GEOPHYSICAL INSTITUTE

UNIVERSITY OF ALASKA

COLLEGE ALASKA

UAG R 42

AURORAL ZONE ABSORPTION OF RADIO WAVES TRANSMITTED VIA THE IONOSPHERE

Tasks A and B

Quarterly Progress Report No. 5
1 March 1955 to 31 May 1955

Signal Corps Contract	No. DA-36-039- SC-56739
Dept. of the Army Project	No. 3-99-03-022
Signal Corps Project	No. 182B

Laboratory Procurement Office, Signal Corps Supply Agency
Fort Monmouth, New Jersey

GEOPHYSICAL INSTITUTE

of the

UNIVERSITY OF ALASKA

AURORAL ZONE ABSORPTION OF RADIO WAVES TRANSMITTED VIA THE IONOSPHERE

Tasks A and B

Quarterly Progress Report No. 5

1 March 1955 to 31 May 1955

The object of this project is to conduct studies of propagation of radio waves in the auroral zone.

Signal Corps Contract	No. DA-36-039 SC-56739
Department of the Army Project	No. 3-99-03-022
Signal Corps Project	No. 182B

Report Prepared By:

Soren Andersen
Electrical Engineer

Robert S. Leonard
Junior Researcher

Report Approved By:

C. T. Elvey
Director of the Institute

TABLE OF CONTENTS

SECTION I PURPOSES

Task A

To conduct research studies of auroral zone absorption of radio waves transmitted via the ionosphere and to provide the services of a supervisory engineer for the stations operated by the Arctic Ionosphere Research Detachment and by the University of Alaska. This task is a continuation of, but over and beyond, Task A under Contract No. DA-36-039 SC-5512.

Task B

To perform radio back-scatter observations of direct scatter from aurora-associated E-layer ionization; to observe the auroral visually in the region of scatter, and to correlate these observations with the field intensity measurements obtained under Task A. This task is a continuation of, but over and beyond, TASK B under Contract No. DA-36-039 SC-5512.

SECTION II ABSTRACT

A discussion of the design for a new antenna system for the transmitter stations is presented together with the measurements and power computation made on the old and new antennas. In the 12 mc back-scatter program at College, the technique used to measure the amplitude of each individual echo and a reanalysis of the range distribution previously reported are discussed. Revisions in the techniques of observation of visual auroras and the methods of recording the data for analysis are described in detail.

SECTION III

PUBLICATIONS, LECTURES, REPORTS, AND CONFERENCES

No publications or reports were issued during this quarter.

SECTION IV FACTUAL DATA

Task A

The operation of all AIRD stations was generally satisfactory during the period covered by this report.

A new antenna system for the transmitter stations was designed, built, and tested. The design is as given in(Fig. A.).

The antenna is made of No. 12 copperweld cut to the appropriate length; the transmission line is RG - 11/U with a characteristic impedance of 75 ohms. The tee and right angle connectors are Amphenol type N, which is weatherproof. At the center of the antenna the connector to the two sections of transmission line is specially made of dural for the exclusion of moisture, for the electrical connection of the shields of the coaxial cable, and for the support of the matching assembling. The connector is sealed with a plastic material, and both the connector and the tee and angle were sprayed with liquid Krylon immediately before erection.

The double length of transmission line (indicated as Section A) is a quarter wave transformed of 150 ohms characteristic impedance which changes the 75 ohms balanced impedance of the half-wave dipole to 300 ohms balanced. The half-wave balun of Sec B then transforms the 300 ohms balanced to the 75 ohms unbalanced which is the characteristic impedance of the RG - 11/U transmission line from the transmitter. Thus the un-

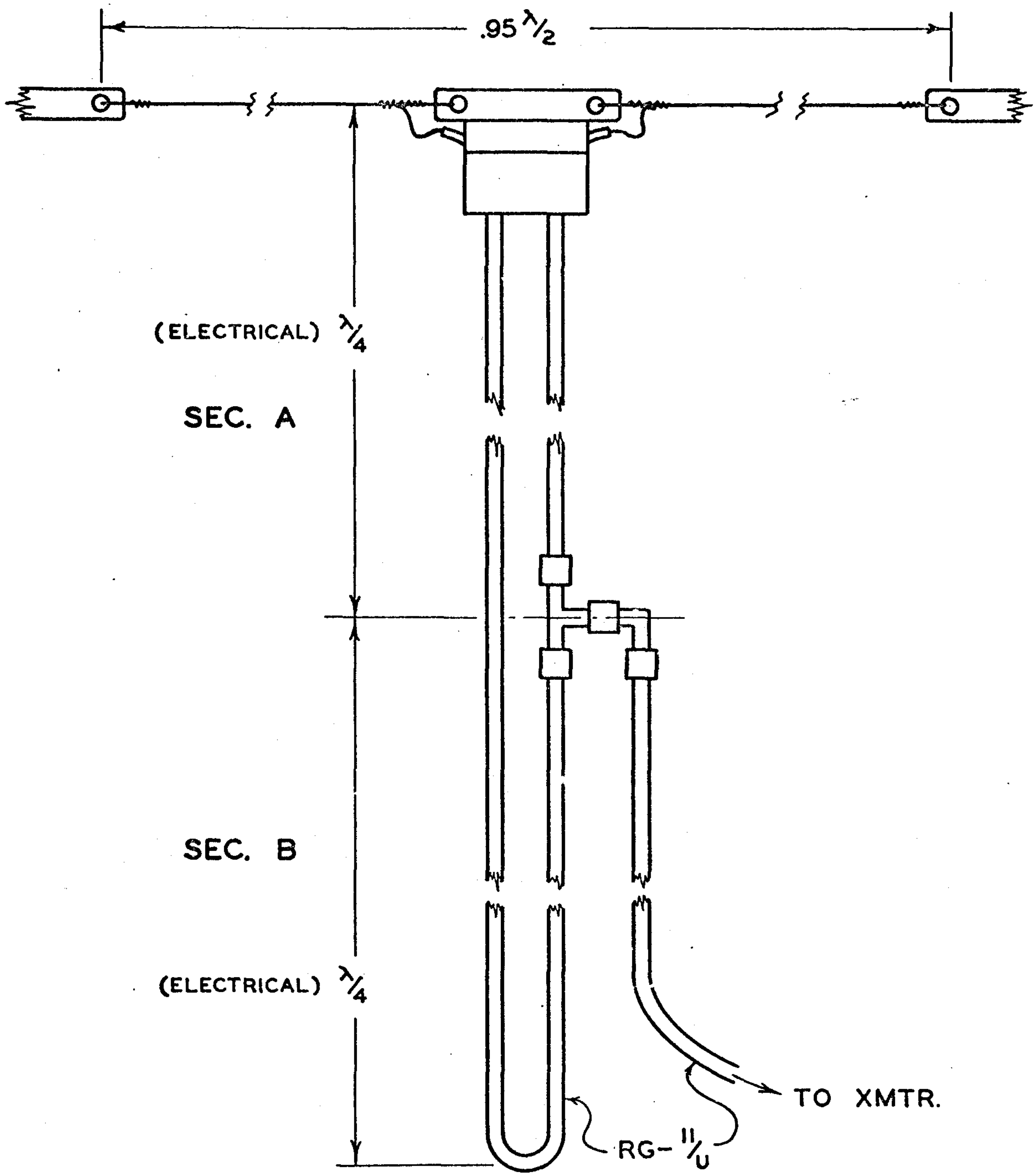


FIG. A XMTR. ANTENNA SYSTEM

balanced output of the transmitter is matched to a balanced antenna, and no r.f. current flows on the shielding of the transmission line as has occurred in the previous installations.

On April 2 and 3, the project engineer installed three antennas of the new design: on 4095 and 12305 kc at Northway and on 7940 kc at Sheep Mountain. Simultaneous impedance measurements were made on old and new antennas at both stations. The measurements and power computation are given in Table A.

Task B

Back-scatter

Because of the interference on our authorized channels by signals outside of the territory, the operation of the 12 mc equipment has been extremely difficult during the period covered by this report. The effect will undoubtedly continue as the critical frequency of the normal layers of an undisturbed ionosphere in the summer permit these signals to arrive at College. Despite this interference, some exploratory work has been done to determine the fade rates of the various echoes detected to the magnetic north of College.

The general technique is to measure the amplitude of each individual echo as presented on the A scope. To accomplish this, a "gate" of approximately 100 microseconds is manually set in the middle of the received echo; this gate is then used as an intensifier signal on another oscilloscope that

TABLE A

FREQUENCY	4095 kc		4240 kc	7580 kc	7940 kc		12072.5 kc	12305 kc	
	OLD	NEW	OLD	OLD	OLD	NEW	OLD	OLD	NEW
TRANSMISSION LINE LENGTH	108 ft.	94 ft.	318 ft.	165 ft.	219 ft.	200 ft.	160 ft.	69 ft.	56 ft.
TRANSMISSION LINE LOSS	0.29 db.	0.254 db	0.87 db.	0.68 db.	0.90 db.	0.82 db.	0.83 db.	0.36 db.	0.29 db.
TRANSMISSION LINE INPUT IMP.	50+j17.5	75+j17.5	46.5-j30.7	86-j27	64 + j2	62-j10	46-j5	99+j41	67-j5
STANDING WAVE RATIO	1.61	1.25	2.01	1.435	1.175	1.36	1.65	1.725	1.140
POWER RADIATED FROM ANTENNA	187 watt	284 watt	152 watt	294 watt	208 watt	205 watt	152 watt	364 watt	250 watt

TABLE A

FREQUENCY	4095 kc		4240 kc	7580 kc	7940 kc		12072.5 kc	12305 kc	
	OLD	NEW	OLD	OLD	OLD	NEW	OLD	OLD	NEW
TRANSMISSION LINE LENGTH	108 ft.	94 ft.	318 ft.	165 ft.	219 ft.	200 ft.	160 ft.	69 ft.	56 ft.
TRANSMISSION LINE LOSS	0.29 db.	0.254 db	0.87 db.	0.68 db.	0.90 db.	0.82 db.	0.83 db.	0.36 db.	0.29 db.
TRANSMISSION LINE INPUT IMP.	50+j17.5	75+j17.5	46.5-j30.7	86-j27	64 + j2	62-j10	46-j5	99+j41	67-j5
STANDING WAVE RATIO	1.61	1.25	2.01	1.435	1.175	1.36	1.65	1.725	1.140
POWER RADIATED FROM ANTENNA	187 watt	284 watt	152 watt	294 watt	208 watt	205 watt	152 watt	364 watt	250 watt

has been adjusted to show no trace without the intensifier gate. This second oscilloscope is then photographed on a rapidly moving film producing a spot for each echo, the ordinate of which represents the amplitude of the echo pulse. By dividing the P.R.F. by the number of spots between successive maximum values of echo amplitude, one obtains an estimate of the frequency of fading. These fading rates are expected to indicate which echoes originate in auroral ionization and which are due to relatively normal ionization. Although to date, insufficient data have been collected to produce convincing results, the equipment has been built and tested; and sufficient information has been collected to indicate that the system operates satisfactorily. Work will proceed along this line whenever ionosphere propagation (and interference) conditions permit.

To prove that the echoes do originate in or very near the visual aurora, the data collected during the month of February, 1955, by the back-scatter and the visual observations were systematically compared. For this purpose, the slant range to the echoing region was converted to geomagnetic latitude of a point directly underneath this region. These resulting latitudes were then grouped into zones one degree in width to agree with the zones used in the visual observations.

As, unfortunately, the auroral echoes nearly all occur with ranges in excess of 300 km, the corresponding visual forms are rather low on the horizon. At these low elevations, estimates of the latitude of aurora are subject to appreciable error owing primarily to deviations from the assumed height. For this comparison, only the discrete forms were used, as the exact location of the diffuse forms and glows near the horizon can not be determined by visual observation.

Each visual observation, taken at 15 minute intervals, was compared with the corresponding back-scatter observation. One hundred eighteen separate comparisons were made, of which 31 percent agreed exactly and 41 percent were in error by only one degree in latitude ($\sim$ 110 kms). Due to the relative inaccuracy of the visual observations at this low angle, these latter were included, thus giving a 72 percent agreement to within one degree. The remaining 28 percent of disagreement can be divided into two classes: the larger being due to diffuse surfaces and glows extending to the northern horizon, and the smaller, due to very active zenith aurora extending down to near the horizon that could possibly obscure to visual observation a faint form at a very low angle.

