTITUTT FOR KOSMISK FYSIKK
Nr. 11

THE AURORAL OBSERVATORY AT TROMSØ

($\varphi = 69^{\circ} 39'.8$ N, $\lambda = 18^{\circ} 56'.9$ E Gr.)

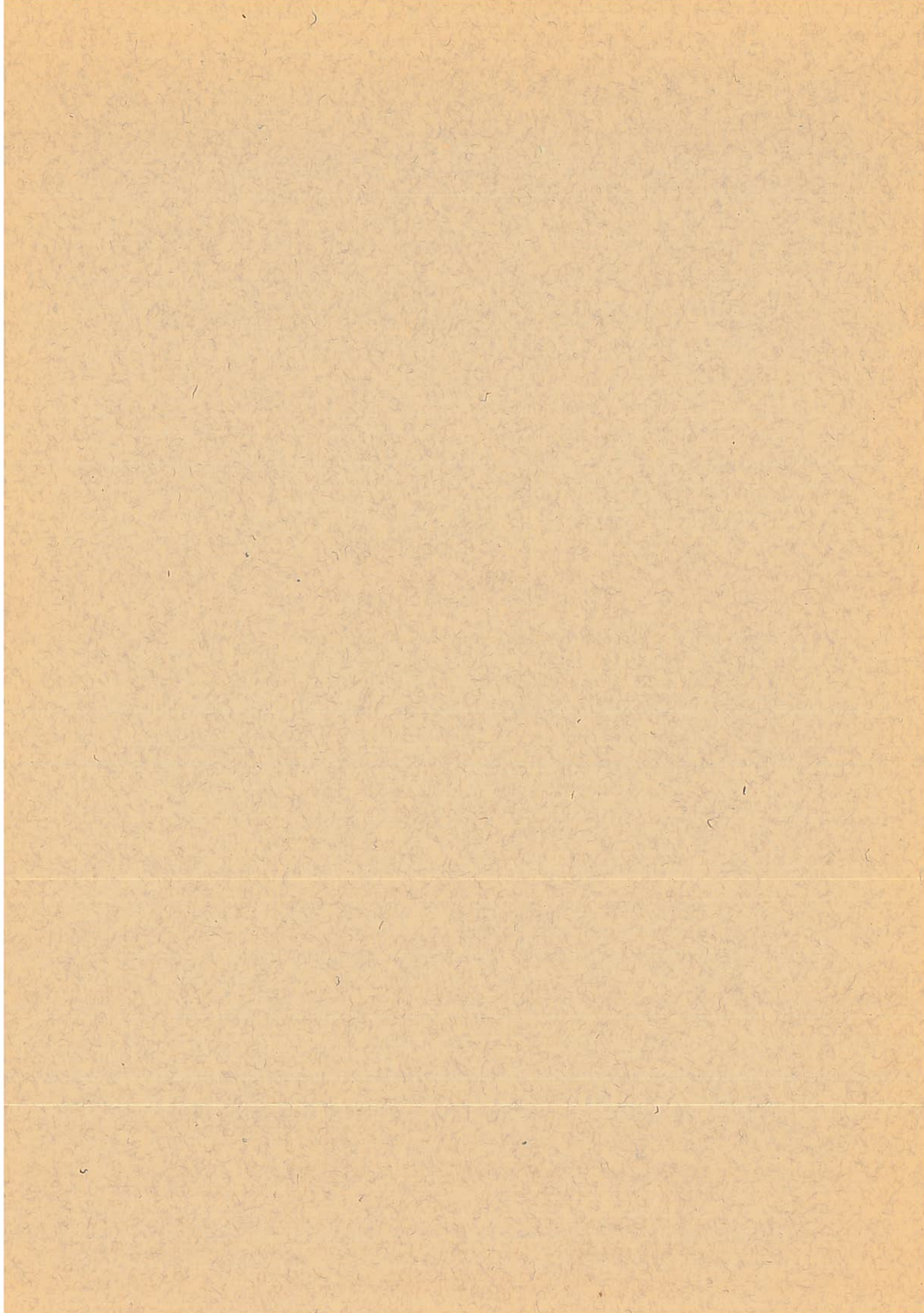
RESULTS OF RADIO ECHO OBSERVATIONS
FOR THE YEARS 1935 AND 1936

BY

LEIV HARANG

1 9 3 7

A.S JOHN GRIEGS BOKTRYKKERI, BERGEN



Publikasjoner fra
DET NORSKE INSTITUTT FOR KOSMISK FYSIKK
Nr. 11

THE AURORAL OBSERVATORY AT TROMSØ

($\varphi = 69^{\circ} 39'.8$ N, $\lambda = 18^{\circ} 56',9$ E Gr.)

RESULTS OF RADIO ECHO OBSERVATIONS
FOR THE YEARS 1935 AND 1936

BY

LEIV HARANG

1 9 3 7

A.S JOHN GRIEGS BOKTRYKKERI, BERGEN

THE AURORAL OBSERVATORY AT TROMSÖ

($\varphi = 69^{\circ} 39'.8$ N, $\lambda = 18^{\circ} 56'.9$ E Gr.)

RESULTS OF RADIO ECHO OBSERVATIONS FOR THE YEARS 1935 AND 1936

BY

LEIV HARANG

§ 1. INTRODUCTION.

The successive developments of methods for investigations of the ionized regions in the upper atmosphere, the *ionosphere*, have presented a new source of information regarding the physical conditions of the upper atmosphere. According to the current theories of aurorae and earth magnetic storms, the main origin of these phenomena is associated with the effects of intrusion of electrically charged particles in the upper atmosphere. The ionospheric studies during the last years have revealed a close connection between the appearance of aurorae, earth magnetic storms and changes within the ionosphere. It will, therefore, be desirable to incorporate the study of the ionosphere in the main programme of observations at the Observatory and to find a mode to present the results of the current ionospheric observations.

From a geophysical point of view it will be desirable to have a description of the electric state of the ionosphere as a function of the height throughout the year, this determined at a number of places selected on the globe. In the following, a presentation of the results of the critical frequency determinations of the layers in the period April 1935—December 1936 will be given. It is intended that a similar report appear annually.

Through the courtesy of the Director of The National Physical Laboratory (Teddington, England), we were allowed to copy the transmitter and receiver developed for radio echo experiments at The Radio Research Station (Slough). We wish to express our sincere thanks to the former superintendent of the Radio Research Station, Mr. R. A. WATSON WATT, and to Messrs. J. F. HERD (†), L. H. BAINBRIDGE-BELL and R. NAISMITH, who have conducted the construction and copying of the instruments. We also wish to express our sincere thanks to Prof. E. V. APPLETON, F. R. S., for most valuable discussions and suggestions concerning the preparations and plans for observations.

The purchase of the apparatus was made possible through a grant of 5.000 kr. from Statens Videnskapelige Forskningsfond and through grants from Norsk Riks-

kringkasting (The Norwegian Broadcasting Company) amounting to 6.000 kr. For these financial supports and for grants later received for carrying through the programme of observations and preparing the results for publication, we wish to express our sincere thanks.

§ 2. METHOD OF OBSERVATION AND INSTRUMENTAL EQUIPMENT.

The existence of the ionized layers by direct reflection of the waves was first proved by APPLETON by the angle of incidence method, and later by the frequency change method by APPLETON and BARNETT.¹ In 1926 BREIT and TUVE introduced the group retardation or pulse method² which is the most convenient method and now almost exclusively used. This method is also used in the observations treated in this paper. As well known, the method consists of sending out very short signals from a transmitter. In a receiver one first obtains the direct signal, the ground-wave, and shortly after the reflected signal, the echo. The time-difference between these two signals is measured out by a cathode ray oscillograph. Concerning details of the construction of the pulse transmitter and receiver, we refer to the discussion on this problem in the book by WATSON WATT, HERD and BAINBRIDGE-BELL: *The Cathode Ray Oscillograph in Radio Research*, p. 110—120 (London 1935). The transmitter consisted of a Hartley oscillator modulated through a thyatron circuit with 50 pulses per sec. locked to the frequency of the mains. The receiver was of the superheterodyne type especially designed for handling short pulses without distortion and lengthening. The receiver was provided with two sets of cathode ray oscillographs, one for recording and the other for simultaneous visual observations of the echo. The time base of the oscillographs was locked to the net frequency, and the ground-wave and the echoes therefore appeared at the same place on the screen and a steady picture was obtained.

As will be explained later, the most important quantity to be measured by these echo experiments is the critical frequencies of the layers, i. e. the limiting penetrating frequencies. This involves observations of the echoes appearing over a considerable frequency range, usually 1.0—12.0 Mgc/sec. The following procedure was used for recording the echoes appearing over a greater frequency range, (see the above mentioned book by W. W., H. and B-B. p. 118; and also R. NAISMITH, *Nature*, 133, 66 (1934). The oscillograph screen was masked so that the time base alone showed through a slit. The condenser of the transmitter was turned slowly by a motor and the tuning of the receiver was carried out by hand watching the echoes appearing on one of the oscillographs. At the same time the echoes appearing on the other oscillograph through the slit on the screen were photographed on a moving strip of photographic paper. For calibration of the oscillographs a frequency of 3000 cycles/sec. was used.

The pulse transmitter was during the first year placed in a small hut about 160 m outside the Observatory, the receiver was placed in the observatory building. During winter time at low temperatures we had difficulties with the thyatron valve in the transmitter, and from February 1936 the transmitter was placed in the same room as the receiver, the distance between the transmitter and receiver thus being about 1.5 m. The transmitting and receiving was performed on two crossed dipoles.

