IRPL-R7

SECOND REPORT ON EXPERIMENTAL STUDIES OF IONOSPHERIC PROPAGATION AS APPLIED TO THE LORAN SYSTEM

ISSUED

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PREPARED BY INTERSERVICE RADIO PROPAGATION LABORATORY
National Bureau of Standards
Washington, D C

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
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Contents

Introduction

The report IRPL-R6, "Experimental Studies of Ionospheric Propagation as Applied to the Loran System", contained the results of Loran sky-wave measurements by the IRPL during October 1943 to January 1944. The measurements were made for the purpose of determining:

(a) The reliability with which sky waves, suitable for Loran measurements, are received at various distances.
(b) The effective layer heights.
(c) Reasonable correction values to be applied to time-difference measurements involving sky waves in order to convert them into equivalent ground-wave time differences.
(d) The variation in corrections that may reasonably be expected as a result of changing ionosphere conditions.
(e) The effects of frequency upon sky-wave Loran propagation.

The conclusions reached and the further work that was considered desirable are listed on pages 18 and 19 of IRPL-R6.

A similar program of Loran measurements was conducted during June and July 1944 to determine the effects of differences in ionospheric conditions during the summer and winter months (in line with V(c), p.19 of IRPL-R6). The present report gives the findings of the summer program.

II. Program of Observations

Measurements of the difference in the time of arrival of Loran ground-wave and sky-wave pulses on 1,950 kc were made during the months of June and July 1944. Because of the rapid variations in the ionosphere with time of day and from one day to the next which have been observed in previous studies it was considered highly desirable, from the standpoint of interpretation of the measurements, to have a large number of observations. A total of 41,528 measurements were made on emissions from three pairs of Loran transmitting stations. A standard Loran receiver and indicator were used for the reception and measurement of the pulses. All sky-wave measurements were made using the leading edge of the first sky-wave pulse.

Observations were made at the IRPL radio receiving station at Sterling, Va., near Washington, D.C., and at a temporary location at Longport, N.Y.

Three sets of ground-wave measurements were made, for pairs of distances of 104, 442; 218, 689; and 442, 885 kilometers, for comparison with values calculated from the coordinates of the points of transmission and reception.

Three sets of ground-wave and sky-wave measurements were made to determine the difference in the time of arrival of the ground and sky waves (sky-wave delay) for distances of 442, 689, and 885 kilometers.

Three sets of sky-wave measurements were made to determine the difference in the sky-wave delay (sky-wave correction) for distances of 218-689, 689-1123, and 1123-1514 kilometers.

The measurements made at Sterling were on transmissions from four Loran stations, as follows:

Station	Distance, in km	Loran pair number
A	218	
		0
B	689	
		1
C	1123	
		2
D	1514	

These observations, made at various times of the day and night, included every day in June and 19 days in July 1944.

The measurements made at Longport were on transmissions from three Loran stations, as follows:

Station	Distance, in km	Loran pair number
A	104	
		0
B	442	
		1
C	885	

Continuous observations were made at this location from 0900 local time 11 July to 0900 local time 15 July 1944.

III. Discussion of Results

1. Ground-wave Observations.

Summaries of ground-wave observations at Longport, N.J., in January and July 1944 are shown in Tables I and II. Table III contains a summary of ground-wave observations made at Sterling, Va., during the periods of December 1943 - January 1944 and June-July 1944. In Tables I, II, and III, column 1, the first number in the figure group identifies the Loran pair from which the measurement was made.

The Longport measurements on the "0" pair were made at distances of 104 and 442 kilometers. The transmission path from station "B" (distance = 442 kilometers) was entirely over sea water. The great-circle path from station "A" (distance = 104 kilometers) ran near the coast line for the entire distance. An increase in ground-wave transmission time from station "A" caused a corresponding increase in the ground-wave reading at this location. The amplitudes of the ground-wave pulses were entirely adequate at all times of the day and night for satisfactory ground-wave measurements.

The distances involved in the Longport measurements on the "1" pair were 442 and 885 kilometers. Both transmission paths were over sea water. The amplitude of the ground-wave pulses from station "C" (distance = 885 kilometers) was not satisfactory for use during the night.

The Sterling measurements on the "0" pair were made at distances of 218 and 689 kilometers. The transmission path from station "A" (distance = 218 kilometers) was entirely over land. The transmission path from station "B" (distance = 689 kilometers) was approximately half over sea water and half over land. The amplitude of the ground-wave pulses from station "B" was not adequate for satisfactory measurement during the night, because of atmospheric radio noise. The amplitude of the ground-wave pulses from station "A" was satisfactory for nighttime measurements approximately half of the time during June and July.

The distribution of ground-wave observations made during June and July 1944 are illustrated in Fig. 1.

On the basis of the distributions of ground-wave observations, it seems that ± 2 microseconds is a reasonable probable error for a single observation and ± 15 microseconds is a reasonable maximum error to be expected from a single observation, as a result of errors in both synchronization at the transmitting stations and measurement at the receiving point.

2. Sky-wave Observations.

Sky-wave measurements during June and July 1944 were attempted in periods covering all hours of the day and night, for distances of 218, 442, 689, 885, 1123, and 1514 kilometers. The periods during which sky waves were usually received are listed below:

Distance, in km	Period during which sky waves were usually received
218	All hours
442	1500 to 1000 local time
689	1500 to 1000 local time
885	1730 to 0745 local time
1123	1830 to 0645 local time
1514	1845 to 0645 local time

Table I.

Loran Ground-Wave Observations on Pair No. 0 - Longport, N.J.
Distances from transmitters: 104 and 442 kilometers.
Calculated Loran reading: 01647.8.

Loran ground-wave reading in microseconds	Number of observations 18-22 Jan. 1944	Number of observations 11-15 July 1944
01642	2	1
01643	-	-
01644	-	-
01645	13	-
01646	5	-
01647	25	8
01648	127	259
01649	281	657
01650	205	887
01651	64	895
01652	15	142
01653	2	5
01654	1	1
01655	-	-
01660	-	1
Total number of observations:	740	2,856
Average reading:	01649.2	01650.0
Median reading:	01649	01650

Table II

Loran Ground-Wave Observations on Pair No. 1 - Longport, N.J.
Distances from transmitters: 442 and 885 kilometers,
Calculated Loran reading: 13911.0

Loran ground-wave reading in microseconds	Number of observations 18-22 Jan. 1944	Number of observations 11-15 July 1944
13901	1	1
13902	3	-
13903	-	2
13904	1	4
13905	1	4
13906	-	9
13907	2	19
13908	10	68
13909	23	247
13910	54	409
13911	60	392
13912	29	187
13913	14	108
13914	6	81
13915	4	40
13916	1	42
13917	3	7
13918	2	21
13919	2	9
13920	1	1
13921	-	4
13922	-	3
Total number of observations:	217	1,658
Average reading:	13910.8	13911.0
Median reading:	13911	13911

Table III

Loran Ground-Wave Observations on Pair No. 0 - Sterling, Va.
Distances from transmitters: 218 and 689 kilometers
Calculated Loran reading: 01210.6

Loran ground-wave reading in microseconds	Number of observations 8 Dec. 1943 to 14 Jan. 1944	Number of observations 1 June 1944 to 29 July 1944
01201	-	1
01202	2	1
01203	2	2
01204	-	-
01205	-	-
01206	4	2
01207	4	1
01208	13	9
01209	52	69
01210	138	83
01211	178	276
01212	114	312
01213	51	276
01214	38	339
01215	26	229
01216	11	366
01217	22	299
01218	23	379
01219	38	249
01220	19	138
01221	6	93
01222	2	30
01223	-	13
01224	-	1
01225	-	-
01226	-	1
01229	-	2
Total number of observations:	743	3,174
Average reading:	01212.3	01215.2
Median reading:	01211	01215

No sky waves were observed between 0900 and 1500 local time from distances greater than 689 kilometers.

During December 1943 and January 1944 sky waves were usually received at all hours of the day from distances of 218, 442, 689, 885, and 1123 kilometers. Sky waves were received at all times during the night and about fifty percent of the time during the middle of the day from a distance of 1514 kilometers.

The amplitudes of the sky wave pulses were greatest between 2100 and 0300 local time. E-layer sky waves (corresponding to equivalent reflection heights between 80 and 130 kilometers) were always present during this period for distances equal to or greater than 442 kilometers. This condition was observed during both the summer and winter observational programs.

The sky-wave pulse patterns varied widely in shape and amplitude. The most complex patterns were observed during the night and on transmissions over the shorter paths.

Three sets of measurements were made of the difference in the times of arrival of the ground and sky waves (sky-wave delay), on transmissions over distances of 442, 689, and 885 kilometers. The observed values of sky-wave delay varied with the length of the transmission path and the time of measurement. The distribution of observations for each transmission distance is shown in Fig. 2. The observations, at each distance, have been divided into four groups composed of measurements made during the hours of 0900 to 1500, 1500 to 2100, 2100 to 0300, and 0300 to 0900 local time. The distributions of observations made during these time periods are shown in Figs. 3 to 5. The equivalent reflection heights, for a triangular sky-wave path and an assumed velocity of propagation of 3×10^8 meters per second, are indicated on these Figures.

Continuous sky-wave delay observations were made, at the rate of one time-difference measurement per minute, when possible, over two 24-hour periods, for each transmission distance. The average and extreme values, for each 20-minute period, are shown in Figs. 6 to 11. The times of sunrise and sunset in the ionosphere at the approximate midpoint of the transmission paths, as computed by the Hydrographic Office, Navy Department, are indicated in Figs. 6 to 11. The individual measurements of sky-wave delay are plotted against local time in Figs. 12 to 33.

The distributions of sky-wave delay observations made during December 1943 and January 1944 and those made during June and July 1944 are shown in Figs. 34 to 36. It should be noted that the sky-wave delay, and thus also the equivalent reflection height of the sky waves, was consistently higher at each distance during the summer of 1944 than during the winter of 1943-44.

Simultaneous measurements of sky-wave delay were made for distances of 442 and 885 kilometers through the night of 14-15 July 1944. The equivalent reflection heights of these observations are plotted against time of day in Figs. 37 to 39. These observations show the simultaneous changes in equivalent reflection height of sky waves over two transmission paths of different length. It should be noted that, while similar general trends were obtained, little correlation appears in the instantaneous values of reflection height over the two paths. Several instances may be seen in which the trends of reflection heights crossed each other.

The "sky-wave correction", or difference between the sky-wave delays from transmissions over two paths, was determined for three pairs of distances. Fig. 40 contains the distribution of sky-wave correction values obtained at distances of 218-689, 689-1123, and 1123-1514 kilometers. The distributions of sky-wave correction values at different times of day for each pair of distances are shown in Figs. 41 to 43. It should be noted, from Figs. 3 to 5 and Figs. 41 to 43, that the variations in sky-wave correction values with time of day are less than the corresponding variations in sky-wave delay values.

The average sky-wave delay is represented as a function of distance from the transmitting station by the "sky-wave delay curve". The purpose of the sky-wave delay curve is to enable an observer to convert a Loran time-difference measurement involving sky waves into an equivalent ground-wave time difference. A Loran observation made by using the ground wave from one transmitting station and a sky wave from the other would differ from a ground-wave measurement by the sky-wave delay. Such a measurement may therefore be converted into an equivalent ground-wave observation by application of the proper sky-wave delay to the original measurement. A practical value for this conversion may be obtained from the sky-wave delay curve and the approximate distance from the transmitting station. A Loran observation made by using the sky waves from both transmitting stations may be converted into an equivalent ground-wave measurement by application of the proper sky-wave correction, which is the difference in the sky-wave delays for the two transmission paths. A practical value for this conversion may be obtained from the sky-wave delay curve and the approximate distances from the transmitting stations. A more complete discussion of the use of the sky-wave delay curve may be found on pages 11 to 13 of IRPL-R6.

Fig. 44 shows the sky-wave delay curve determined from nighttime measurements made during June and July 1944. The average and median values of sky-wave delay observations made at distances of 442, 689, and 885 kilometers are indicated on the curve. The sky-wave delay for distances of 1123 and 1514 kilometers were determined from the sky-wave correction observations. The sky-wave delay curve derived by the Bureau of Ships, Navy Department, for determination of Loran sky-wave corrections, which was found to be in excellent agreement with nighttime observations made in December 1943 and January 1944, is also shown in Fig. 44. Equivalent reflection heights corresponding to the delay curves of Fig. 44 are shown in Fig. 45.

The nighttime delay curves indicate a shift of from 13 to 21 microseconds in the average sky-wave delay obtained under summer and winter conditions. However, the slopes of the two curves are quite similar. It therefore appears that, from an operational standpoint, differences in sky-wave corrections derived from the two curves are negligible in comparison with normal variations to be expected from the ionosphere.

The sky-wave delay or sky-wave correction, obtained from the sky-wave delay curves, is an average value, and can be considered only as a reasonable value for operational use. In practice wide variations in sky-wave delay and corrections are observed. Table IV shows the range of variation of night sky-wave delay observed during the winter of 1943-44 and the summer of 1944. The variations in sky-wave correction values observed during June and July 1944 are shown in Table V.

Sky-wave correction observations were made on sky-wave transmissions from distances of 689 and 1123 kilometers on 29 nights during June and July 1944. A set of sky-wave correction measurements, representative of conditions normally encountered at these distances during June and July, is shown in Fig. 46. Measurements differing by greater than 50 microseconds from the value predicted by the Bureau of Ships, Navy Department, sky-wave delay curve were obtained on three nights. Most of these observations were made on the night of 14-15 June and are shown in Fig. 47.

Sky-wave correction observations were made on sky-wave transmissions from distances of 1123 and 1514 kilometers on 25 nights during June and July 1944. A set of sky-wave correction measurements, representative of conditions normally encountered at these distances during June and July, is shown in Fig. 48. Measurements differing from the value predicted by the Bureau of Ships sky-wave delay curve by an amount greater than 50 microseconds were obtained on two nights. All except two of these observations were made on the night of 14-15 June and are shown in Fig. 49.

The sky-wave observations made on 14-15 June 1944, at distances of 689, 1123, and 1514 kilometers, were characterized by unusually weak sky waves that varied widely in shape on all three transmission paths. Other ionosphere and geomagnetic data indicate that these measurements were made during the most disturbed period during June and July.

A discussion of the relationship between vertical-incidence ionosphere measurements and oblique-incidence sky-wave transmission is contained in the paper, "The relation of radio sky-wave transmission to ionosphere measurements" by N. Smith, Proc. I.R.E. 27, 332; May 1939. On the basis of simple theory, it is shown that the virtual height of reflection, measured at vertical incidence, for a radio frequency f, is equal to the height of the equivalent triangular path for a higher frequency f', at oblique incidence.

Table IV

Nighttime Sky-Wave Delay Observations

Distance from transmitting station, in km:	442	689	885
Average sky-wave delay, in microseconds, obtained from the IRPL-R6 winter observations, which agree with the Bureau of Ships sky-wave delay curve:	144	96	80
Number of observations, 8 Dec. 1943 to 14 Jan. 1944:	656	711	718
Range, in microseconds, of 50% of observations, 8 Dec. 1943 to 14 Jan. 1944:	141 to 150	91 to 101	79 to 86
Total range, in microseconds, of observations, 8 Dec. 1943 to 14 Jan. 1944:	109 to 181	73 to 113	71 to 98
Average sky-wave delay, in microseconds, obtained from summer sky-wave delay curve (Fig.44):	166	114	97
Number of observations, 1 June to 29 July 1944:	1062	3233	716
Range, in microseconds, of 50% of observations, 1 June to 29 July 1944:	154 to 172	110 to 123	90 to 100
Total range, in microseconds, of observations, 1 June to 29 July 1944:	131 to 204	74 to 175	77 to 123

Table V

Sky-Wave Correction Observations,
1 June to 29 July 1944

Distances from transmitting stations, in km:	689 and 1123	1123 and 1514
Average sky-wave correction, in microseconds, obtained from the IRPL-R6 winter observations, which agree with the Bureau of Ships sky-wave delay curve:	25	-5
Average sky-wave correction, in microseconds, obtained from summer sky-wave delay curve (Fig. 44):	27	-7
Number of observations, 1500 to 2100 local time:	1321	1376
Range, in microseconds, of 50% of observations, 1500 to 2100 local time:	20 to 34	-6 to -14
Total range, in microseconds, of observations, 1500 to 2100 local time:	-19 to 101	11 to -34
Number of observations, 2100 to 0300 local time:	5932	6201
Range, in microseconds, of 50% of observations, 2100 to 0300 local time:	20 to 32	-7 to -15
Total range, in microseconds, of observations, 2100 to 0300 local time:	-19 to 164	11 to -88
Number of observations, 0300 to 0900 local time:	912	525
Range, in microseconds, of 50% of observations, 0300 to 0900 local time:	17 to 33	-5 to -13
Total range, in microseconds, of observations, 0300 to 0900 local time:	-12 to 51	12 to -30

The approximate vertical-incidence frequencies, equivalent to the oblique-incidence Loran observations made on 1,950 kc during June and July 1944, are shown in Tables VI and VII.

Average and median values of oblique-incidence measurements made between 2100 and 0300 local time, representing nighttime conditions, are shown in Table VI. A curve, derived from the points listed in Table VI, illustrating the variation in height of equivalent reflection against equivalent vertical-incidence frequency, is shown in Fig. 50. Fig. 50 also shows a similar curve derived from nighttime observations during December 1943 and January 1944.

Average and median values of oblique-incidence measurements made between 0900 and 1500 local time, representing daytime conditions, are shown in Table VII. In view of the fact that these values represent relatively small groups of observations and that measurements at distances of 442 and 689 kilometers were seldom possible at or near noon, a curve representing equivalent reflection height vs equivalent vertical-incidence frequency has not been derived for summer conditions. However, the points listed in Table VII are shown in Fig. 51 with the daytime equivalent reflection height vs equivalent vertical-incidence frequency curve derived from measurements made between 0900 and 1500 local time during December 1943 and January 1944.

Vertical-incidence ionosphere measurements, covering the required frequency range, are not available for checking the virtual height of the equivalent vertical-incidence frequencies encountered in the observations covered by this report.

Table VI

Nighttime Equivalent Vertical-Incidence Frequencies

Oblique-Incidence Transmission Path Length in km		Equivalent Reflection Height in km	Equivalent Vertical-Incidence Frequency in kc
442	average	103.5	850
442	median	103.1	845
689	average	102.5	582
689	median	101.5	577
885	average	99.6	470
885	median	100.5	475
1123	average	101.5	380
1123	median	102.5	383
1514	average	99.1	330
1514	median	101.6	335

Table VII

Daytime Equivalent Vertical-Incidence Frequencies

Oblique-incidence Transmission Path Length in km		Equivalent Reflection Height in km	Equivalent Vertical-Incidence Frequency in kc
218	average	97.0	1295
218	median	97.2	1297
442	average	98.6	815
442	median	100.0	825
689	average	88.5	513
689	median	88.5	513

IV. Conclusions

Sky-wave propagation, with equivalent reflection heights between 60 and 120 kilometers, is obtained from the present Loran transmitting stations on 1,950 kc at all times of the night at distances of 450 to 1500 kilometers. This situation was found to be true for summer conditions, given by this report, as well as the winter conditions described in IRPL-R6. The maximum night distance is probably around 2500 kilometers.

Daytime reception of Loran sky waves on 1,950 kc varies with the season. Sky waves from distances of 450 to 1500 kilometers are obtained at all times of the day approximately 50 percent of the time during the winter. They are seldom received in the middle of the day in the summer.

The effective reflection height of Loran sky waves on 1,950 kc at night was observed to be approximately ten kilometers higher in summer than in winter. The indications were that the daytime height was also greater in summer than in winter, although the data available are insufficient for conclusive quantitative results, owing to high ionospheric absorption.

Correction values for Loran sky-wave observations made under summer conditions may be obtained from the sky-wave delay curve of Fig. 44, which corresponds to the equivalent reflection heights of Fig. 45. Values of sky-wave delay obtained from this curve are approximately 13 to 21 microseconds greater than those obtained from winter nighttime observations discussed in report IRPL-R6 which are in excellent agreement with the Bureau of Ships sky-wave delay curve. However, sky-wave correction values derived from the summer sky-wave delay curve, for transmission distances normally used in the Loran system, are not appreciably different from those indicated by the nighttime observations made during the winter of 1943-44.

Loran observations made by using sky waves from both transmitting stations in a Loran pair, at distances greater than 450 kilometers, are subject to less diurnal and seasonal variation than measurements employing the sky wave from one station and the ground wave from the other, at comparable distances.

V. Further Work Needed

Observations made during the winter of 1943-44 (given in IRPL-R6) and the summer of 1944 (given in this report) have indicated the necessity for further study on 1,950 kc.

The subjects, mentioned in IRPL-R6, which have been partly covered by the present report but require additional work are as follows:

(a) Determination of diurnal variation in sky-wave correction values.

(b) Alternate measurements of the sky-wave delay from two Loran stations.

(c) Periodic measurement of sky-wave delay, for the purpose of determining the seasonal trend in equivalent reflection height.

The subjects, mentioned in IRPL-R6, upon which no work has been done are as follows:

(d) Measurement of virtual height at equivalent vertical-incidence frequencies.

(e) Determination of sky-wave delay for an east and west path and for a north and south path.

(f) Determination of sky-wave field intensities, for correlation with equivalent reflection heights, in order to see whether normal E-layer, sporadic-E or scatter is mainly responsible for the Loran reflections, and to what extent ionospheric absorption is related to reflection heights.

(g) Determination of sky-wave delay at latitudes other than Washington. In view of the observed diurnal and seasonal variations in sky-wave delay it seems that a variation in sky-wave delay with latitude may be present. Loran observations at latitudes other than Washington should therefore be made. The transmission paths of the sky-wave observations made by the IRPL ran approximately northeast from the receiving point. As the lengths of the transmission paths increased, the points of reflection were progressively farther north. A set of sky-wave measurements should be made from a northern location such that the sky-wave reflection points will progress in a southerly direction as the transmission path lengths increase. This information is desirable to determine whether the decrease in equivalent reflection height with increasing transmission path length is a function of latitude effect.

The results of the summer program indicate the advisability of investigating the following subject not mentioned in IRPL-R6:

(h) Fluctuations in average sky-wave delay and sky-wave corrections from day to day. While these variations are usually only a few microseconds, at times ionospheric conditions have been observed that produce errors of the order of 50 to 100 microseconds in Loran sky-wave observations (see Figs. 47 and 48). An an error of this magnitude can be quite serious from an operational standpoint, it seems that a systematic study of E-layer sky-wave propagation is needed to determine the frequency of periods during which such erratic sky-wave delays may occur and, if possible, to determine methods by which such periods may be predicted. Such a study should include a program of nightly observations, at oblique incidence, over a period of several months, for correlation with other information relative to ionospheric radio wave propagation.

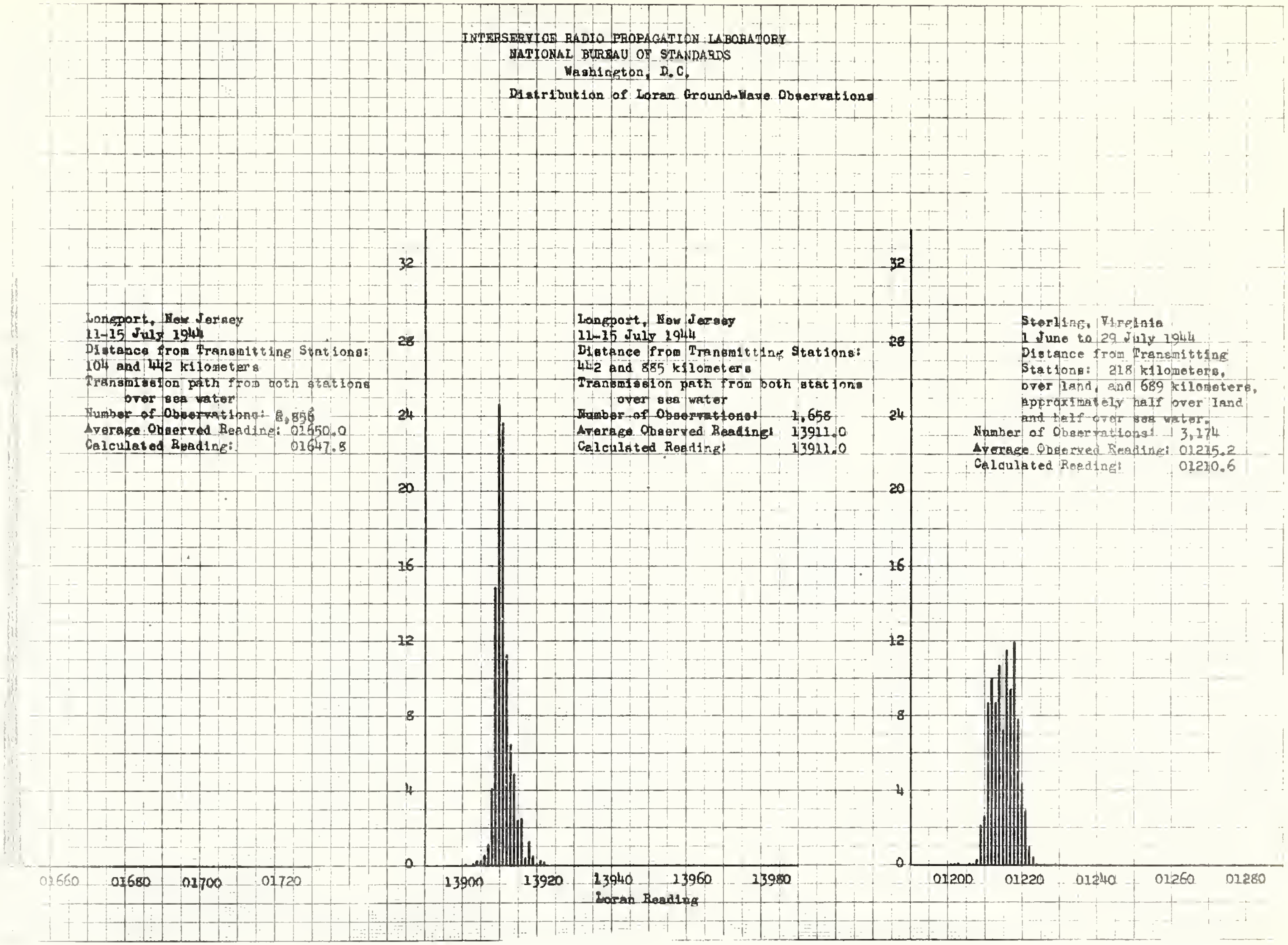

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Distribution of Loran Ground-Wave Observations
Longport, New Jersey
11-15 July 1944
Distance from Transmitting Stations:
104 and 442 kilometers
Transmission path from both stations
over sea water
Number of Observations: 2,856
Average Observed Reading: 01650.0
Calculated Reading: 01647.8
Longport, New Jersey
11-15 July 1944
Distance from Transmitting Stations:
442 and 885 kilometers
Transmission path from both stations
over sea water
Number of Observations: 1,658
Average Observed Reading: 13911.0
Calculated Reading: 13911.0
Sterling, Virginia
1 June to 29 July 1944
Distance from Transmitting
Stations: 218 kilometers,
over land, and 689 kilometers,
approximately half over land
and half over sea water.
Number of Observations: 3,174
Average Observed Reading: 01215.2
Calculated Reading: 01210.6
32
28
24
20
16
12
8
4
0
01660
01680
01700
01720
13900
13920
13940
13960
13980
01200
01220
01240
01260
01280
Loran Reading

Fig. 1.