The range distribution previously reported (Report No. 4) has been re-analyzed to include more echoes obtained in the first part of this quarter as well as to provide two types of range distributions, the first utilizing all the echoes recorded, and the second restricted to the nearest echo on each trace. This second analysis is therefore limited to those echoes arising from direct back-scatter by the aurora, and does not include any of the echoes that are believed to originate by ground scatter reflected back to the receiver by patches of ionization associated with the aurora. These sums are normalized to 23 intervals for each value of K from 0 to 5; and the results presented in the histograms of Figure B. The solid bars are the range distributions for all echoes; the cross hatched bars the range distributions utilizing only the nearest echo observed on each trace.

There is no difference in the sums for range groups of less than 500 km. as the double echoes do not appear with ranges of less than this. For K equal to 0 and 1 there is nearly no difference as the auroral activity is very low, but for K values of 2, 3, and 4, the difference is rather marked in the 600 to 900 km. range groups where the difference between the 2 sums shows a distribution closely resembling the distribution in the 300 to 450 km. group. For K equal to 5 the difference is extremely slight and the total sums show no double peak, probably due to high ionospheric absorption of any ground scattered signal, which would have to penetrate the absorbing layer four times in its passage from transmitter to ground (via the ionosphere), and back again.

The conclusion is that the first echo is caused by direct scatter from the aurora, and the second echo occurring at ranges equal to or slightly greater than twice the first is caused by the signal being scattered forwards by approximately horizontal ionized clouds located at or very near the aurora. Some of this energy is propagated back over the same path after scattering from the ground at a range approximately twice that of the aurora.

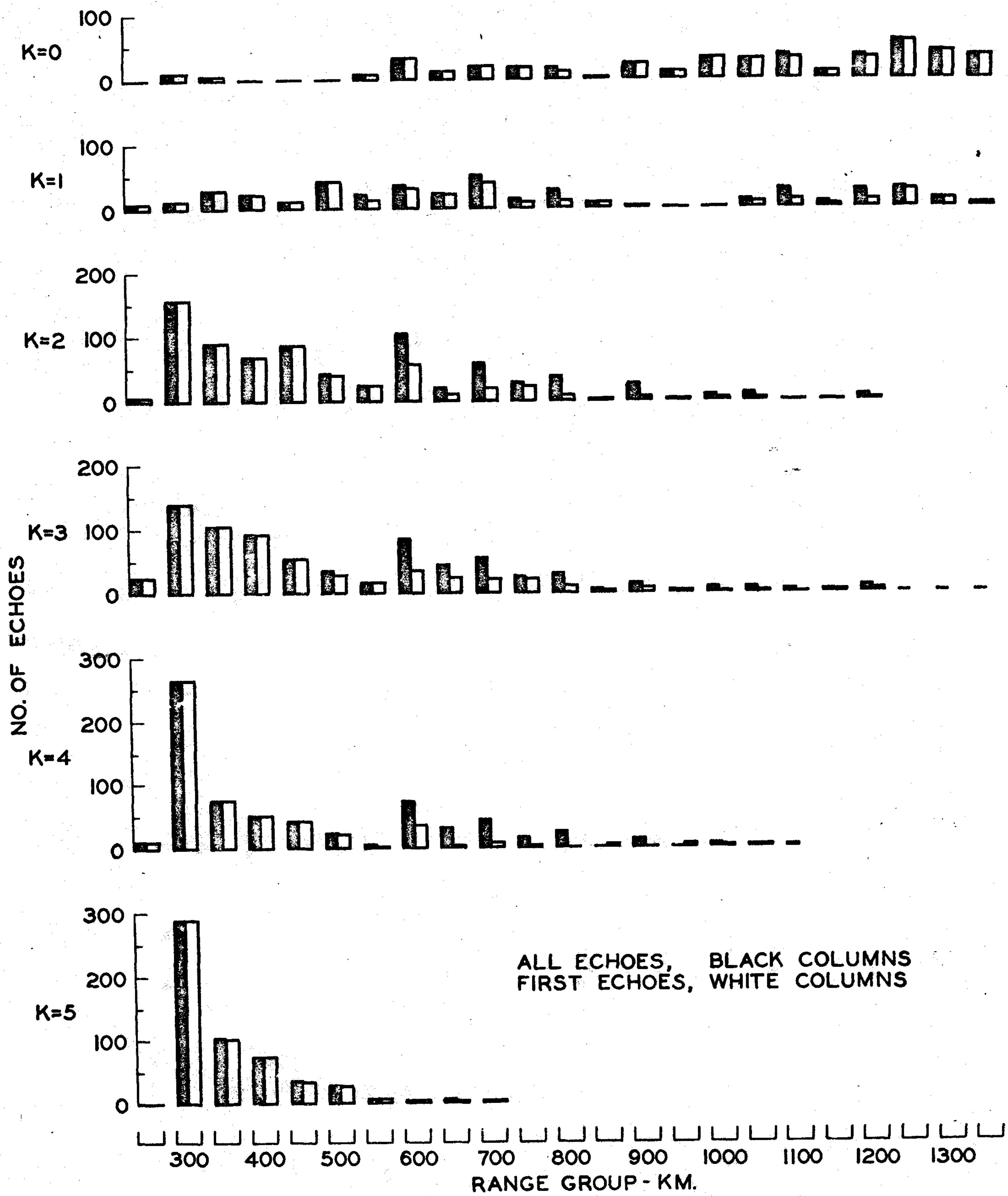


FIG. B HISTOGRAMS OF AURORAL ECHOES AT 12 MC

Visual Observations

The reduction of the visual observations of auroras for the season 1953-54 have been completed and a paper summarizing the methods of observation and reduction and a discussion of the results is included with this report as Appendix "A". The paper, "Visual Observations of Aurora in Alaska, 1953-54," has been prepared with the dual purpose, (1) reporting the data obtained on Task B, and (2) fulfilling the request by the Comité Spécial Année Géophysique Internationale 1957-58 (CSAGI) that the author prepare a description of the suitable grids for visual observations of auroras and distribute the report to persons and institutions preparing for the auroral program of the International Geophysical Year (IGY). Reprints of the Appendix "A" will be used as the latter report.

Although reduction of the visual observations of auroras for the past season is progressing, the method has been altered to use IBM punched cards rather than the UNISORT ANALYSIS CARD. The use of IBM cards for small amounts of data such as we are analysing is of no marked advantage; however, for increased volume of data obtained by the U.S. in the IGY their use will be of considerable advantage. Hence, a trial run is being made using the IBM cards in the reduction of the 1954-55 data.

SECTION V
CONCLUSIONS AND RECOMMENDATIONS

Task A

Measurements and computations arising from the new antenna system indicate that the new design is sufficiently improved over the old system to warrant recommending the installation at the remaining transmitter stations.

Task B

Back-scatter experiments are proving to be a valuable tool for an understanding of the modes of propagation of radio waves in the arctic. It is recommended that the back-scatter experiments be continued and that a receiver and transponder unit be installed at an appropriate site.

SECTION VI
PLANS FOR NEXT QUARTER

Task A

Present plans are to construct and to install the three remaining antenna systems during the next quarter, as it is felt that enough improvements are shown by the measurements to warrant proceeding; also the properly balanced transmission lines, with no r.f. current on the outer shields will be less susceptible to seasonal changes in their environment.

Task B

Experiments on fading rates will be continued.

SECTION VII PERSONNEL

C. T. Elvey	Project Supervisor
C. Gordon Little	Assistant Project Supervisor
Soren Andersen	Supervisory Engineer
Robert S. Leonard	Researcher
Wade Peterson	Researcher
Elizabeth Cahill	Technician
Jack Garrison	Technician
Grace P. Lobanov	Technician
Paula Beebe	Technician
Eleanor Tikka	Technician
Marion Mitchell	Technician
Keith Hart	Technician
Marion Jackson	Technician
Merle J. Young	Electronic Technician
Robert A. Stark	Electronic Technician
Dick Shoup	Electronic Technician
Dan Wilder	Draftsman

APPENDIX A

"VISUAL OBSERVATIONS OF THE AURORA IN ALASKA, 1953-1954"

BY C. T. ELVEY

VISUAL OBSERVATIONS OF THE AURORA IN ALASKA, 1953-1954

By C. T. Elvey

Visual observations of auroras are made at five stations in Alaska: College, near Fairbanks; Northway, on the Alaska Highway a few miles from the Canadian border; Sheep Mountain, on the Glenn Highway about one hundred miles east of Anchorage; Nome, on the southern coast of the Seward Peninsula; and Point Barrow, on the Arctic Coast. The stations are shown (in Fig. 1) on a map on which a grid of geomagnetic coordinates has been superimposed. The auroral observations made at these stations during the season 1952-1953 were discussed by Elvey, Leinbach, Hessler, and Noxon (Ref. 1). The zenith observations made at the same stations during the season 1951-1952 were also discussed in the same paper.

Some revisions in the techniques of observation and in the method of recording the data for analysis have been devised for the season 1953-1954. These techniques and methods will be described in detail for a dual purpose: to present the data for the season, and to describe the techniques of observation as requested of the author by the Comité Spécial Année Géophysique Internationale 1957-1958 (CSAGI) at the meeting held in Rome from September 30 to October 4, 1954.

The technique of observing adopted in Alaska assumes that the average height to the lower edge of an auroral feature can be used to determine the geographical distribution of auroras to a considerable distance from an observer. The average height of the base of the auroras has been investigated extensively by Carl Stormer (Ref. 2) and others (Ref. 3) and is very near 100 km. Using this figure, we have computed the zenith distance at which the parallels of geomagnetic latitude projected to this height above the surface of the earth intersect the magnetic meridian for the observer. A grid (Fig. 2) is oriented in the magnetic meridian so that the observer standing under it has the computed zenith distances as reference marks. The grid thus defines the auroras incident over the various zones of geomagnetic latitude to the north or south of the observer. An addition to the grid, termed the "outrigger," marks a circle parallel with the horizon at a zenith distance of 80°, the points at which the parallels of latitude cross the circle being indicated by short vertical markers.

Observations are recorded graphically on a sketch which is a projection of the grid, (Fig. 3). Coded symbols and numbers designate the various forms of the auroras, their intensities, their internal motions and colors, and the state of the sky. Observations are made at 15 minute intervals: 00, 15, 30, and 45 minutes of each hour throughout the night.

As the total number of observations made at five stations in one observing season (September to April at our latitude) is quite large, and as we wished to study the distribution of auroras for various functions, the observations were transferred to cards to make the data readily available. The card employed is the UNISORT ANALYSIS CARD, 5 by 8 inches, with a single row of holes around the sides for punching. (See Fig. 4. The upper illustration shows the code for punching; the lower one, the recorded data.) The aurora coordinates are the geomagnetic latitude and longitude of the geographical area over which the aurora is incident. Dates and times are given in Greenwich Mean Time. In addition to the planetary index of magnetic activity, K_p, the local K-index is recorded for both College and Point Barrow. As Northway is in the same geomagnetic latitude zone as is College, the College K-index is used for that station. A preliminary investigation indicated that it was feasible to use the K-index of Sitka for the Sheep Mountain and Nome stations. The geomagnetic latitude of Sitka is 60°, of Sheep Mountain 62°, and of Nome 61°. In the analysis, the considerable differences in longitude between these stations, especially between Sitka and Nome, must be kept in mind.

A preliminary study made of the College data for February, 1954, indicates a high degree of correlation between the frequency of auroras and the local magnetic activity, as illustrated in Figure 5 which gives the diurnal variations of the index of magnetic activity, K, the planetary index, K_p, and the frequency of auroras at the zenith. When the K-indices for a number of stations around the globe at high magnetic latitudes are averaged to give the K_p index, little diurnal variation is left; the reason, of course, that the K_p was defined. This preliminary study indicates that the same strong diurnal control exists for both the frequency of auroras and the local K-index.

It should be noted that February, 1954, is a period of low sunspot numbers, 0.3 being a relative sunspot-number, during the minimun of the sunspot cycle.

As the total number of observations at the higher magnetic activities was not large, we combined the data for the K-indices into four groups: a group of observations at low magnetic activity, formed by combining K-indices 0 and 1; two groups of intermediate activity, formed by combining K 2 and 3, and K 4 and 5; and a group of high magnetic activity, formed by combining K 6 and 7, the highest values during the periods of observation. The data for each of the five stations have been treated separately for the reasons which will be brought out in the discussion.

The first study concerned the distribution with geomagnetic latitude for the auroras observed from each station, the results being shown graphically in Figs. 6-10. The first grouping was made without regard to the form of the aurora. Thus the upper diagrams of each of the Figures show the distribution of auroras of any form incident over each of the latitude zones. The second grouping was the homogeneous forms and consists primarily of homogeneous arcs. The third grouping was the rayed forms and consists of all rayed arcs, rays, rayed bands, draperies, and coronas. Flaming aurora and pulsating surface classes were not discussed as the data are too small to indicate the distribution. Diffuse surfaces can not be considered as studied; the lower border is extremely difficult to define, and consequently only when the diffused surface is near the zenith is it possible to know the geographical area over which it is incident.