¹ *Nature*, 115, 333 (1925), *Proc. Roy. Soc. A* 109, 621 (1925), *Proc. Roy. Soc. A* 113, 450 (1926).

² *Phys. Rev.*, 28, 554 (1926).

According to the theory of propagation of radio waves in an ionized gas in presence of the earth magnetic field¹, a signal will be split up in several components with different states of polarisation depending on the direction of propagation relative to the earth's magnetic field. At high latitudes as in Tromsø where the direction of propagation at vertical incidence will be approximately along the direction of the field, a signal will be split up in three circular polarized components, two having the same and the third having opposite senses of rotation, all of which having different values of refractive indices and coefficients of absorption. Usually one of these three components is totally absorbed (except in high latitudes as in Tromsø during winter time, where it may be observed),² and from the magnetoionic theory the electron density N at the reflection point at vertical incidence is given by the following equations, including the polarisation term:

$$N = \frac{3 \pi m}{2 e^2} \cdot f^2 = 1.87 \cdot 10^{-8} f^2 \text{ (ordinary component)}$$

$$N = \frac{3 \pi m}{2 e^2} \cdot (f^2 - f_H f) = 1.87 \cdot 10^{-8} (f^2 - 1.39 \cdot 10^{-6} f) \text{ (extraordinary component)}$$

Here e and m are the charge and mass of the electron, f is the frequency of the radio waves and $f_H = \frac{H_0 e}{2 \pi m e}$ is the gyro frequency of the free electron which is determined by the earth's magnetic field H_0 . For Tromsø is $f_H = 1.39$ Mgc/sec.

By echo experiments the critical frequencies, *i. e.* the limiting frequencies which just penetrate the layers, can be determined and from these the *maximum* electron density of the layer is computed by means of the equations given above. The critical frequencies, or, the maximum electron density is the quantity which in the following is regarded as the most convenient measure for the ionisation in the layer.

The systematic radio echo observations have shown that the ionosphere consists of two main divisions, the lower Kennelly-Heaviside-layer or E -layer at about 120 km height and the Appleton- or F -layer at about 230 km height. The F -layer shows in day time a ledge in the ionisation curve at the lower boundary which sometimes deepens to a stratification. The ledge is named as the F_1 -layer and the main layer as the F_2 -layer. The most complete expression of the results of echorecords taken over a greater frequency range, is the P' , f -curve,³ which gives the *equivalent height* (or the *path* which is the double amount of the height at vertical incidence) of the reflection point as a function of the *frequency*.

The equivalent heights are computed from the time difference measured between the reception of the ground-wave and the echoes, putting the group velocity of the signals equal to the velocity of light. As the group velocity is always smaller than the phase velocity, the computed equivalent heights are always greater than the geometrical heights. Especially in the vicinity of the critical frequencies the group velocity decreases strongly and the equivalent heights here computed differ considerably from the geometrical heights. In the following tables the character of the P' , f -curves is taken as an indication of the gradient of the electron density in the layers, as a change in the gradient will alter the character of the P' , f -curve. On Fig. 1 a number of echo records

¹ APPLETON, J. Inst. Electr. Eng., 71, 642 (1932). ² HARANG, Terr. Mag. 41, 143 (1936).

³ APPLETON, Proc. Phys. Soc., 42, 321 (1930).

are reproduced showing the types of records obtained during summer and winter conditions, and below the P' , f -curves deduced from these records are drawn up. A and C give the typical character of the P' , f -curve during summer and winter time respectively. During spring and autumn there is a gradual development between these types.

§ 3. PRINCIPLES FOR TABULATION OF THE OBSERVATIONS.

At an earth magnetic highly disturbed place like Tromsø, lying in the vicinity of the auroral zone, the influence of the earthmagnetic storms and aurorae will be superimposed on the diurnal and annual variations of the electron density in the ionosphere, which are due to the varying heights of the Sun. It is, therefore, necessary when using the tables to be aware of the effects of the earth magnetic storms and aurorae on the P' , f -curves recorded. These are summarized as follows:¹

1. Momentary formation of a new layer in the level of the E -layer during the storm.
2. Formation of an absorbing layer below the usual E -layer during the most intense phase of the storm, cessation of echoes on all wave lengths.
3. During and after the storm, high F -layers are formed which show decreasing heights with time.
4. In periods of great earth magnetic activity the noon values of the critical frequencies of the F_1 - and F_2 -layers are reduced.
5. During periods of earth magnetic activity the P' , f -curves vary due to changes in the gradient of the electron density.
6. During periods of earth-magnetic activity the reflection coefficient of the layers decreases.

Observations for determining the critical frequencies and the P' , f -curves have been taken regularly at 10h, 12h, and 14h *local* time, usually on six days in the week. At intervals, day runs during which the P' , f -curves were determined each half hour during 24 or 36 hours were undertaken in order to obtain the diurnal variations at different seasons, and for studying the influence of the aurorae and the earth-magnetic storms.

In the following tables the results of the critical frequency determinations taken regularly during the day will be given. The following quantities have been tabulated:

The critical frequency of the *ordinary* component (*i. e.* the lower of the two critical frequencies). For the F_1 - and F_2 -layers the ordinary and extraordinary components are usually identified easily. For the E -layer the extraordinary component is usually absorbed totally and only the ordinary component is visible as a critical frequency.²

The reflection coefficient (REFL. COEFF.) estimated from the intensity and numbers of the multiple reflections, as high (H), medium (M), low (L) and very low (VL).

The column headed NOTES contains a characterization of the P' , f -curve.

In the last column the earth-magnetic activity during the day is characterized. (The hourly values of the activity, the Storminess, is tabulated in the Observatory's yearbook on the results of the earth-magnetic registrations, publication No. 8 and 12).

¹ APPLETON, NAISMITH and BUILDER, *Nature*, 132, 340 (1933). A more detailed and quantitative study of the effects are given in the following papers: Harang, *Gerl. Beiträge zur Geophysik*, 46, 438 (1936), *Terr. Mag.*, 41, 143 (1936), *Terr. Mag.*, 42, (1937), *Geofysiske Publikasjoner* Vol. XIII, No. 17 (1937), Oslo.

² RATCLIFFE and E. L. C. WHITE, *Phil. Mag.*, 16, 125 (1933).

In the tables, N.R. denotes No Records and TR. denotes that only Traces of echoes have been recorded.

At the end of the yearbook, summary tables and figures are given. Further reproduction of typical records for critical frequency determinations during quiet and earth-magnetic disturbed conditions are given. The typical diurnal maximum electron density curves for the layers at different seasons of the year given in fig. 3 have been computed from the critical frequencies observed using the equations given on p. 5.

From the summary tables and also from fig. 1 it is evident that a considerable annual increase in the values of the critical frequencies from 1935 to 1936 was observed. For the F_2 -layer this increase was so great that the wave range of the transmitter and receiver had to be extended in order to obtain the critical frequencies recorded in some cases. For a short period in the autumn 1936 we have, therefore, not obtained the critical frequencies on some days with very high values. This is indicated in the tables by marking out the values by <, and in fig. 1 by a vertical arrow. Judging from the character of the P', f-curve and the gradual increase of the equivalent heights with frequency, the actual critical frequencies on these days are not more than 0.5—1.0 Mgc/sec. greater than the minimum values given in the tables.

We wish to express our thanks to M. JACOBSEN, instrument maker, and Mr. T. MELKILD who have assisted during the observations.

Fig. 1. Echo Records.

- A. Record taken 27/5 1935 at 9h 10m MET. E -, F_1 - and F_2 -layers are present. Summer conditions of the ionosphere.
- B. Record taken 4/7 1935 at 15h 05m MET.
- C. Record taken 12/10 1936 at 11h MET. Only E - and F_2 -layer, with high critical frequencies of the F_2 -layer. Winter conditions of the ionosphere.
- D and E. Records taken 10/10 1935 at 18h 05m and 18h 11m MET/ during an earthmagnetic disturbance. A number of layers in the E -niveau and between E and F are appearing. Typical record during an earthmagnetic disturbance of moderate strength accompanied by auroral.