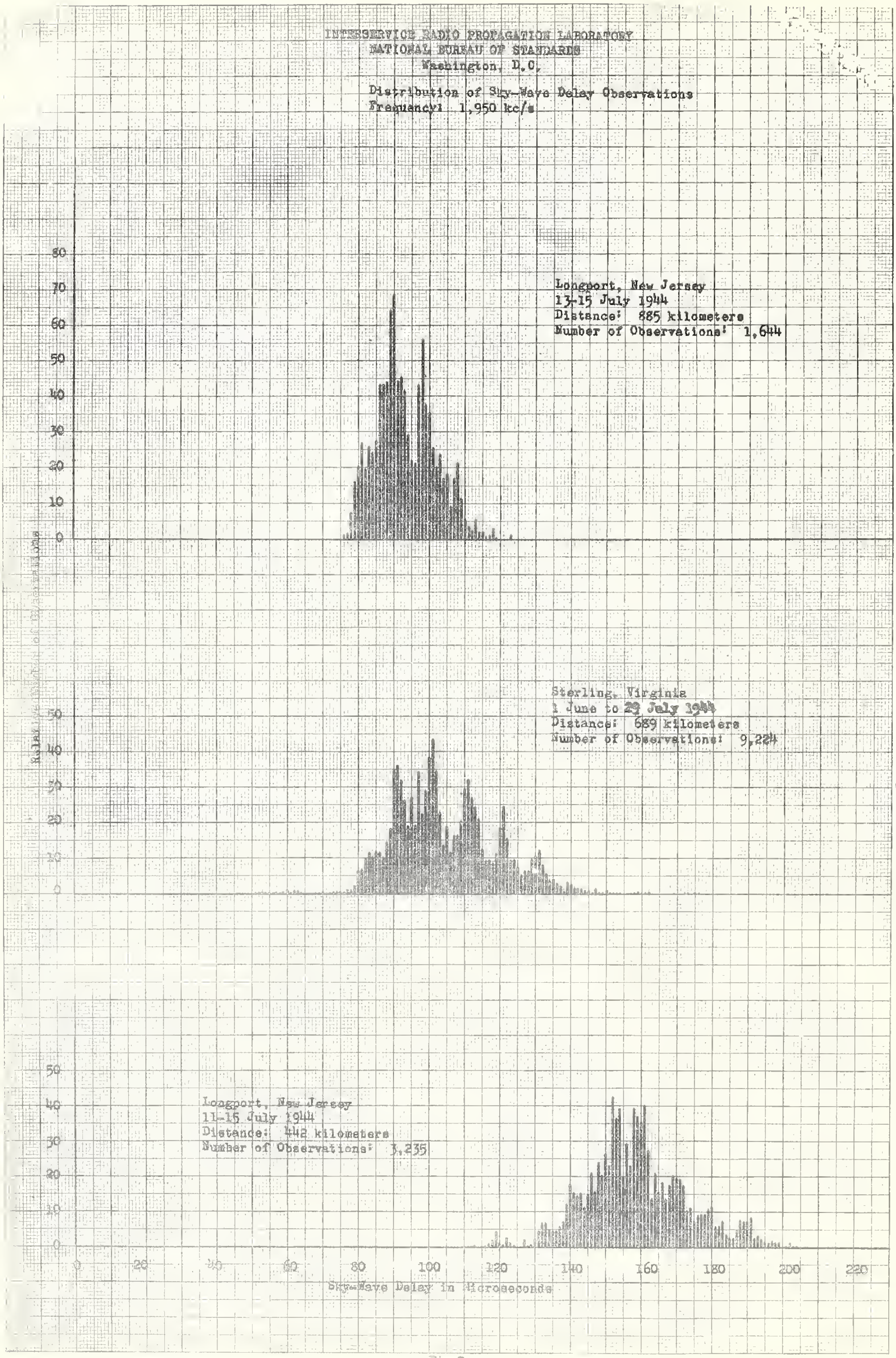
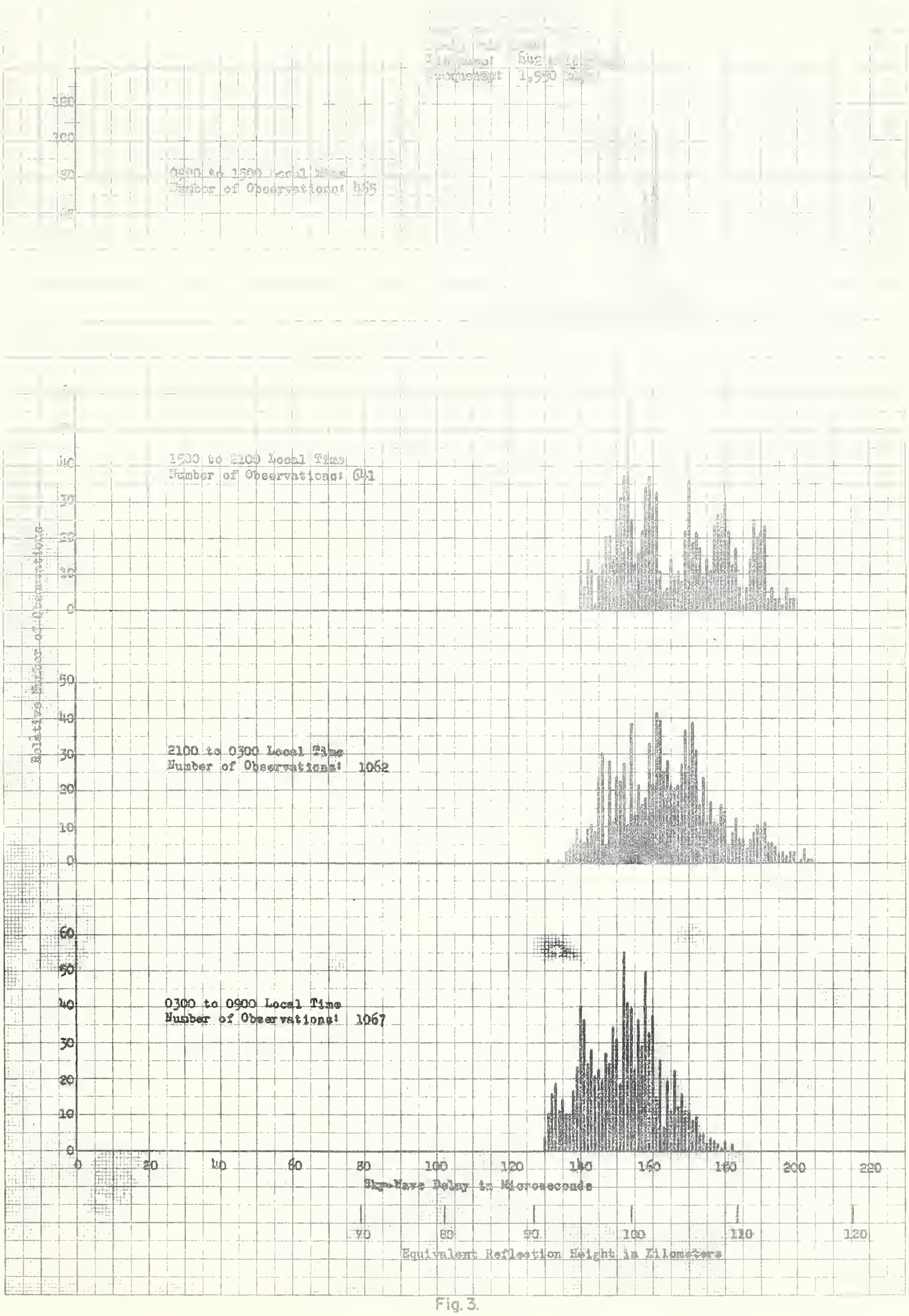

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Distribution of Sky-Wave Delay Observations
Frequency: 1,950 kc/s
Longport, New Jersey
13-15 July 1944
Distance: 885 kilometers
Number of Observations: 1,644
Sterling, Virginia
1 June to 29 July 1944
Distance: 689 kilometers
Number of Observations: 9,224
Longport, New Jersey
11-15 July 1944
Distance: 442 kilometers
Number of Observations: 3,235
0
10
20
30
40
50
60
70
80
0
20
40
60
80
100
120
140
160
180
200
220
Sky-Wave Delay in Microseconds

Fig.2.



1500 to 2100 Local Time
Number of Observations: 641
2100 to 0300 Local Time
Number of Observations: 1062
0300 to 0900 Local Time
Number of Observations: 1067
Relative Number of Observations
Sky-Wave Delay in Microseconds
Equivalent Reflection Height in Kilometers

Fig. 3.

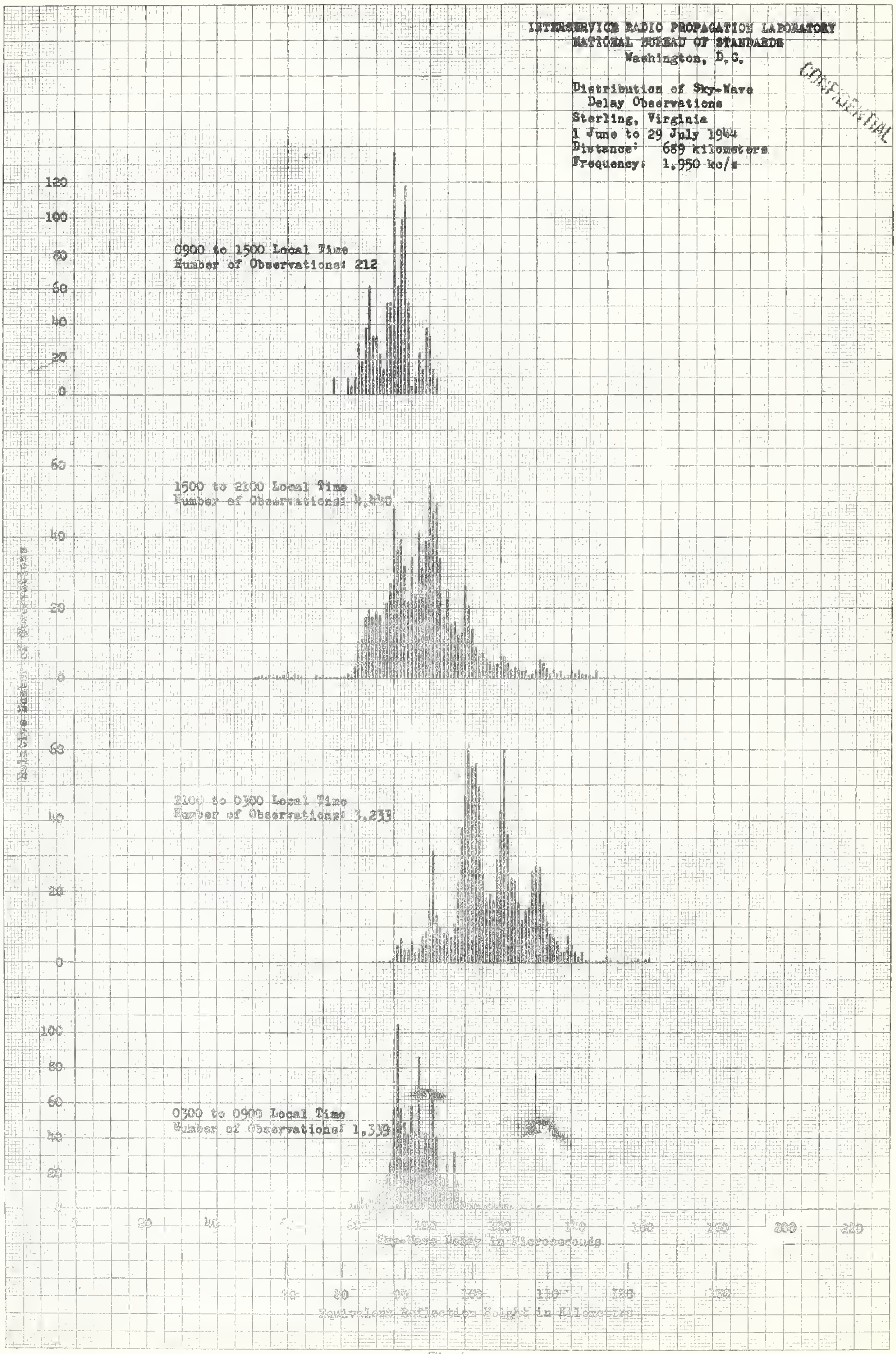

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Distribution of Sky-Wave
Delay Observations
Sterling, Virginia
1 June to 29 July 1944
Distance: 689 kilometers
Frequency: 1,950 kc/s
CONFIDENTIAL
0900 to 1500 Local Time
Number of Observations: 212
1500 to 2100 Local Time
Number of Observations:
2100 to 0300 Local Time
Number of Observations:
0300 to 0900 Local Time
Number of Observations: 1,339
120
100
80
60
40
20
0

Fig.4

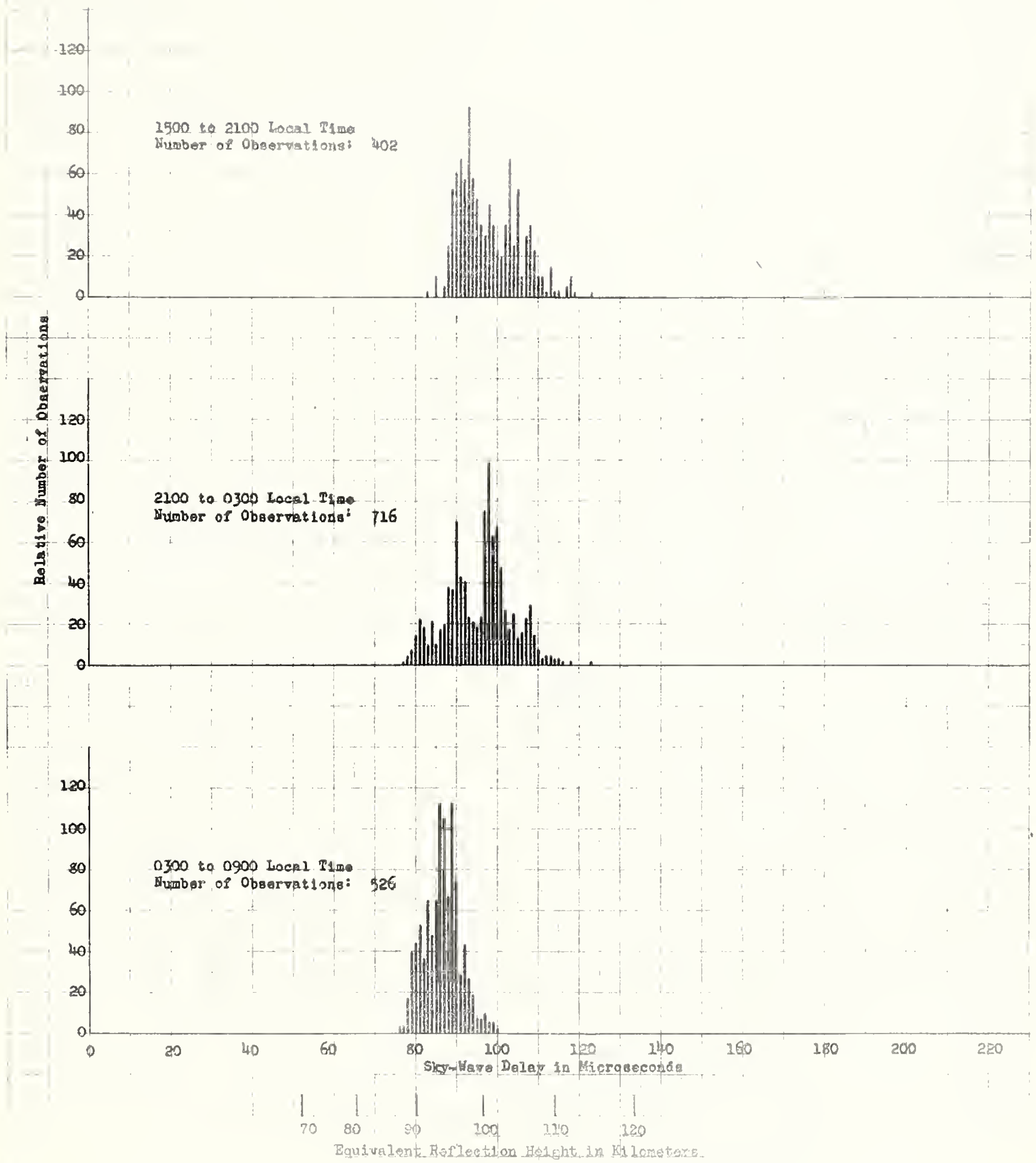
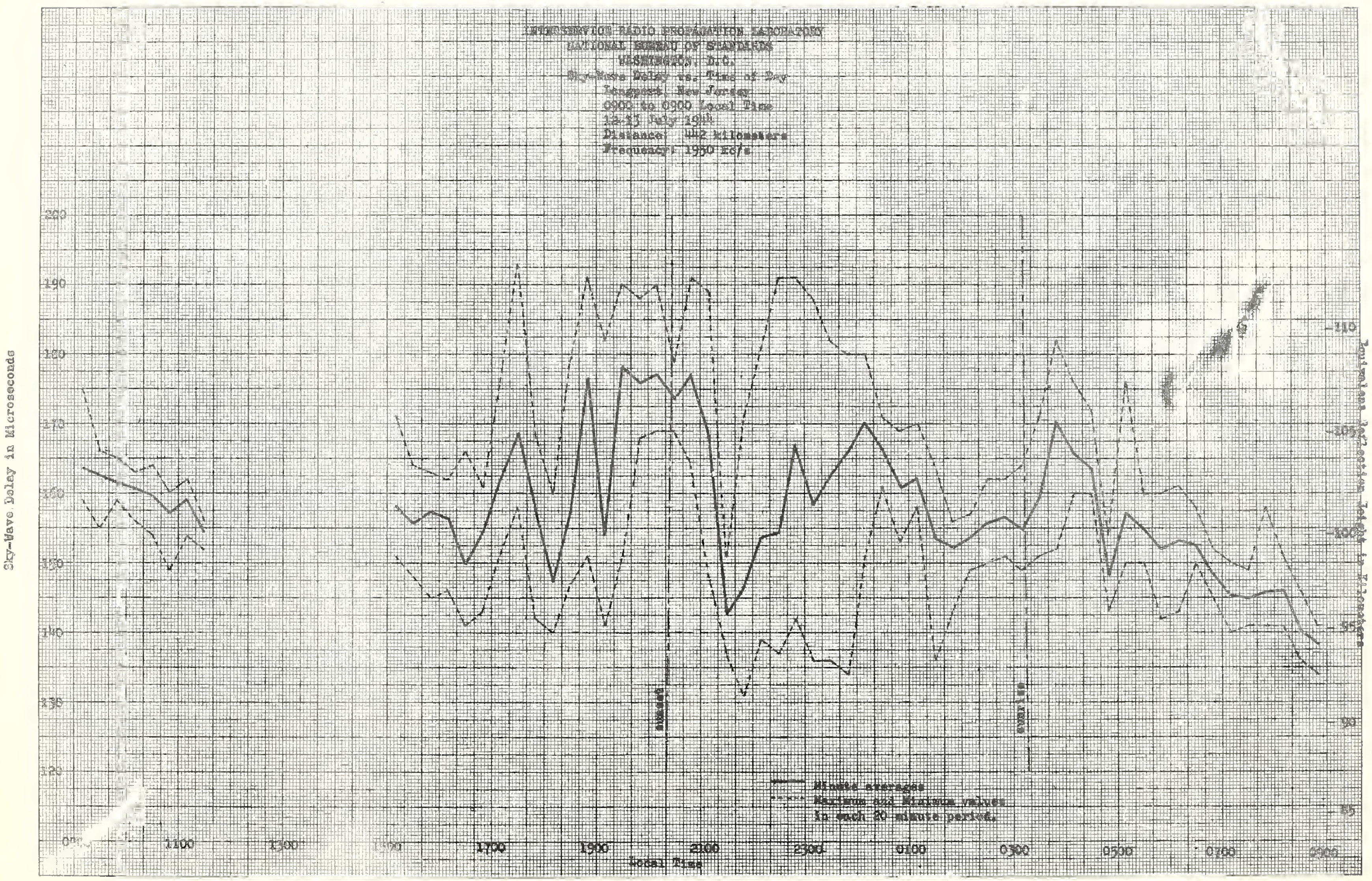

1500 to 2100 Local Time
Number of Observations: 402
2100 to 0300 Local Time
Number of Observations: 716
0300 to 0900 Local Time
Number of Observations: 526
Relative Number of Observations
Sky-Wave Delay in Microseconds
Equivalent Reflection Height in Kilometers

Fig. 5.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WASHINGTON, D.C.
Sky-Wave Delay vs. Time of Day
Longport, New Jersey
0900 to 0900 Local Time
12-13 July 1944
Distance: 442 kilometers
Frequency: 1950 kc/s
Sky-Wave Delay in Microseconds
Equivalent Reflection Height in Kilometers
Local Time
sunset
sunrise
Minute averages
Maximum and Minimum values in each 20 minute period.

Fig. 6.

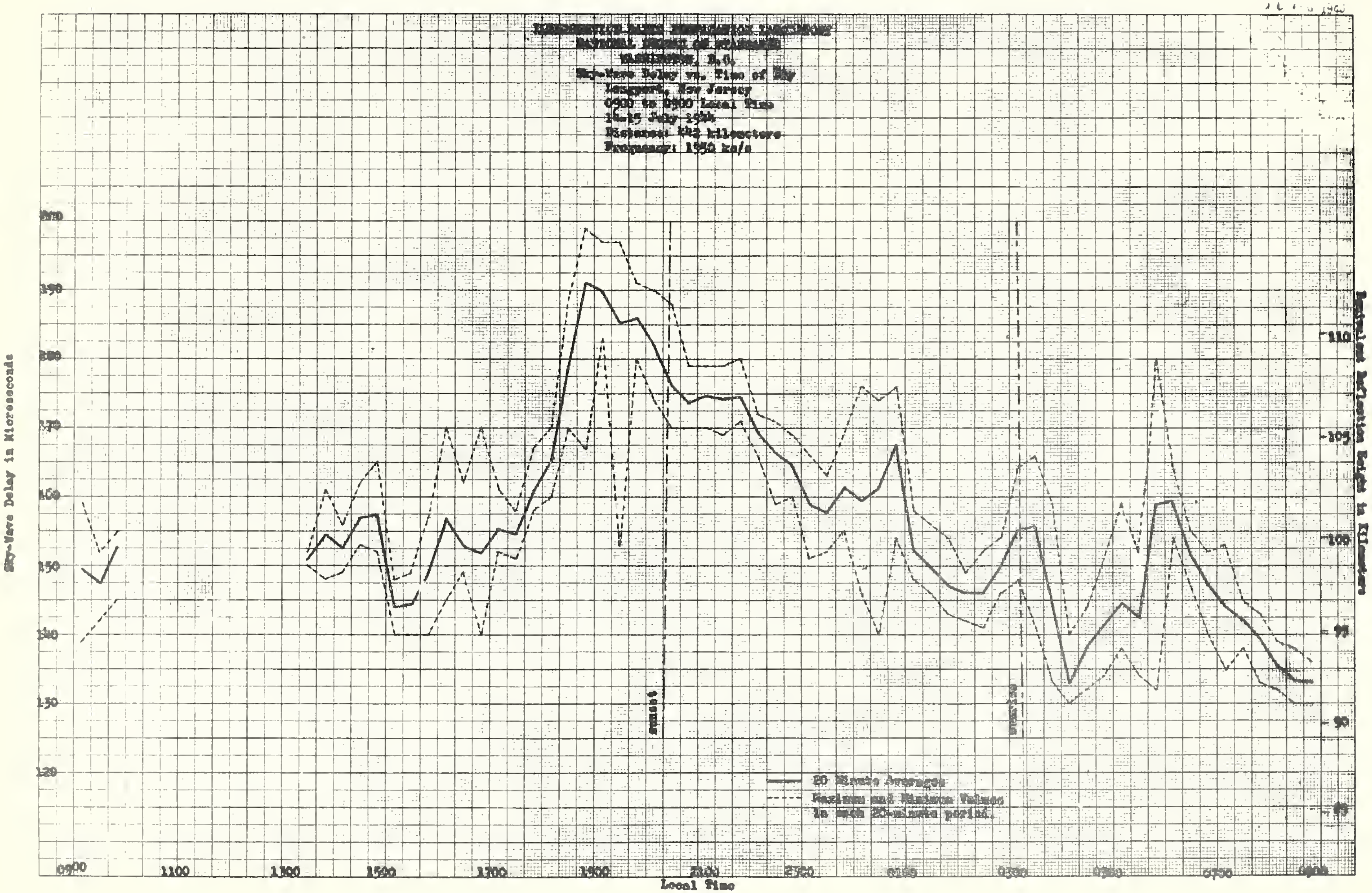
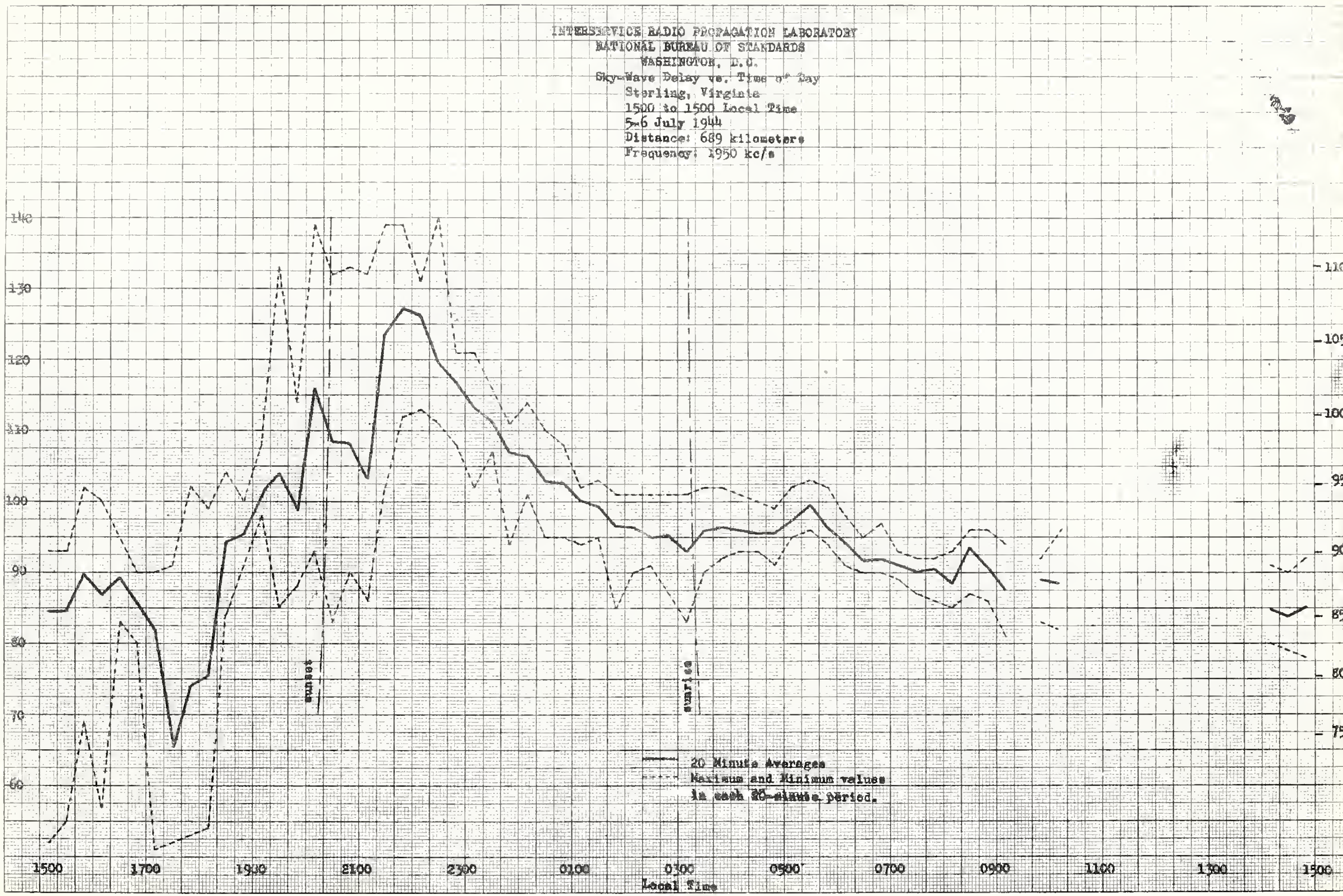

Sky-Wave Delay vs. Time of Day
0900 to 0900 Local Time
Frequency: 1550 kc/s
Sky-Wave Delay in Microseconds
Equivalent Reflection Height in Kilometers
Local Time
sunset
sunrise
20 Minute Averages
Maximum and Minimum Values
in each 20-minute period.

Fig 7


INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
WASHINGTON, D.C.
Sky-Wave Delay vs. Time of Day
Sterling, Virginia
1500 to 1500 Local Time
5-6 July 1944
Distance: 689 kilometers
Frequency: 1950 kc/s
Sky-Wave Delay in Microseconds
Equivalent Reflection Height in Kilometers
sunset
sunrise
20 Minute Averages
Maximum and Minimum values in each 20-minute period.
Local Time
1500
1700
1900
2100
2300
0100
0300
0500
0700
0900
1100
1300
1500
140
130
120
110
100
90
80
70
60
110
105
100
95
90
85
80
75
Fig. 8.