No corrections have been made to the data; and it is quite obvious that corrections and allowances must be made. A correction must be made for the zenith distances. Most auroras are thin in comparison with their length or height, and consequently one appearing at the zenith appears brighter because of the greater optical path. Hence, the observer is able to see a fainter aurora at the zenith than he can to the north and south of him. Yet any correction for zenith distances is apt to be very complicated and probably not worthwhile. As any correction obviously depends upon the ratio of the thickness to the extent in height, the correction will be small for the arcs which are wide or for arcs which are multiple; these latter appearing as a single arc from the side and as two or more arcs overhead. For only an extremely thin arc observed along the magnetic meridian will the correction for zenith distance be relatively constant for all zenith angles until close proximity of the magnetic zenith is reached. Another correction which must be applied to the data is that for extinction. Its effect is that of changing the threshold of intensity at which the observer begins to count auroras, and thus the correction depends upon the frequency distribution of the fainter auroras. An additional difficulty met in evaluating the data from the various stations is that of the "personal equation," that is, the differences in the competence and reliability of the observers. Most of the observations are taken by military personnel assigned to auroral observing as an additional duty, and who may have no personal interest in the program. Although many devices for supervision have been employed in an effort to gain uniformity, allowances must still be made for the fact that the observations vary in quality.

A comparison of the upper diagram of Figure 6 with those of Figures 7-10 shows that the apparent distribution of the auroras with geomagnetic latitude at Point Barrow is quite different from that of the other stations. The same type of distribution was present during the two previous years, (Ref. 1). Two explanations for this difference in distribution are suggested: First, the apparent distribution indicates a very narrow auroral zone. Since Point Barrow is just inside of the center of the auroral zone, it is possible that during the time of sunspot minimum that the zone passes directly over that location. Secondly, the apparent decrease toward the horizon is due to extinction, the distribution of auroras for several degrees north or south of Point Barrow being essentially uniform. The first suggestion is not verified by the apparent distributions observed at the four more southerly stations. Assuming the second explanation to be valid, we plotted the data against the optical air mass (Fig. 11), using semi-log graph paper. The closed circles represent all the data combined; the open circles represent only the data for the K-index of 6 and 7 to the south of Point Barrow. The data are represented quite satisfactorily by:

$$N = N_o 10^{-ka}$$

where N is the auroral data for a given optical air mass, a; N_o is the auroral data for optical air mass zero; and k is a constant. The constant k determined from the Point Barrow data is 0.18.

Using this constant, we reduced all of the data to the zenith (air mass unity) for observations taken at high magnetic activity, K 6 and 7, (Fig. 12a) and those taken at low magnetic activity, K 0 and 1 (Fig. 12b). Since the data from Point Barrow apparently does not correspond with the data from the other stations, probably it should not have been used to determine the zenith distance correction. Although systematically fewer auroras are recorded by the Point Barrow observers than by observers at the other stations, we have no reason to suspect that they give preference to any part of the sky.

We find, after the correction for zenith distance is made, that all stations except College record a distinct increase in the percentage of auroras observed in the farthest north latitude-zone seen by the observer. The increase probably arises from the observer's inclusion of more distant auroras owing to the difficulty of making observations at the large zenith distances. At College the obscuration of the farthest north zone by the tops of trees on the hill immediately north of the Geophysical Institute accounts for the smaller number recorded.

The analyses of the auroral data for 1953-1954 do not confirm the tentative conclusions drawn from the data for 1951-1952 and for 1952-1953, namely, that in or near the auroral zone the frequency of auroras is independent of magnetic activity. For the season under consideration, a definite increase of auroral activity with magnetic activity is indicated.

These data indicate that the auroral zone in Alaska expands southward, and that there is increased activity at all points. The increase in activity, percentagewise, is greater along the southern boundary of the expanded zone.

The changes in the frequency of visual auroras over given latitude zones with magnetic activity is readily shown from the observations during the season 1953-1954. The percentages of observing time that auroras are seen over each of the latitude zones by the various stations are shown in Figure 13. Again, the observations at the zenith for each of the stations are the most reliable; that is, the incidence of auroras over the latitude zone in which the observer is located is the most accurate. The adjoining zones to either side are also quite reliable, but, as pointed out earlier, observations of auroras incident over a latitude zone as much as four degrees to the north of the observer really include the high auroras of the zones farther away and the low auroras of the zones closer.

A study was also made of the nocturnal variations of auroras for the various latitudes at each of the stations, (graphically shown in Fig. 14). That the maximum of activity is around local midnight and that such activity is a function of the geomagnetic latitude is quite evident. The relationship between maximum of activity and geomagnetic latitude is especially apparent in the data from Point Barrow and College; the maximum of auroral frequency occurring near midnight at Point Barrow and becoming later toward the south. At College, in the geomagnetic zone 64° the maximum occurs at 1330 GMT or 3:30 Alaska Standard Time.

The analysis of data using the UNISORT ANALYSIS CARD has proven very satisfactory for small amounts of data and it does not require a large amount of equipment. On the other hand when there are large volumes of data as will be obtained during the International Geophysical Year (IGY), a machine system for handling the coded data is most desirable. For a trial run prior to the IGY we are transferring the auroral observations for the season 1954-1955 to IBM punched cards, using a code devised by C. W. Gartlein of Cornell University. (The following is a quotation, with some modifications, of a paper presented by Neil Davis at the Sixth Alaskan Science Conference, June 1-4, 1955, at College, Alaska.)

"The possibility of twelve punches in each of the 80 columns on a standard IBM card provides more than ample space to record detail information about the aurora in each latitude zone of the grid. All observations along a meridian for a given station for a specific time are punched on one card, the first eleven columns being used to record the station where the observation is made, the observer and the time of observation. The latter requires designation of the year, month, day, hour and minute. Two columns describe the general presence of aurora, either on or off the grid and the presence of interfering conditions such as cloudiness, twilight and moonlight. Other columns give information about the general auroral motion, unusual coloring, and particular geometric forms which are not covered in the detail-information columns assigned to each latitude zone of the grid.

"At least one pair of columns is given to the description of aurora in each section of the grid. The zenith and nearby zones may be observed in greater detail and so are given more than one pair of columns. Each column pair has punches for eleven auroral forms, as well as for the auroral intensity and the existence of clouds covering the section. It is in these detail columns that the bulk of the actual auroral information is contained."

The coding for the first 52 columns of the IBM card is shown in Fig. 15.

The observations of auroras at the five stations were taken at specified times in order that synoptic maps of the distribution of auroras over Alaska might be constructed. All nights during the season 1953-54 on which observations were made from three or more stations have been reviewed for the quality of the observations, that is lack of interference from moon or clouds, and for the degree of magnetic activity. The magnetic activity is determined from the sum of the K-indices over the several three-hour periods during the observations, 0600 to 1500 GMT.

One night, March 26-27, 1954, for which all five stations had clear sky all night, is selected as an illustration. Maps showing the distribution of auroras were constructed from the observations at each 15-minute interval beginning at 2100 AST and are shown in Fig. 15. The magnetic meridians through each of the observing sites and the circles of geomagnetic co-latitude are shown as dashed lines. The observed areas over which auroras were incident are shown employing a coding system to indicate the form of the aurora. The fact that auroras do not always extend across the Territory often results from lack of observations rather than non-existence, owing to first priority being given to observations along the magnetic meridian through the observer, second priority given to observations on the horizontal circle at 80° zenith distance and with little or no attention being given to the intermediate areas. The point in question is illustrated by the observation at 2145 AST at which time the observers at Point Barrow noted the three homogeneous arcs and a single rayed arc crossing the meridian and the observer at College noted the arc at three points; however, since it was far to the north it was impossible to distinguish the multiple feature of the homogeneous arc and the ray structure of the northern-most one. The observers at College and Northway noted rays on the meridian, but no doubt others were present to either side of the meridian.

The forms of aurora are indicated by the following code system: Straight lines represent auroral arcs and if the arc is rayed short perpendicular lines are added. A bundle of lines represent rays, a series of small arcs with short perpendicular lines are for rayed bands, wedges for draperies and an asterisk is a corona. A double lobed figure is a diffuse surface and with one of the lobes filled is a pulsating surface. A dotted area denotes faint extensive surfaces or veil of auroral light.

A copy of the magnetogram from College for the hours of observing is shown in Fig. 16. It is seen that a small disturbance begins shortly after 2100 AST March 26, 0700 GMT March 27, and lasts until shortly after 0300 of March 27.

The major break-up of the arc system began shortly after local midnight, corresponding closely with the beginning of the magnetic bay in the H-component. Within a very short time the entire area over Alaska was a mass of rapidly moving and active auroral forms. Following the maximum dip in the H-tracing, the aurora changed to the quieter forms of diffuse surfaces which contracted into a belt of diffuse surfaces or veil of aurora nearly centered over the position of the maximum of the auroral zone.

We conclude that observations of auroras from one station can be made with sufficient accuracy to determine the distribution of auroras over an area whose radius is 300 to 400 km for either statistical studies or for constructing synoptic maps.