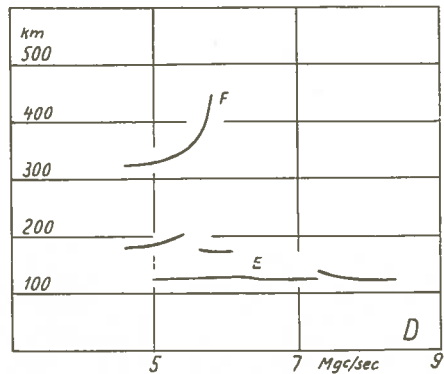
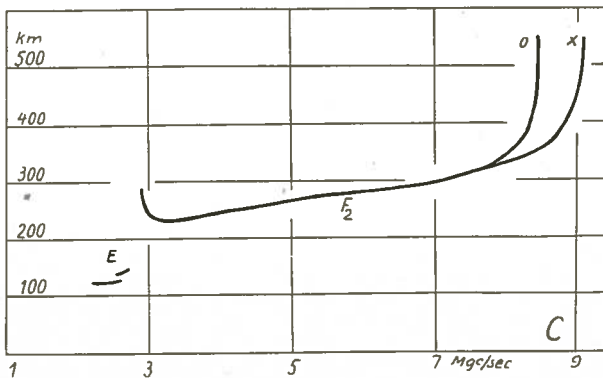
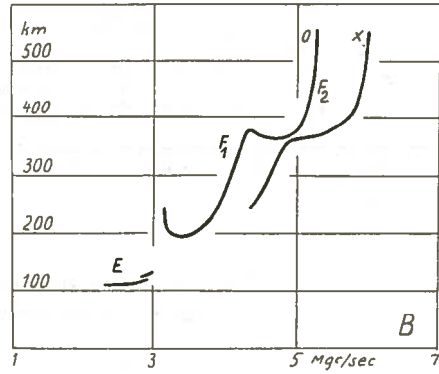
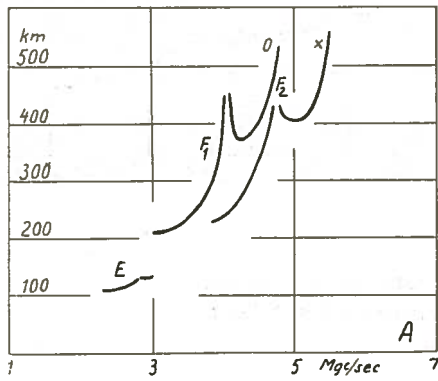
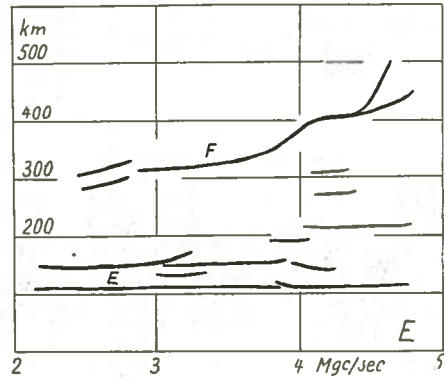
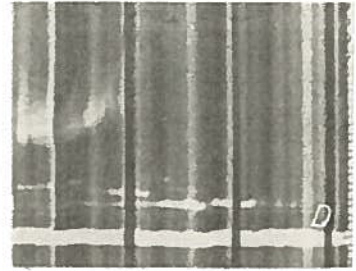
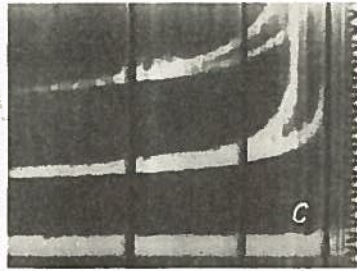
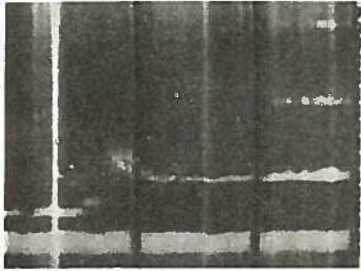
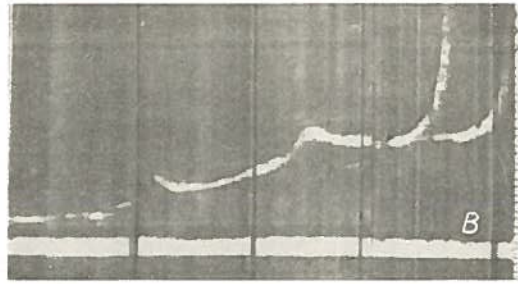
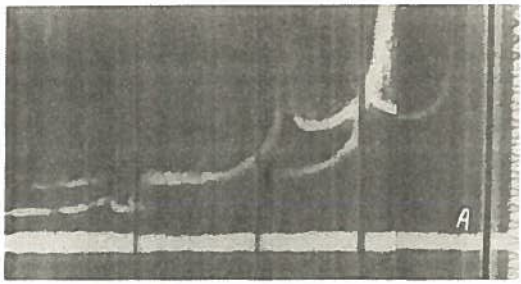


Fig. 1.

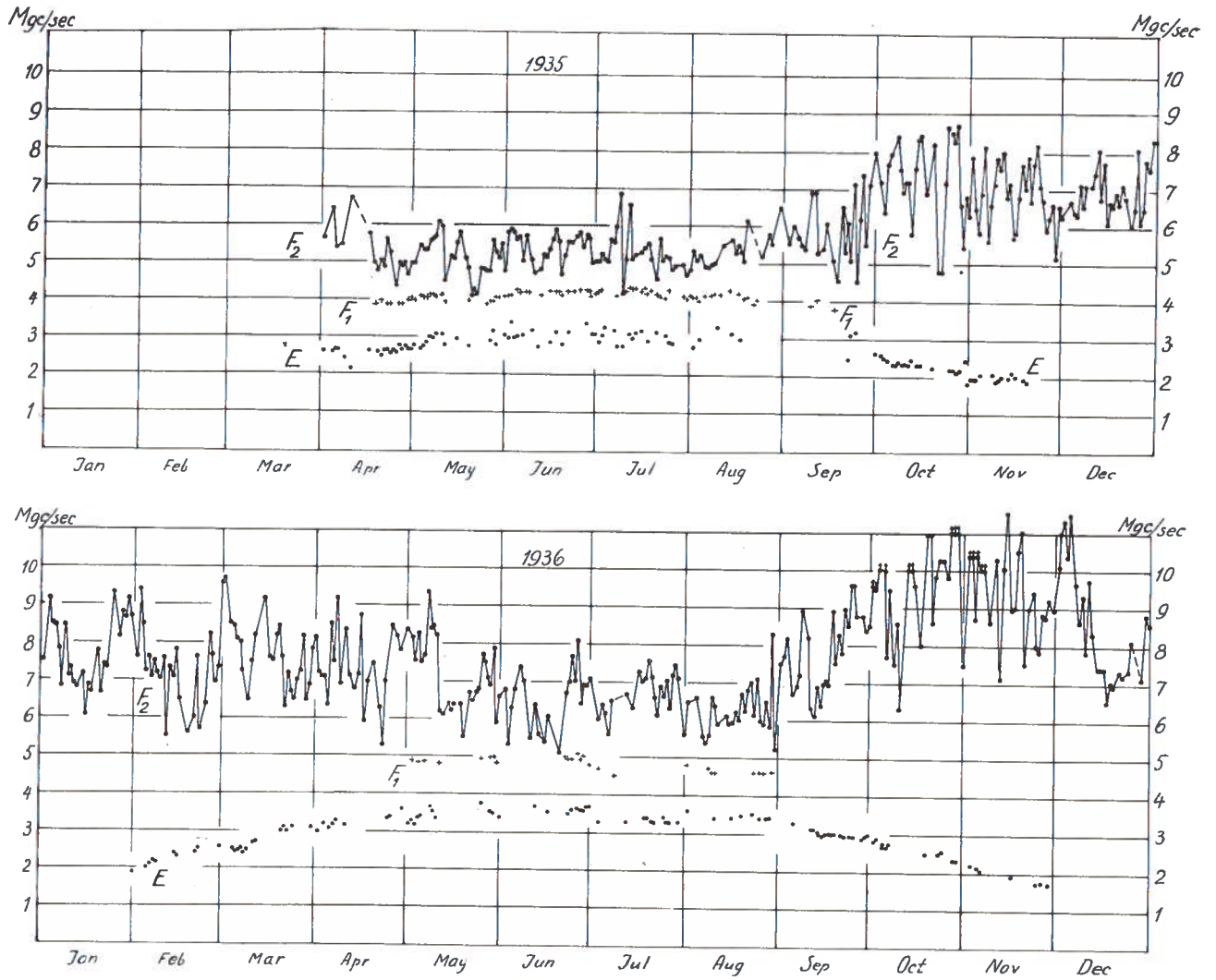


Fig. 2.

Noon-values of the critical frequencies in Mgc/sec. for the E-,
F₁ and F₂-layers during the year, — only ordinary component.