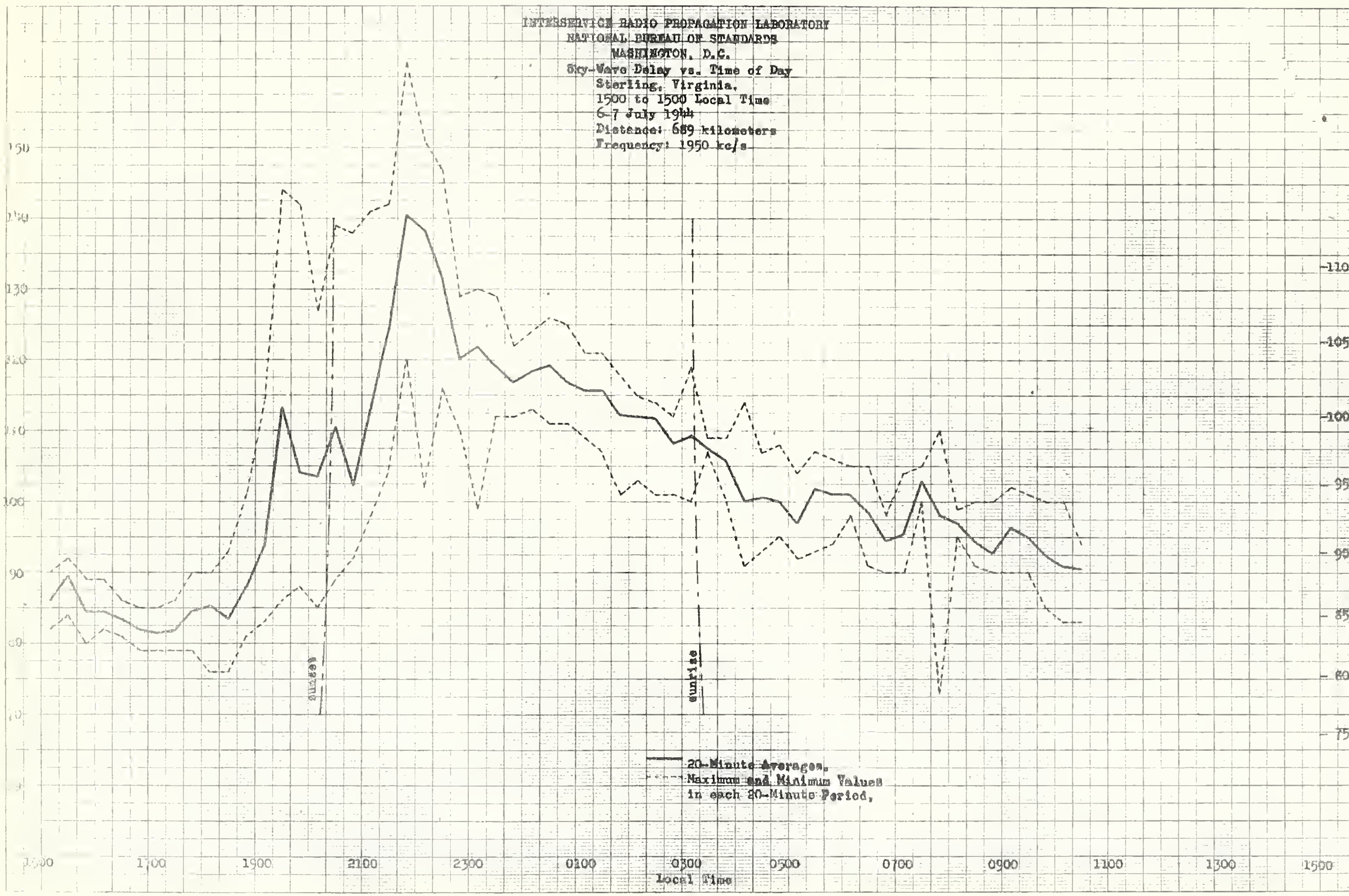

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
WASHINGTON, D.C.
Sky-Wave Delay vs. Time of Day
Sterling, Virginia.
1500 to 1500 Local Time
6-7 July 1944
Distance: 689 kilometers
Frequency: 1950 kc/s
Sky-Wave Delay in Microseconds
Equivalent Reflection Height in Kilometers
sunset
sunrise
20-Minute Averages.
Maximum and Minimum Values
in each 20-Minute Period.
Local Time
1500
1700
1900
2100
2300
0100
0300
0500
0700
0900
1100
1300
1500
150
140
130
120
110
100
90
80
70
110
105
100
95
90
85
80
75

Fig. 9

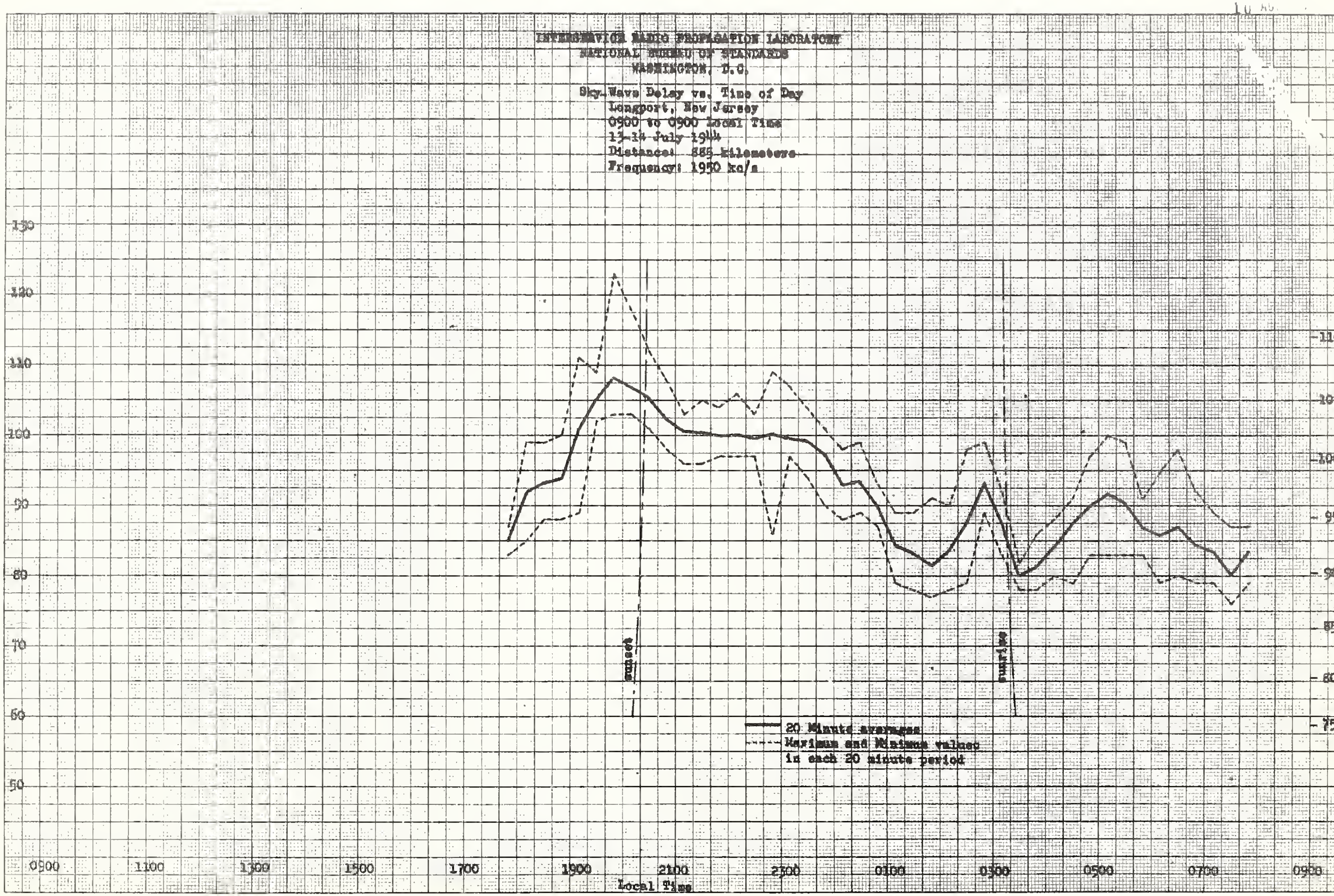
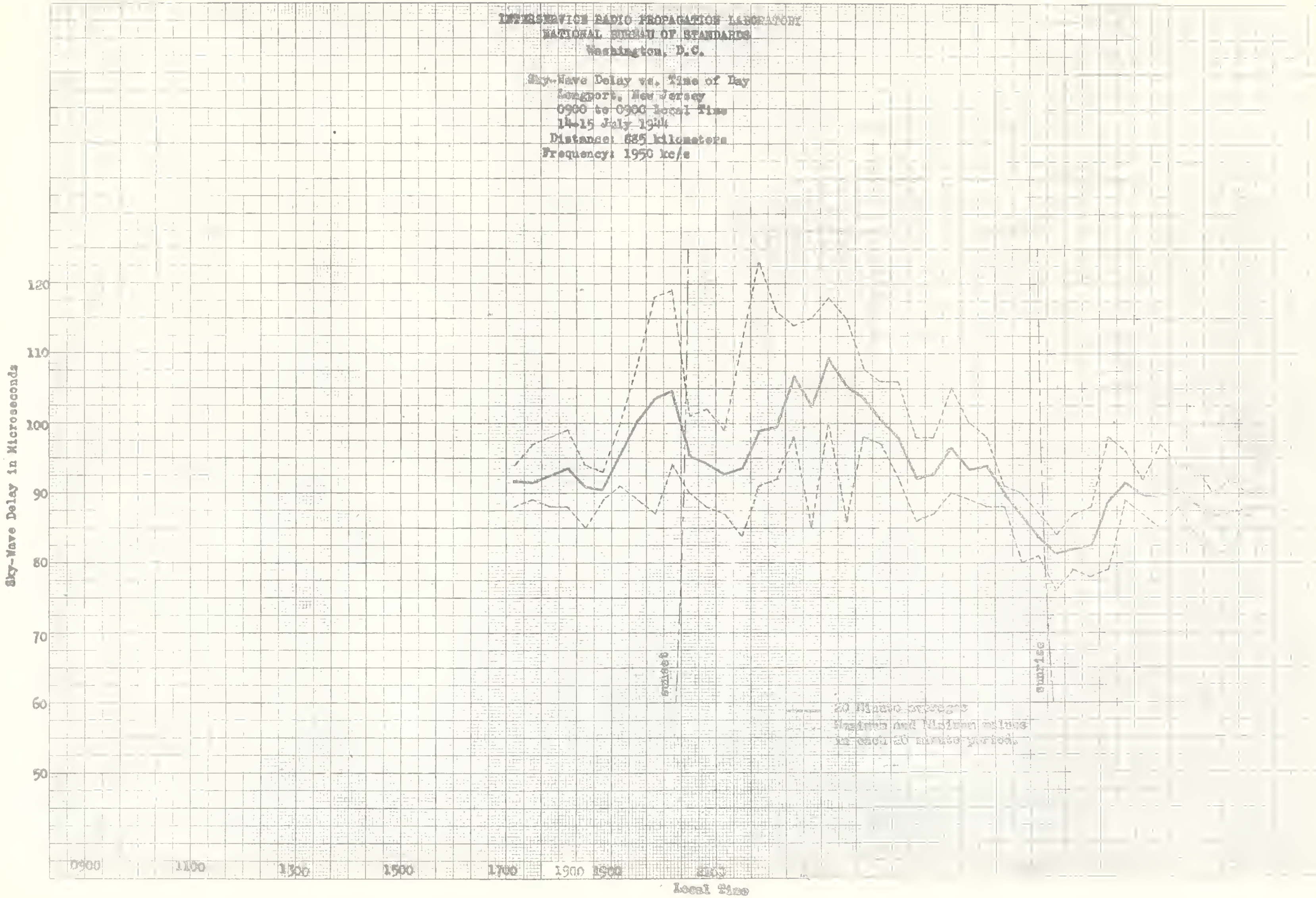

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
WASHINGTON, D.C.
Sky-Wave Delay vs. Time of Day
Longport, New Jersey
0900 to 0900 Local Time
13-14 July 1944
Distance: 885 Kilometers
Frequency: 1950 kc/s
Sky-Wave Delay in Microseconds
Equivalent Reflection Height in Kilometers
Local Time
sunset
sunrise
20 Minute averages
Maximum and Minimum values in each 20 minute period

Fig. 10.


INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs. Time of Day
Longport, New Jersey
0900 to 0900 Local Time
14-15 July 1944
Distance: 685 kilometers
Frequency: 1950 kc/s
Sky-Wave Delay in Microseconds
120
110
100
90
80
70
60
50
sunset
sunrise
20 Minute averages
Maximum and Minimum values in each 20 minute period.
0900
1100
1300
1500
1700
1900
Local Time
Fig. 11.

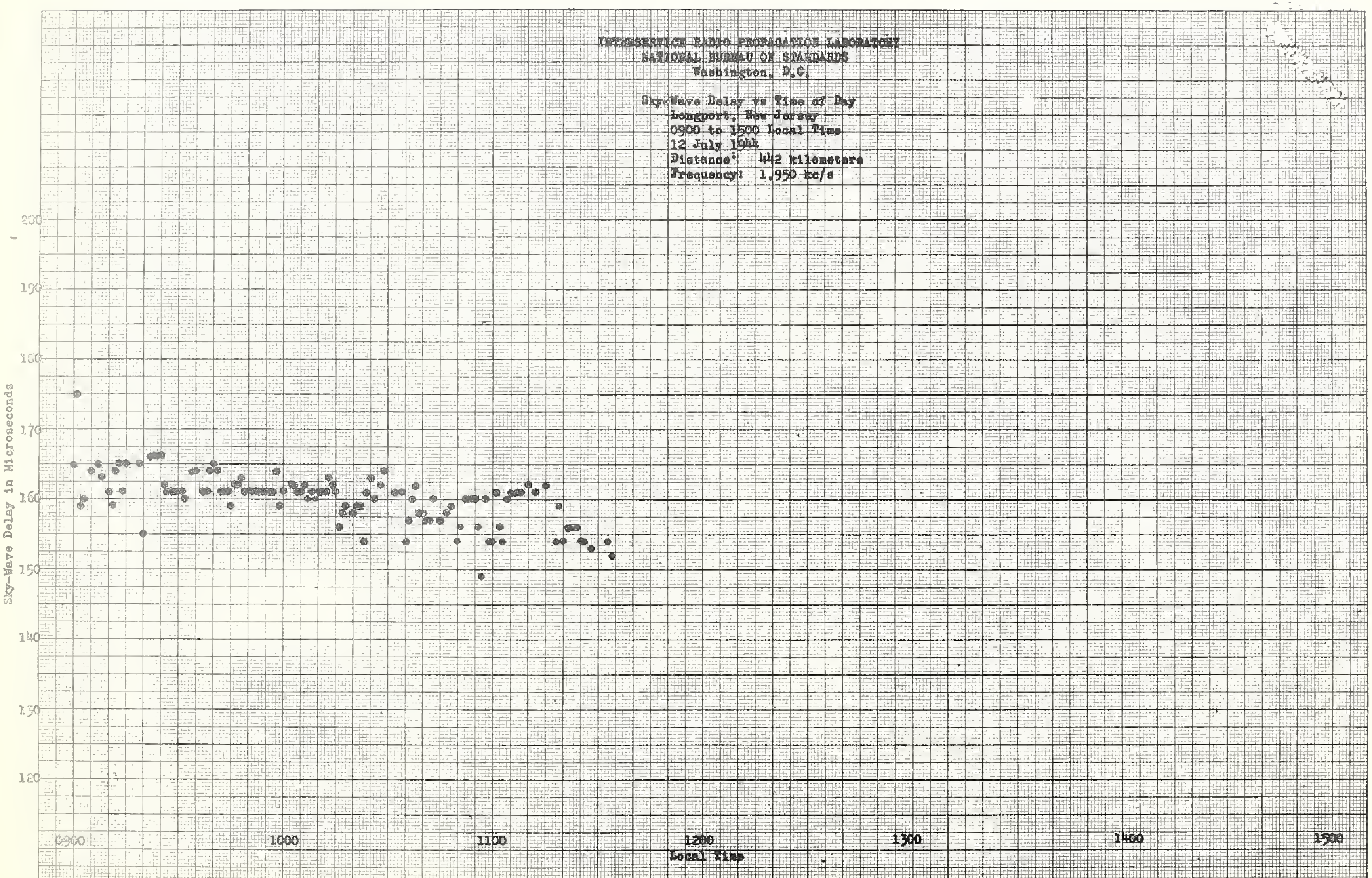

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Longport, New Jersey
0900 to 1500 Local Time
12 July 1944
Distance: 442 Kilometers
Frequency: 1,950 kc/s
Sky-Wave Delay in Microseconds
200
190
180
170
160
150
140
130
120
0900
1000
1100
1200
1300
1400
1500
Local Time

Fig. 12.

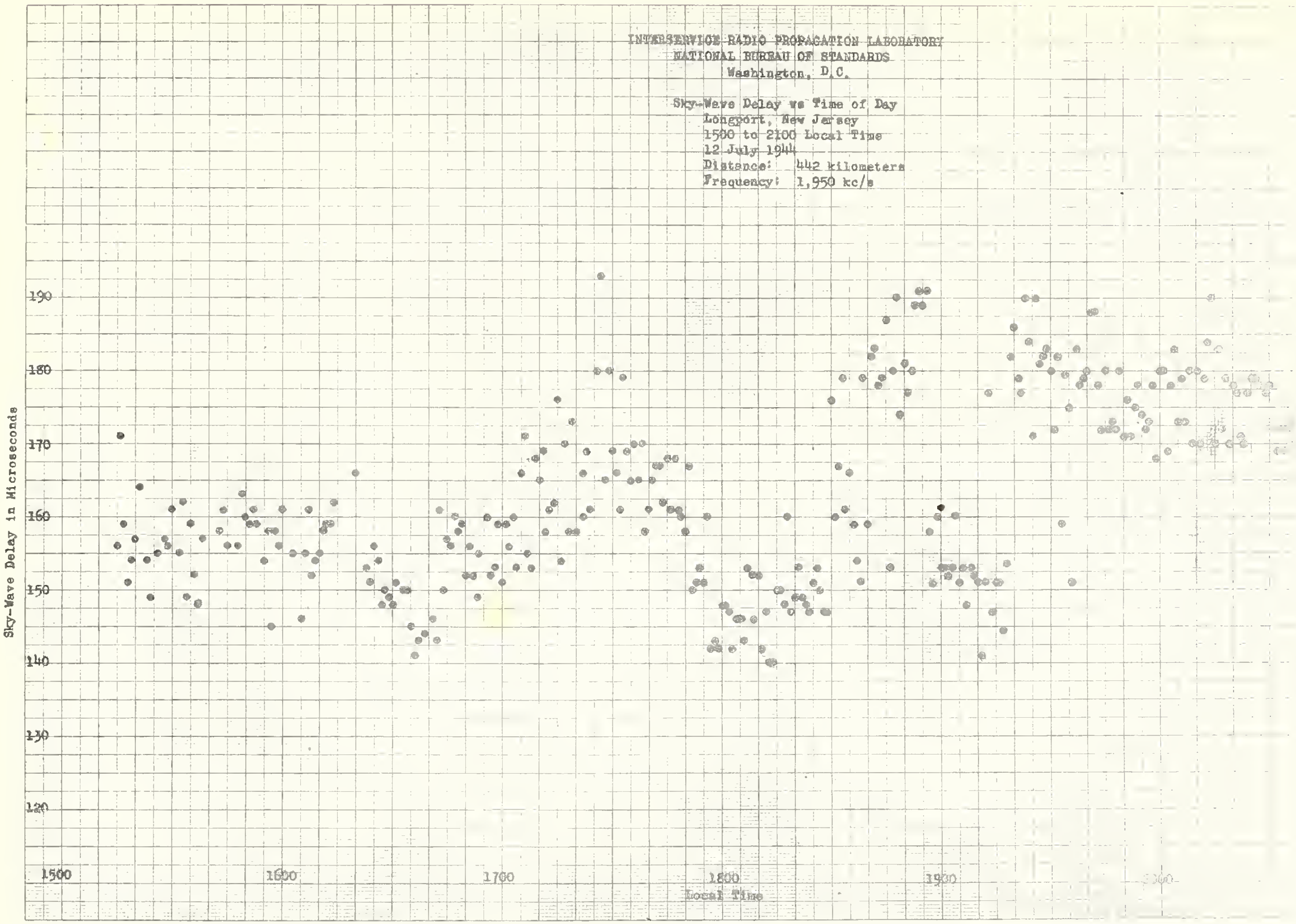

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Longport, New Jersey
1500 to 2100 Local Time
12 July 1944
Distance: 442 kilometers
Frequency: 1,950 kc/s
Sky-Wave Delay in Microseconds
190
180
170
160
150
140
130
120
1500
1600
1700
1800
1900
Local Time

Fig. 13.

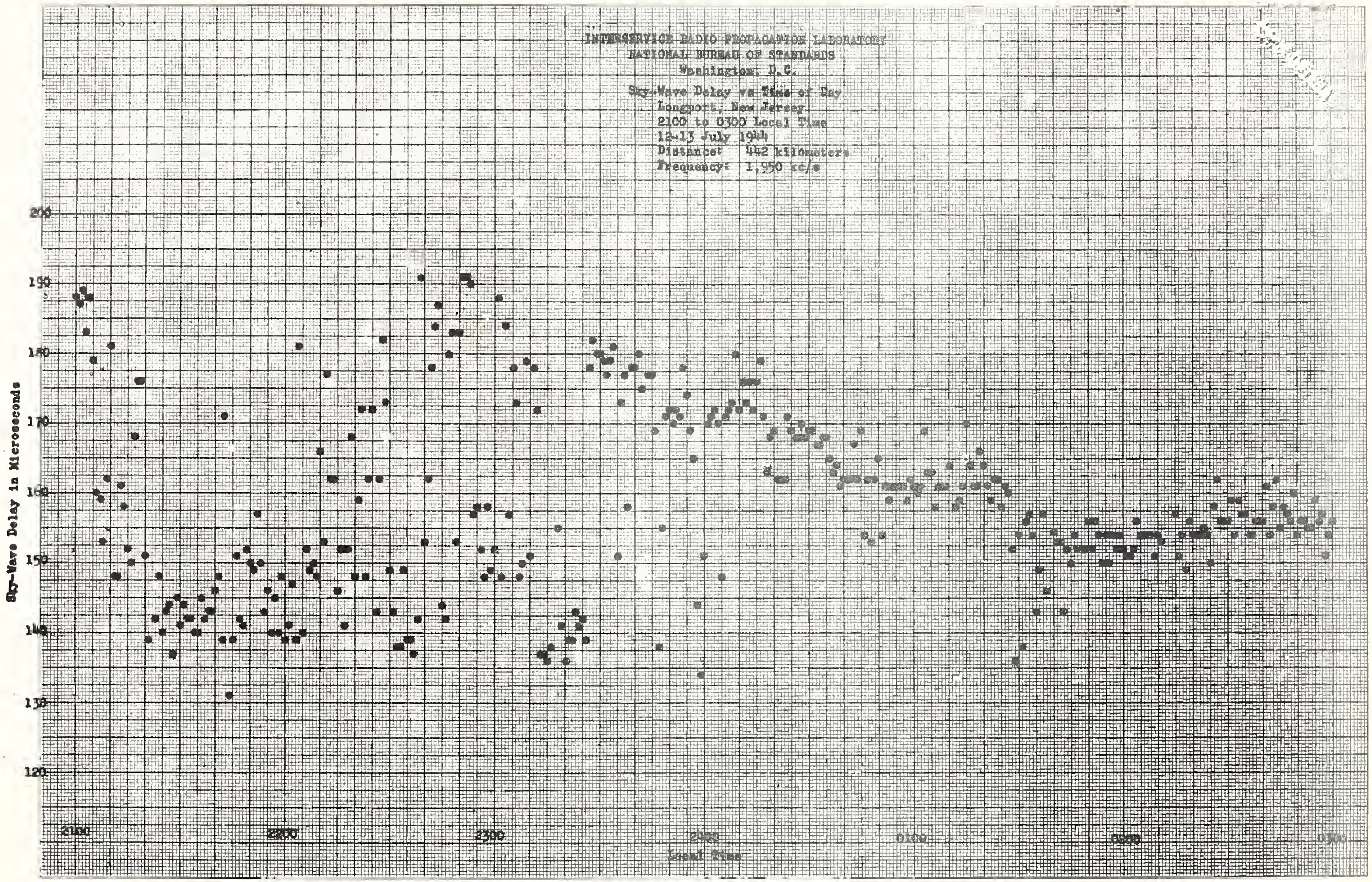

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Longport, New Jersey
2100 to 0300 Local Time
12-13 July 1944
Distance: 442 kilometers
Frequency: 1,950 kc/s
200
190
180
170
160
150
140
130
120
Sky-Wave Delay in Microseconds
2100
2200
2300
2400
0100
0200
0300
Local Time

Fig. 14.

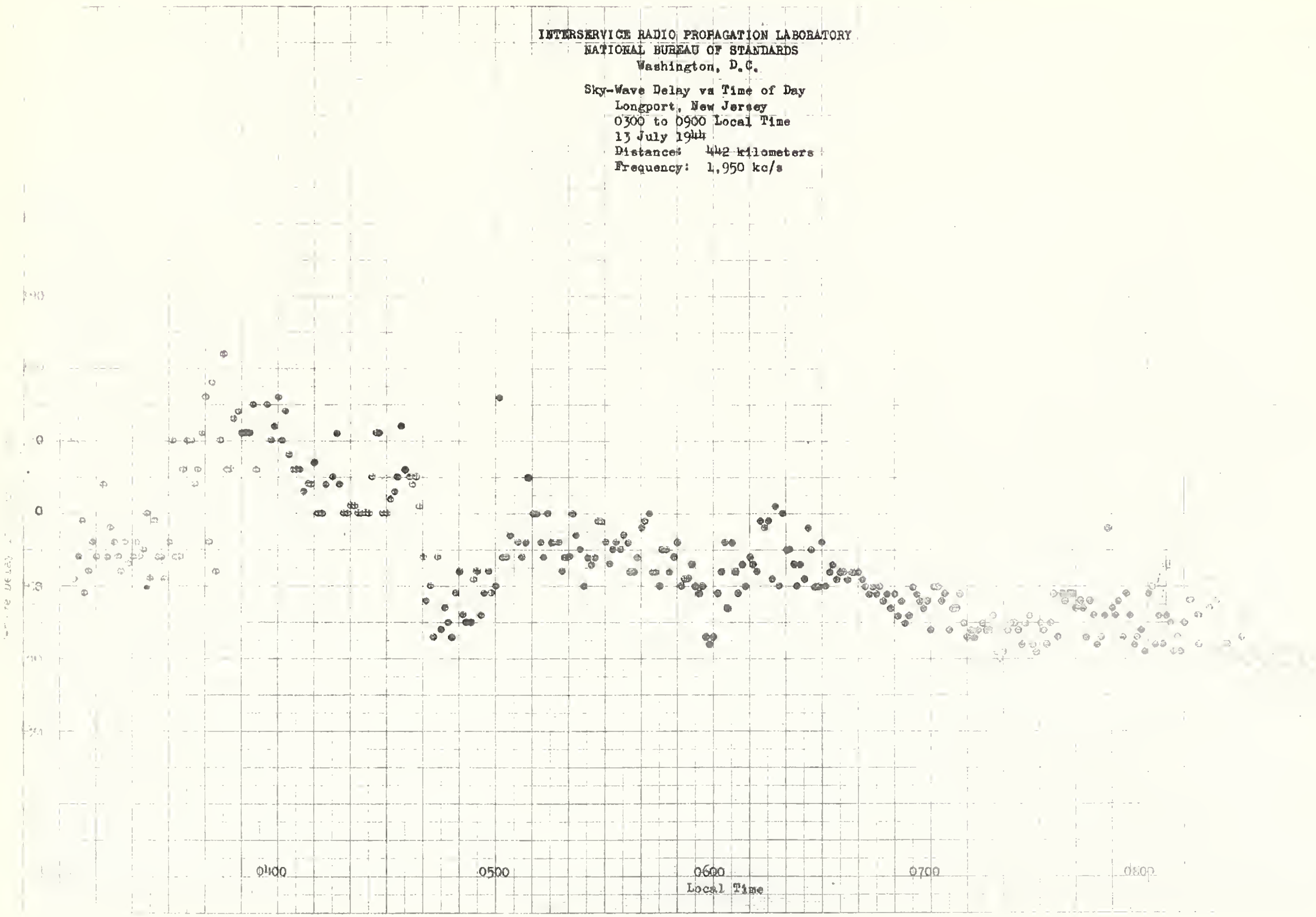

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Longport, New Jersey
0300 to 0900 Local Time
13 July 1944
Distance: 442 kilometers
Frequency: 1,950 kc/s
0400
0500
0600
0700
0800
Local Time

Fig 15.