REFERENCES

1. Elvey, Leinbach, Hessler and Noxon
in press Trans. A. G. U.

2. Carl Stromer
Geof. Publ. XVIII No. 7, 1953

3. Mitra
"The Upper Atmosphere", The Asiatic Society, Calcutta, 1952

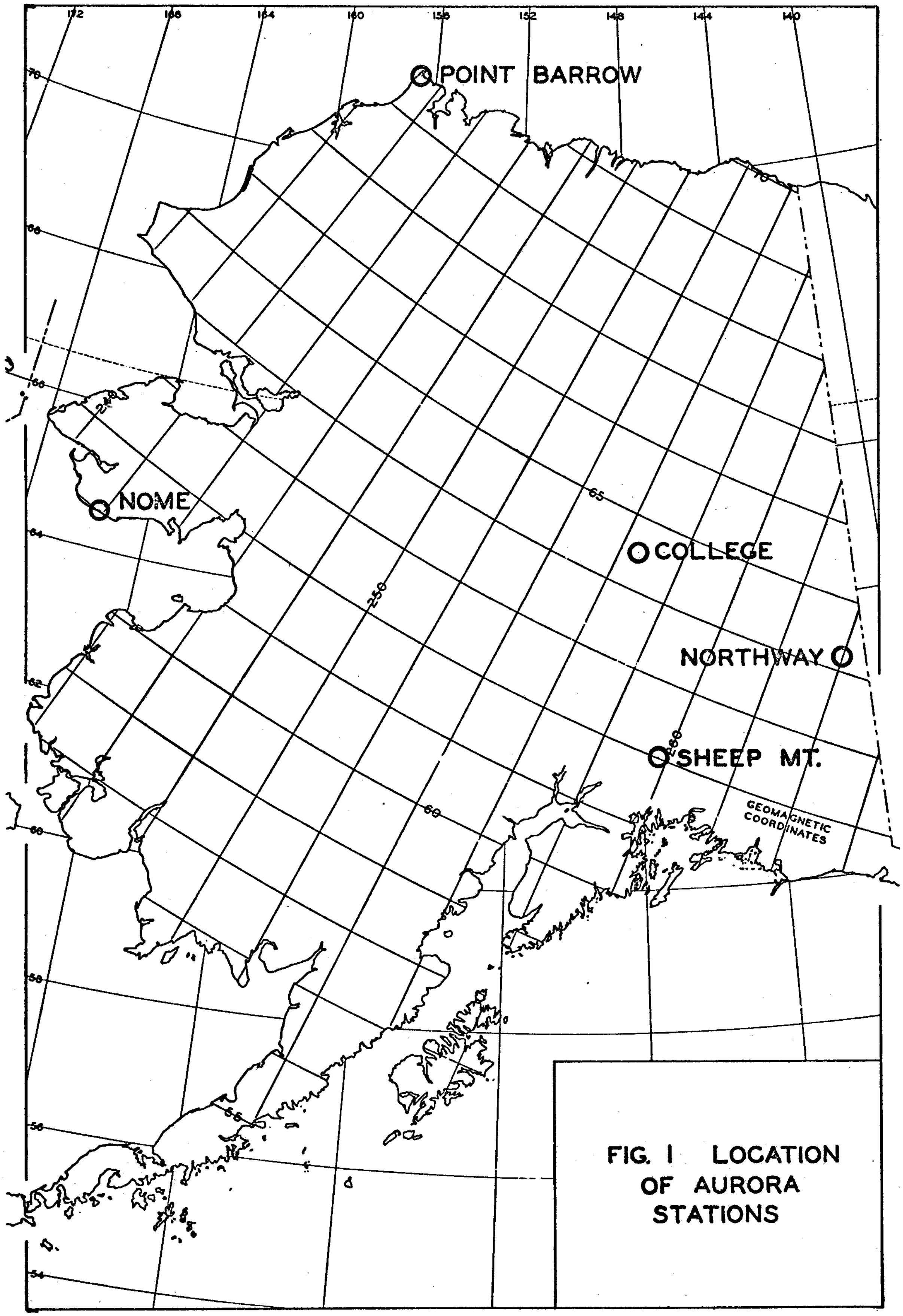
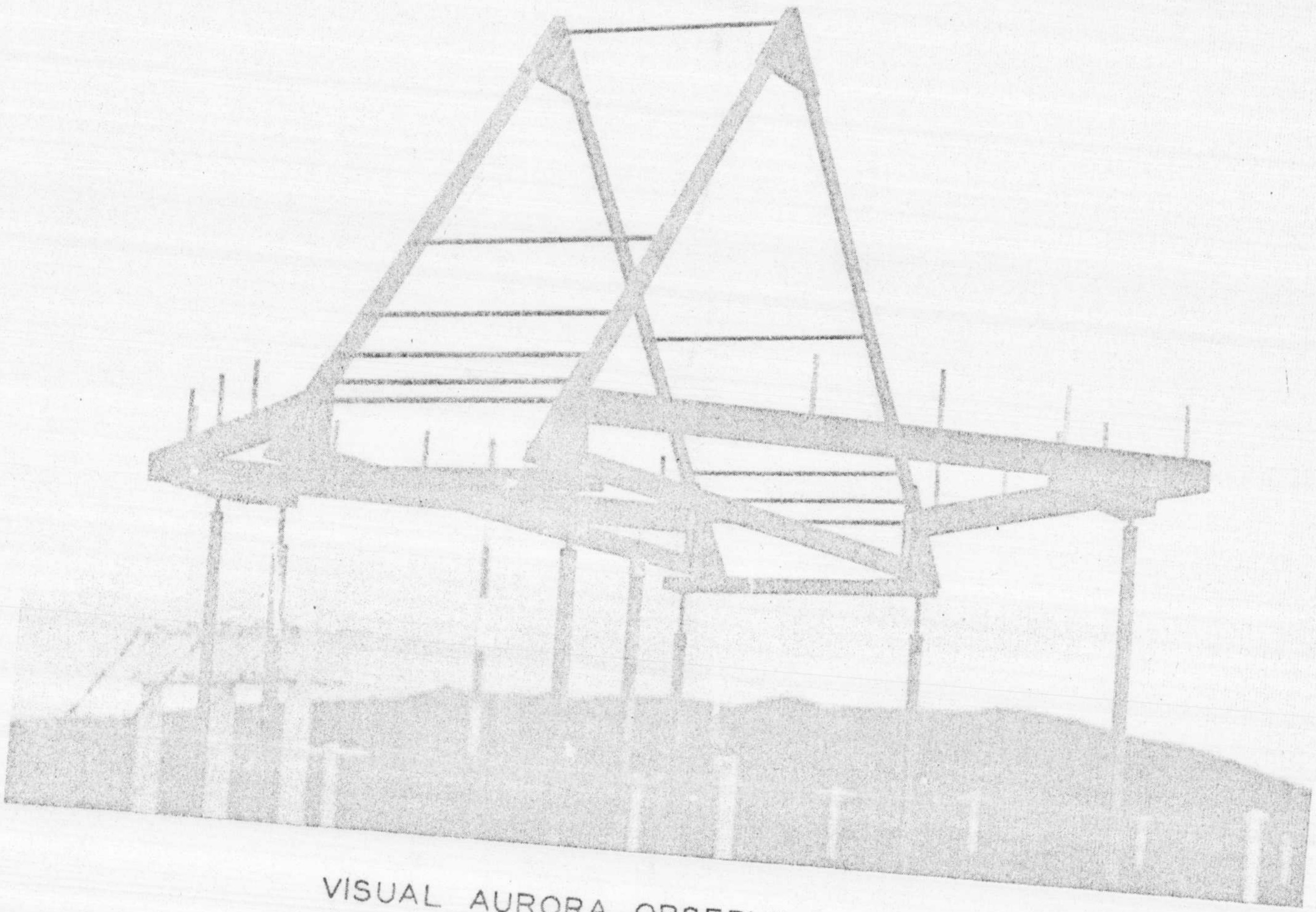
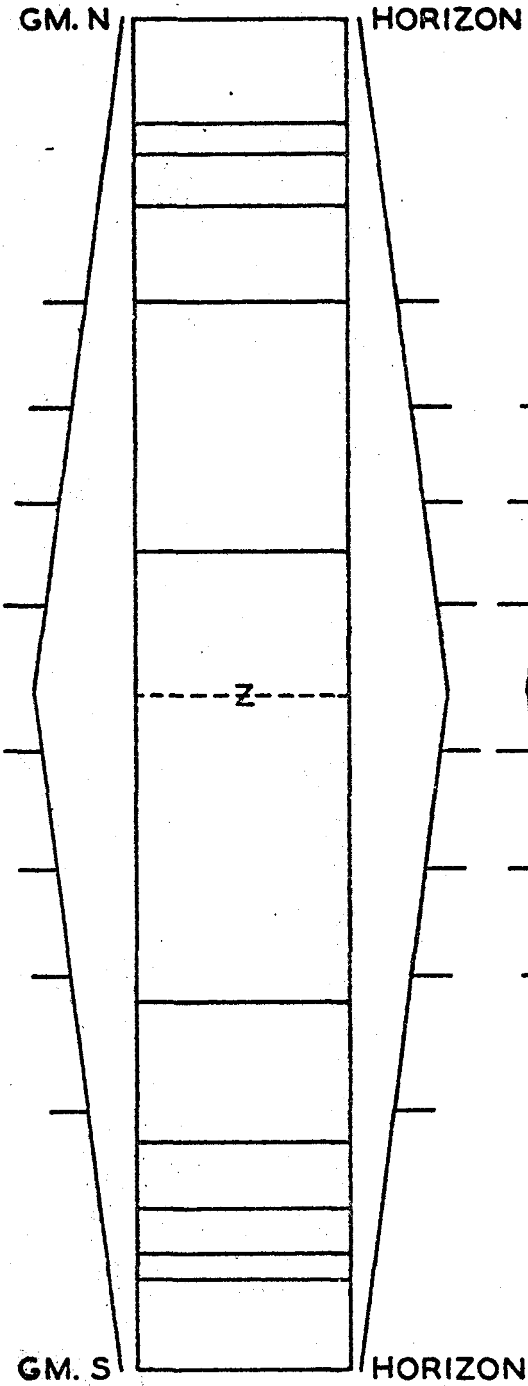