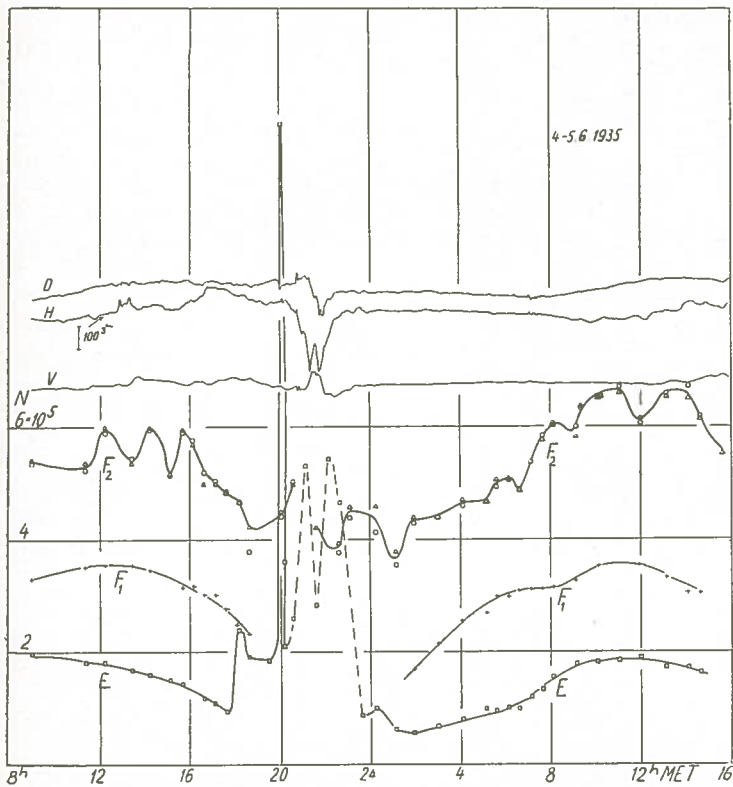
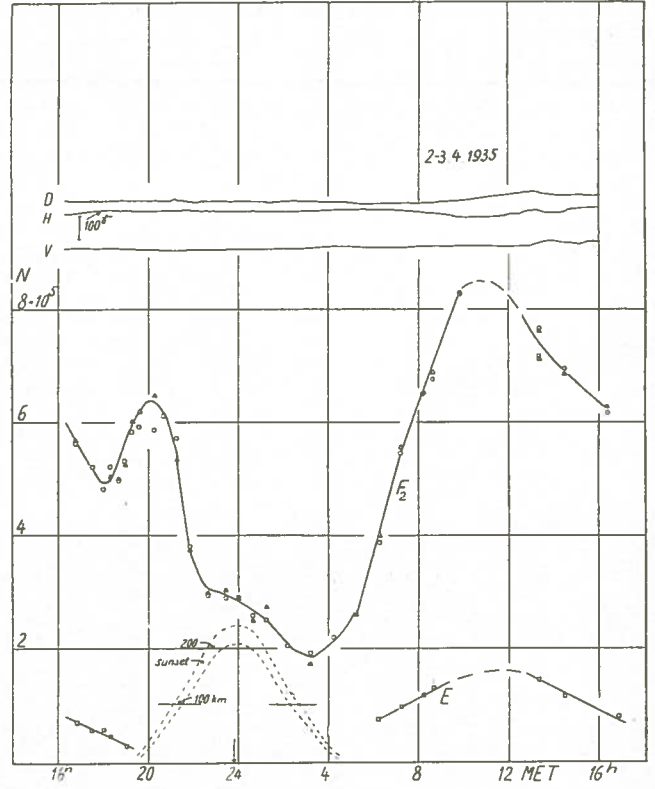
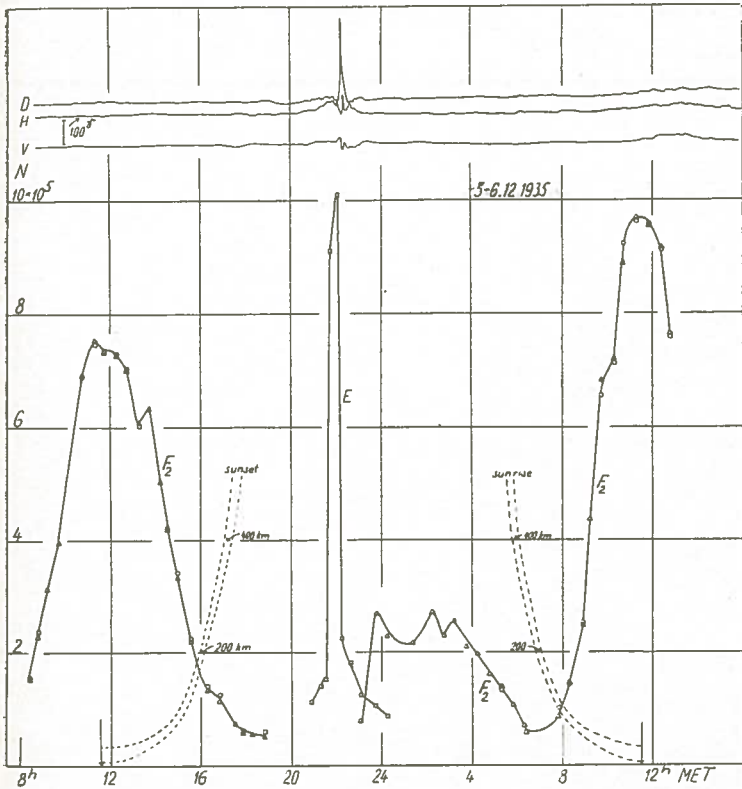


Fig. 3.

Diurnal variations of the maximum electron densities in the E-, F₁- and F₂-layers during winter, spring and summer time, computed from the critical frequencies recorded. In the figures 0 and Δ designate the maximum electron-density N in the F₂-layer computed from the ordinary and extraordinary component, + the maximum electron-density in the F₁-layer computed from the ordinary component and □ the maximum electron-density in the E-layer computed from the ordinary component.

The earthmagnetic records from the observatory are reproduced at the top of each figure. The broken line indicates the time of sunset (and sunrise) in different heights, the two lines indicate the position of the Earth's shadow with and without taking the effect of refraction into account.

TABLES

APRIL 1935

CRITICAL FREQUENCIES IN MGC/SEC										REPL. COEF.	NOTES	EARTH MAGNETIC CONDITIONS
DAY	F ₂ - LAYER			E - LAYER			F ₁ - LAYER					
	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h			
1		5.68		2.65						M	NORMAL P', F-CURVE, E ^{II} -LAYER	VERY QUIET
2												
3												
4		6.45		2.62						M	" "	SMALL DISTURBANCE
5		5.40		2.68						M-L	" "	VERY QUIET
6		5.40		2.68						L	" "	" "
7												
8		5.50		2.45						M	" "	QUIET
9												
10		6.74		2.20						M	IRREGULAR "	GREAT STORM APPROACHING
11												
12												
13												
14												
15												
16		5.80		2.66						L	IRREGULAR "	SMALL DISTURBANCE
17												
18		5.00						3.88		VL	NO E-ECHOES	STORM
19		4.80		2.62						L	NORMAL P', F-CURVE	SOME DISTURBANCE
20		5.06		2.52				3.98		M	" "	QUIET
21		4.90		2.68						M	" "	"
22		5.66		2.70				3.90		M	" "	"
23		5.30		2.59				3.90		M-L	ONLY TRACES OF F-ECHOES	SOME DISTURBANCE
24				2.66						VL	IRREGULAR P', F-CURVE	QUIET, STORM PRECEDING NIGHT
25		(4.40)		2.62						L-VL	NORMAL "	QUIET
26		5.00		2.80				3.88		M-L	" "	"
27		4.92		2.70				3.90		M	" "	"
28		5.02		2.80						L	" "	"
29		4.68		2.72				4.00		VL	" "	"
30		5.00		2.70				4.06		L-VL	" "	"
M:		5.30		2.63				3.94				

MAY 1935

CRITICAL FREQUENCIES IN MGC/SEC													REPL. COEF.	NOTES	EARTH MAGNETIC CONDITIONS	
DAY	F ₂ - LAYER			E - LAYER			F ₁ - LAYER			10 ^h	12 ^h	14 ^h				
	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h							
1		5.00			2.82			4.00					M	NORMAL P',F-CURVE	QUIET	
2		N.E.													NO ECHOES	GREAT STORM
3		5.50			2.72			4.10					M	NORMAL P',F-CURVE	SMALL DISTURBANCE	
4		5.38			2.80			4.05					M	" "	QUIET	
5		5.38			2.90			4.05					M	" "	VERY QUIET	
6		5.60			3.00			4.15					M-L	" "	QUIET	
7		5.65			3.00			4.14					V	" "	"	
8	5.30	5.73	5.90	3.00	3.10	2.90		4.10					M	" "	"	
9	5.91	6.12	5.58			2.96							H	" "	"	
10	6.32	5.98	5.82	3.15	3.10	3.00							H-M	" "	"	
11	4.72	4.50	(4.50)	2.80	2.62			3.97					L-VL	ABNORMAL GREAT F ₁ -LEDGE	STORM PRECEEDING NIGHT	
12	SCATTERED ECHOES			SCATTERED ECHOES									VL	ONLY F-ECHOES	" " "	
13	5.21	TR.	N.E.	NO ECHOES									L	" "	" " "	
14	4.80	5.10	4.87			2.80							L	IRREGULAR P',F-CURVE	QUIET	
15	5.85	5.56	5.52		3.00	2.78							M	NORMAL P',F-CURVE	"	
16	5.85															STORM
17	NO RECORDS															QUIET
18	5.10	5.12		2.66	NO ECHOES			4.00					L	" "	VERY QUIET	
19		4.86	4.86		2.80	2.75							L-VL	IRREGULAR P',F-CURVE	STORM PRECEEDING NIGHT	
20	NO ECHOES (4.10)					3.13									" "	GREAT STORM
21	4.32							3.82					VL	" "	QUIET	
22	TRACES		4.15			2.80							VL	TRACES OF F-ECHOES	SMALL DISTURBANCE	
23	4.83	TR.		TRACES									VL	" "	QUIET	
24	4.86	4.82	4.74										M-L	NORMAL P',F-CURVE,HIGH E-IONISATION	QUIET	
25	4.82		4.78	N.E.		2.80		3.90	3.96				L	" "	QUIET	
26	4.80	4.80	5.00	2.97	2.97	2.60		4.18	4.00	3.94			M	" "	"	
27	4.92	5.62	4.95	2.78	3.22	3.00		4.03	4.00	3.95			H-M	" "	SMALL DISTURBANCE	
28	5.38	5.29	5.05	2.60	2.84	2.73		3.95	4.10				M	" "	"	
29	5.20	5.14							4.10				M	" "	"	
30	5.85	5.50											M	" "	SOME DISTURBANCE	
31	5.06	4.80	5.06	3.08	3.10	3.10		4.13	4.12	4.04			M-L	" "	QUIET	
M	5.22	5.31	5.06	2.88	2.95	2.88		4.04	4.06	4.02						
JUNE																
1	6.05	5.85	5.32	2.75	3.02	2.80		4.25	4.12	4.17			M	NORMAL P',F-CURVE	QUIET	
2		5.90	5.72		3.45	2.80			4.16	4.20			M	" "	"	
3	N.E.	5.83	5.35						4.30	4.20			L	" "	SMALL DISTURBANCE	
4	5.30	5.62	5.65	2.98	3.02	2.80		4.22	4.22	4.20			M	" "	"	
5	5.92	5.70	6.00	2.99	3.03	2.93		4.21		4.10			M	" "	"	
6		5.03	5.00			3.21			4.23				L	" "	"	
7	6.08	5.75	5.13	3.02	3.08	2.94		4.22	4.25	4.08			M	" "	"	
8	NO ECHOES														NO ECHOES	GREAT STORM
9		5.09			3.25			4.20					M	IRREGULAR P',F-CURVE	" "	
10	FAINT F		4.77			2.80		4.05					VL	" "	STORM	
11	NO ECHOES														NO ECHOES	"
12	4.72	4.85	4.70	2.89	2.80	2.85			4.16				L	IRREGULAR P',F-CURVE	SOME DISTURBANCE	
13	5.08	5.25	4.90	2.74	N.E.	2.93							L	" "	"	
14	5.24		5.18	3.02		2.90		4.16		4.22			M	NORMAL P',F-CURVE	QUIET	
15	5.82	5.40	5.20	3.05	2.93	2.93		4.38	4.25	4.25			M-L	" "	VERY QUIET	
16		5.67											L-VL	" "	QUIET	
17	6.03	5.92	5.50	3.12	3.20	2.85		4.28	4.25	4.23			M	" "	"	
18	5.46	5.60	N.E.	NO E-ECHOES				4.23	4.25				M-L	" "	STORM	
19	4.60	4.70	4.88	2.80	2.85	2.90		4.08	4.15	4.10			L	IRREGULAR P',F-CURVE	SMALL STORM	
20	5.21	5.25	4.82			3.10			4.24	4.16			VL	" "	SOME DISTURBANCE	
21	5.28	5.60	5.57	3.15	3.20	2.87				4.32			VL	NORMAL P',F-CURVE	SMALL DISTURBANCE	
22	5.60														QUIET	"
23	NO RECORDS															"
24	5.94	5.75	5.45	3.00		3.15		4.30	4.25	4.20			M	NORMAL P',F-CURVE	"	
25	5.63	5.85	5.85						4.34				M	" "	"	
26	5.93	5.44	5.40			3.30				4.23			L-VL	" "	"	
27	5.73	(5.80)	5.50	3.20	3.40	2.83		4.28	4.30	4.20			M	" "	SMALL DISTURBANCE	
28	5.73	5.68	5.85					4.18	4.27	4.30			M	" "	"	
29	4.77	5.00	N.E.	3.08	3.10				4.10				L	" "	SOME DISTURBANCE	
30		5.05	5.07		3.10	3.10			4.20				L	" "	"	
M	5.51	5.48	5.31	2.98	3.17	2.95		4.22	4.23	4.20						