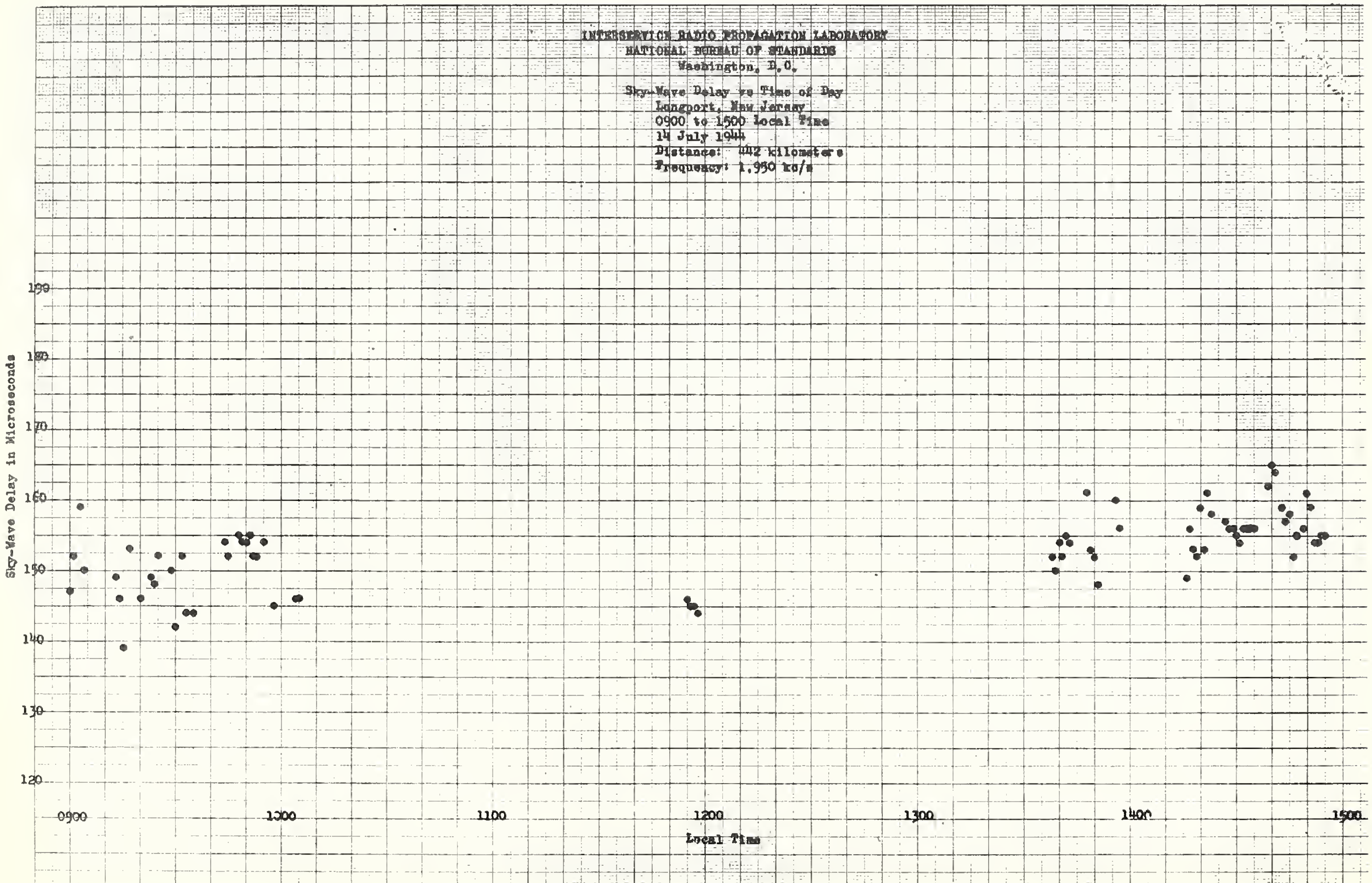
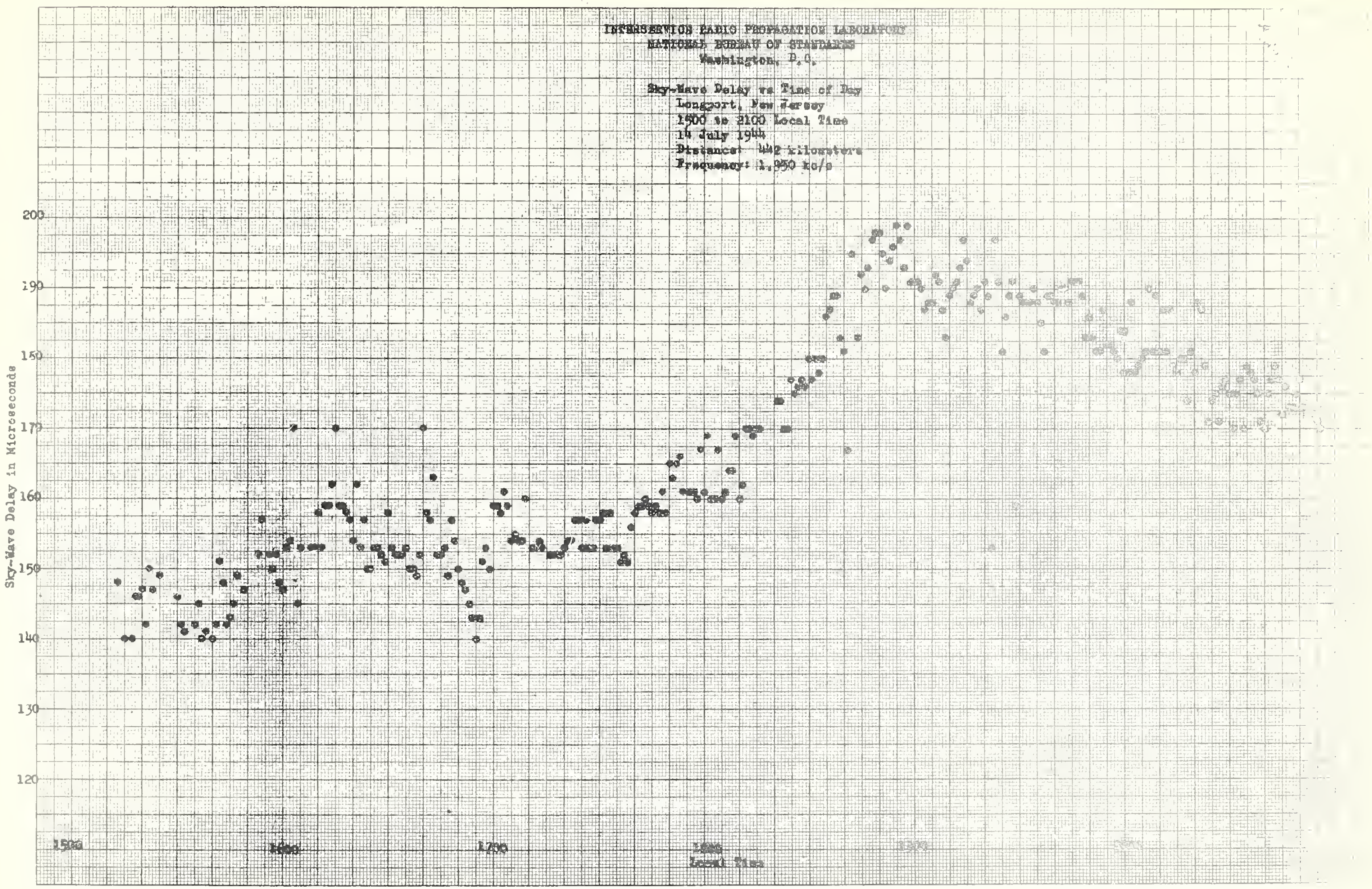

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Longport, New Jersey
0900 to 1500 Local Time
14 July 1944
Distance: 442 kilometers
Frequency: 1,950 kc/s
Sky-Wave Delay in Microseconds
190
180
170
160
150
140
130
120
0900
1000
1100
1200
1300
1400
1500
Local Time

Fig. 16.



INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Longport, New Jersey
1500 to 2100 Local Time
14 July 1944
Distance: 442 kilometers
Frequency: 1,950 kc/s
Sky-Wave Delay in Microseconds
200
190
180
170
160
150
140
130
120
1500
1600
1700
1800
Local Time

Fig. 17.

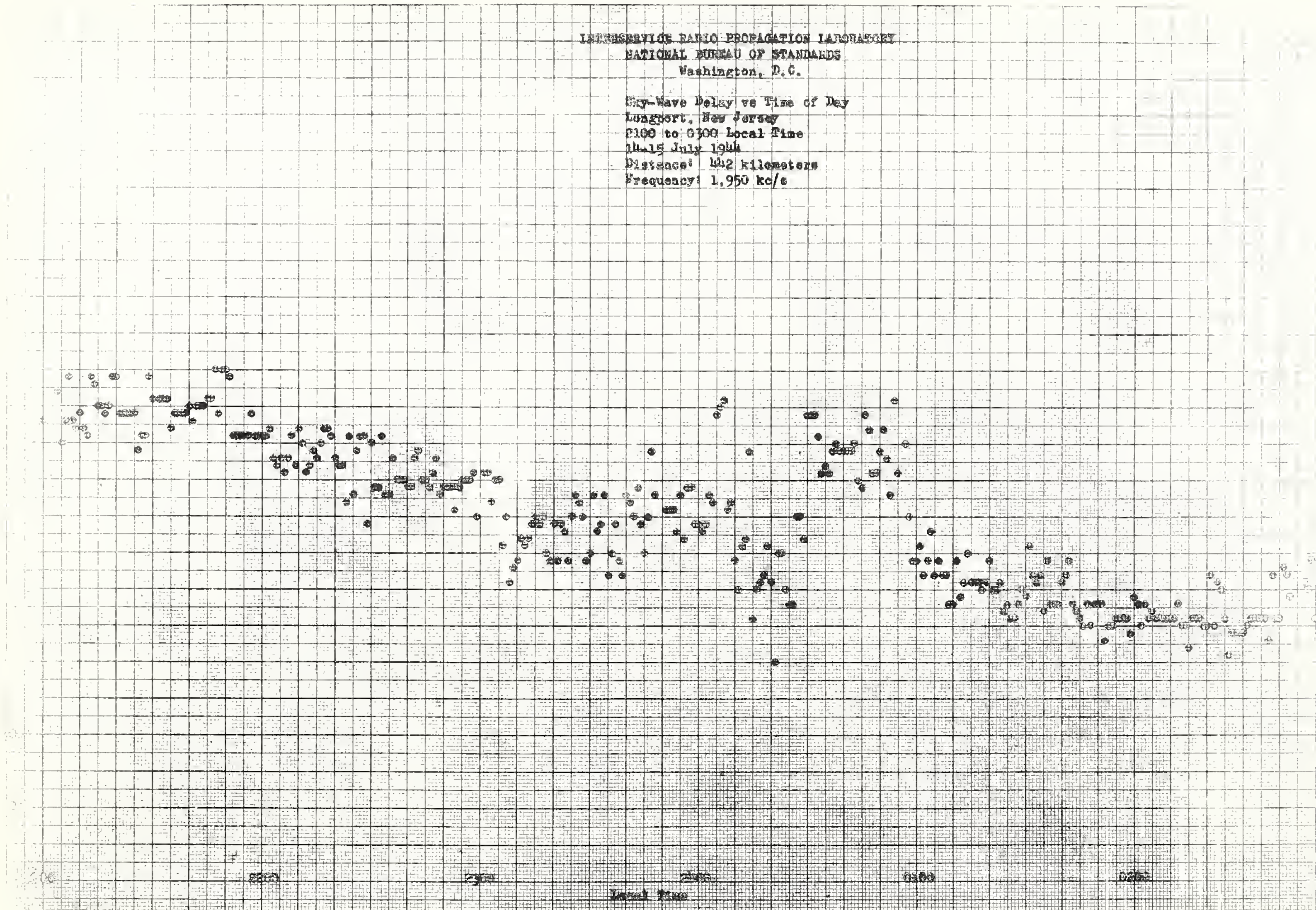

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Longport, New Jersey
2100 to 0300 Local Time
14-15 July 1944
Distance: 142 kilometers
Frequency: 1,950 kc/s
Local Time

Fig. 18.

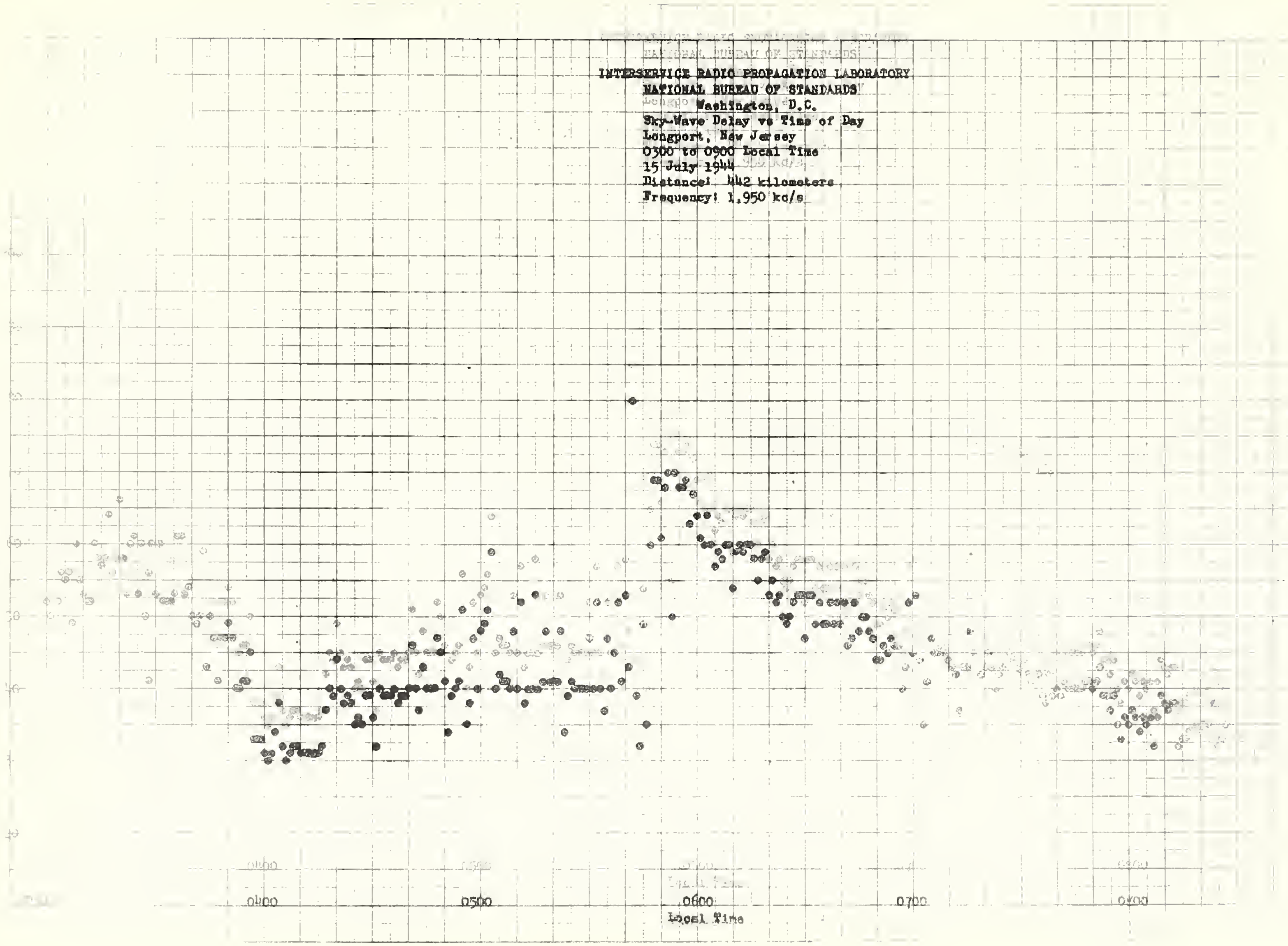

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Longport, New Jersey
0300 to 0900 Local Time
15 July 1944
Distance: 442 kilometers
Frequency: 1,950 kc/s
0400
0500
0600
0700
0800
Local Time

Fig. 19

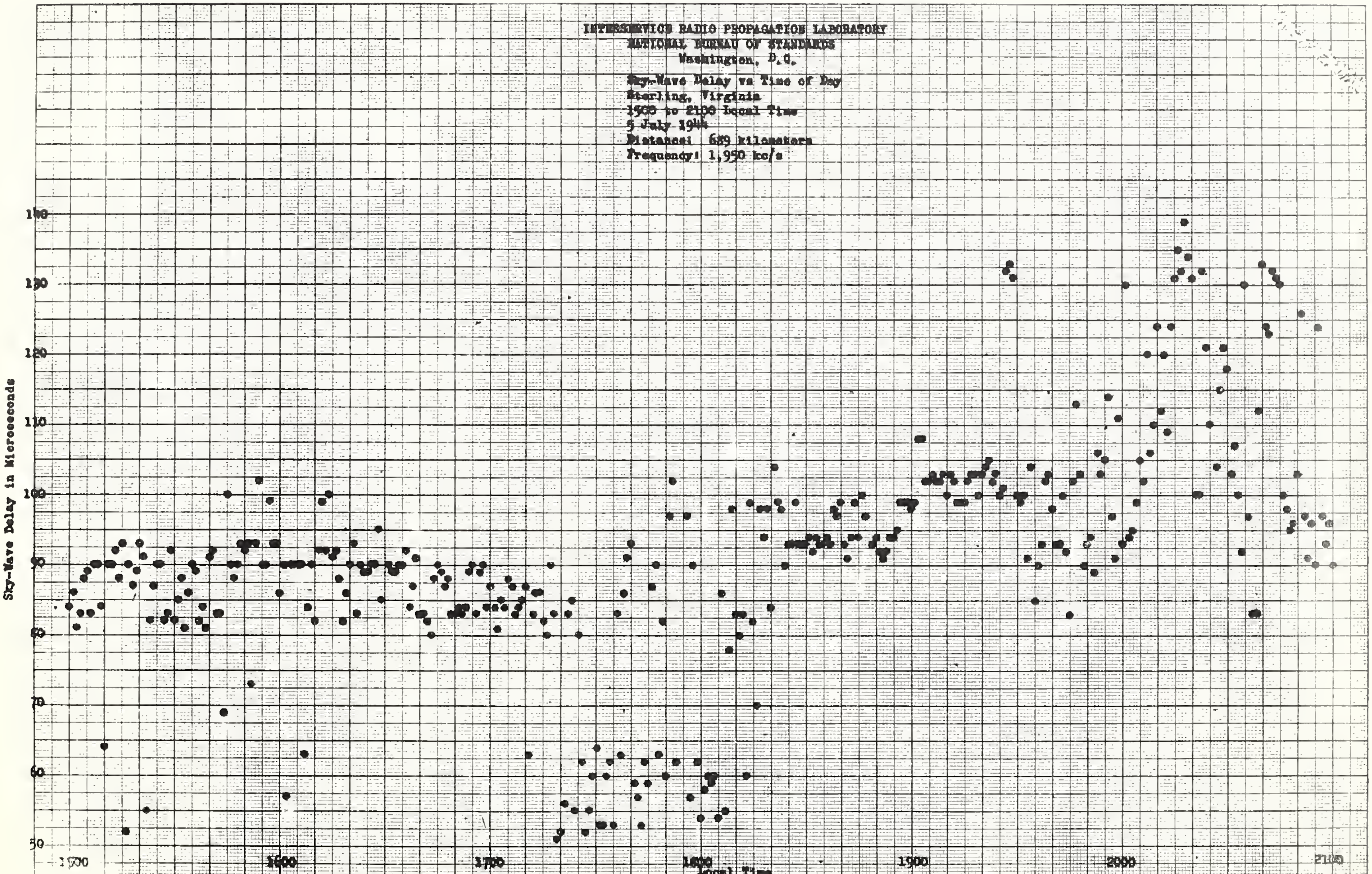

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Sterling, Virginia
1500 to 2100 Local Time
5 July 1944
Distance: 689 kilometers
Frequency: 1,950 kc/s
140
130
120
110
100
90
80
70
60
50
1500
1600
1700
1800
1900
2000
2100
Local Time
Sky-Wave Delay in Microseconds

Fig.20.

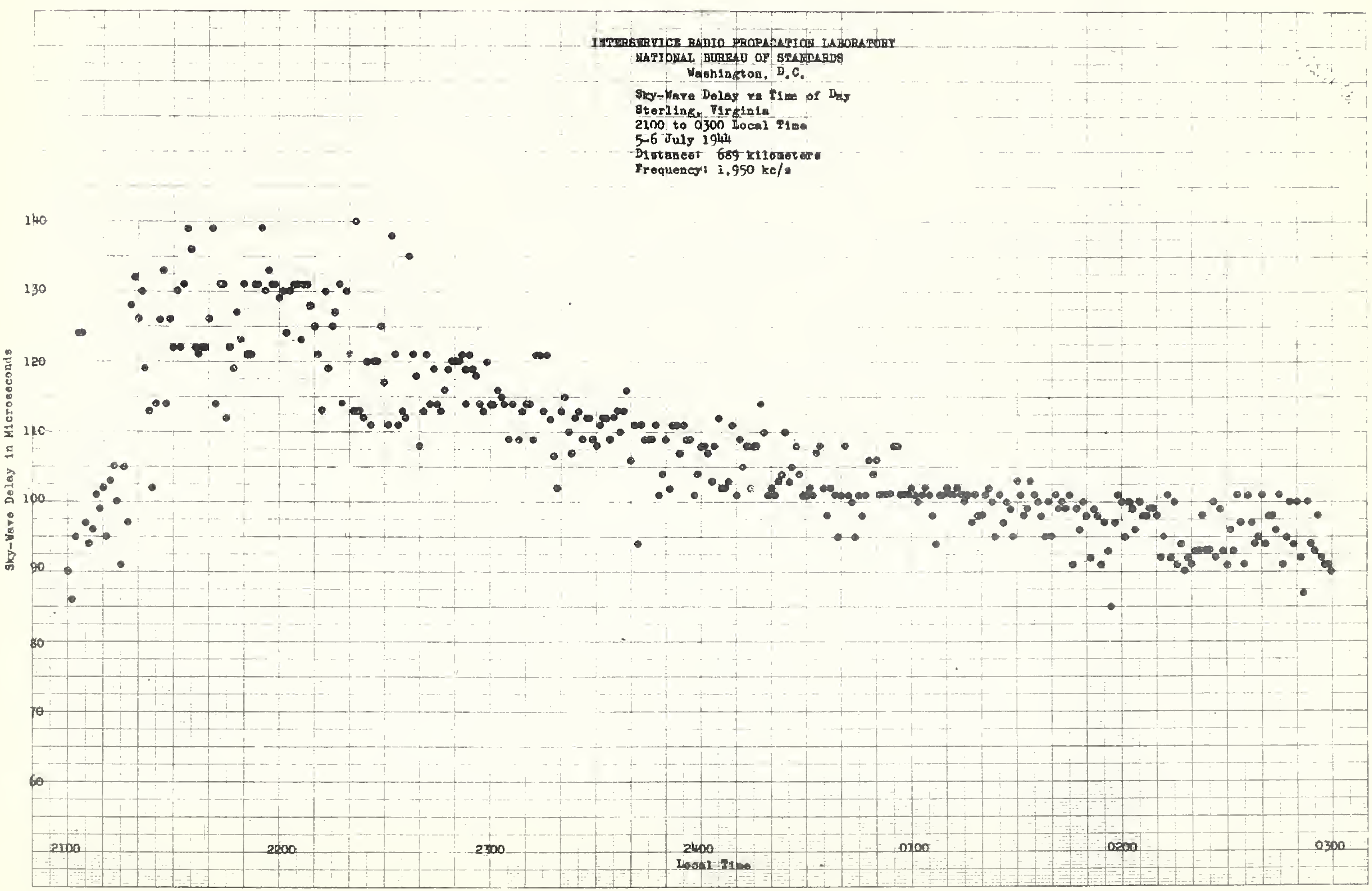
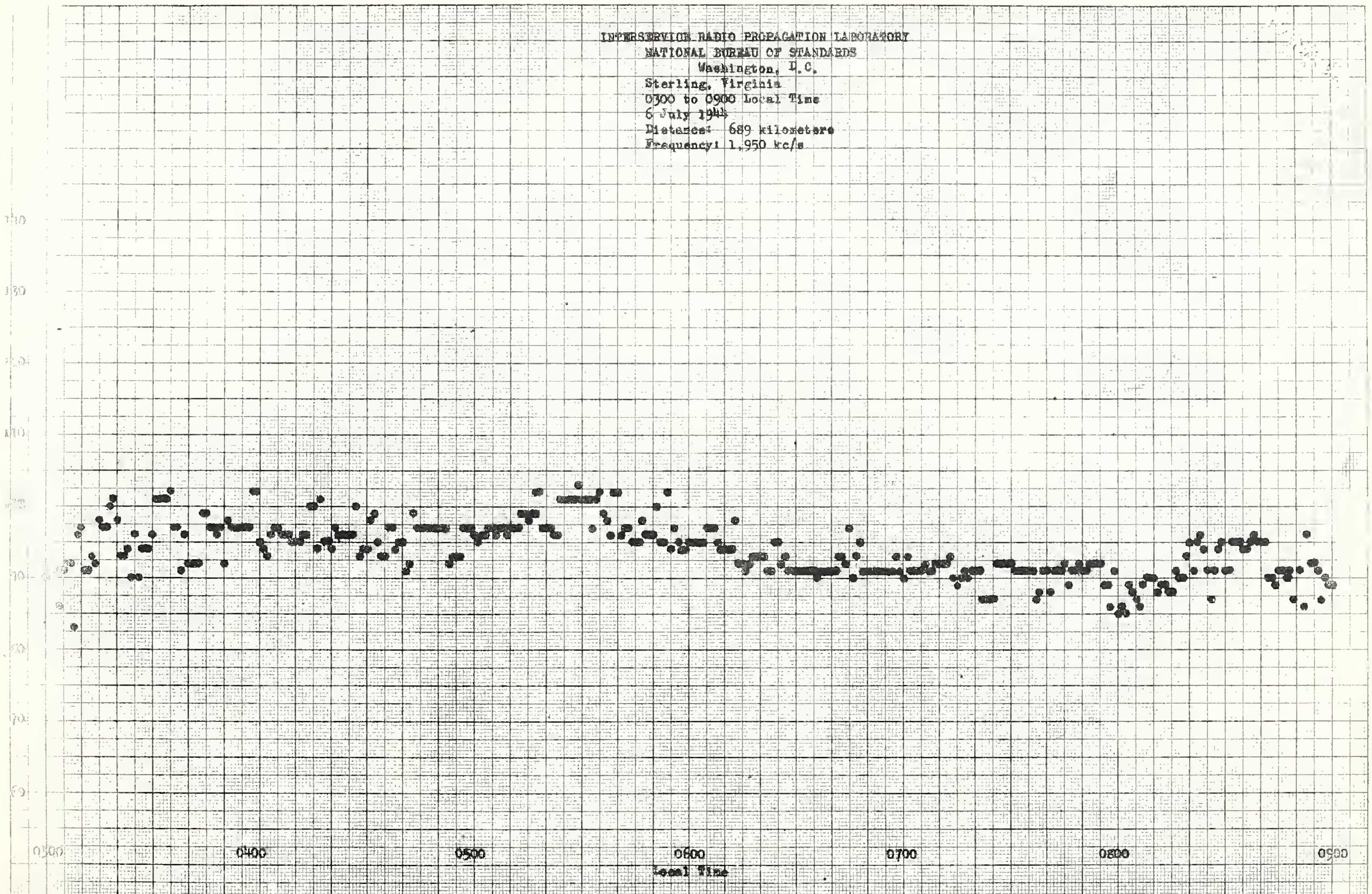
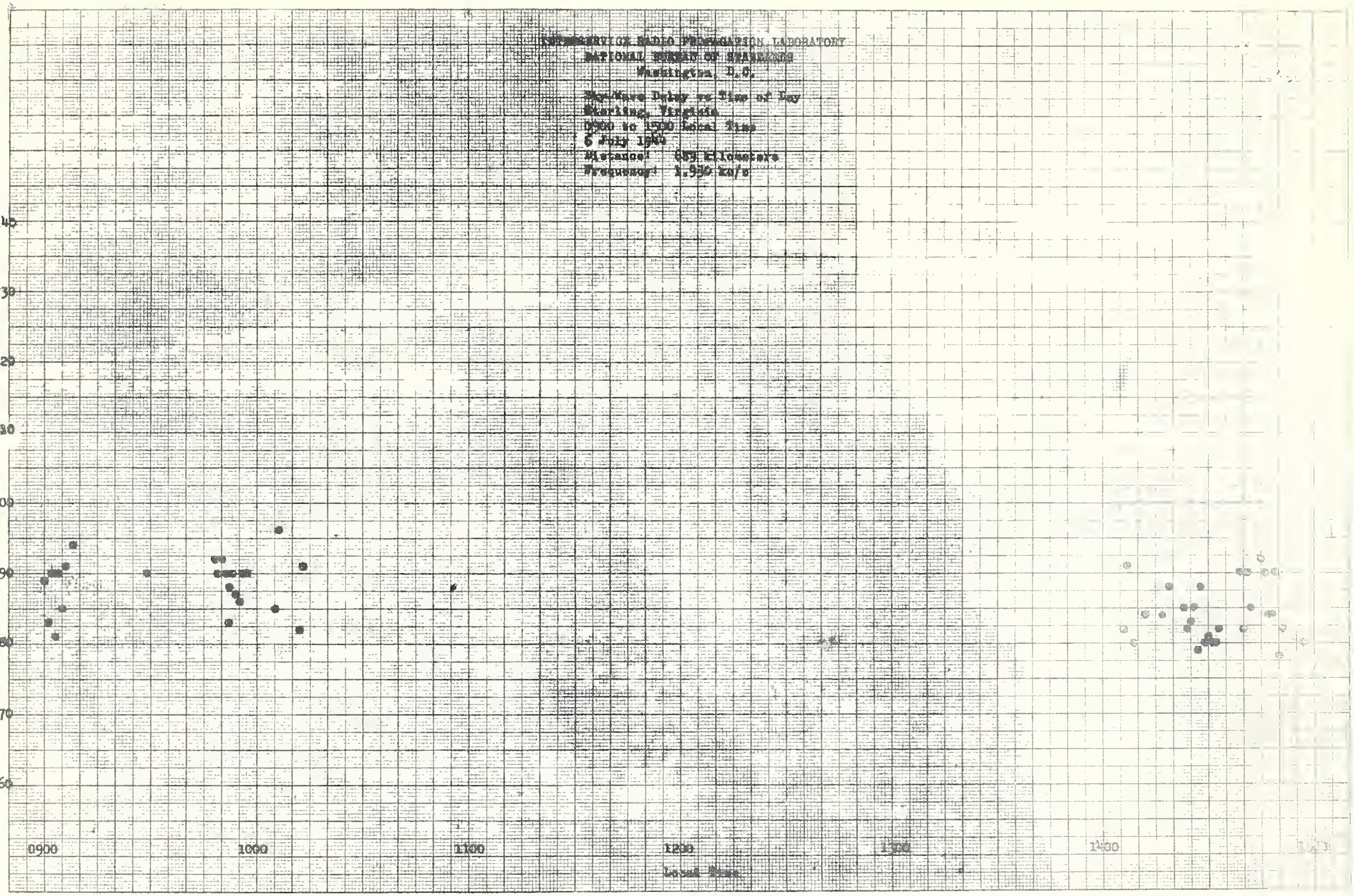

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Sterling, Virginia
2100 to 0300 Local Time
5-6 July 1944
Distance: 689 kilometers
Frequency: 1,950 kc/s
Sky-Wave Delay in Microseconds
140
130
120
110
100
90
80
70
60
2100
2200
2300
2400
0100
0200
0300
Local Time

Fig. 21.



INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sterling, Virginia
0300 to 0900 Local Time
6 July 1944
Distance: 689 kilometers
Frequency: 1,950 kc/s
0300
0400
0500
0600
0700
0800
0900
Local Time

Fig. 22.



INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Sterling, Virginia
0900 to 1500 Local Time
Sky-Wave Delay in Microseconds
140
130
120
110
100
90
80
70
60
0900
1000
1100
1200
1300
1400
Local Time

Fig.23.

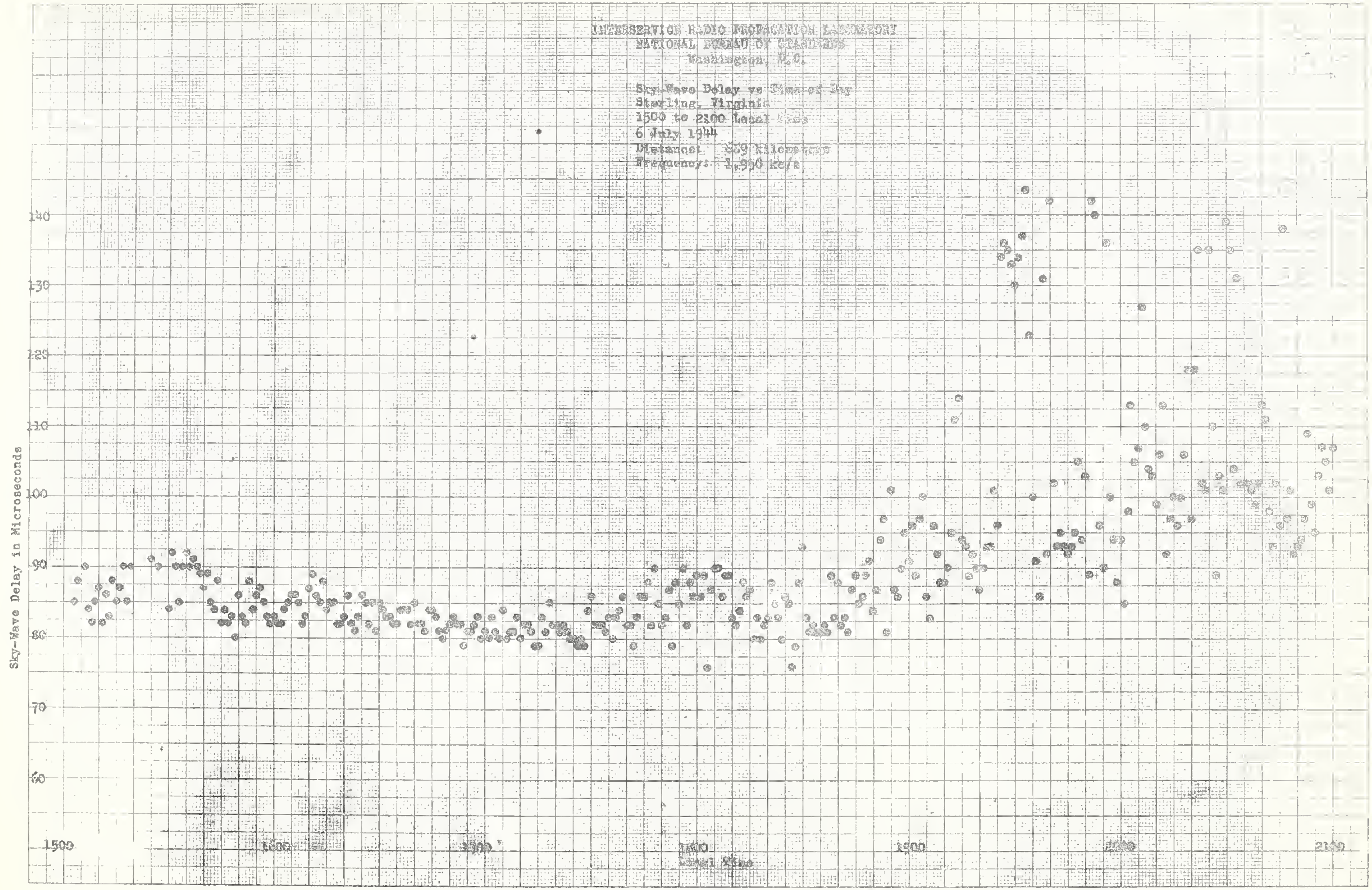

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Sterling, Virginia
1500 to 2100 Local Time
6 July 1944
Distance:
Frequency:
Sky-Wave Delay in Microseconds
140
130
120
110
100
90
80
70
60
1500
1600
1700
1800
1900
2000
2100
Local Time

Fig. 24.

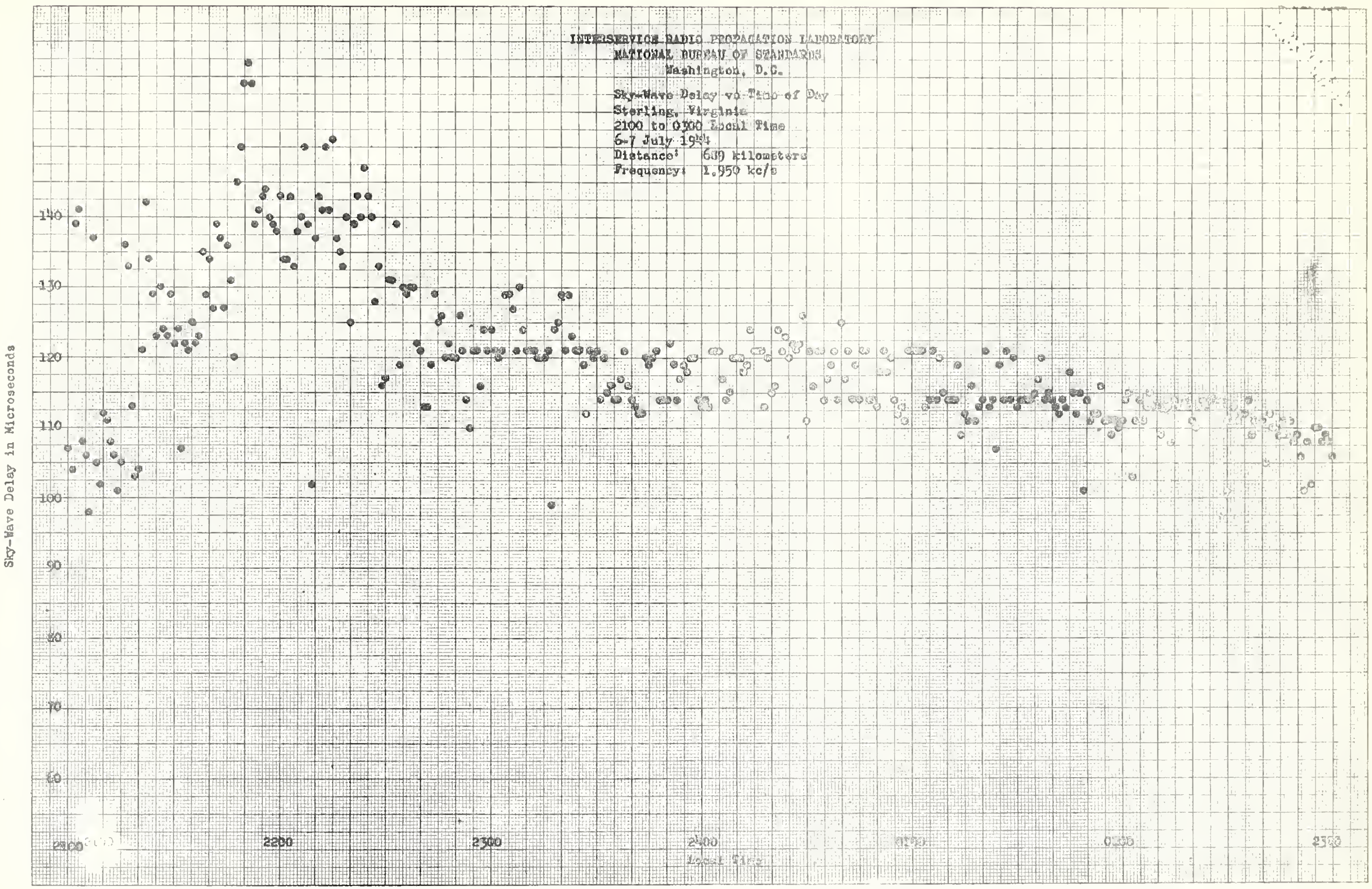

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Sterling, Virginia
2100 to 0300 Local Time
6-7 July 1944
Distance: 689 kilometers
Frequency: 1,950 kc/s
Sky-Wave Delay in Microseconds
140
130
120
110
100
90
80
70
60
2100
2200
2300
2400
0100
0200
0300
Local Time

Fig. 25.

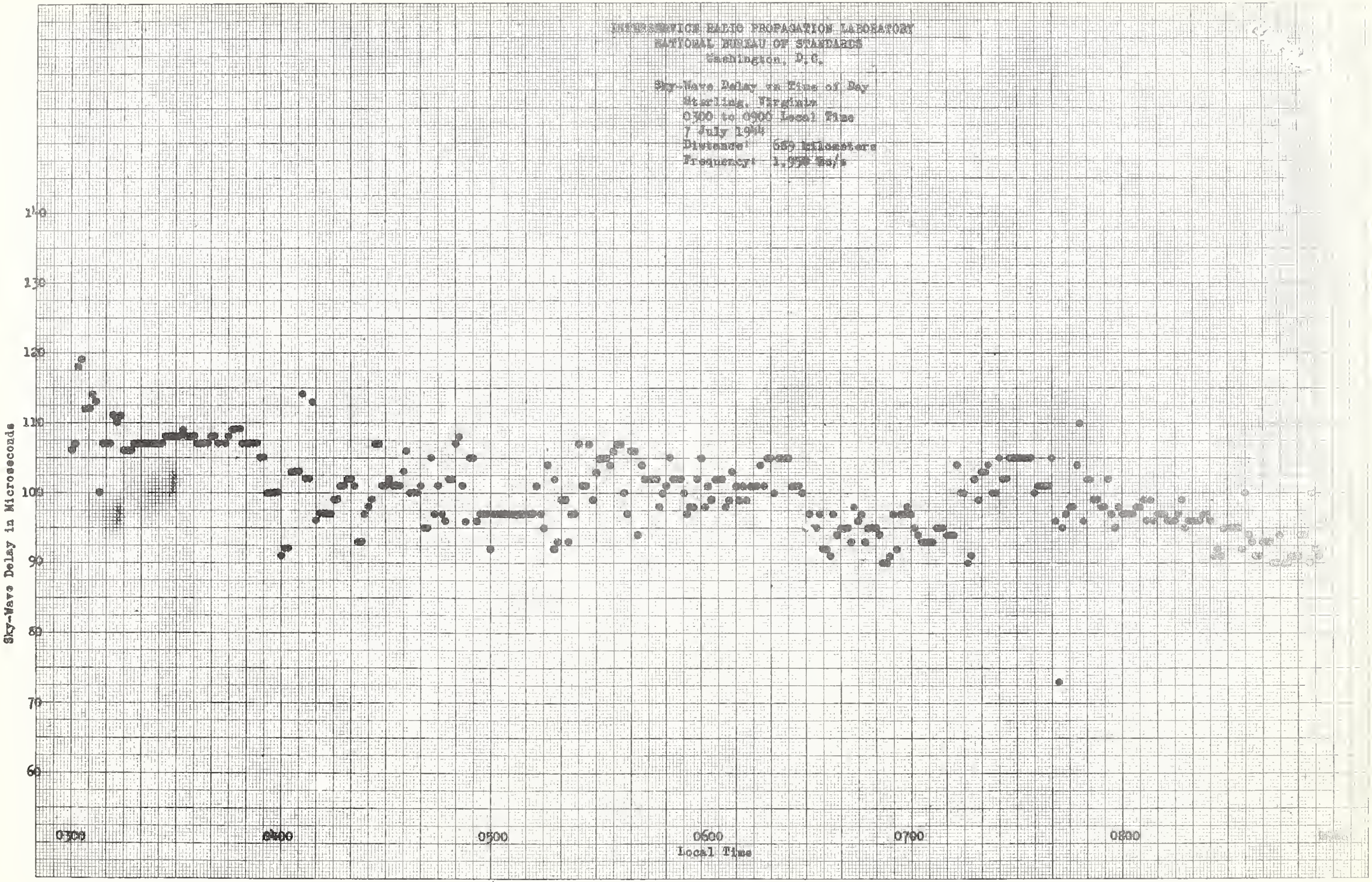
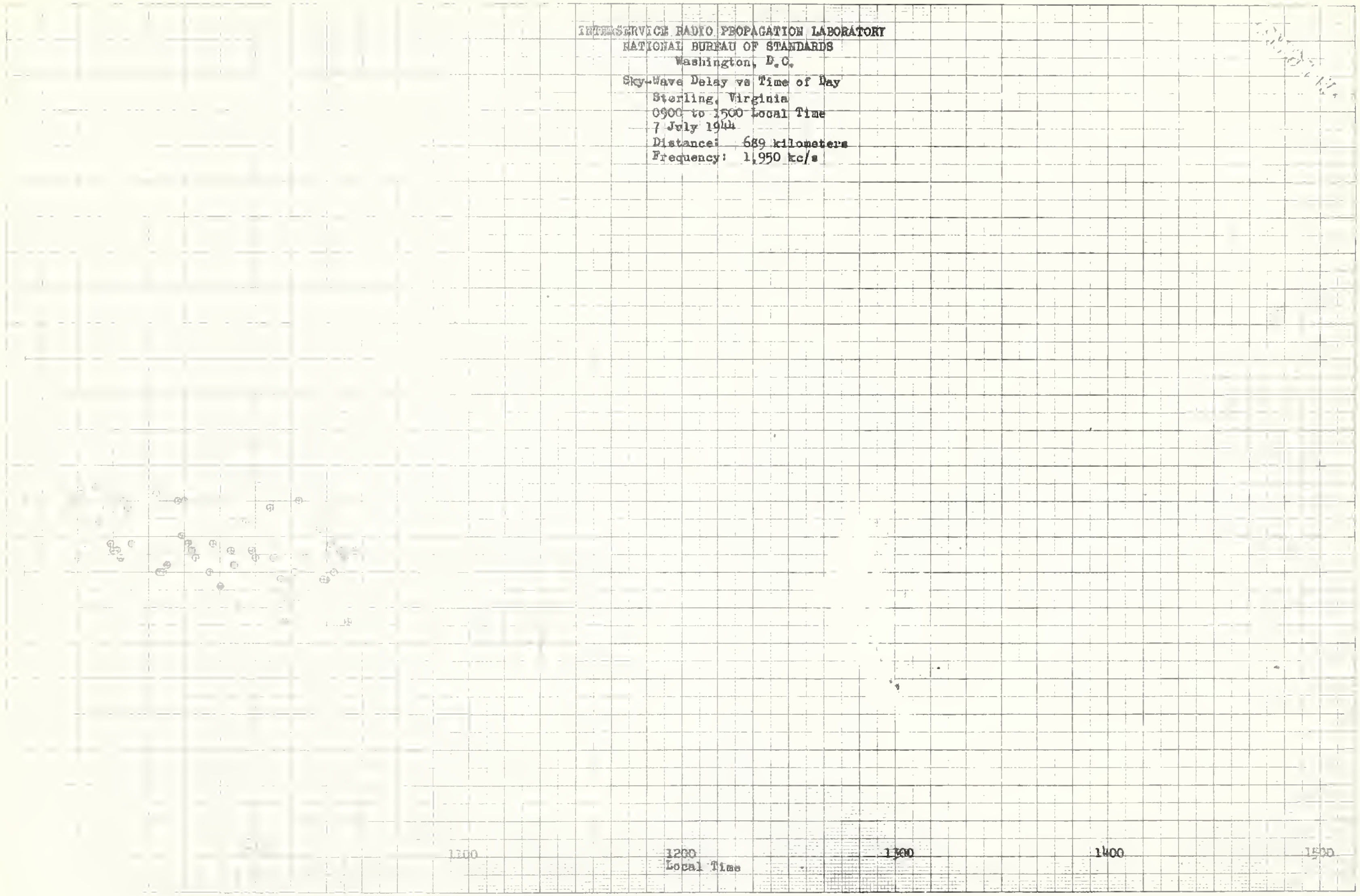

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Sterling, Virginia
0300 to 0900 Local Time
7 July 1944
Distance: 689 kilometers
Frequency: 1,950 kc/s
140
130
120
110
100
90
80
70
60
Sky-Wave Delay in Microseconds
0300
0400
0500
0600
0700
0800
Local Time

Fig. 26.



INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Sterling, Virginia
0900 to 1500 Local Time
7 July 1944
Distance: 689 kilometers
Frequency: 1,950 kc/s
1100
1200
1300
1400
1500
Local Time

Fig. 27.

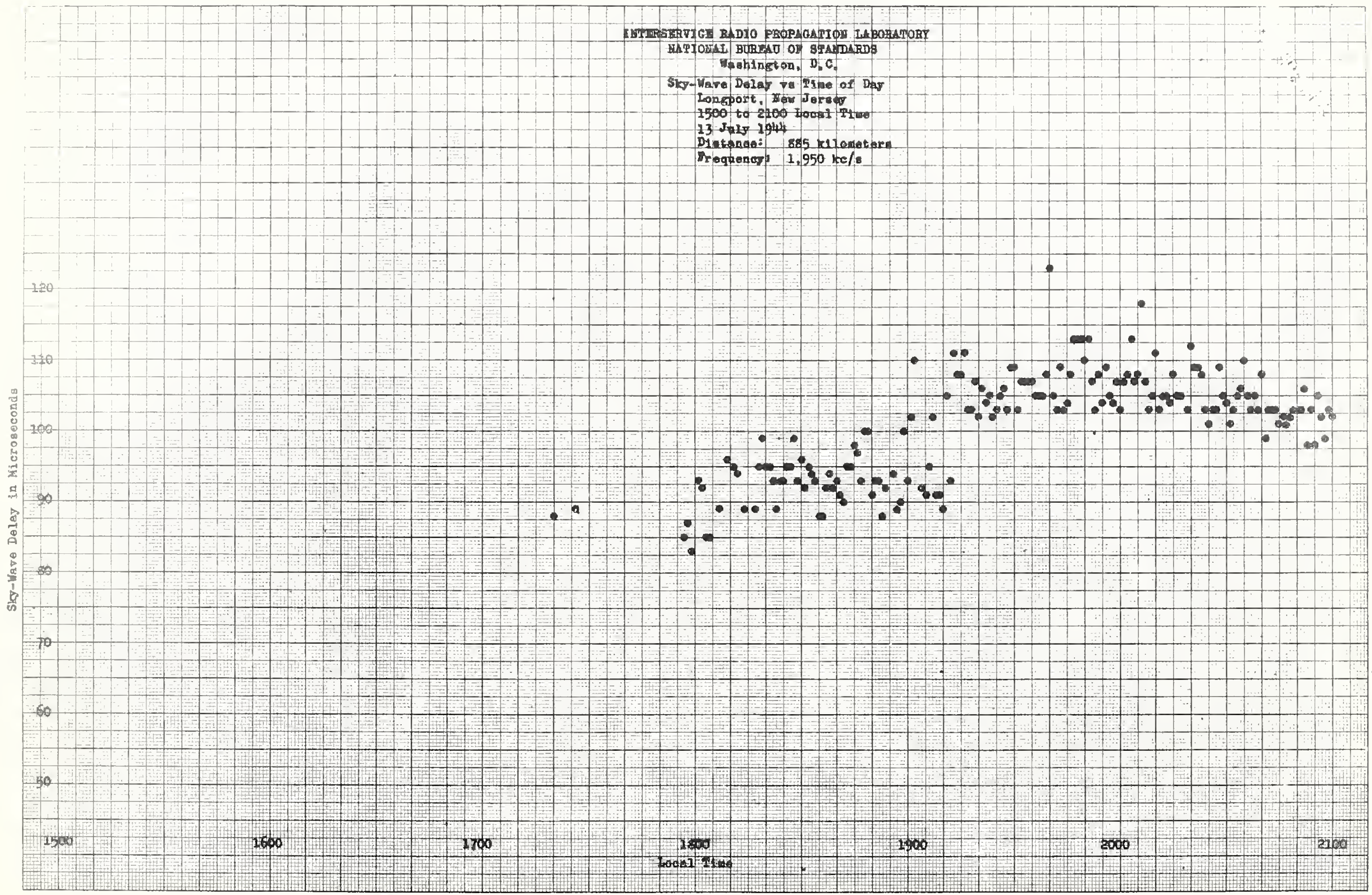

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Longport, New Jersey
1500 to 2100 Local Time
13 July 1944
Distance: 885 kilometers
Frequency: 1,950 kc/s
Sky-Wave Delay in Microseconds
120
110
100
90
80
70
60
50
1500
1600
1700
1800
1900
2000
2100
Local Time

Fig.28

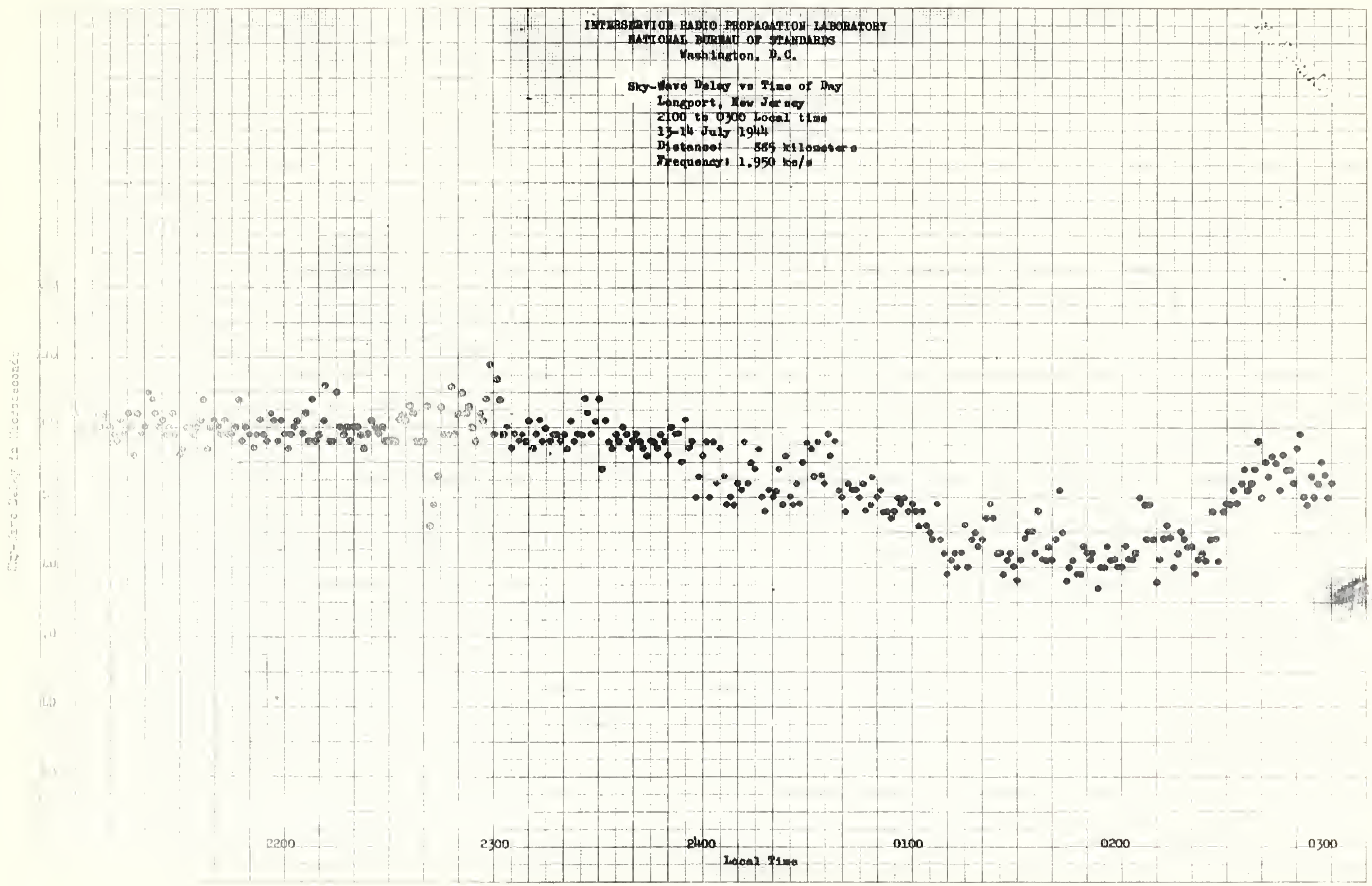
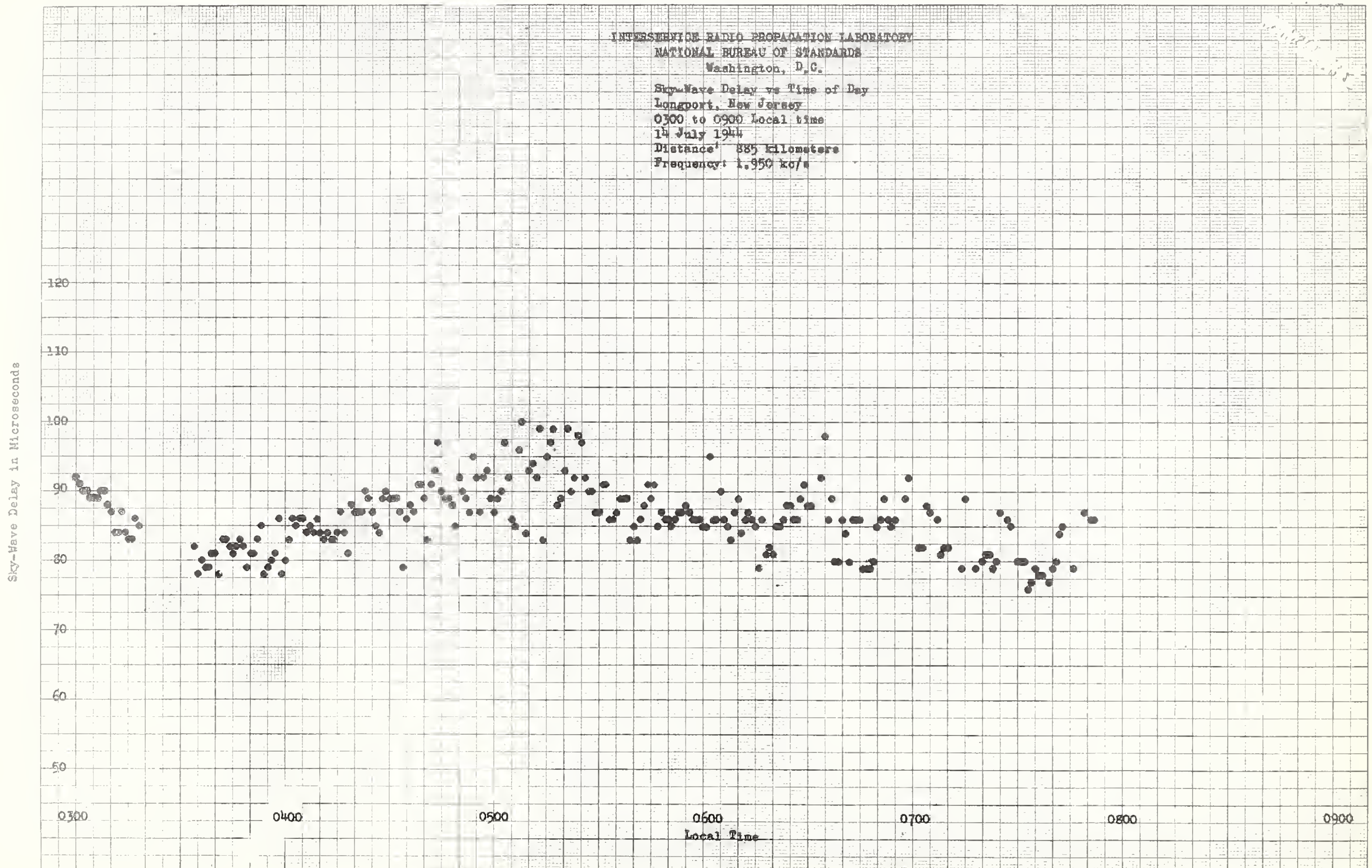
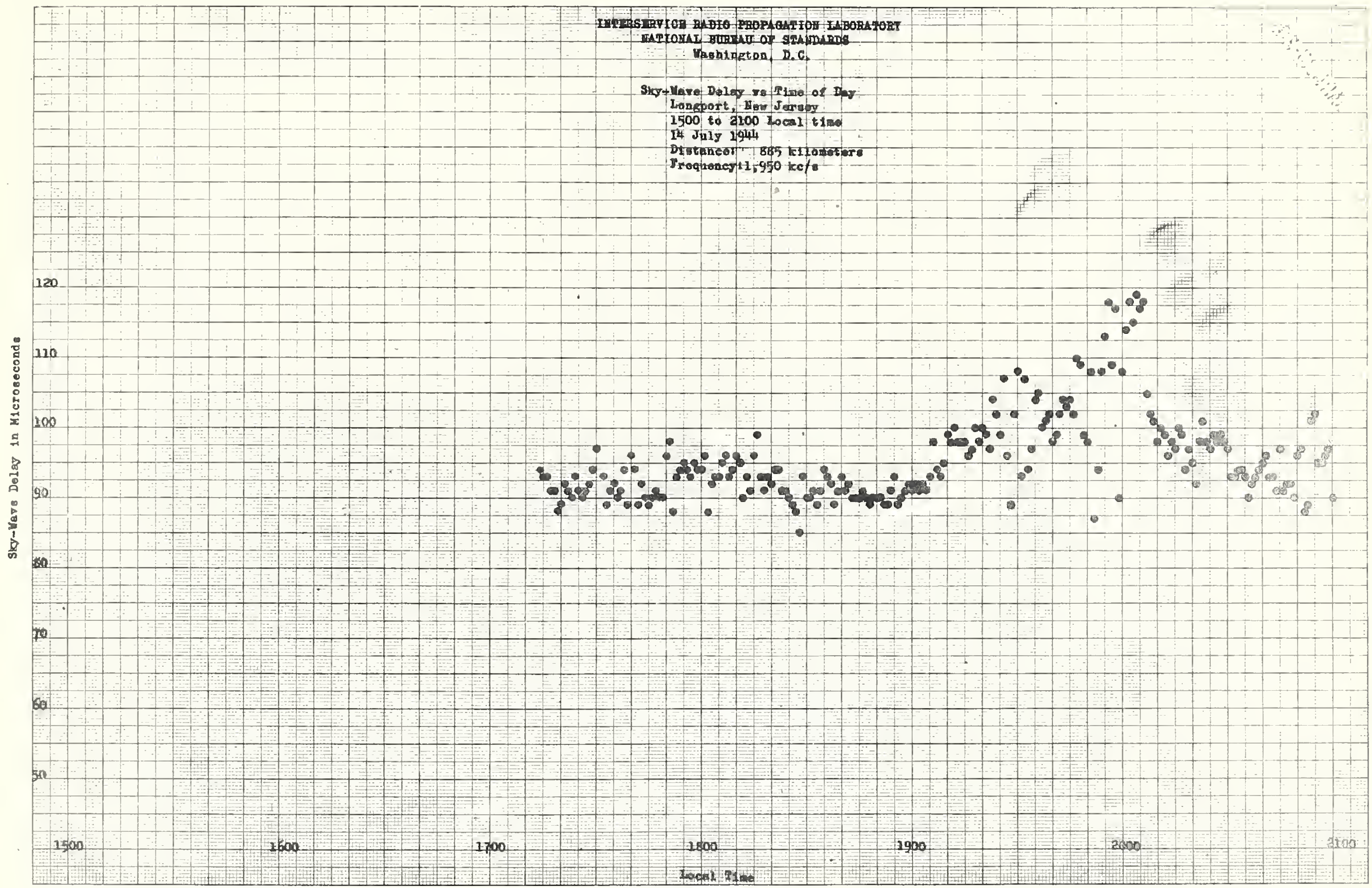

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Longport, New Jersey
2100 to 0300 Local time
13-14 July 1944
Distance: 585 kilometers
Frequency: 1,950 kc/s
2200
2300
2400
0100
0200
0300
Local Time

Fig. 29.



INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Longport, New Jersey
0300 to 0900 Local time
14 July 1944
Distance: 885 Kilometers
Frequency: 1,950 kc/s
Sky-Wave Delay in Microseconds
120
110
100
90
80
70
60
50
0300
0400
0500
0600
0700
0800
0900
Local Time

Fig. 30.



INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Longport, New Jersey
1500 to 2100 Local time
14 July 1944
Distance: 885 kilometers
Frequency: 1,950 kc/s
Sky-Wave Delay in Microseconds
120
110
100
90
80
70
60
50
1500
1600
1700
1800
1900
2000
2100
Local Time

Fig. 31.

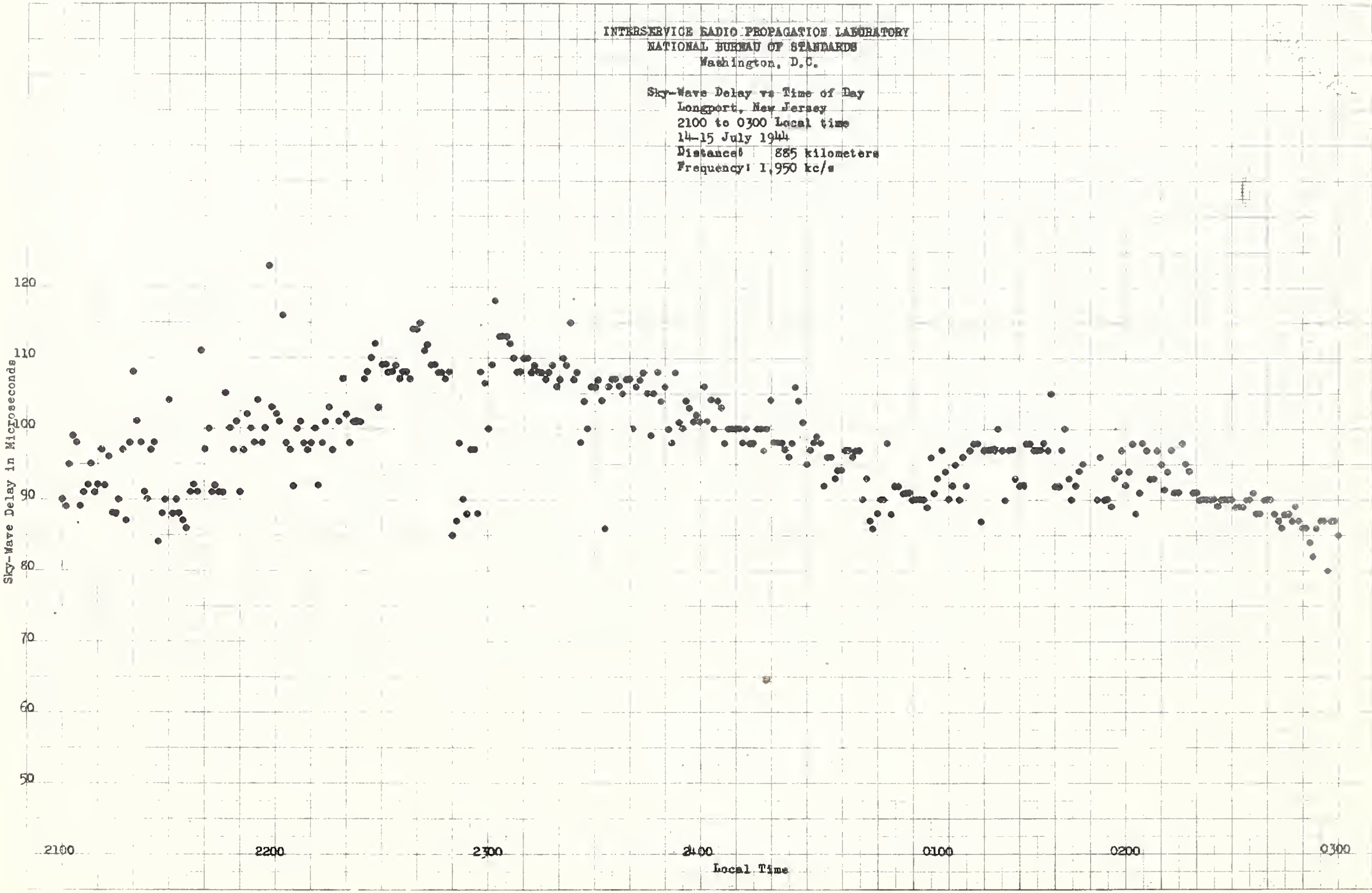
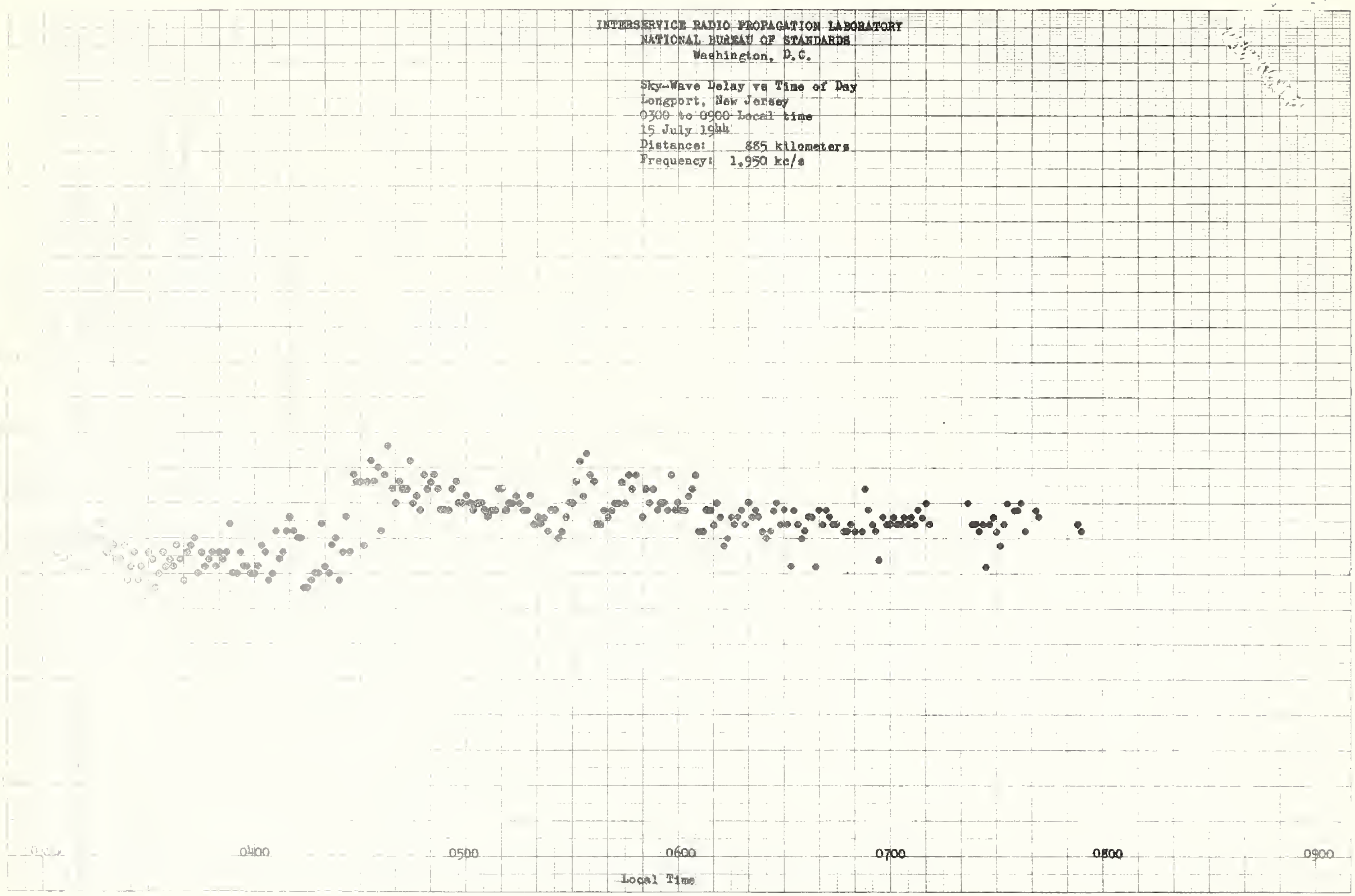

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Longport, New Jersey
2100 to 0300 Local time
14-15 July 1944
Distance: 885 kilometers
Frequency: 1,950 kc/s
Sky-Wave Delay in Microseconds
120
110
100
90
80
70
60
50
2100
2200
2300
2400
0100
0200
0300
Local Time

Fig.32.


INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Delay vs Time of Day
Longport, New Jersey
0300 to 0900 Local time
15 July 1944
Distance: 885 kilometers
Frequency: 1,950 kc/s
0400
0500
0600
0700
0800
0900
Local Time
Fig.33.

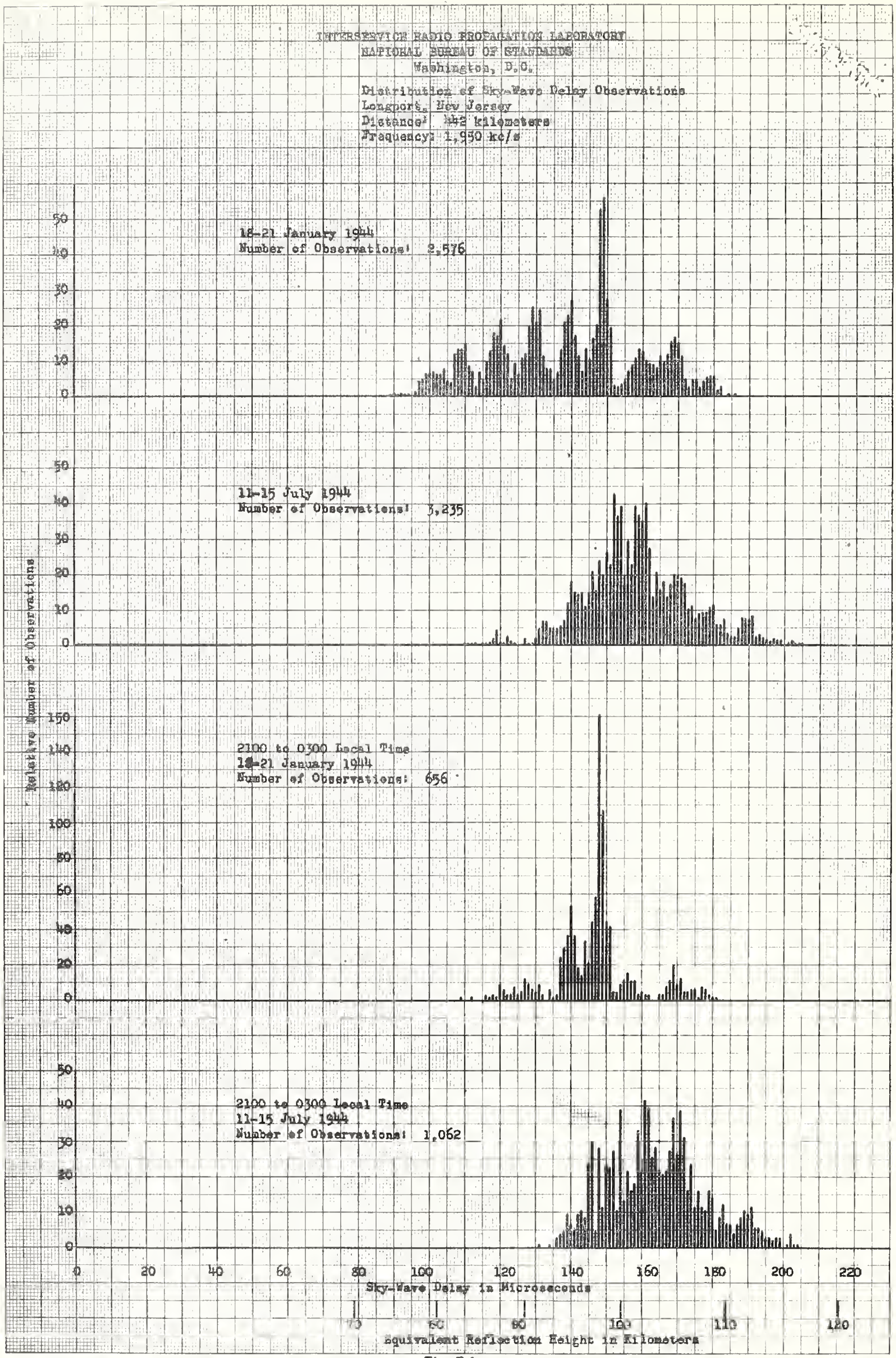
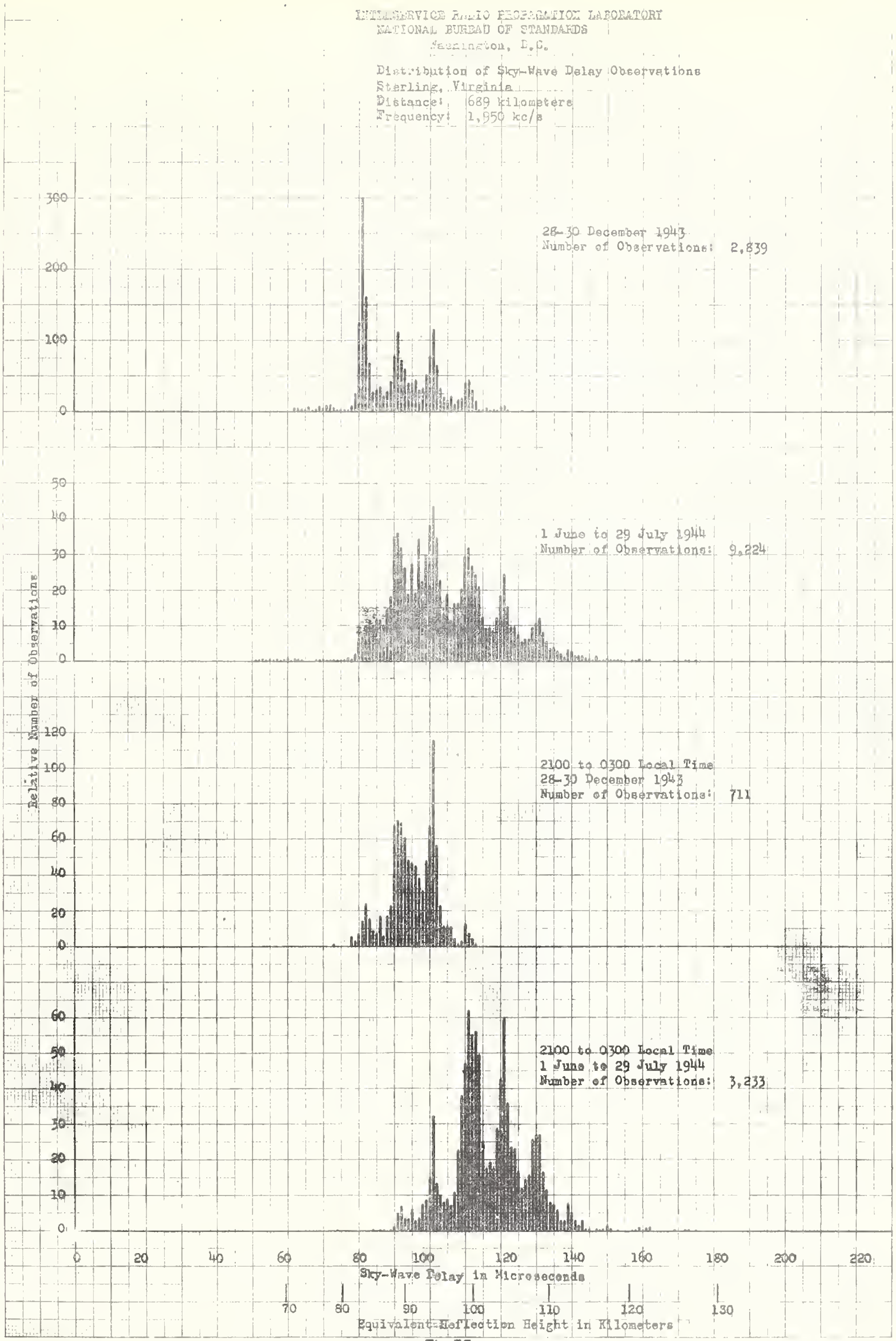
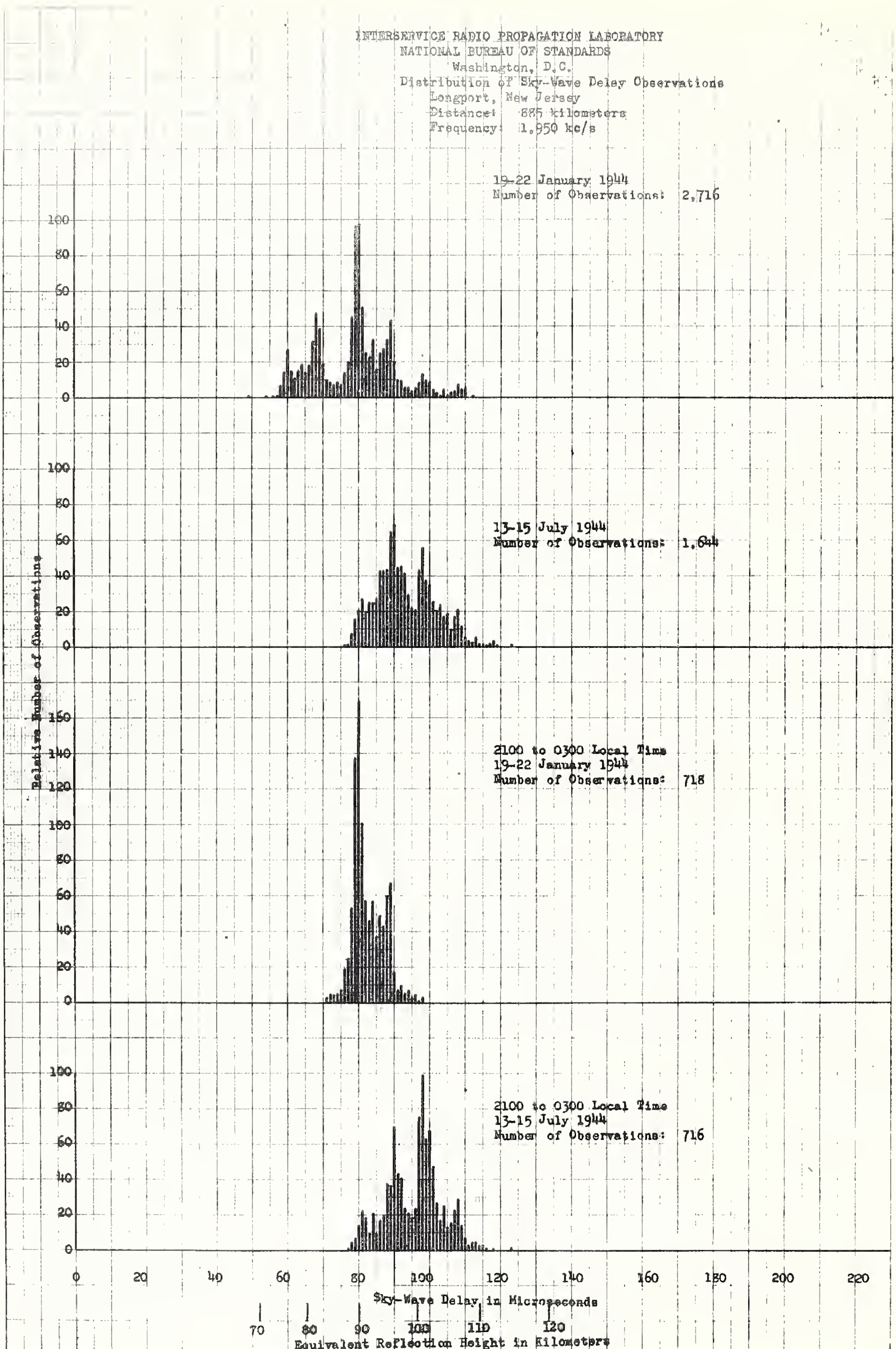

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Distribution of Sky-Wave Delay Observations
Longport, New Jersey
Distance: 142 kilometers
Frequency: 1,950 kc/s
18-21 January 1944
Number of Observations: 2,576
11-15 July 1944
Number of Observations: 3,235
2100 to 0300 Local Time
18-21 January 1944
Number of Observations: 656
2100 to 0300 Local Time
11-15 July 1944
Number of Observations: 1,062
Relative Number of Observations
Sky-Wave Delay in Microseconds
Equivalent Reflection Height in Kilometers

Fig. 34.


INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Distribution of Sky-Wave Delay Observations
Sterling, Virginia
Distance: 689 kilometers
Frequency: 1,950 kc/s
28-30 December 1943
Number of Observations: 2,839
1 June to 29 July 1944
Number of Observations: 9,224
2100 to 0300 Local Time
28-30 December 1943
Number of Observations: 711
2100 to 0300 Local Time
1 June to 29 July 1944
Number of Observations: 3,233
Relative Number of Observations
Sky-Wave Delay in Microseconds
Equivalent Reflection Height in Kilometers
Fig. 35.


INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Distribution of Sky-Wave Delay Observations
Longport, New Jersey
Distance: 885 kilometers
Frequency: 1,950 kc/s
19-22 January 1944
Number of Observations: 2,716
13-15 July 1944
Number of Observations: 1,644
2100 to 0300 Local Time
19-22 January 1944
Number of Observations: 718
2100 to 0300 Local Time
13-15 July 1944
Number of Observations: 716
Relative Number of Observations
Sky-Wave Delay in Microseconds
Equivalent Reflection Height in Kilometers
Fig.36.

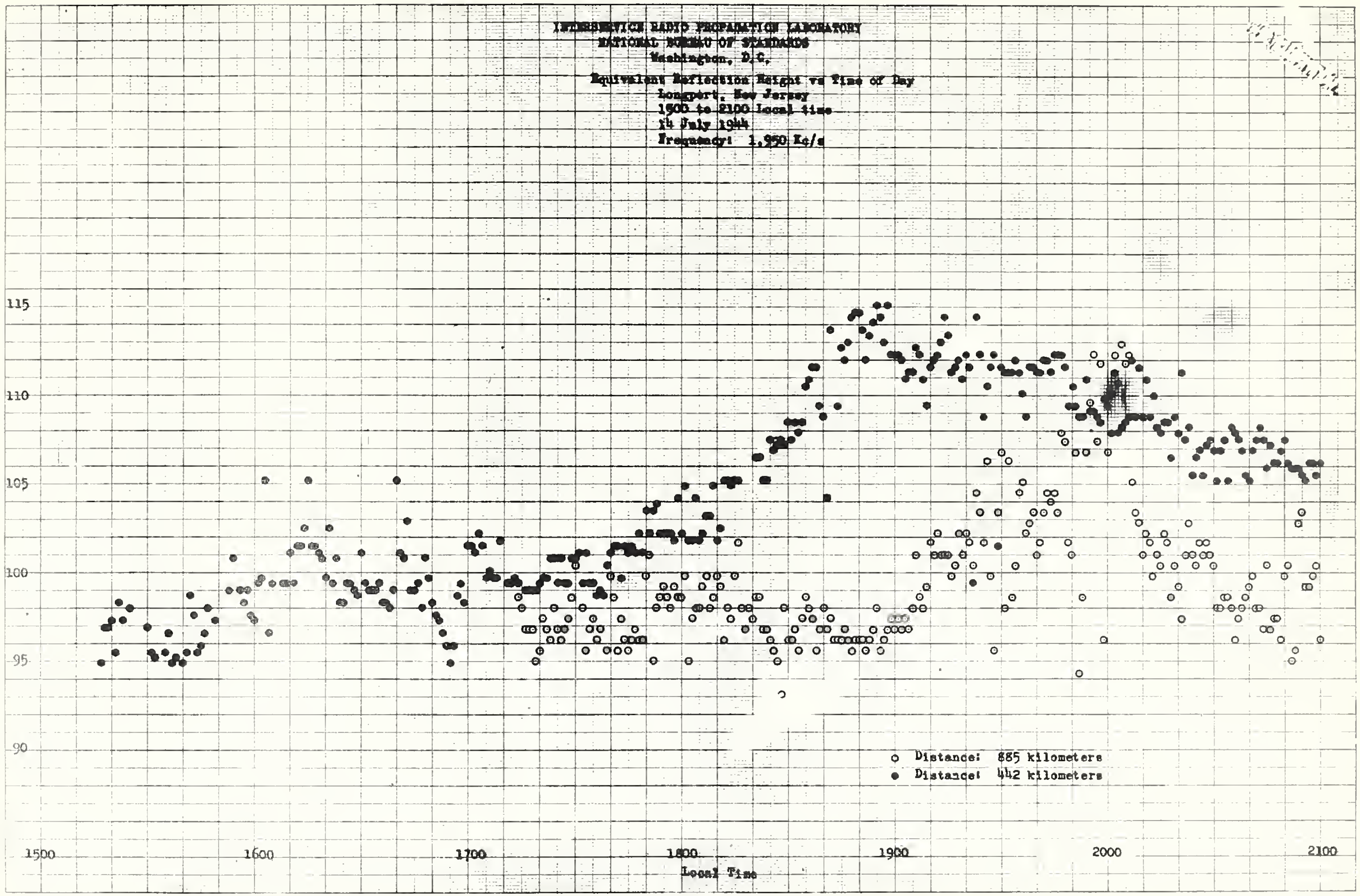

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Equivalent Reflection Height vs Time of Day
Longport, New Jersey
1500 to 2100 local time
14 July 1944
Frequency: 1,950 Kc/s
Equivalent Reflection Height in Kilometers
115
110
105
100
95
90
Distance: 885 kilometers
Distance: 442 kilometers
1500
1600
1700
1800
1900
2000
2100
Local Time

Fig. 37

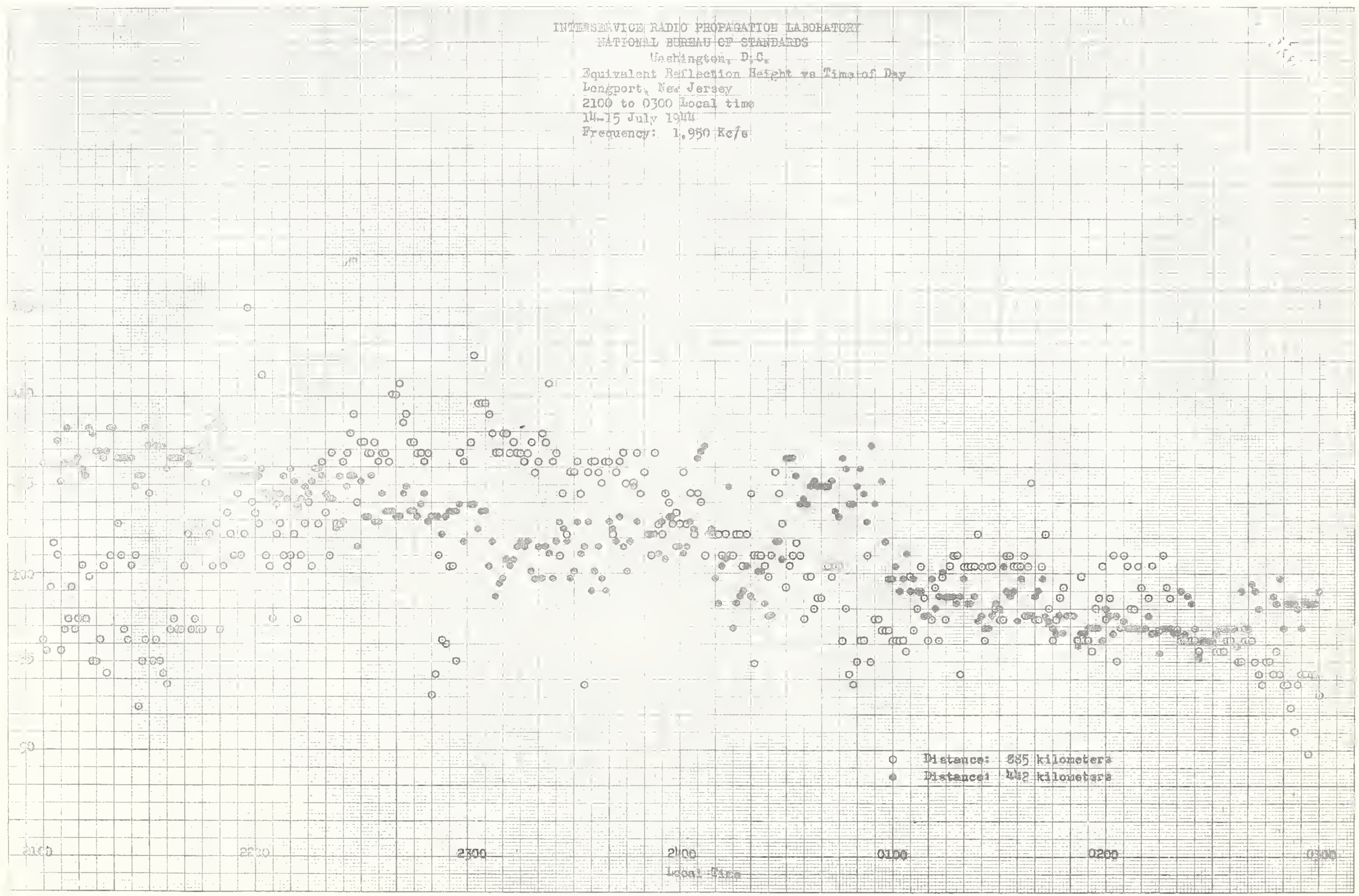

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Equivalent Reflection Height vs Time of Day
Longport, New Jersey
2100 to 0300 Local time
14-15 July 1944
Frequency: 1,950 Kc/s
Distance: 885 kilometers
Distance: 442 kilometers
2100
2200
2300
2400
0100
0200
0300
Local Time
90
100

Fig.38.