FIG. 1 LOCATION OF AURORA STATIONS

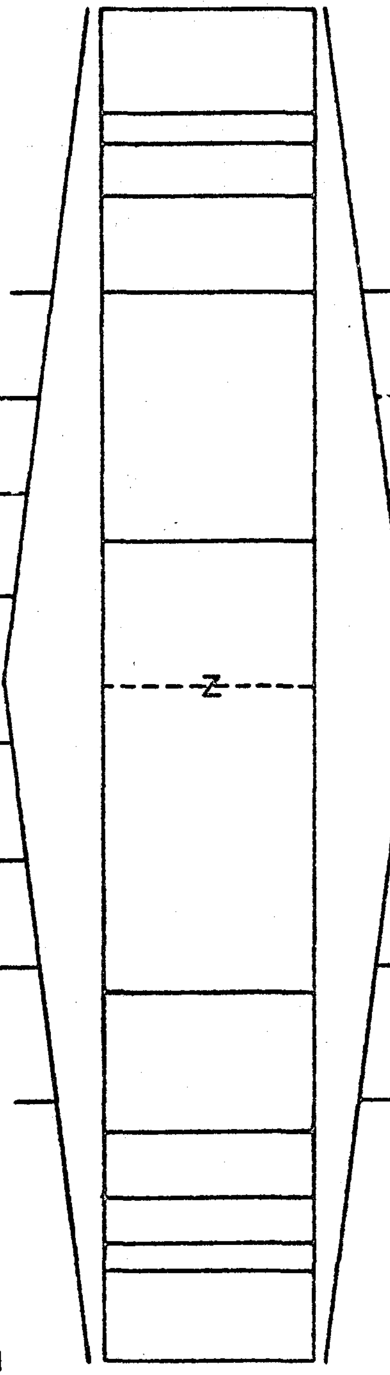


VISUAL AURORA OBSERVING GRID
FIG. 2

COLLEGE

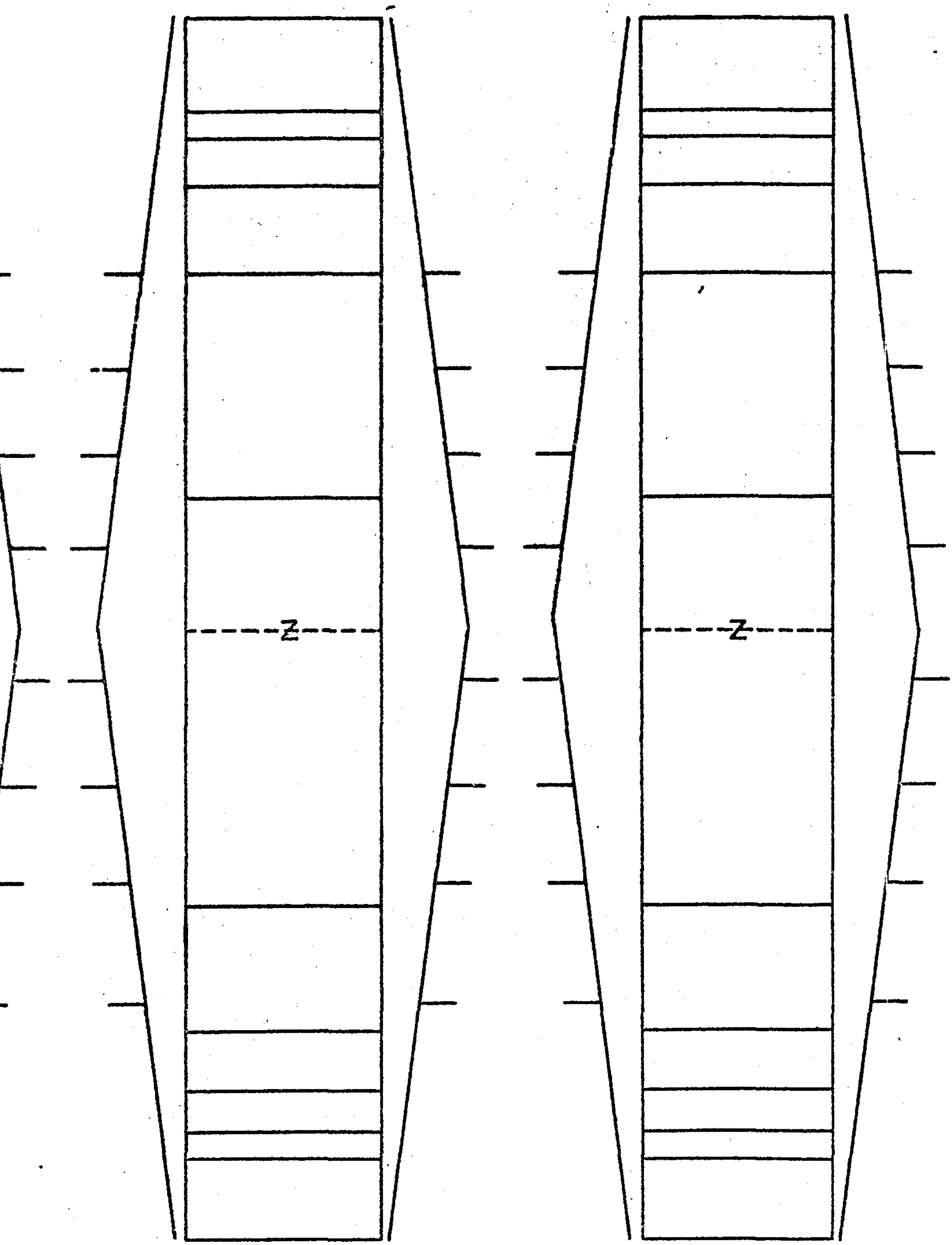


TIME ________
OBS. ________



TIME ________
OBS. ________

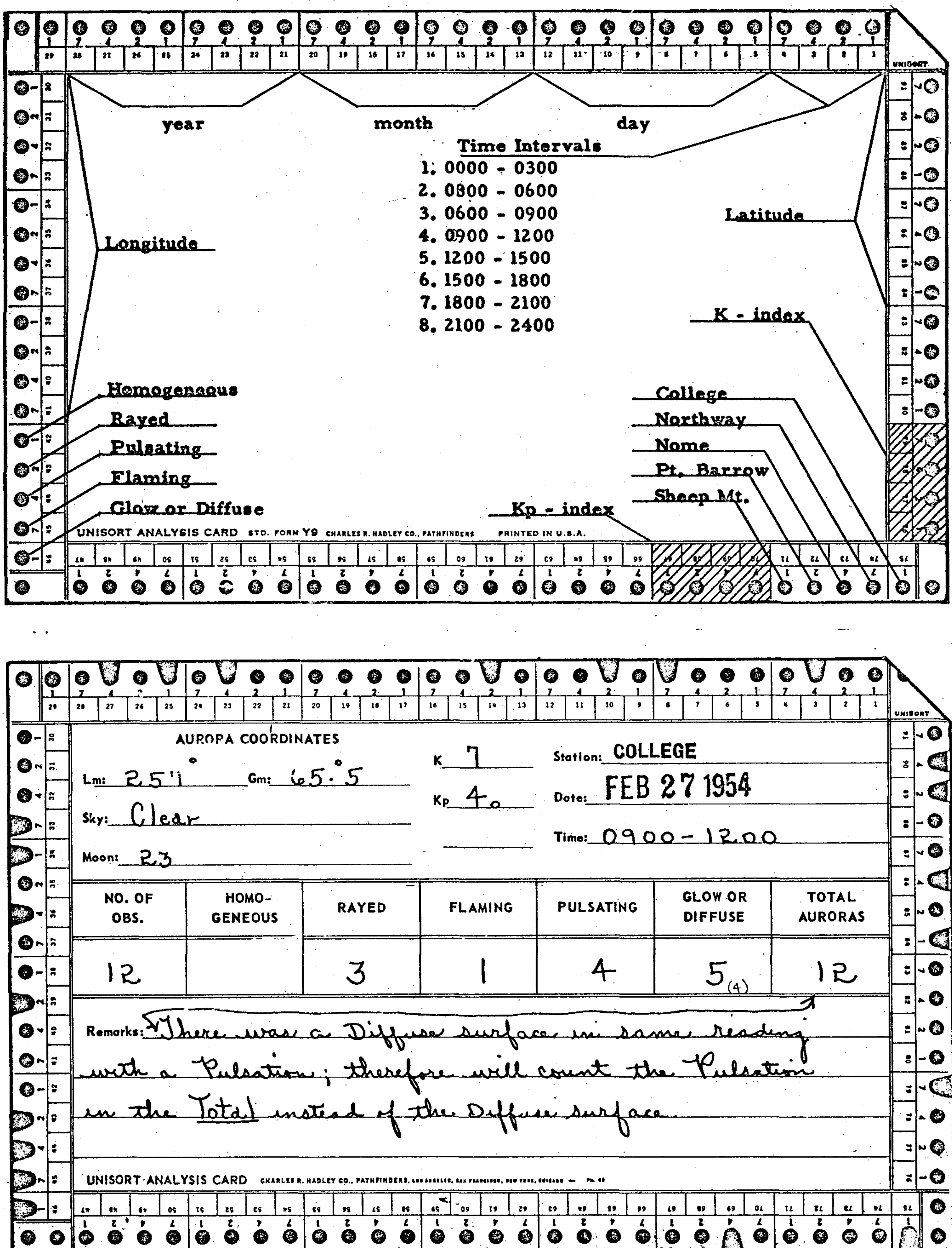
DATE ______________



TIME ______ OBS. ______

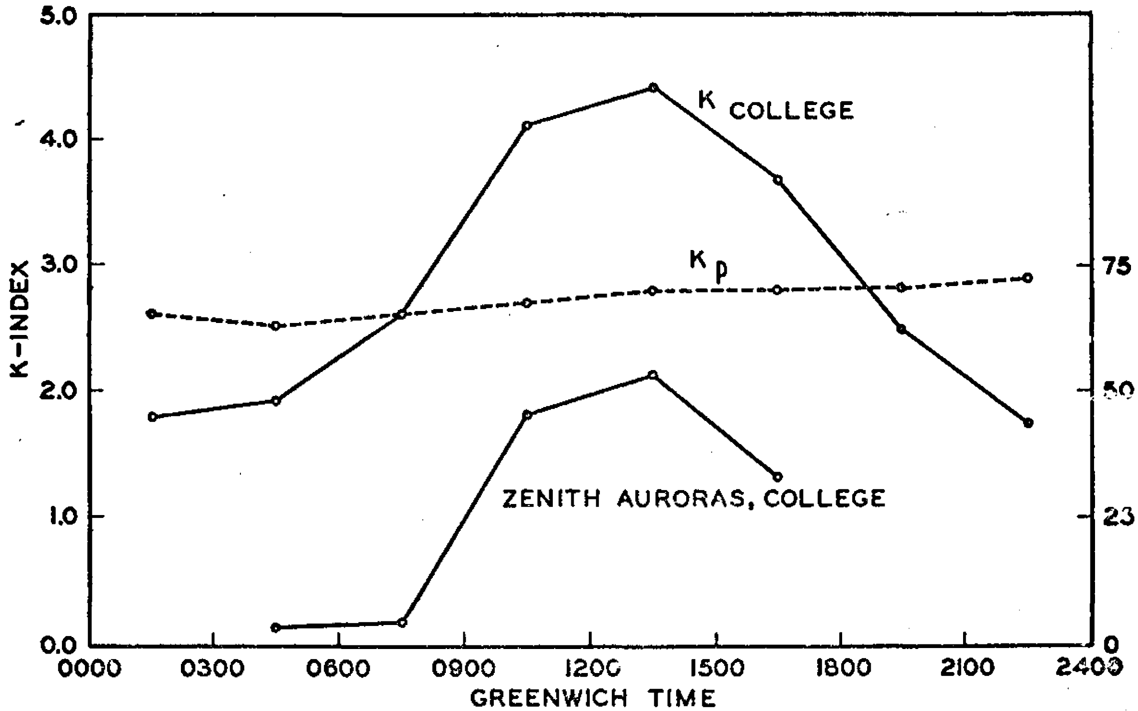
TIME ______ OBS. ______

FIG. 3



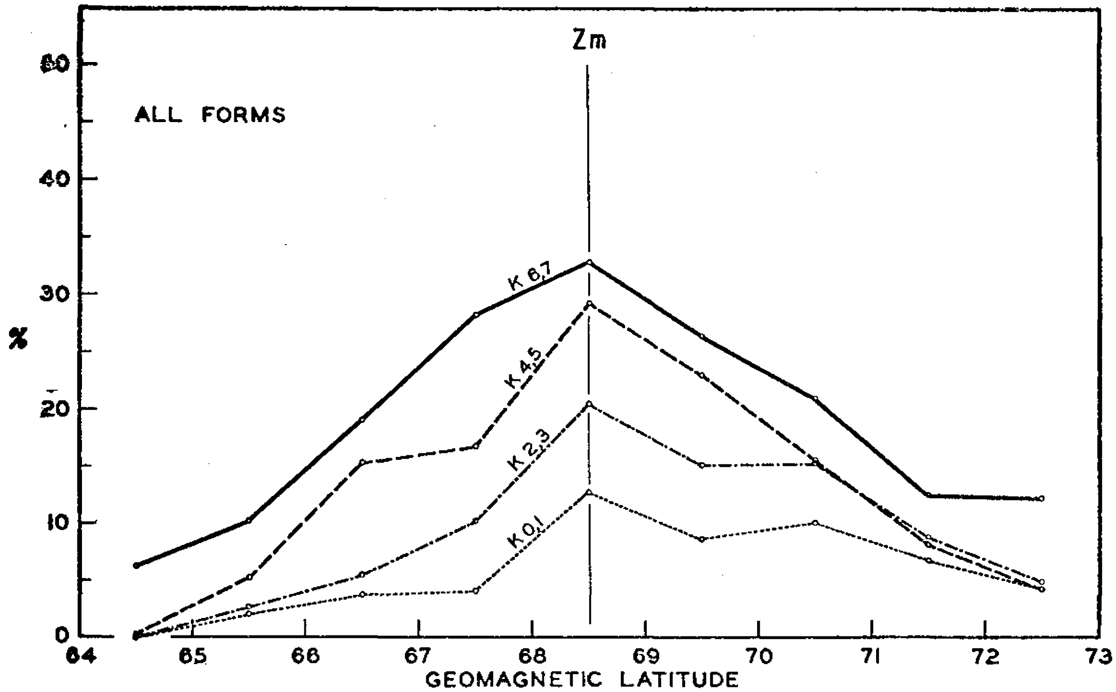
year
month
day
Time Intervals
1. 0000 - 0300
2. 0300 - 0600
3. 0600 - 0900
4. 0900 - 1200
5. 1200 - 1500
6. 1500 - 1800
7. 1800 - 2100
8. 2100 - 2400
Longitude
Latitude
K - index
Homogeneous
Rayed
Pulsating
Flaming
Glow or Diffuse
College
Northway
Nome
Pt. Barrow
Sheep Mt.
Kp - index
UNISORT ANALYSIS CARD STD. FORM Y9 CHARLES R. HADLEY CO., PATHFINDERS PRINTED IN U.S.A.
AURORA COORDINATES
Lm: 25°1 Gm: 65°.5
Sky: Clear
Moon: 23
K 7
Kp 4o
Station: COLLEGE
Date: FEB 27 1954
Time: 0900-1200
NO. OF OBS. 12
HOMO-GENEOUS
RAYED 3
FLAMING 1
PULSATING 4
GLOW OR DIFFUSE 5 (4)
TOTAL AURORAS 12
Remarks: There was a Diffuse surface in same reading with a Pulsation; therefore will count the Pulsation in the Total instead of the Diffuse surface.
UNISORT ANALYSIS CARD CHARLES R. HADLEY CO., PATHFINDERS