JULY 1935

CRITICAL FREQUENCIES IN MCG/SEC										REPL. COEF.	NOTES	EARTH MAGNETIC CONDITIONS
DAY	F ₂ - LAYER			E - LAYER			F ₁ - LAYER					
	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h			
1	5.32	5.03	5.13	2.19	2.90	2.83	4.15	4.22	4.22	H-M	NORMAL P',F-CURVE	SMALL DISTURBANCE
2	5.33	5.27	5.19	3.03	3.11	2.70	4.28	4.30	4.20	M	"	"
3	5.53	5.12	5.30	3.40	3.30	3.18	4.18		4.30	M	"	QUIET
4	5.50	5.03	5.30	2.90		3.40			4.15	H	"	"
5	5.50	5.63	5.30	2.95						M	"	VERY QUIET
6	5.45	5.56	5.27	3.08	3.22	3.30	4.32			M	"	"
7		6.00	5.52		2.81	2.81		4.12	4.20	M-L	"	QUIET
8	(6.90)	N.E.	TR.	NO E-ECHOES			4.05			M	IRREGULAR	GREAT STORM
9	N.E.		4.21			2.80				L-VL	"	SOME DISTURBANCE
10	5.18	5.10	5.10				4.12	4.23	4.09	M-L	NORMAL	QUIET
11	6.03	6.60	5.62		3.12	2.94	4.40	4.35	4.23	M-L	"	"
12	5.28	5.12	5.12		3.00	2.69	4.16	4.32	4.20	M	"	SMALL DISTURBANCE
13	5.42	5.24	5.60	2.90	3.17	(2.65)	4.30	4.33	4.32	M-L	"	QUIET
14	NO ECHOES										NO ECHOES	SMALL DISTURBANCE
15	5.22	5.30	4.98	2.80	3.20	2.90	4.21	4.23	4.13	M	NORMAL	"
16	5.50	5.42	5.10	NO E-ECHOES			4.16	4.28	4.19	M	"	"
17	5.51	5.58	5.10	2.97	2.97	2.71	4.24	4.21		H-M	"	QUIET
18	5.50	5.12	5.10	2.70		(3.03)	4.28	4.28		M	"	"
19	TRACES			TRACES						VL	IRREGULAR	SMALL DISTURBANCE
20	4.65	(4.60)	5.06	3.20	3.20	3.00	4.13	4.18	4.10	L	"	QUIET
21		(5.68)						4.13		M	NORMAL	SOME DISTURBANCE
22	N.E.	5.10	5.20	NO E-ECHOES					4.08	L	"	"
23	5.12	5.22	5.20	2.80	3.10	2.82	4.02	4.08	4.15	L	"	"
24	N.E.	5.15	5.45	N.E.	2.92	2.83		4.30	4.15	M	"	"
25	N.E.	4.82	N.E.	N.E.	2.90			(3.93)		L	"	STORM
26	(4.50)	(4.98)					3.91			VL	"	QUIET
27	VERY FAINT ECHOES									VL	"	SMALL DISTURBANCE
28	NO RECORDS										"	"
29	4.95	4.98					4.13	4.12		L	"	"
30	(4.50)	4.70						4.05	4.05	M-L	NORMAL P',F-CURVE	QUIET
31		4.85	TR.		(3.50)			4.12		M	"	SMALL DISTURBANCE
M:	5.34	5.25	5.19	2.99	3.09	2.91	4.18	4.20	4.17			
AUGUST												
1	5.22	5.35	5.22	2.70	2.80		3.94	4.10	4.03		IRREGULAR P',F-CURVE	SMALL DISTURBANCE
2	(4.70)	5.05	4.60	(3.50)			4.13	4.10			NORMAL P',F-CURVE	QUIET
3	(4.60)	5.27	5.00		3.00		4.04	4.00	4.00		"	"
4	NO RECORDS										"	"
5	4.80	4.95	5.02				4.12	4.12	4.16		IRREGULAR	SMALL DISTURBANCE
6	TR.		4.93						4.13		"	"
7	(4.85)	5.00		2.70			4.00	4.17	4.00		NORMAL	"
8	5.03	5.05	5.00	2.90			4.14	4.21	4.11		"	QUIET
9	TR.	5.28	5.12		3.30	2.93			4.02		"	SMALL DISTURBANCE
10	TR.	5.50	TR.				4.26	4.20	4.20		"	"
11	NO RECORDS										"	QUIET
12	BAD	"									"	"
13	5.42	5.68	5.20	2.90			4.14	4.30	4.15		"	"
14	5.85	5.30	5.62	3.08	3.16	3.00	4.30				"	"
15	5.43		5.56	3.15		3.10					"	"
16	5.85	5.35	N.R.	3.07	3.00		4.12	4.21	4.13		"	SMALL DISTURBANCE
17	TR.	5.04	4.85	2.70			4.04	4.06			"	QUIET
18	NO RECORDS										"	"
19	5.70	6.20	6.12					4.10			"	SMALL DISTURBANCE
20	BAD RECORDS								4.00		"	"
21	"	"					3.97	3.96			"	"
22	"	"						4.05	3.98		IRREGULAR	SOME DISTURBANCE
23	"	"									NO ECHOES	SMALL
24	5.18		5.28				4.05				"	QUIET
25	NO RECORDS										NORMAL P',F-CURVE	SMALL DISTURBANCE
26	6.00	5.80	5.80								"	QUIET
27		5.53	5.13								"	"
28	5.72	5.89	5.60								"	SMALL DISTURBANCE
29	NO RECORDS										"	QUIET
30	6.30	6.53	5.80	2.90							"	SMALL DISTURBANCE
31	NO RECORDS										"	"
M:	5.38	5.45	5.29	2.96	3.05	3.01	4.10	4.12	4.08			