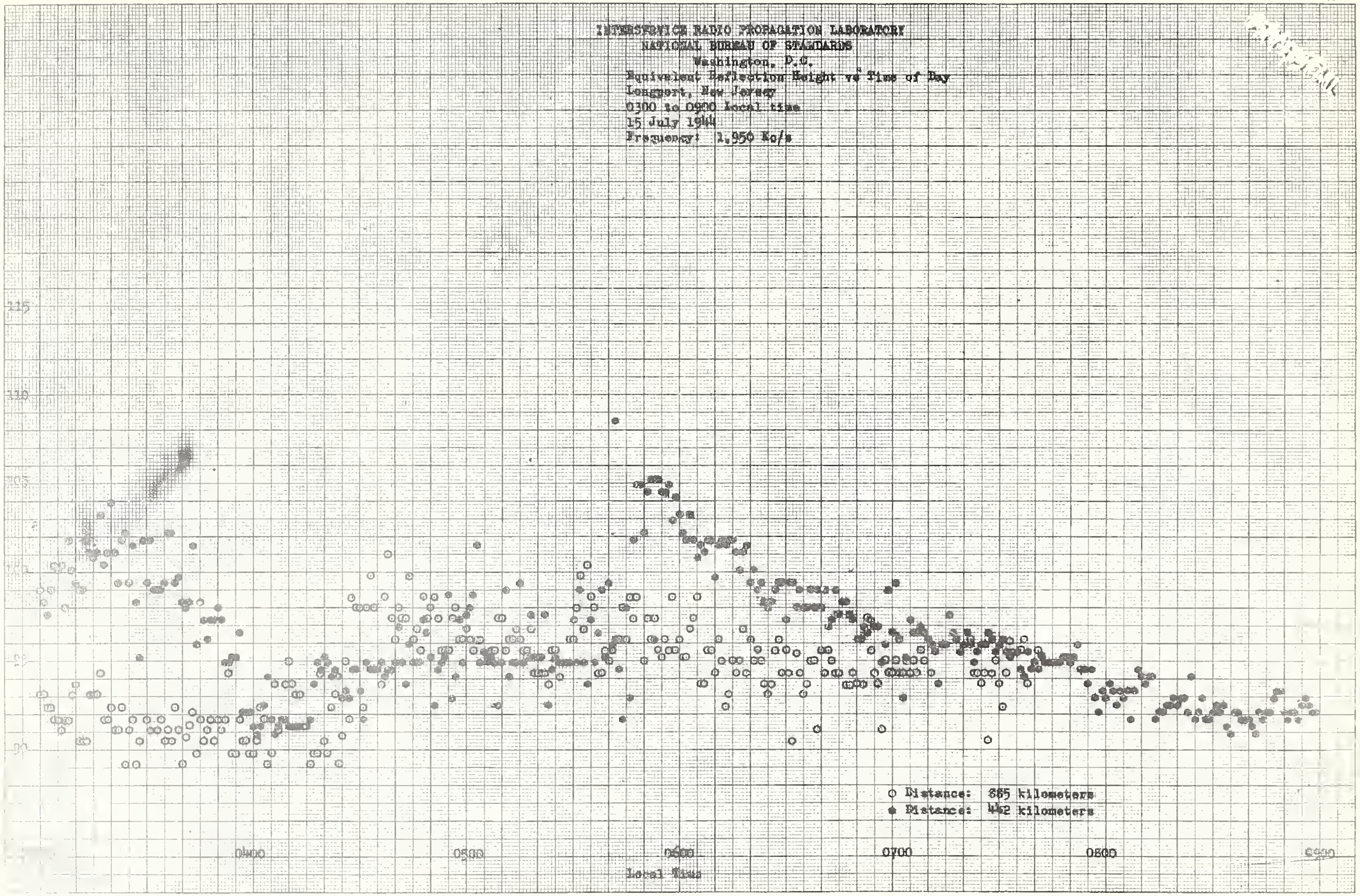

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Equivalent Reflection Height vs Time of Day
Longport, New Jersey
0300 to 0900 Local time
15 July 1944
Frequency: 1,950 Kc/s
115
110
105
100
95
90
o Distance: 385 kilometers
• Distance: 442 kilometers
0400
0500
0600
0700
0800
0900
Local Time

Fig. 39.

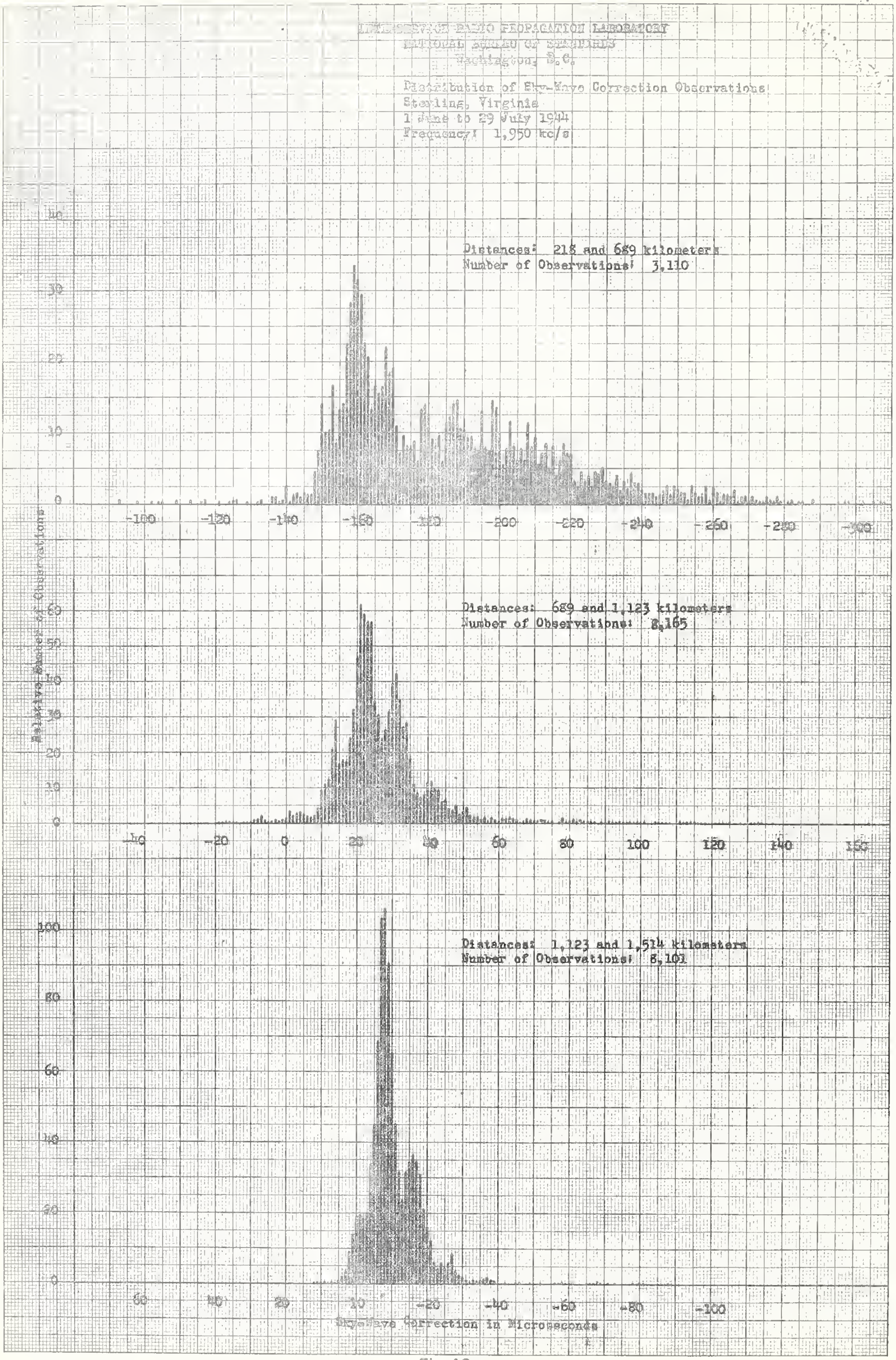
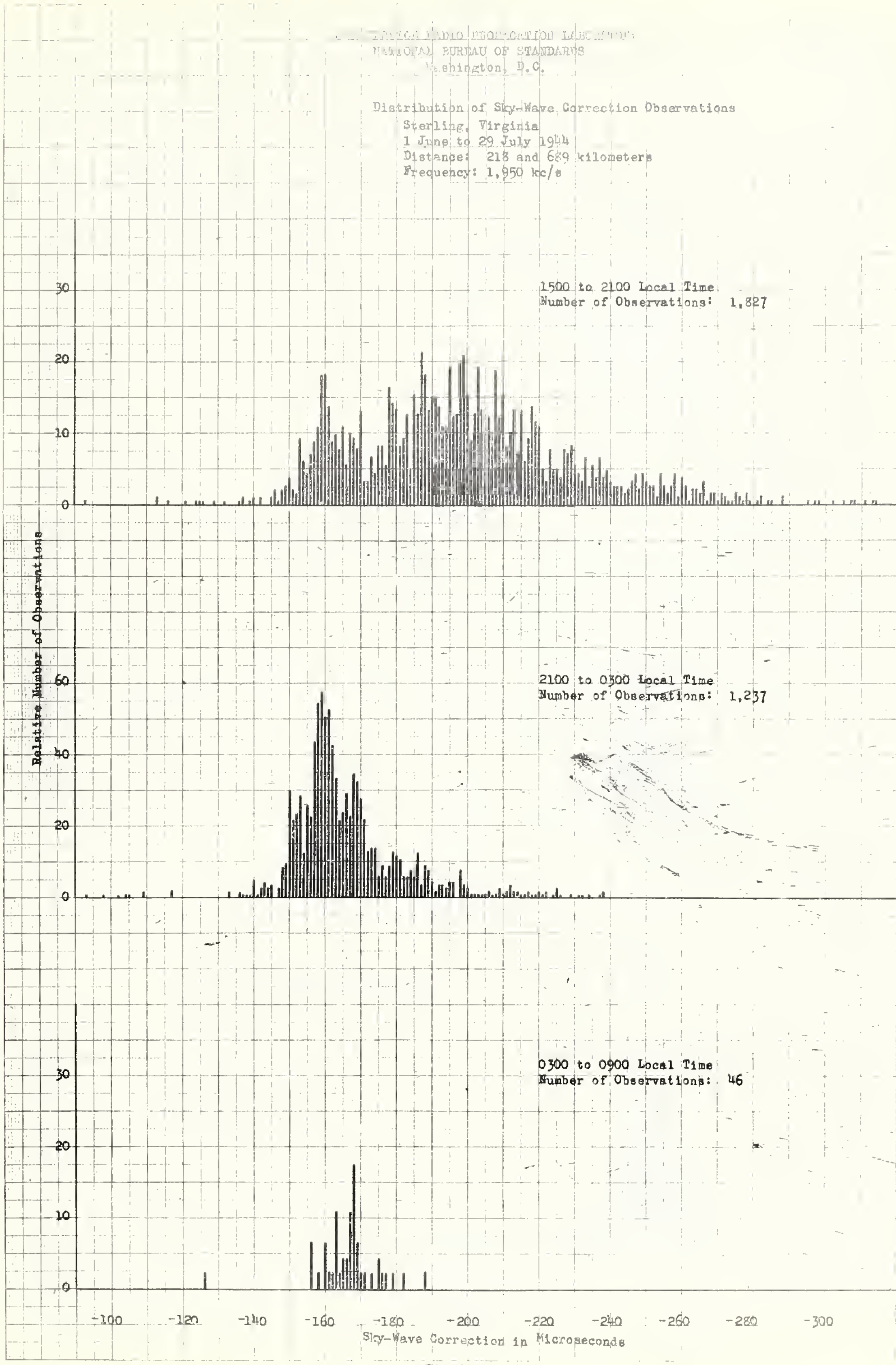
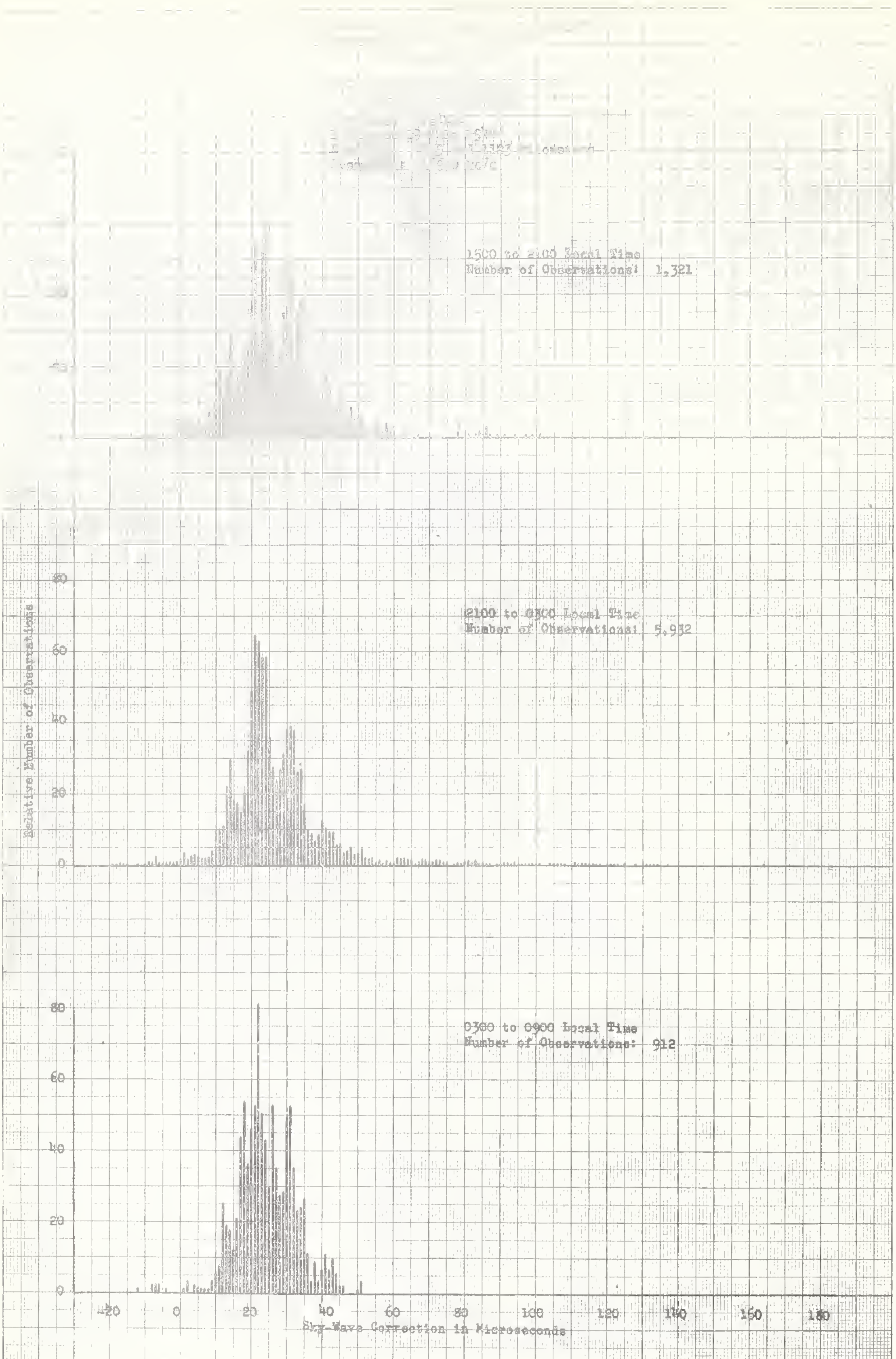

Distribution of Sky-Wave Correction Observations
Sterling, Virginia
1 June to 29 July 1944
Frequency: 1,950 kc/s
Distances: 218 and 689 kilometers
Number of Observations: 3,110
Distances: 689 and 1,123 kilometers
Number of Observations: 8,165
Distances: 1,123 and 1,514 kilometers
Number of Observations: 8,101
Relative Number of Observations
Sky-Wave Correction in Microseconds

Fig. 40.



NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Distribution of Sky-Wave Correction Observations
Sterling, Virginia
1 June to 29 July 1944
Distance: 218 and 689 kilometers
Frequency: 1,950 kc/s
1500 to 2100 Local Time
Number of Observations: 1,827
2100 to 0300 Local Time
Number of Observations: 1,237
0300 to 0900 Local Time
Number of Observations: 46
Relative Number of Observations
30
20
10
0
60
40
20
0
30
20
10
0
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
Sky-Wave Correction in Microseconds

Fig. 41



1500 to 2100 Local Time
Number of Observations: 1,321
2100 to 0300 Local Time
Number of Observations: 5,932
0300 to 0900 Local Time
Number of Observations: 912
Relative Number of Observations
Sky-Wave Correction in Microseconds

Fig. 42.

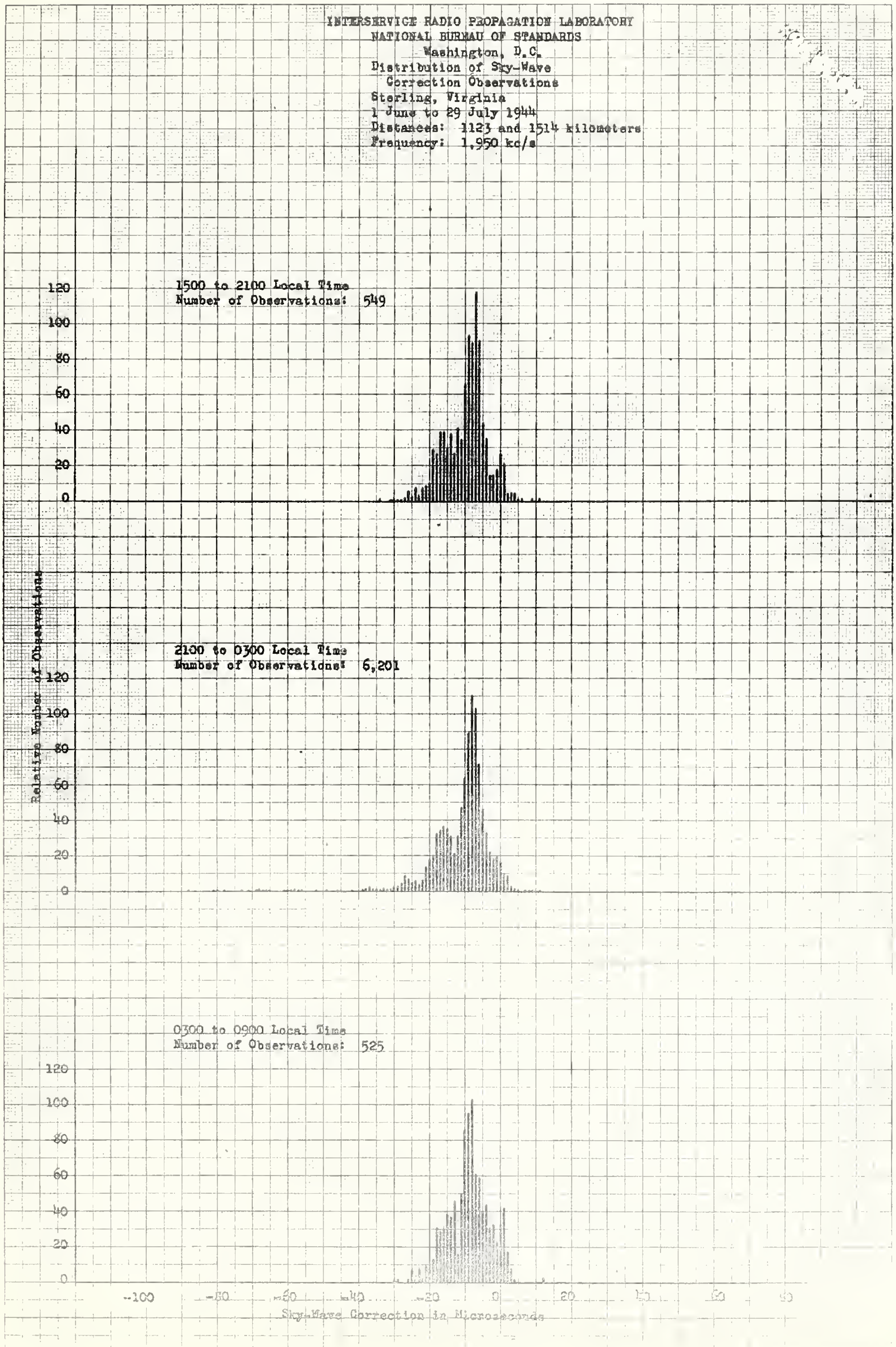

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Distribution of Sky-Wave
Correction Observations
Sterling, Virginia
1 June to 29 July 1944
Distances: 1123 and 1514 kilometers
Frequency: 1,950 kc/s
1500 to 2100 Local Time
Number of Observations: 549
2100 to 0300 Local Time
Number of Observations: 6,201
0300 to 0900 Local Time
Number of Observations: 525
Relative Number of Observations
120
100
80
60
40
20
0
-100
-80
-60
-40
-20
0
20
40
60
80
Sky-Wave Correction in Microseconds

Fig. 43.

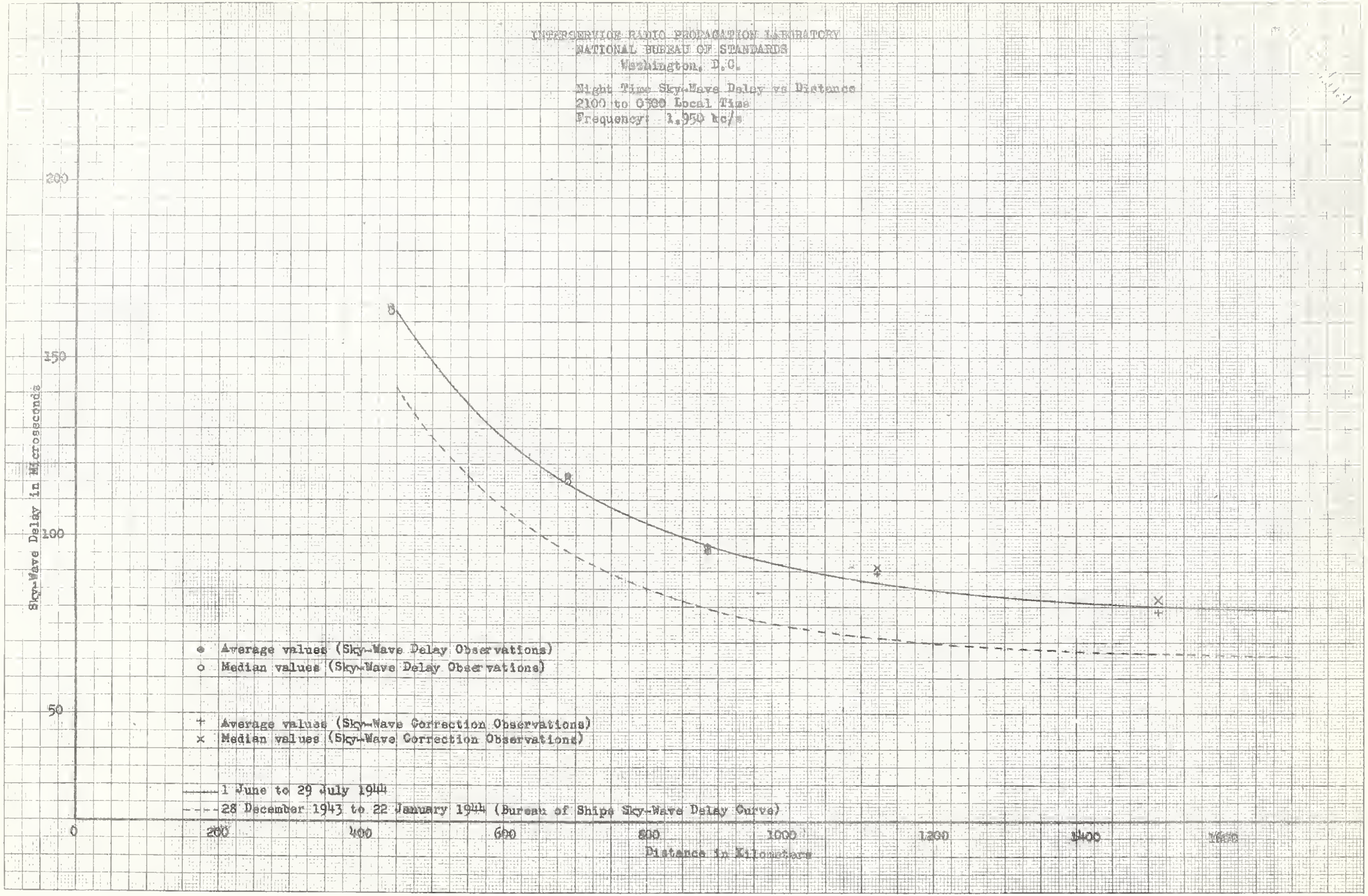

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Night Time Sky-Wave Delay vs Distance
2100 to 0300 Local Time
Frequency: 1,950 kc/s
Sky-Wave Delay in Microseconds
200
150
100
50
0
200
400
600
800
1000
1200
1400
1600
Distance in Kilometers
• Average values (Sky-Wave Delay Observations)
○ Median values (Sky-Wave Delay Observations)
+ Average values (Sky-Wave Correction Observations)
× Median values (Sky-Wave Correction Observations)
—— 1 June to 29 July 1944
- - - 28 December 1943 to 22 January 1944 (Bureau of Ships Sky-Wave Delay Curve)

Fig. 44.