FIG. 4

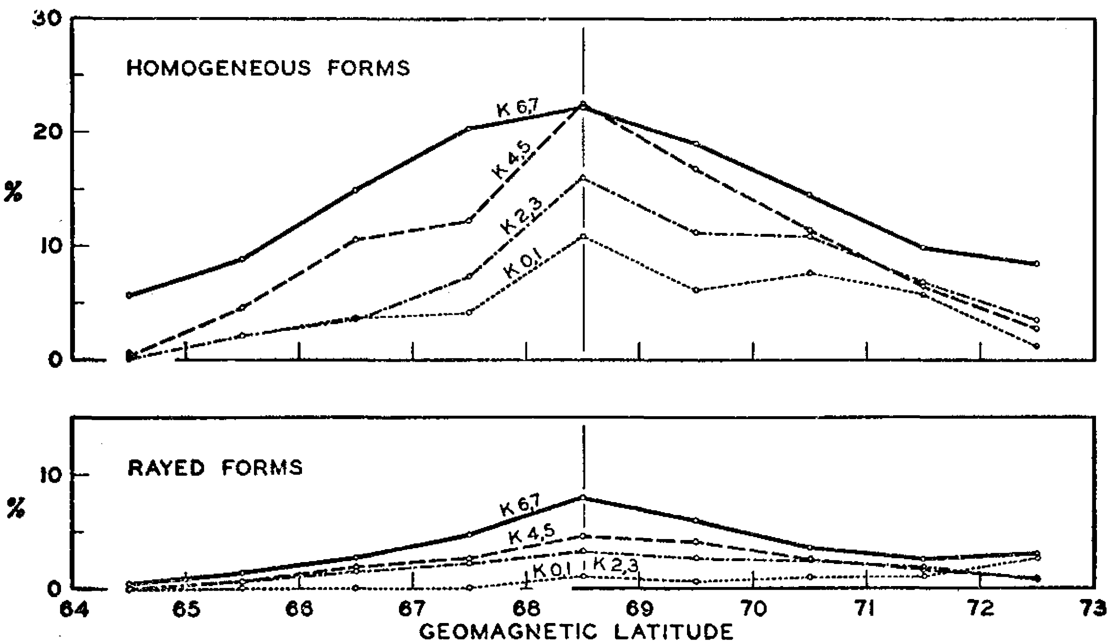


MAGNETIC ACTIVITY AND AURORAS, FEBRUARY 1954

FIG. 5

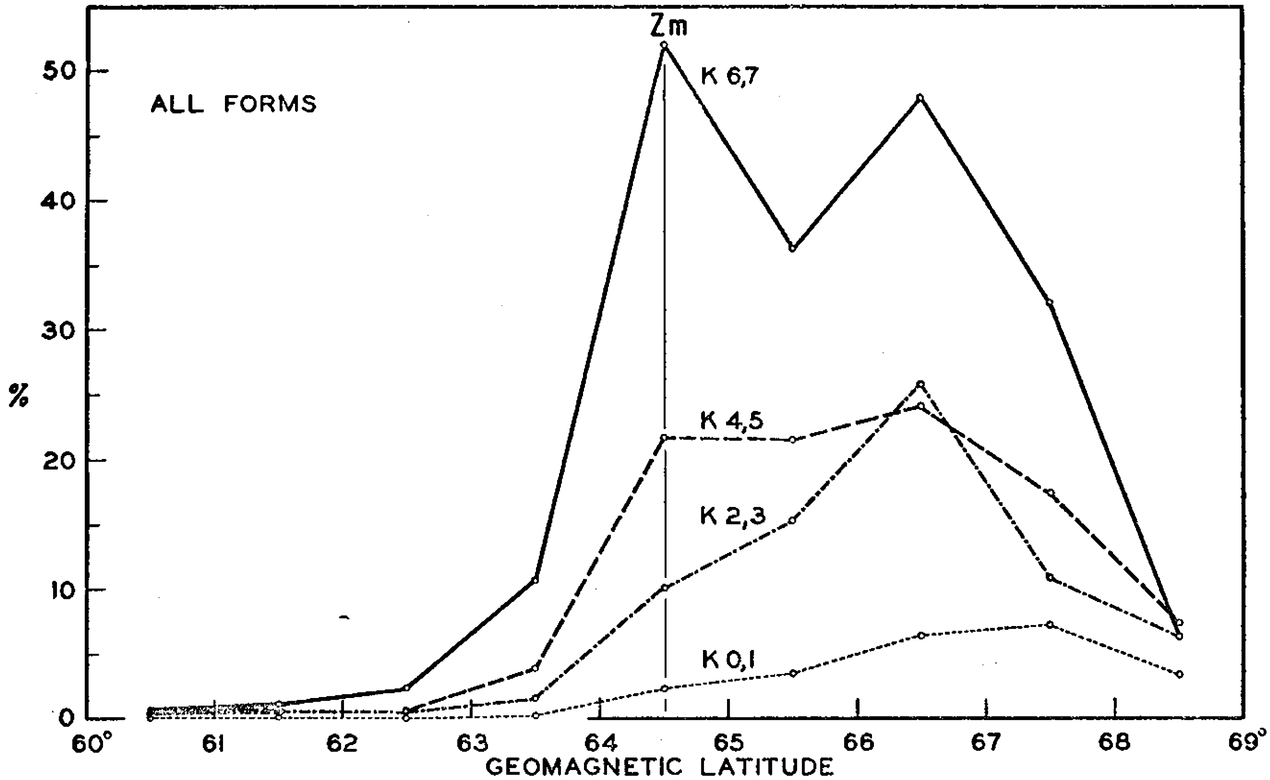


FREQUENCY OF AURORAS SEEN FROM PT. BARROW, ALASKA, 1953-54.