SEPTEMBER 1935

CRITICAL FREQUENCIES IN MGC/SEC

DAY	F ₂ - LAYER			E - LAYER			F ₁ - LAYER			REPL. COEFF.	NOTES	EARTH MAGNETIC CONDITIONS
	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h			
1	NO RECORDS											QUIET
2	5.52										BAD RECORD	VERY QUIET
3	6.03		5.70								" "	" "
4	5.88	5.95	5.70								NORMAL P',F-CURVE	" "
5	5.70	5.74	5.42								" "	SMALL DISTURBANCE
6	5.30	5.52	5.50								" "	" "
7	5.58	5.40	5.52								" "	" "
8	NO RECORDS										" "	QUIET
9	6.45	6.95	6.20								" "	" "
10	6.35	6.95	6.70					3.90			" "	SOME DISTURBANCE
11	N.R.	5.28	N.R.								" "	STORM
12	NO ECHOES							4.02			NO ECHOES	GREAT STORM
13			5.40								BAD RECORD	QUIET
14	5.84	6.10									NORMAL P',F-CURVE	" "
15	NO RECORDS										" "	" "
16			5.05								BAD RECORD	SOME DISTURBANCE
17	NO ECHOES										NO ECHOES	STORM
18		4.52						3.80			ABNORMAL P',F-CURVE	GREAT STORM
19		6.55	6.30								NORMAL "	SOME DISTURBANCE
20			5.30								BAD RECORD	" "
21	5.44	6.10		2.40	2.42						NORMAL P',F-CURVE	QUIET
22		5.05			3.10						" "	" "
23	6.70	7.17	5.72		2.60	2.40					" "	SOME DISTURBANCE
24	4.40	4.52	4.95		3.20	2.40					FAINT ECHOES	GREAT STORM
25	(6.45)	6.20									NORMAL P',F-CURVE	" "
26	(6.60)	7.40	7.25								" "	" "
27	5.60	5.50	5.40			2.93					" "	SOME DISTURBANCE
28	7.00	7.12	6.02								" "	" "
29	NO RECORDS										" "	" "
30	7.20	8.00	5.95		2.62						" "	STORM
M:	6.00	6.11	5.79	(2.40)	2.79	(2.64)		(3.91)				
OCTOBER												
1	NO ECHOES (5.21)			NO ECHOES						VL	IRREGULAR P',F-CURVE	SOME DISTURBANCE
2	7.45	7.22	6.70	2.46	2.56	2.40				H	NORMAL "	QUIET
3	5.65	6.35	6.05	2.35	2.45	2.25				M	" "	" "
4	6.40	7.68	6.95	2.33	2.40	2.26				VH	" "	" "
5	(7.42)	(7.98)	N.R.	2.30	N.R.					M-H	" "	" "
6	NO RECORDS										" "	" "
7	6.90	8.40	7.50	2.26	2.30	N.E.				M	" "	" "
8	7.22	7.50	8.50	2.30	2.34	2.25				M	" "	SOME DISTURBANCE
9	6.60	6.90	7.90	2.24	2.30	2.17				M	" "	SMALL "
10	6.65	7.20	7.00	2.22	2.32	2.15				M	" "	QUIET
11	5.80	7.21	6.95	2.27	2.30	2.25				M	" "	" "
12	5.20	5.80	6.02	2.20	2.45	2.10				M	" "	SMALL DISTURBANCE
13	N.R.	7.65	N.R.	NO RECORDS							" "	QUIET
14	N.R.	(8.30)	(6.73)	N.E.	2.30	2.17				M-L	" "	SOME DISTURBANCE
15	6.20	8.42	7.45	2.23	2.31	(2.95)				M	" "	" "
16	NO ECHOES 5.91			NO ECHOES						VL	" "	STORM
17	6.20	6.88	6.74							M-L	" "	SOME DISTURBANCE
18	N.E.	TR.	(5.75)							VL	" "	" "
19	7.45	8.20	7.90	(2.30)	2.22					H	" "	" "
20	(6.90)	NO ECHOES									" "	GREAT STORM
21	NO ECHOES (4.80)									VL	IRREGULAR P',F-CURVE	" "
22	(4.75)	N.E.	(4.80)							VL	" "	" "
23	6.20	7.20	7.08							M	NORMAL "	QUIET
24	8.60	8.70	N.E.							M-L	SOME IRREGULARITIES	GREAT STORM
25	7.40	8.55	5.42	2.08	2.21	2.03				M	NORMAL P',F-CURVE	QUIET
26	(7.60)	8.28	8.00	2.22	2.20	1.92				H	" "	" "
27	(8.70)				2.13					H	" "	GREAT STORM APPROACHING
28	N.E.	6.60	6.20		2.19	1.95				L	" "	STORM
29	5.90	N.E.	5.00	2.06	N.E.	1.98				L	" "	" "
30	7.00	6.83	N.E.		2.45					L	IRREGULAR "	GREAT STORM
31	(6.25)	6.30	5.25		1.80	(3.10)				L	" "	" "
M:	6.63	7.51	6.62	2.25	2.29	2.14						

JANUARY 1936

CRITICAL FREQUENCIES IN MGC/SEC										REFL. COEF.	NOTES	EARTH MAGNETIC CONDITIONS
DAY	F ₂ - LAYER			E - LAYER			F ₁ - LAYER					
	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h			
1		7.50								H	NORMAL P ₁ , P-CURVE	QUIET
2	5.40	8.00	7.05							H	" "	"
3	5.20	9.15	7.80							H	" "	"
4	(6.00)	8.50								H	" " .SCATTERING	"
5		8.45								M	" "	"
6	5.80	7.80	7.95							H	" "	"
7	4.60	6.80	6.65							H	" "	"
8		8.45	4.70							M	IRREGULAR "	STORM APPROACHING
9	N.E.	7.05								L	" "	SOME DISTURBANCE
10		(7.35)	IRR.							L	" "	" "
11	4.90	6.90								L	" "	" "
12		6.80								M	" "	" "
13	4.50	6.90	TR.							L	" "	" "
14		7.15								M	" "	" "
15	TR.	6.05	5.90							L	" "	" "
16	(5.00)	6.85	5.85							H	NORMAL "	QUIET
17	5.52	6.65	6.10							H	" " .SCATTERING	"
18	N.E.									M	IRREGULAR "	STORM
19		7.75								M	" "	SMALL DISTURBANCE
20	(4.70)	6.65	5.35							M	NORMAL "	QUIET
21	6.22	7.40	(6.25)							H	" "	"
22	(7.60)	7.30	TR.							H	" "	DISTURBANCE
23	(4.80)	8.70	6.50							M	IRREGULAR "	"
24	5.95	9.30	8.20							H	NORMAL "	"
25	5.80	8.60	7.70							M	" "	STORM
26		8.10								M	" "	"
27	7.12	8.80	8.70							H	" "	SOME DISTURBANCE
28		8.65	8.20							H	" "	" "
29	7.00	9.20	8.15							H	" "	QUIET
30	6.80	8.70	7.70							H	" "	SOME DISTURBANCE
31	7.70	TR.	8.60							M	IRREGULAR "	" "
M:	5.78	7.78	7.09									
FEBRUARY												
1	6.32	(7.60)		1.85						M	NORMAL P ₁ , P-CURVE	SMALL DISTURBANCE
2			9.40							H	" "	QUIET
3	7.60	8.50	7.90							M	" "	"
4	7.25	N.E.	(7.10)							M	IRREGULAR "	SMALL DISTURBANCE
5	(6.70)	(7.60)	(7.10)		2.00					M	" "	SOME "
6	8.50	7.05	(7.70)			2.05	1.80			H	NORMAL "	QUIET
7	6.80	7.50	7.50	1.90	2.18	2.10				M	" "	"
8	6.70	7.20	8.10	1.90	2.10					H	" "	"
9	NO REC.		(7.00)							M	IRREGULAR "	SOME DISTURBANCE
10	N.E.	TR.	(7.60)							M	" "	" "
11	(4.50)	N.E.	6.30			2.25				M	" "	" "
12	6.25	7.35	(7.90)							H	NORMAL "	QUIET
13	(7.30)	7.05								M	" "	"
14	5.80	7.80	TR.		2.40					H	" "	"
15	5.50	6.50		2.05	2.30					M	IRREGULAR "	SMALL DISTURBANCE
16			TR.							VL	" "	STORM
17	N.E.	N.E.	N.E.									"
18	N.E.	5.60	(5.50)							VL	VERY PAINT ECHOES	SOME DISTURBANCE
19	N.E.	N.E.	TR.							VL	" "	STORM
20	6.00		6.00				2.30			L	NORMAL P ₁ , P-CURVE	QUIET
21	TR.	7.60	6.55		2.40	2.30				M	IRREGULAR "	SOME DISTURBANCE
22	5.70	N.E.								L	NORMAL "	" "
23	NO RECORDS											" "
24	N.E.	6.35	7.05		2.50					L	" "	SMALL "
25	7.50	8.20	8.50			2.36				M	IRREGULAR "	SOME "
26	7.40	7.65	7.25							H	NORMAL "	QUIET
27	N.E.	6.90	5.90							M	IRREGULAR "	STORM
28	6.55	7.30	7.50			2.45				M	NORMAL "	QUIET
29	9.20	9.50	(9.50)	2.38	2.55					M	" "	"
M:	6.64	7.40	7.37	(2.02)	2.48	(2.22)						