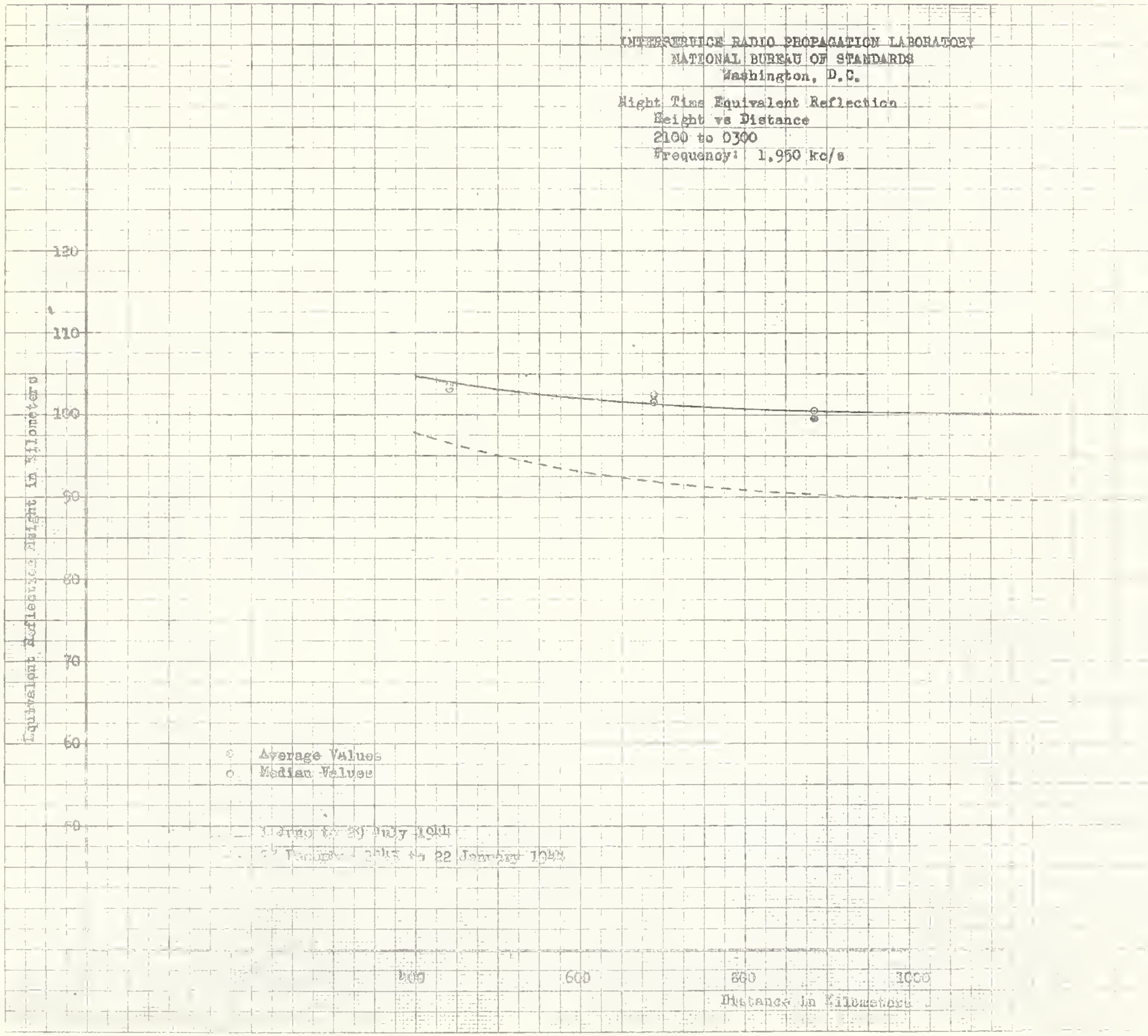

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Night Time Equivalent Reflection
Height vs Distance
2100 to 0300
Frequency: 1,950 kc/s
Equivalent Reflection Height in Kilometers
120
110
100
90
80
70
60
50
Average Values
Median Values
400
600
800
1000
Distance in Kilometers

Fig. 45.

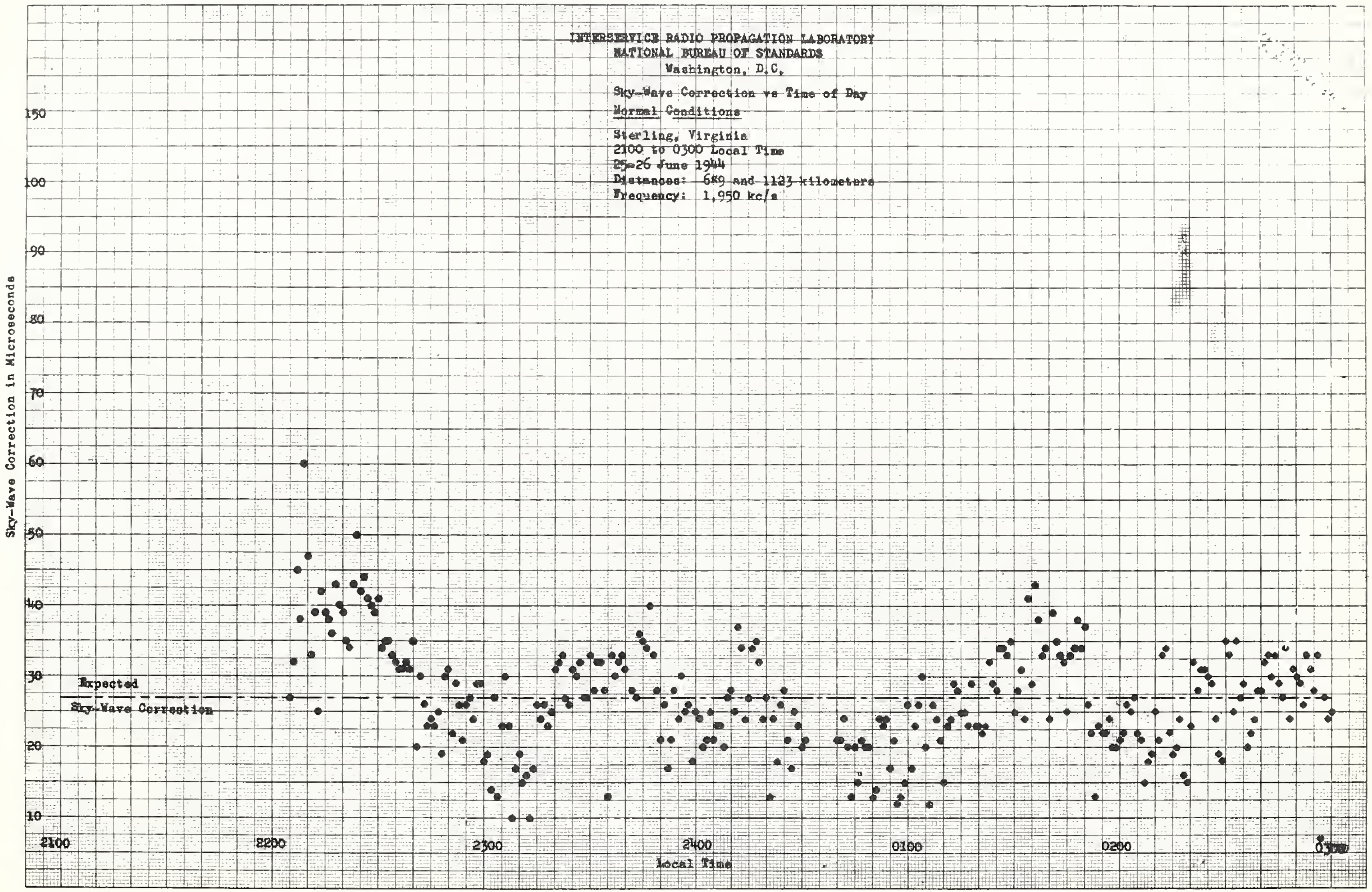
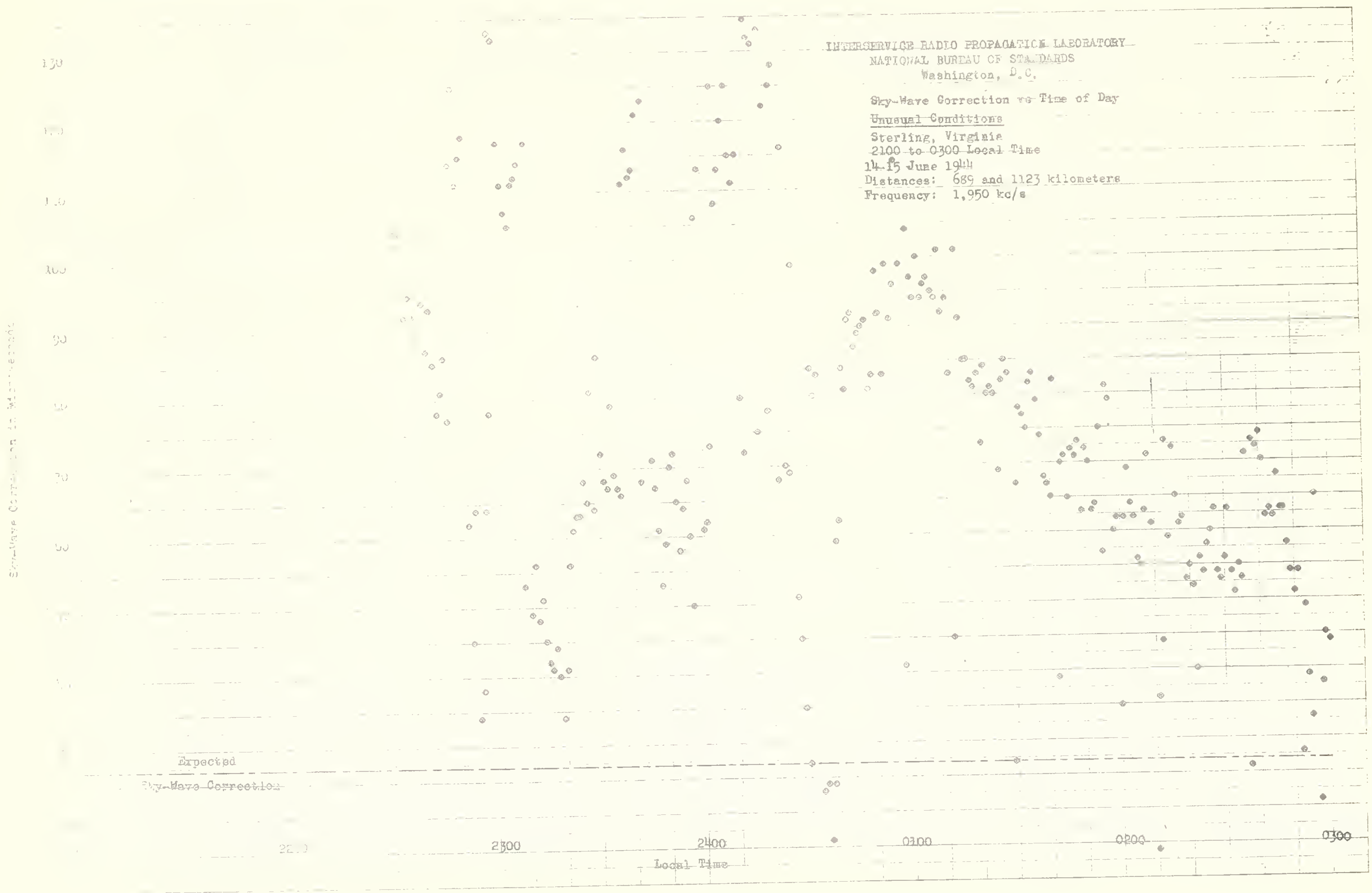

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Correction vs Time of Day
Normal Conditions
Sterling, Virginia
2100 to 0300 Local Time
25-26 June 1944
Distances: 689 and 1123 kilometers
Frequency: 1,950 kc/s
Sky-Wave Correction in Microseconds
150
100
90
80
70
60
50
40
30
20
10
Expected
Sky-Wave Correction
2100
2200
2300
2400
0100
0200
0300
Local Time

Fig.46.



INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Correction vs Time of Day
Unusual Conditions
Sterling, Virginia
2100 to 0300 Local Time
14-15 June 1944
Distances: 689 and 1123 kilometers
Frequency: 1,950 kc/s
Expected
Sky-Wave Correction
2300
2400
0100
0200
0300
Local Time

Fig. 47

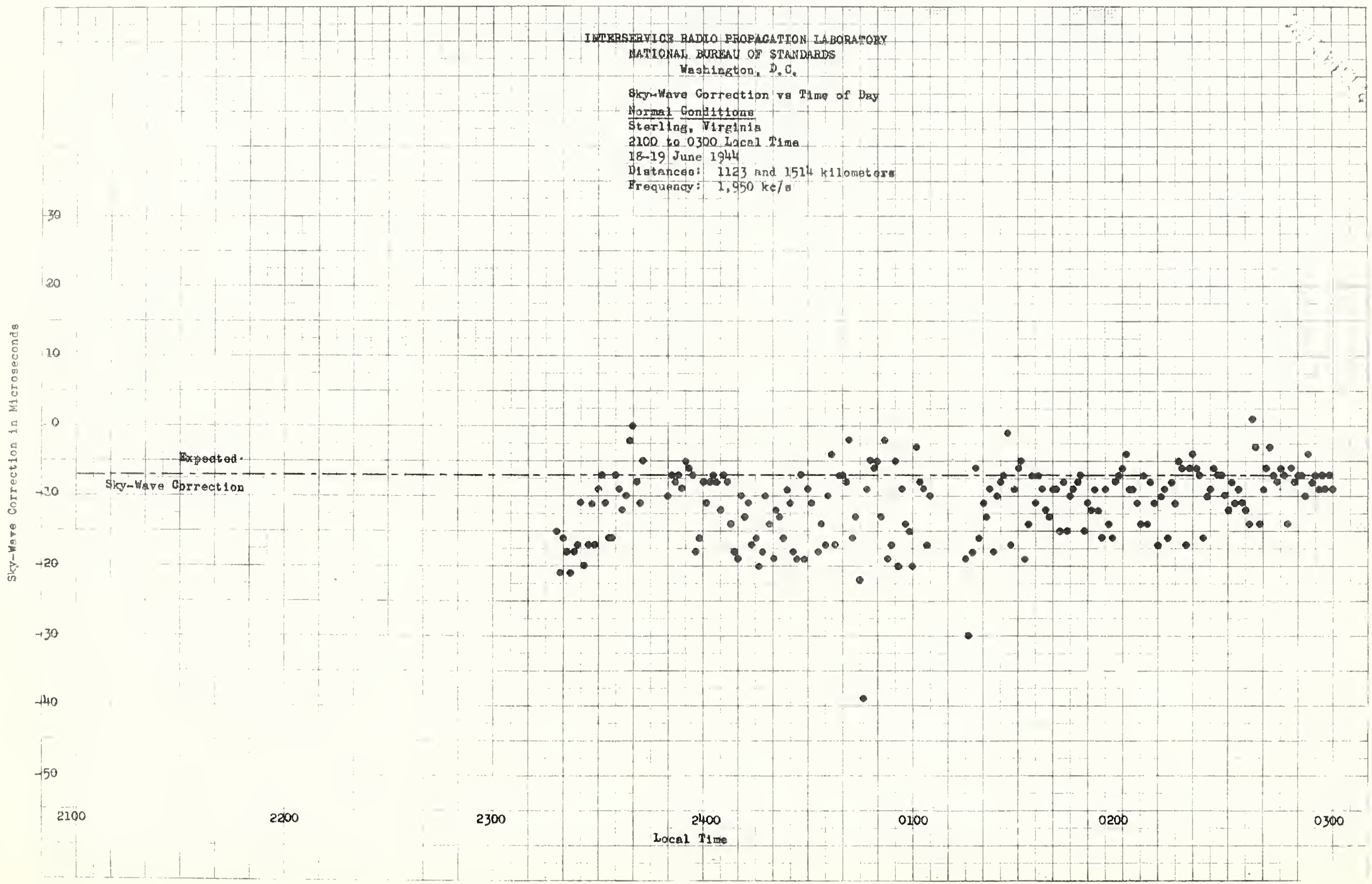
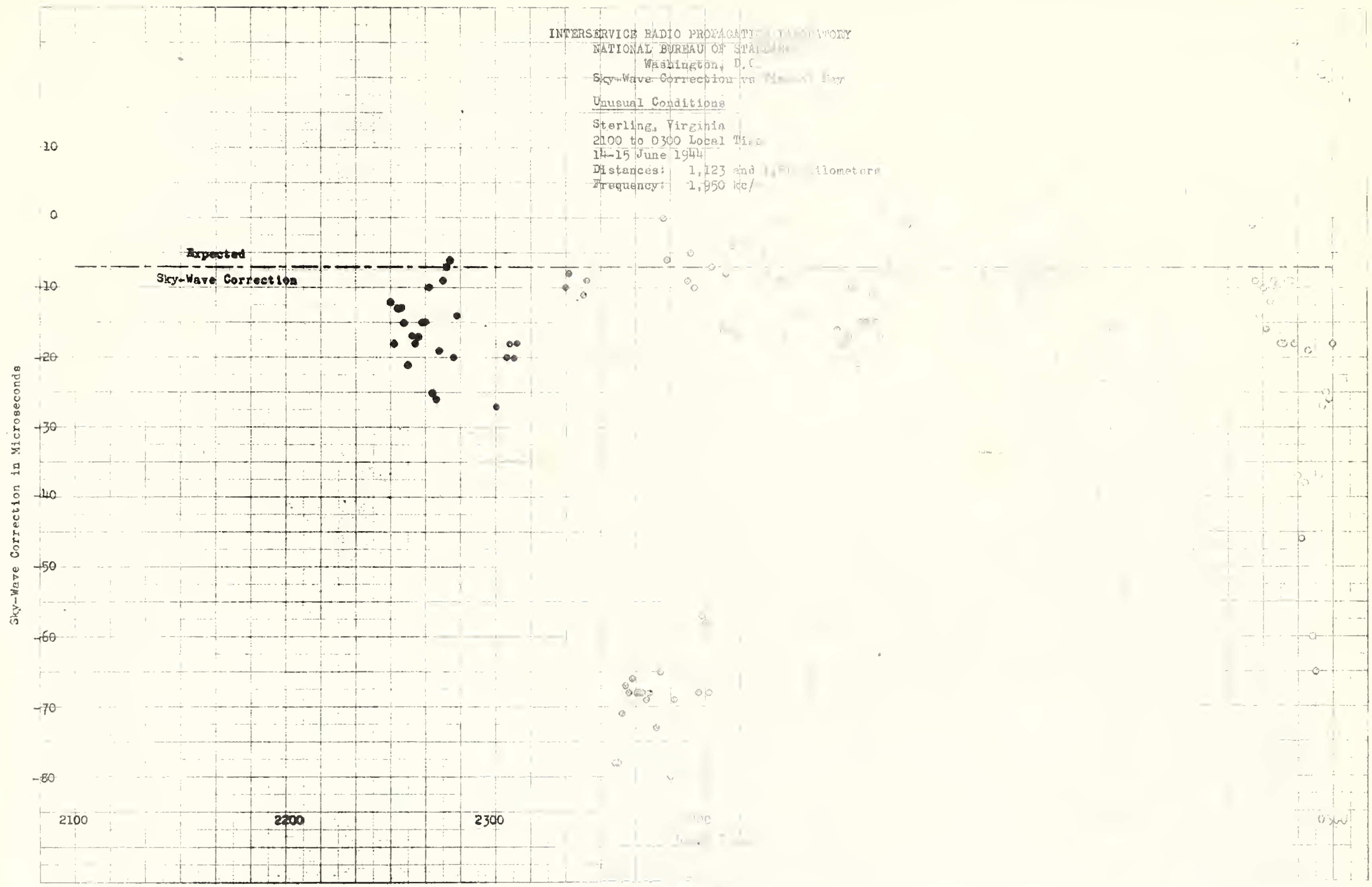

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Sky-Wave Correction vs Time of Day
Normal Conditions
Sterling, Virginia
2100 to 0300 Local Time
18-19 June 1944
Distances: 1123 and 1514 kilometers
Frequency: 1,950 kc/s
Expected
Sky-Wave Correction
Sky-Wave Correction in Microseconds
30
20
10
0
-10
-20
-30
-40
-50
2100
2200
2300
2400
0100
0200
0300
Local Time

Fig. 48.


INTERSERVICE RADIO PROPAGATI
NATIONAL BUREAU OF
Washington, D.C.
Sky-Wave Correction vs
Unusual Conditions
Sterling, Virginia
2100 to 0300 Local
14-15 June 1944
Distances: 1,123 and
Frequency: 1,950 kc/
Expected
Sky-Wave Correction
Sky-Wave Correction in Microseconds
10
0
-10
-20
-30
-40
-50
-60
-70
-80
2100
2200
2300

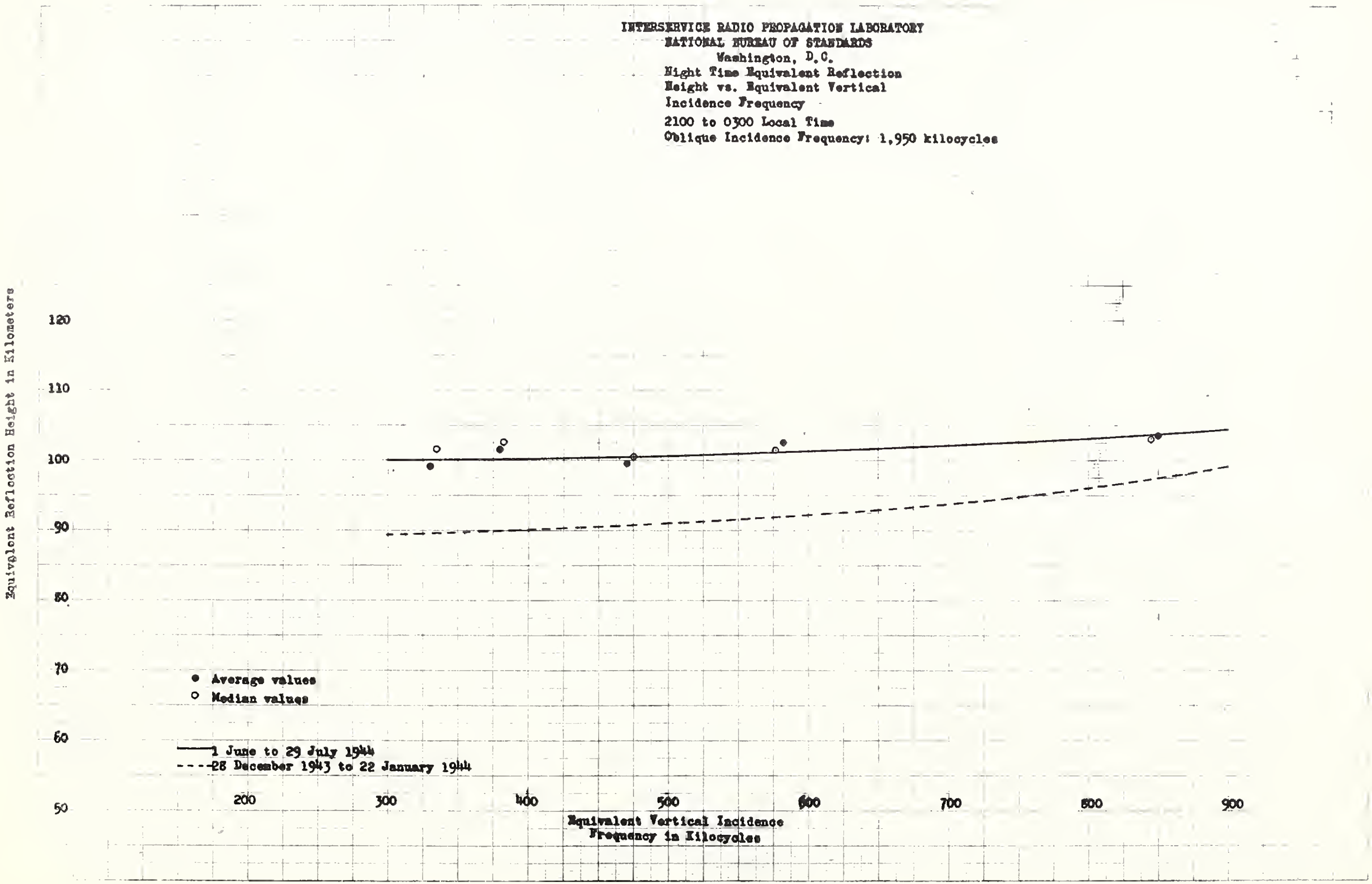
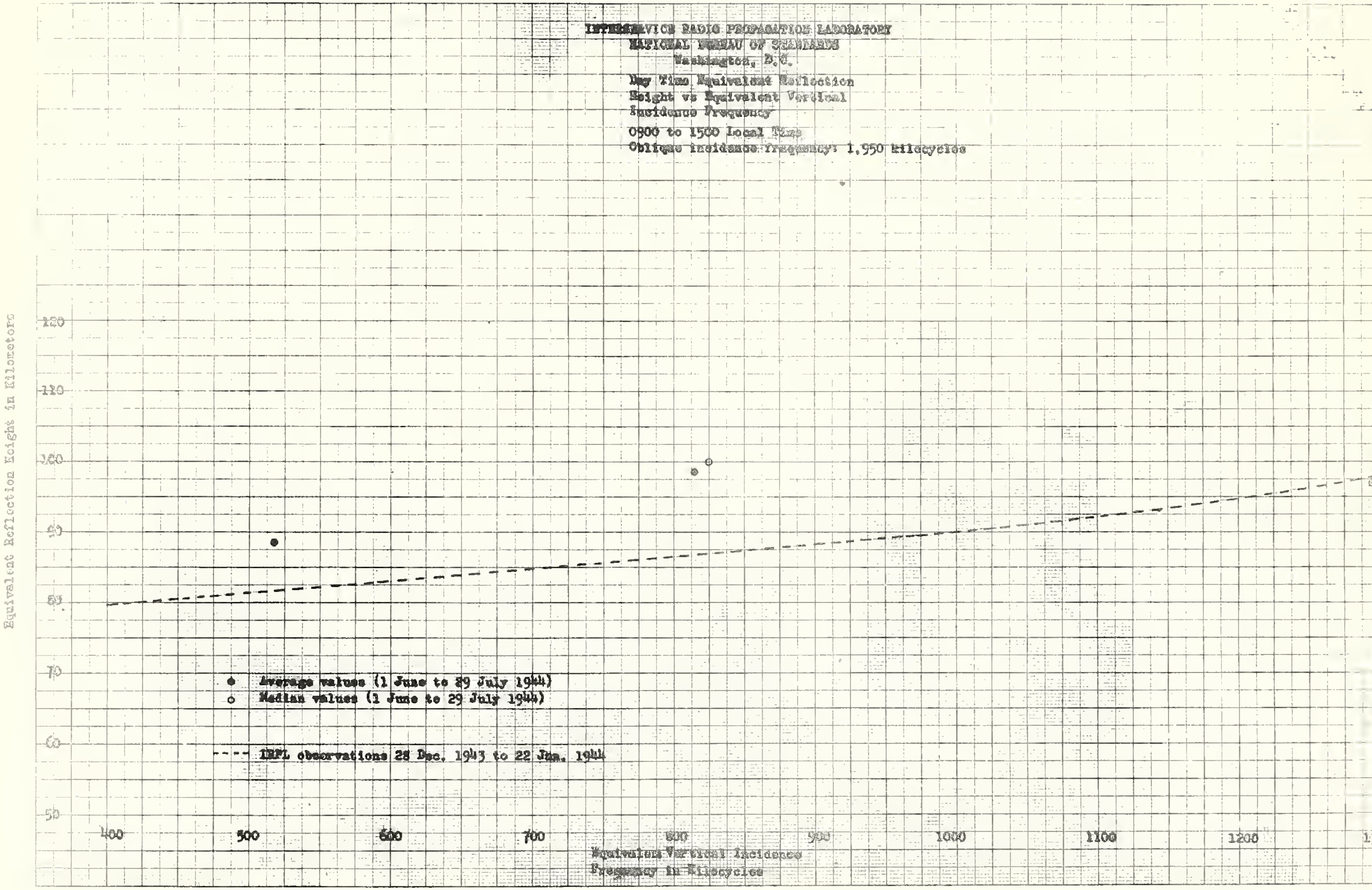

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Night Time Equivalent Reflection
Height vs. Equivalent Vertical
Incidence Frequency
2100 to 0300 Local Time
Oblique Incidence Frequency: 1,950 kilocycles
Equivalent Reflection Height in Kilometers
120
110
100
90
80
70
60
50
Average values
Median values
1 June to 29 July 1944
28 December 1943 to 22 January 1944
200
300
400
500
600
700
800
900
Equivalent Vertical Incidence
Frequency in Kilocycles

Fig. 50.



INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
Washington, D.C.
Day Time Equivalent Reflection
Height vs Equivalent Vertical
Incidence Frequency
0800 to 1500 Local Time
Oblique incidence frequency: 1,950 kilocycles
Equivalent Reflection Height in Kilometers
130
120
110
100
90
80
70
60
50
400
500
600
700
800
900
1000
1100
1200
1300
Equivalent Vertical Incidence
Frequency in Kilocycles
● Average values (1 June to 29 July 1944)
○ Median values (1 June to 29 July 1944)
---- IRPL observations 28 Dec. 1943 to 22 Jan. 1944

Fig. 51.