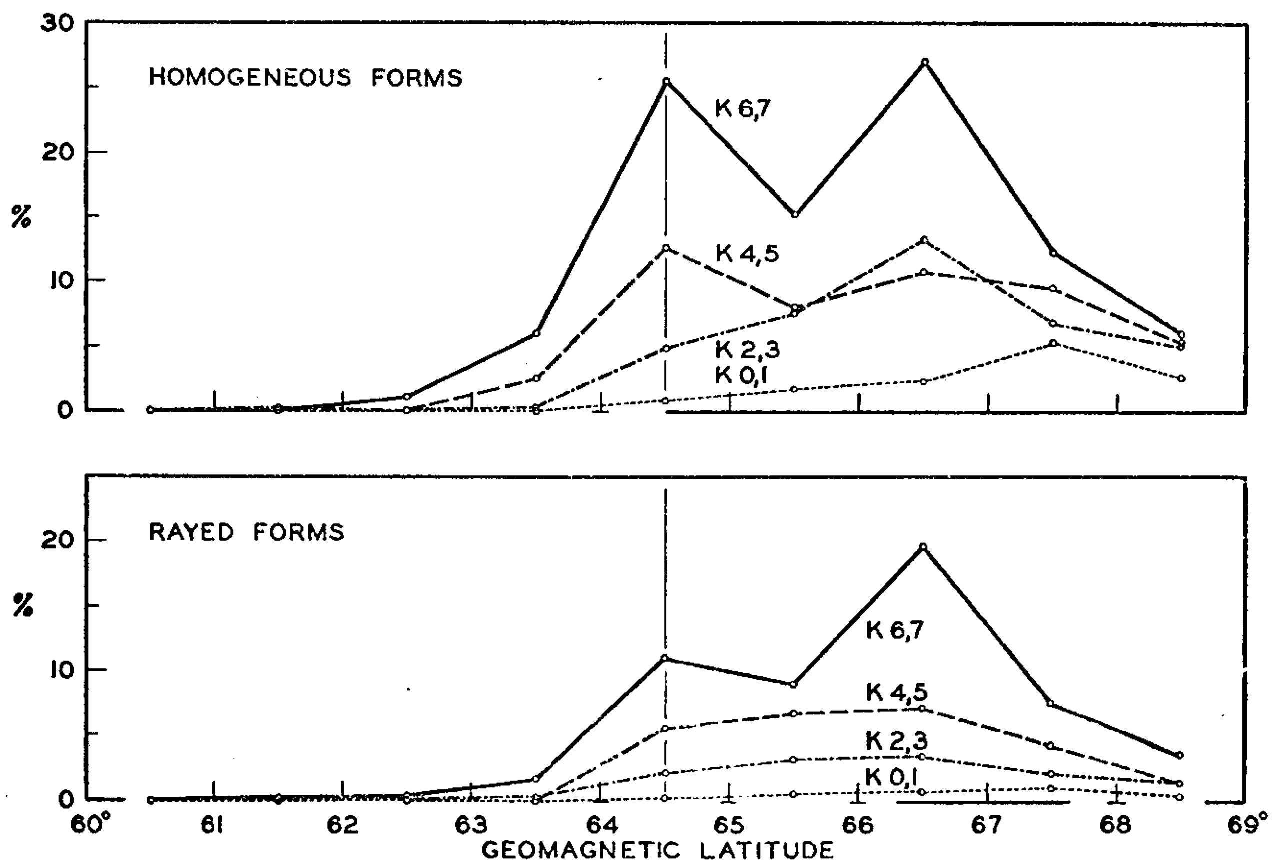


FREQUENCY OF AURORAS SEEN FROM PT. BARROW. ALASKA. 1953-54

FIG. 6

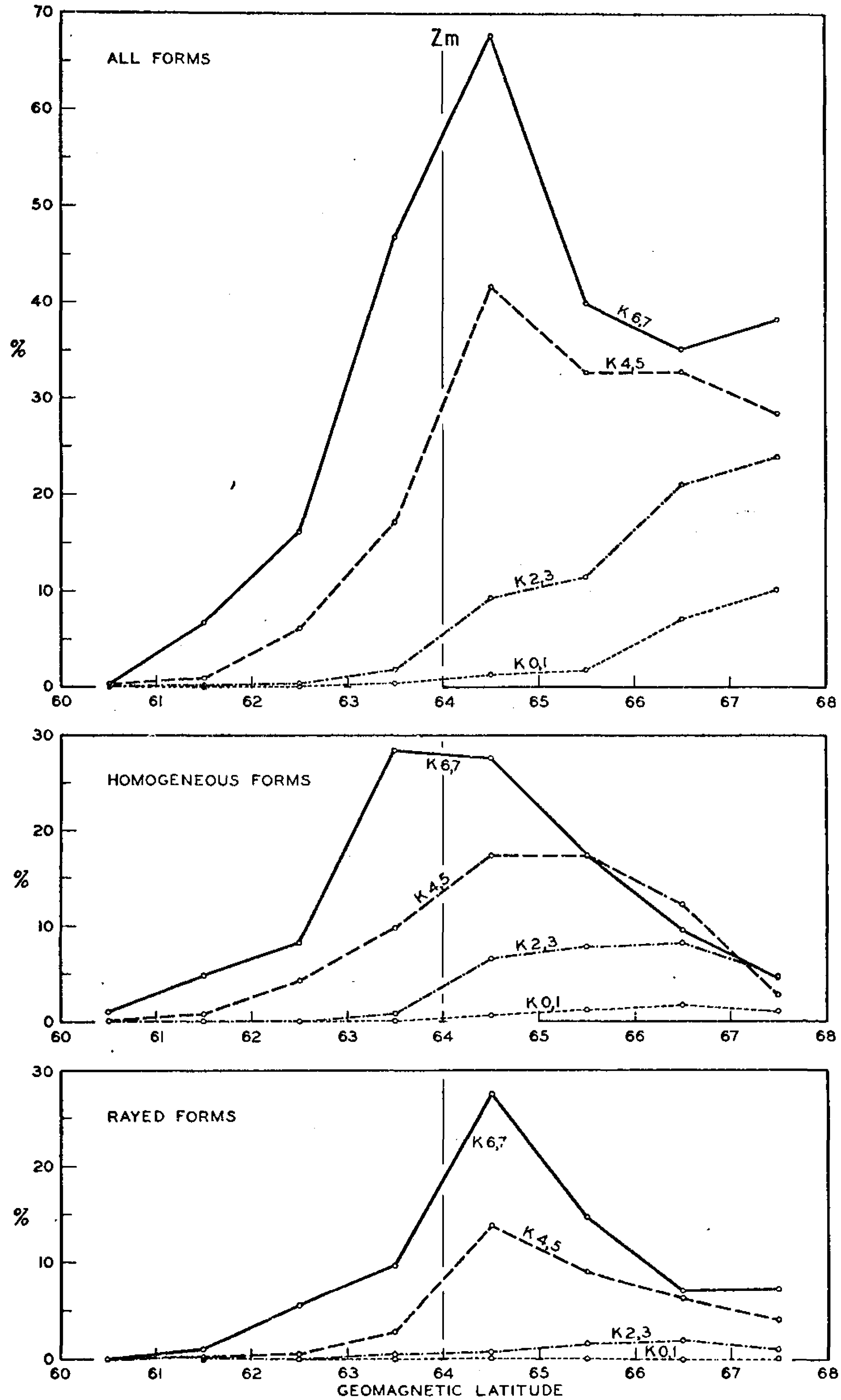


FREQUENCY OF AURORAS SEEN FROM COLLEGE, ALASKA, 1953-54



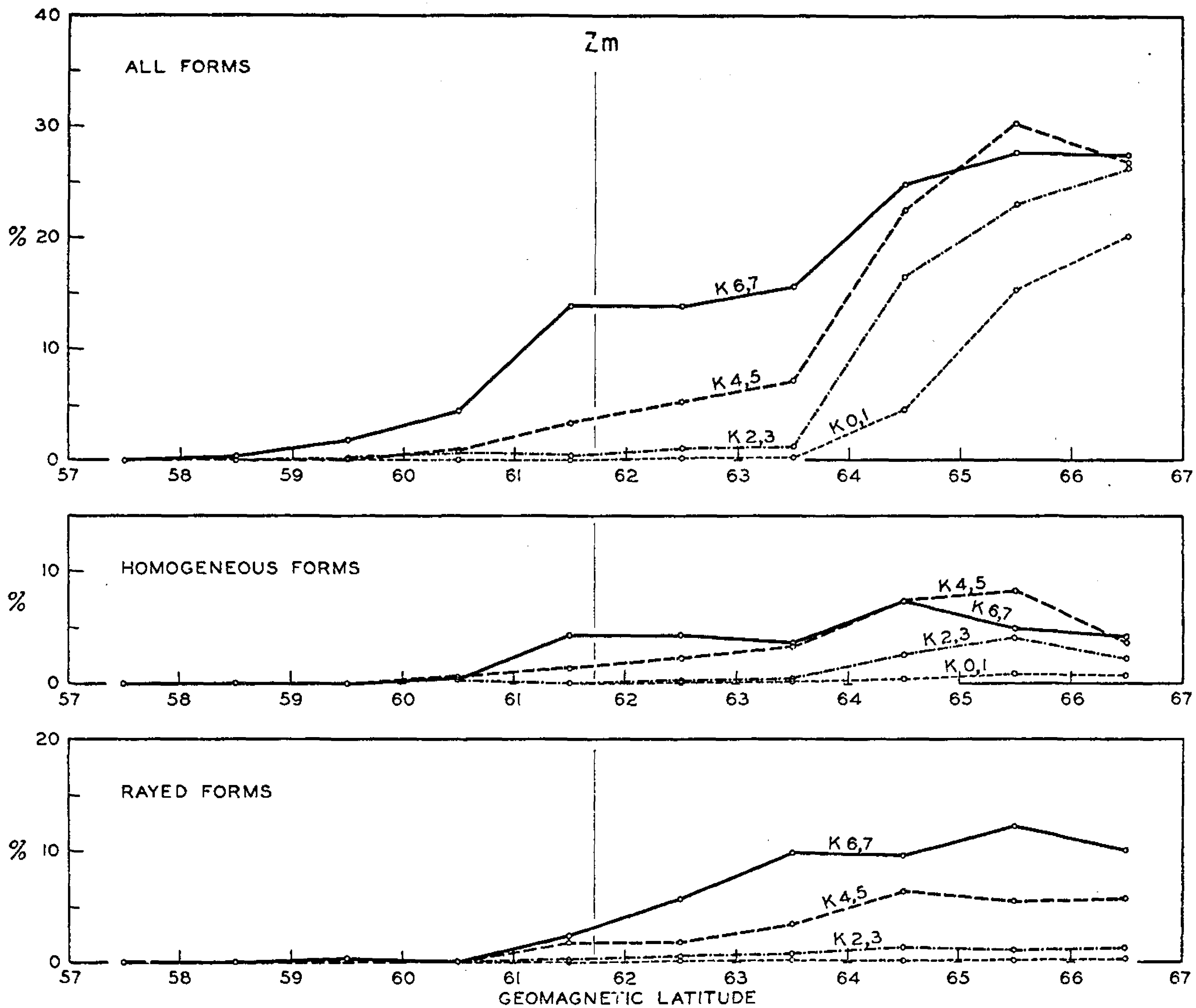
FREQUENCY OF AURORAS SEEN FROM COLLEGE. ALASKA. 1953-54

FIG. 7



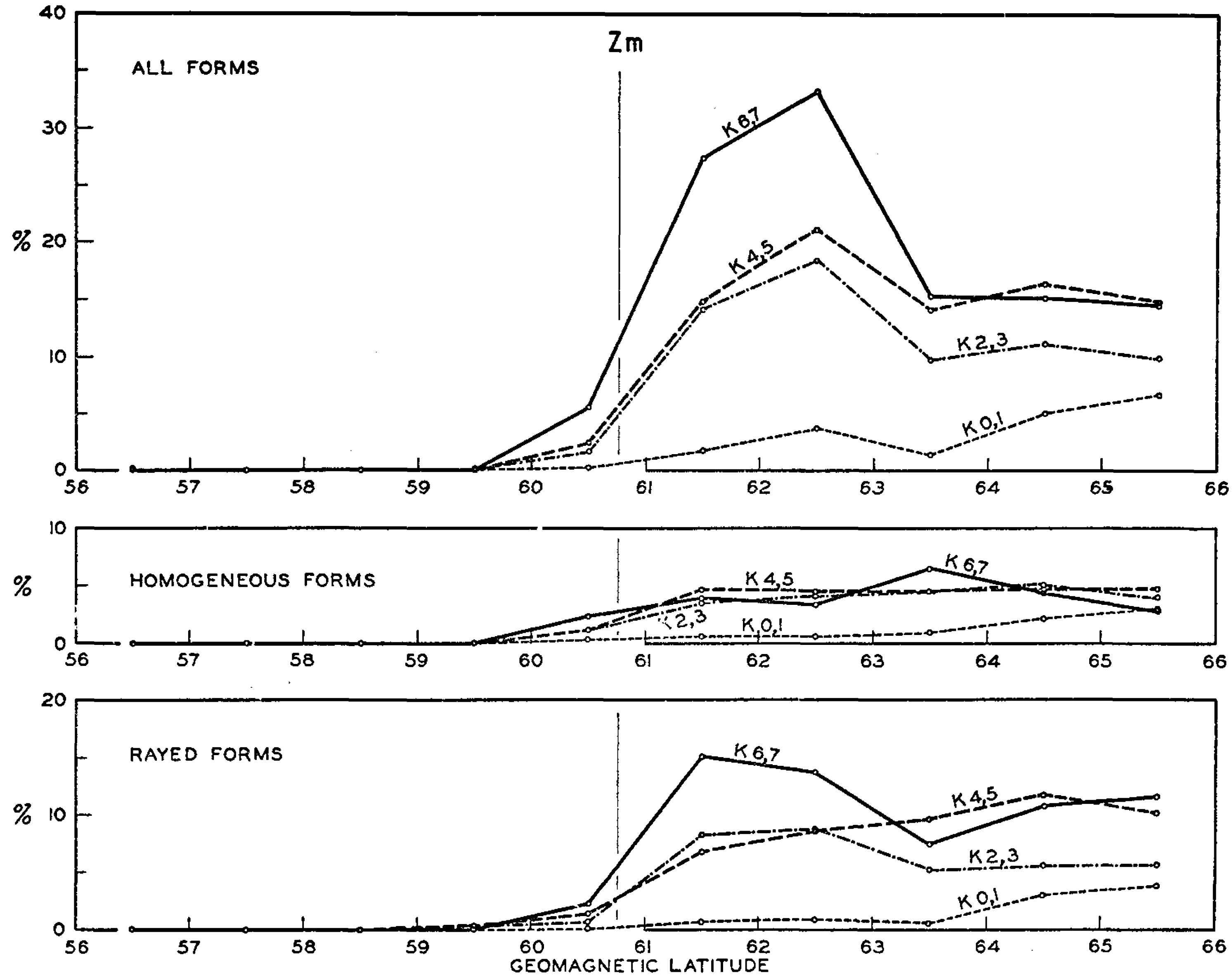
FREQUENCY OF AURORAS SEEN FROM NORTHWAY, ALASKA, 1953-54

FIG. 8



FREQUENCY OF AURORAS SEEN FROM SHEEP MOUNTAIN, ALASKA, 1953-54

FIG. 9



FREQUENCY OF AURORAS SEEN FROM NOME, ALASKA, 1953–54

FIG. 10

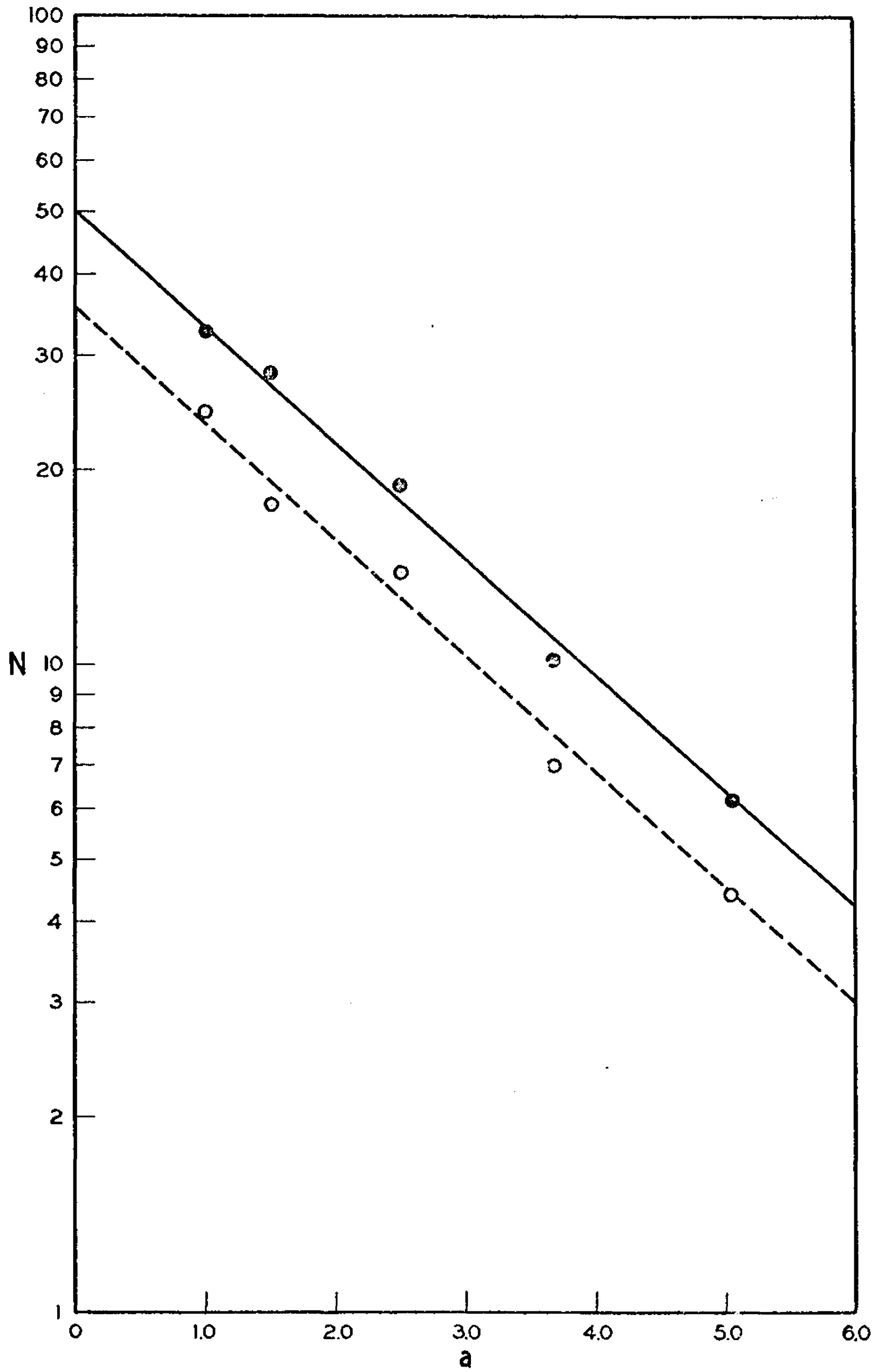
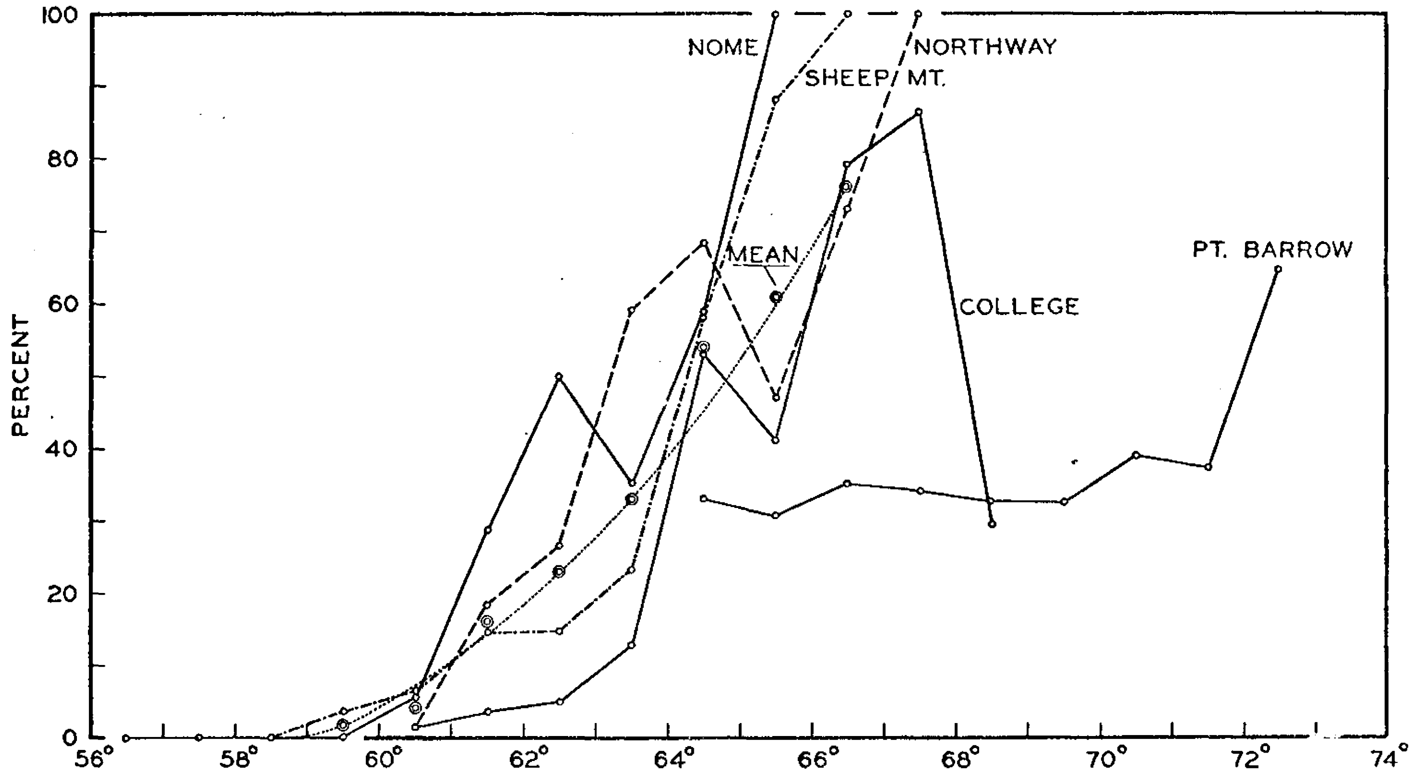
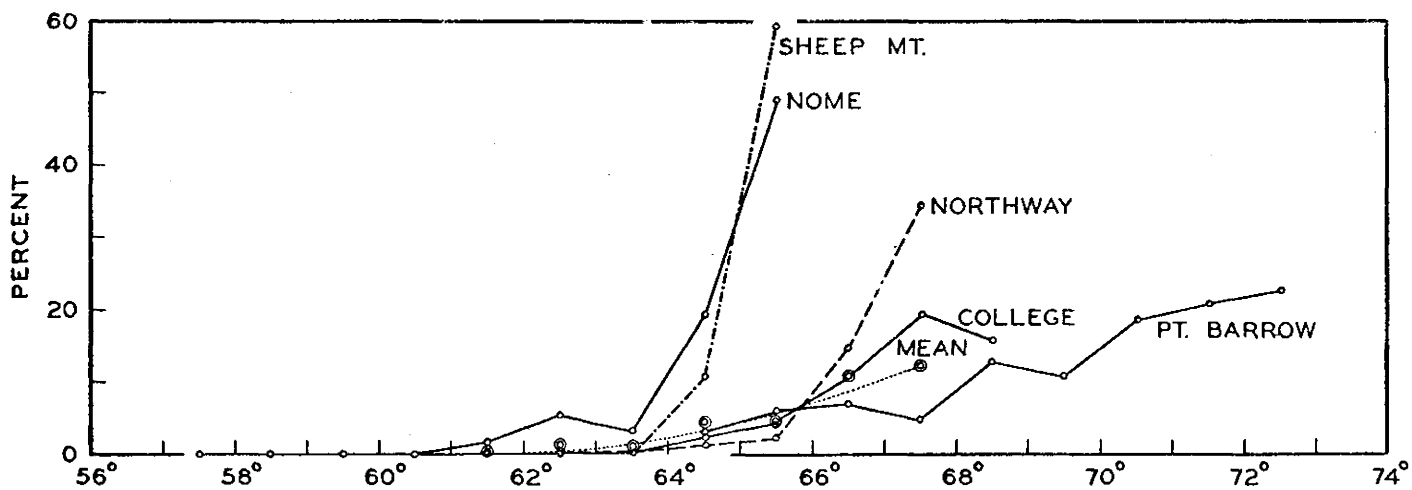