MARCH 1936

CRITICAL FREQUENCIES IN Mc/SEC										REPL. COEF.	NOTES	EARTH MAGNETIC CONDITIONS
DAY	F ₂ - LAYER			E - LAYER			F ₁ - LAYER					
	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h			
1		9.70										SMALL DISTURBANCE
2		NO RECORDS										QUIET
3		8.50	9.45			2.35				H	NORMAL P ₁ , P ₂ -CURVE	"
4	7.85	8.42	9.05		2.32	2.52	2.50			H	"	"
5	7.22	8.10	8.40		2.40	2.42	2.40			H	"	"
6	7.15	8.05	8.45		2.40	2.45	2.32			H	"	"
7	6.85	7.30	7.35			2.52	2.45			H	"	SMALL DISTURBANCE
8		NO RECORDS										"
9	5.92	6.50	6.85			2.40				M	"	SOME "
10	7.18	7.50	8.10		2.38	2.50	2.48			H	"	QUIET
11	7.75	8.20	7.50			2.70	2.45			H	"	"
12	7.50		8.60		2.60	2.70	2.60			H	"	"
13		NO RECORDS										"
14	8.80	9.20								M	IRREGULAR	"
15		NO RECORDS										"
16	7.30	7.60	8.15		2.78					H	NORMAL	"
17	(6.50)	7.55	8.10							H	"	"
18	7.00	8.20	8.10							M	"	SOME DISTURBANCE
19	7.50	8.45	8.60				2.82			H	"	SMALL "
20	8.25	N.E.	(7.60)			(3.00)				M	IRREGULAR	STORM
21	N.E.	(6.30)				3.10				M	"	"
22	NO RECORDS	7.20				2.98				H	NORMAL	SMALL DISTURBANCE
23	TR.	N.E.	6.70							M	IRREGULAR	STORM
24	N.E.	6.50	6.80			3.13				H	NORMAL	"
25	6.23	7.00	6.65							H	"	"
26	N.E.	7.26	7.68				2.90			H	"	SOME DISTURBANCE
27	7.40	8.20								M	IRREGULAR	"
28	5.70	6.45	7.60		2.90	3.00				M	NORMAL	QUIET
29		(6.90)								L	IRREGULAR	SOME DISTURBANCE
30	7.17	7.85	8.45			3.10				H	NORMAL	QUIET
31	7.65	8.15	7.75							H	"	"
M:	7.21	7.73	7.87		2.54	2.75	2.58					
APRIL												
1	7.10	7.25	7.80		3.00	3.05	3.00			H	NORMAL P ₁ , P ₂ -CURVE	SMALL DISTURBANCE
2	6.54	7.10	6.80		NO ECHOES					M-L	ONLY F-ECHOES	"
3	6.63	7.10	7.20		3.10	3.20	3.00			H	NORMAL P ₁ , P ₂ -CURVE	"
4	N.E.	6.30								M-L	ONLY F-ECHOES	"
5		8.50				3.08				H	NORMAL P ₁ , P ₂ -CURVE	QUIET
6	7.40	7.50	7.50		3.20	3.20	3.20			H	"	"
7	9.30	9.20	9.00		3.10	3.25	3.15			H	"	SMALL DISTURBANCE
8	N.E.	6.90								M	IRREGULAR	STORM
9		NO RECORDS										QUIET
10		8.35				3.15				M	NORMAL	"
11		7.15								M	"	"
12		NO RECORDS										SOME DISTURBANCE
13		6.00								M	IRREGULAR	"
14	6.70	7.20	7.80							M	NORMAL	"
15	8.00	8.80	6.70							M-L	IRREGULAR	STORM
16	5.50	5.90	6.75				(3.30)			M	NORMAL	QUIET
17	6.30	7.00	7.10							L	"	"
18		NO ECHOES										STORM
19		7.50								L	"	"
20	N.E.	N.E.	5.35							VL	IRREGULAR	"
21	N.E.	6.30	N.E.							L	"	"
22	N.E.	5.30	N.E.							VL	"	"
23	N.E.	7.00	6.40							L	"	"
24	6.40	7.80	6.80			3.35	3.30			H	NORMAL	SOME DISTURBANCE
25	7.60	8.45	7.60			3.40	3.40			M	"	"
26		NO RECORDS										QUIET
27	8.20	TR.	8.30		3.35		3.30			M	"	"
28	8.30	7.80	7.50		3.45					M	"	"
29	7.40	8.10	8.10		3.30	3.60	3.25			H	"	"
30	8.05	8.40	7.50							M	"	"
M:	7.30	7.40	7.29		3.21	3.25	3.21					

MAY 1936

CRITICAL FREQUENCIES IN MGC/SEC										REFL. CORF.	NOTES	EARTH MAGNETIC CONDITIONS
DAY	F ₂ - LAYER			E - LAYER			F ₁ - LAYER					
	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h			
1		7.00			3.20					H	NORMAL P ₁ ,P-CURVE	QUIET
2	7.65	8.15		3.30	3.30			4.90		H	" "	"
3		7.50			3.20					H	" "	"
4	9.00	8.30	7.50		3.35	3.30		4.85	4.80	H	" "	SOME DISTURBANCE
5	7.20	7.50	7.50	3.30	3.40	3.30				M	" "	QUIET
6	7.80	7.70	7.50	3.40				4.85		H	" "	"
7	9.10	9.40	9.20	3.40		3.30				H	" "	"
8	8.90	8.40	8.05	3.30	3.65					H	" "	"
9	8.60	8.50		3.35	3.55					H	" "	"
10		8.20			3.35					M	" "	"
11	6.60	6.20	6.50	3.30		3.30		4.80		M	" "	SMALL DISTURBANCE
12	6.20	N.E.	5.90							L	IRREGULAR	SOME "
13	NO ECHOES											" "
14	6.80	6.40	6.40							L	" "	" "
15	6.25	6.20	6.50							VL	" "	" "
16		6.40								VL	" "	STORM
17	NO RECORDS											"
18	N.E.	6.40	5.50							VL	" "	"
19	6.15	5.50	N.E.							VL	" "	"
20	NO ECHOES											"
21	N.E.	6.70									" "	SOME DISTURBANCE
22		6.45		3.32				4.85		L	NORMAL	SMALL "
23		6.70		3.35						M	" "	QUIET
24		6.80								M	" "	"
25	7.80	7.70	7.50	3.40	3.75	3.40		4.80	4.95	H	" "	"
26	7.50	7.50	6.50	3.40				4.85		M	" "	STORM
27	6.65	7.10	6.70							M	IRREGULAR	SOME DISTURBANCE
28	7.30	6.90	6.90	3.50	3.55	3.50			4.98	H	" "	QUIET
29	7.40	7.90	6.30	3.40	3.50			4.80	4.95	H	" "	STORM
30	5.85	5.90						4.70	4.80	M	" "	QUIET
31		6.60			3.40			4.80		M	" "	"
M:	7.32	7.19	6.96	3.36	3.43	3.35		4.80	4.89	4.80		
JUNE												
1	NO RECORDS											STORM
2	7.20	6.80	5.60							M	IRREGULAR P ₁ ,P-CURVE	SOME DISTURBANCE
3	5.30	5.45	5.50							H	NORMAL	QUIET
4		6.30	7.00			3.30				H	" "	"
5	7.35		6.30					4.75		H	" "	"
6	7.20	7.20								H	" "	"
7		7.40								M	" "	"
8	6.85		7.15							H	" "	"
9	IRR. SCATTERING									L	IRREGULAR	STORM
10	5.70		5.40	3.30				4.60	4.65	M	" "	"
11												SOME DISTURBANCE
12		6.40	5.70			3.70				M	NORMAL	SMALL "
13	6.00	5.60								M	" "	" "
14										L	IRREGULAR	SOME "
15	5.60	5.40								L	" "	" "
16	6.50	6.10				3.55				M	" "	" "
17	NO RECORDS											" "
18	"	"										" "
19	IRR. SCATTERING									L	SCATTERED ECHOES	GREAT STORM
20	5.40	5.10		3.45						M	IRREGULAR P ₁ ,P-CURVE	SOME DISTURBANCE
21	NO RECORDS											SMALL "
22	6.60	6.70	6.60	3.45		3.50		5.00		H	NORMAL	QUIET
23	6.80	7.00	7.10	3.50	3.55			4.95	4.95	4.95	H	" "
24	7.60	7.70	7.30		3.60	3.55		4.90	4.95		H	" "
25	6.90	7.00	6.90	3.50		3.50		4.95		5.00	H	" "
26	8.40	8.10	7.30	3.55	3.65	3.50		6.10	5.10	5.00	H	" "
27	6.20	6.40		3.50	3.60				4.90		H	" "
28		6.90			3.60				5.00		H	" "
29	7.00	6.90	6.60	3.65	3.70	3.55				4.90	H	" "
30	7.40	7.10	6.70		3.70	3.40		4.80			H	" "
N:	6.61	6.61	6.51	3.49	3.61	3.47		4.87	4.96	4.90		

JULY 1936

CRITICAL FREQUENCIES IN MGC/SEC										REFL. COEF.	NOTES	EARTH MAGNETIC CONDITIONS
DAY	F ₂ - LAYER			E - LAYER			F ₁ - LAYER					
	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h			
1	6.90	6.50	6.00	3.55	3.60	3.50	4.80	4.80	4.60	H	NORMAL P', P-CURVE	QUIET
2	N.E.	TR.	TR.							VL	HIGHLY IRREGULAR	STORM
3	NO ECHOES											SOME DISTURBANCE
4	6.70	6.60								L	SOME IRREGULARITIES	QUIET
5	NO ECHOES											SOME DISTURBANCE
6	5.60	TR.	TR.							VL	IRREGULAR P', P-CURVE	STORM
7	5.40	TR.	5.60						4.60	VL	" "	SOME DISTURBANCE
8	6.00	5.60	6.10					4.70	4.60	M	SOME IRREGULARITIES	" "
9	6.40	6.60	6.10	3.40			4.60	4.60	4.60	M	NORMAL P', P-CURVE	QUIET
10		6.40	5.80		3.40	3.40		4.60	4.60	M	" "	SOME DISTURBANCE
11	5.90	N.E.	N.E.									STORM
12	NO RECORDS											SOME DISTURBANCE
13	TRACES											" "
14	6.10		6.00	3.40		3.40	4.60		4.60	M	" "	QUIET
15			5.90		3.40					L	" "	"
16	5.80		6.10	3.40		3.40				M	" "	"
17	6.10		6.30	3.40		3.40	4.60			M	" "	SMALL DISTURBANCE
18	5.90	6.00	5.90	3.40		3.35	4.50			H	" "	SOME "
19		6.70			3.45					M	" "	SMALL "
20		6.20								L	" "	" "
21	6.20	6.80	6.60							M	" "	QUIET
22		7.00								M	" "	"
23	6.20	6.10	5.90	3.30	3.50	3.40	4.60	4.60		H	" "	"
24	7.60	7.10	7.05			3.40				H	" "	"
25	6.10	6.00	6.10	3.30	3.40		4.50	4.60		M	" "	"
26		5.90			3.40			4.60		M	" "	"
27		6.50								VL	IRREGULAR "	SMALL DISTURBANCE
28	5.70	5.80			3.40					L	NORMAL "	" "
29	7.20	6.30	7.90		3.40		4.50	4.60		M	" "	DISTURBANCE
30	5.20			3.30			4.40			L	" "	SOME DISTURBANCE
31												SMALL "
M:	6.16	6.46	5.97	3.40	3.40	3.40	4.60	4.60	4.60			
AUGUST												
1												SMALL DISTURBANCE
2												QUIET
3		6.00			3.30			4.70		L	NORMAL P', P-CURVE	"
4	6.50		6.30							L	" "	"
5		6.15								M	" "	SMALL DISTURBANCE
6		5.60								VL	" "	" "
7		6.50								M	" "	QUIET
8								4.50			" "	"
9	NO ECHOES											SMALL DISTURBANCE
10	NO ECHOES											DISTURBANCE
11												QUIET
12		6.70			3.30							"
13												"
14		6.30										"
15												"
16		7.30								H	NORMAL P', P-CURVE	"
17		7.00								M	" "	"
18		7.10	6.90		3.40	3.35				M	" "	"
19	7.70	7.60			3.20					H	" "	"
20	6.90	7.10	7.30		3.25	3.30	3.25			H	" "	"
21	6.40	6.60	N.E.		3.30					H	" "	"
22		(6.10)								VL	IRREGULAR "	"
23		6.90								M	NORMAL "	"
24	6.80	6.60	6.80		3.30	3.40	3.22			M	" "	"
25	6.90	7.10	6.80			3.30				M	" "	"
26	6.30	6.30	6.90		3.25	3.30	3.10			H	" "	"
27	7.20		7.20		3.30		3.10			H	" "	SOME DISTURBANCE
28	7.30	7.50	7.30				3.40			M	" "	QUIET
29	7.30	7.10			3.05	3.30				M	" "	"
30	NO RECORDS											SOME DISTURBANCE
31	5.90	5.60	6.00							L	SOME IRREGULARITIES	" "
M:	6.84	6.66	6.83	3.23	3.30	3.24		4.60				

SEPTEMBER 1936.

CRITICAL FREQUENCIES IN MGC/SEC.										REFL. COEF.	NOTES	EARTH MAGNETIC CONDITIONS
DAY	F ₂ - LAYER			E - LAYER			F - LAYER					
	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h	10 ^h	12 ^h	14 ^h			
1	7.70	7.50	7.50							L	NORMAL P',F-CURVE	QUIET
2	7.40	7.70	7.70			3.05				M	" "	"
3		8.20	7.60	3.10						M	" "	"
4	NE	NE	7.40								SOME IRREGULARITIES	SMALL DISTURBANCE
5	7.00	6.70	NR	3.10	3.25					M	NORMAL P',F-CURVE	" "
6	6.90	NR	NR	3.20						L	" "	QUIET
7	7.10	7.20	7.20	3.10						M	" "	"
8	NE	8.90	7.90							L	" "	SMALL DISTURBANCE
9	TRACES											" "
10	7.10	8.20	8.50							VL	" "	" "
11	6.30	6.30	6.40	3.00	3.10	3.00				M	" "	" "
12	6.30	6.10	NR		3.10					L	" "	QUIET
13	NR	6.90	NR		3.05					L	" "	"
14	6.30	6.40	7.20	2.90	2.95					L	" "	"
15	6.60	7.00	7.10	2.70	2.95					M	" "	"
16	6.70	7.05	7.60	2.80	3.00	2.75				M	" "	"
17	7.00	7.00	6.70	2.95	3.00	2.90				M	" "	"
18	8.70	9.00	9.00	2.75	3.00					H	" "	"
19	6.70	7.50	NR	2.75	3.00					M	" "	"
20	NR	NR	8.40								" "	"
21	7.10	7.80	8.40	2.65	3.00	2.80				H	" "	"
22	8.60	9.00	8.70	2.80	2.95	2.85				H	" "	"
23	7.70	8.50	8.60							L	" "	DISTURBANCE
24	8.60	9.50	9.50		2.95	2.80				H	" "	QUIET
25	8.70	9.50	9.30		2.95	2.75				H	" "	"
26	9.30	8.80	NR							L	IRREGULAR	DISTURBANCE
27	NO RECORDS											SMALL DISTURBANCE
28	9.10	8.80	8.80		2.90					H	NORMAL P',F-CURVE	" "
29	7.20	8.40			2.95					M	" "	" "
30	8.30	8.50	9.50			2.70				H	" "	QUIET
M.	7.50	7.85	8.05	2.93	3.01	2.84						
OCTOBER												
1	9.50	9.60	NE							M	NORMAL P',F-CURVE	QUIET
2	9.50	9.50	10.00	2.65	2.80	2.60				H	" "	"
3	9.50	10.00	NR	2.60	2.85					H	" "	"
4	NO RECORDS										" "	"
5	9.50	10.00	10.00	2.60	2.75	2.60				H	" "	"
6	7.50	7.70	NE	2.60	2.65					M	" "	DISTURBANCE
7	9.50	9.50	9.20	2.60	2.75	2.55				H	" "	SMALL DISTURBANCE
8	NE	NE	7.50			2.55				M	" "	DISTURBANCE
9	7.50	8.60	TR							M	" "	"
10	6.00	6.30	NR							L	IRREGULAR	GREAT DISTURBANCE
11	NO RECORDS											"
12	8.40	9.80	10.00								" "	QUIET
13	10.00	10.00	10.00	2.50	2.55					H	NORMAL P',F-CURVE	"
14	9.20	10.00	10.00	2.40	2.55	2.40				H	" "	"
15	7.70	9.60	9.40	2.37	2.55					H	" "	"
16	9.50	10.50	10.00							M	" "	"
17	7.10	(8.00)	NR							L	SCATTERING	DISTURBANCE
18	NO RECORDS										" "	"
19	10.50	(11.00)	9.00	2.35	2.50	2.45				H	NORMAL P',F-CURVE	QUIET
20	9.40	(11.00)	11.00			2.35				H	" "	"
21	7.50	8.60	8.50								" "	"
22	8.50	9.80	11.60	2.30		2.30				H	" "	"
23	9.50	10.20	(10.30)		2.50					H	" "	"
24	9.50	10.20	NR		2.53					H	" "	SMALL DISTURBANCE
25	NO RECORDS										" "	"
26	9.50	9.80	9.10			(2.42)					" "	QUIET
27	10.00	11.00	10.60							H	" "	"
28	9.80	11.00	11.00		2.35					H	" "	"
29	10.20	11.00	11.00		2.35					H	" "	"
30	NO RECORDS										" "	"
31	9.70	7.50		2.10						M	" "	"
K.	8.98	9.61	9.90	2.46	2.59	2.47					SOME IRREGULARITIES	DISTURBANCE

RESUMING TABLES.ANNUAL VARIATION OF THE CRITICAL FREQUENCIES OF THE F_2 - LAYER. 1935.

LOCAL TIME.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
10 ^h					5.22	5.57	5.34	5.38	6.00	6.62	5.77	4.66
12 ^h				5.30	5.31	5.48	5.25	5.45	6.11	7.51	6.90	7.00
14 ^h					5.06	5.31	5.19	5.29	5.79	6.62	6.29	5.59

ANNUAL VARIATION OF THE CRITICAL FREQUENCIES OF THE F_1 - LAYER. 1935.

LOCAL TIME.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
10 ^h					4.04	4.22	4.18	4.10				
12 ^h				3.94	4.06	4.23	4.20	4.12	(3.91)			
14 ^h					4.02	4.20	4.17	4.08				

ANNUAL VARIATION OF THE CRITICAL FREQUENCIES OF THE E - LAYER. 1935.

LOCAL TIME.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
10 ^h					2.88	2.98	2.99	2.96	(2.40)	2.25	1.88	
12 ^h				2.63	2.95	3.17	3.09	3.05	2.79	2.29	1.98	
14 ^h					2.88	2.95	2.91	3.01	(2.64)	2.14	1.90	

ANNUAL VARIATION OF THE CRITICAL FREQUENCIES OF THE F_2 - LAYER. 1936.

LOCAL TIME.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
10 ^h	5.78	6.64	7.21	7.30	7.32	6.61	6.16	6.84	7.50	8.98	7.69	6.13
12 ^h	7.78	7.40	7.73	7.40	7.19	6.61	6.46	6.66	7.85	9.61	9.42	8.52
14 ^h	7.09	7.37	7.87	7.29	6.96	6.57	5.97	6.83	8.05	9.90	7.03	8.23

ANNUAL VARIATION OF THE CRITICAL FREQUENCIES OF THE F_1 - LAYER. 1936.

LOCAL TIME.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
10 ^h					4.80	4.87	4.60					
12 ^h					4.89	4.96	4.60	4.60				
14 ^h					4.80	4.90	4.60					

ANNUAL VARIATION OF THE CRITICAL FREQUENCIES OF THE E - LAYER. 1936.

LOCAL TIME.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
10 ^h		(2.02)	2.54	3.21	3.36	3.49	3.40	3.23	2.93	2.46	1.82	
12 ^h		2.48	2.75	3.25	3.43	3.61	3.40	3.30	3.01	2.59	1.93	
14 ^h		(2.22)	2.58	3.21	3.35	3.47	3.40	3.24	2.84	2.47	1.88	