FIG. II



INCIDENCE OF AURORAS. K=6,7.
FIG. 12 A



INCIDENCE OF AURORAS. K=0,1.
FIG. 12 B

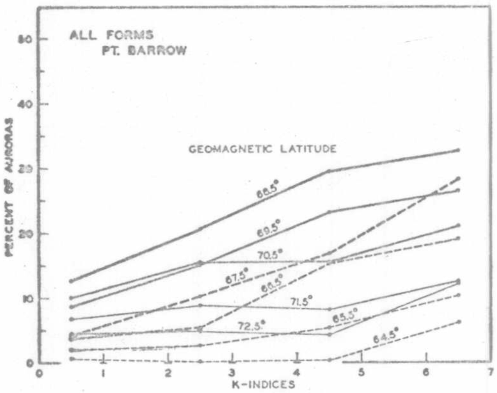


FIG. 13 A

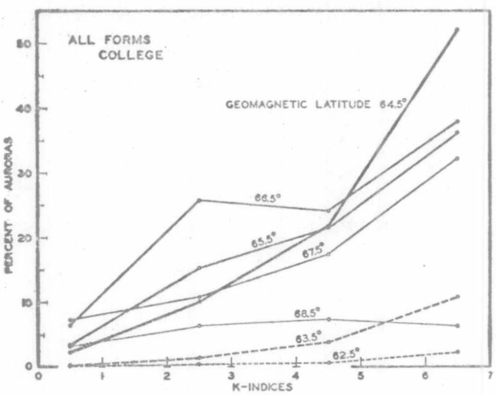


FIG. 13 B

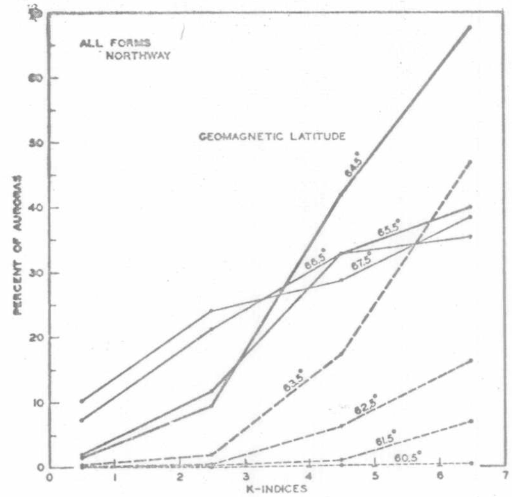


FIG. 13 C

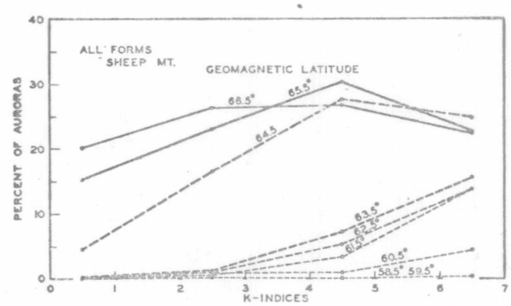


FIG. 13 D

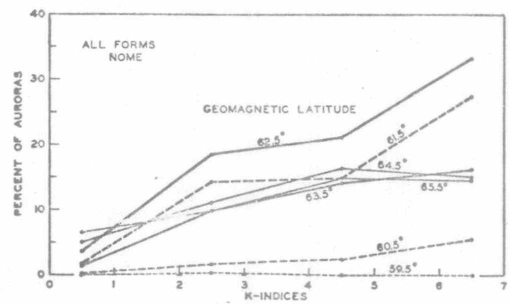
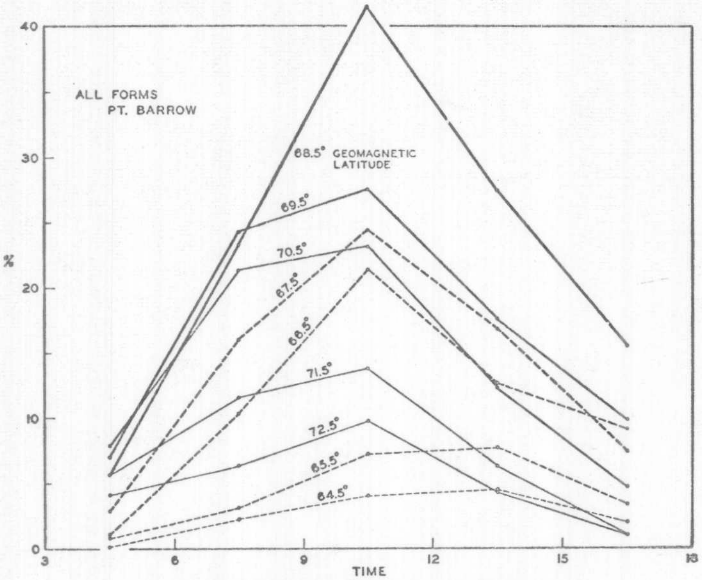
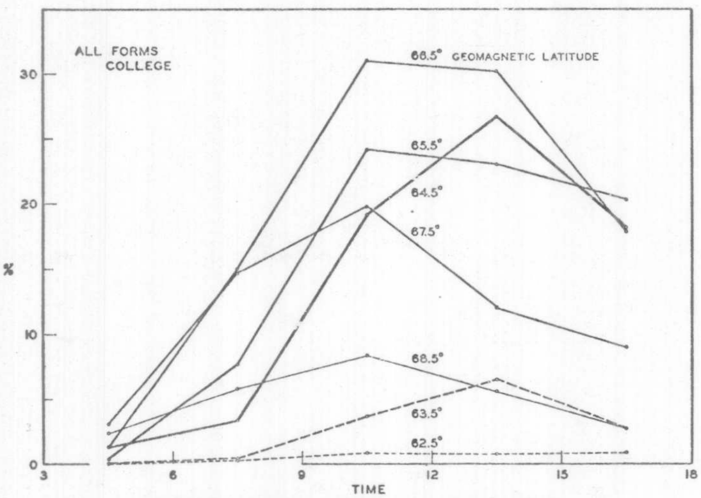


FIG. 13 E



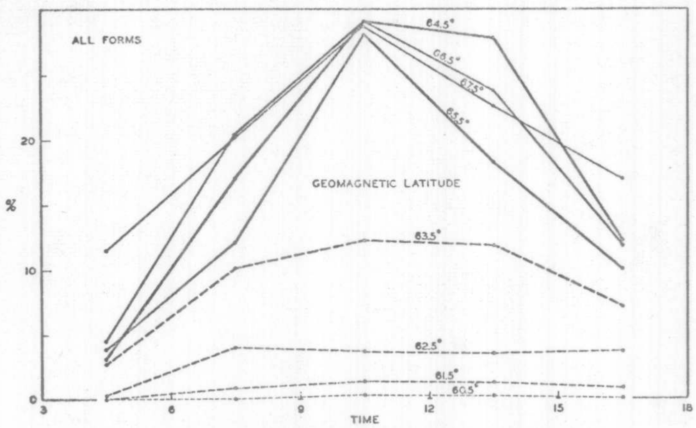
AVERAGE NOCTURNAL VARIATION OF AURORAS. 1953-54.

FIG. 14 A



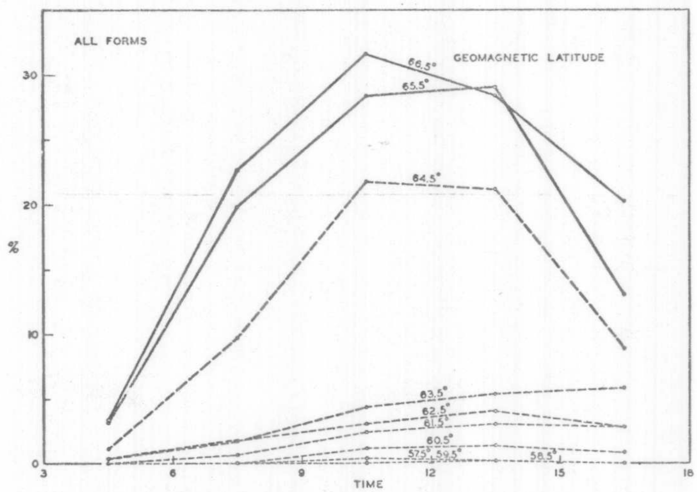
AVERAGE NOCTURNAL VARIATIONS OF AURORAS, 1953-54.

FIG. 14 B



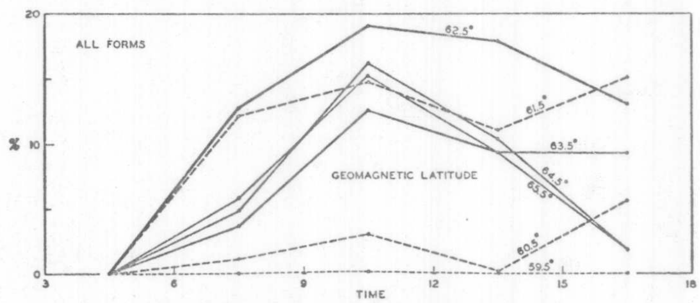
AVERAGE NOCTURNAL VARIATION OF AURORAS. NORTHWAY, ALASKA, 1953-54

FIG. 14 C



AVERAGE NOCTURNAL VARIATION OF AURORAS. SHEEP MOUNTAIN, ALASKA, 1953-54

FIG. 14 D



AVERAGE NOCTURNAL VARIATION OF AURORAS. NOME, ALASKA, 1953-54

FIG. 14 E

VISUAL AURORA IBM CODE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
	STATION	OBSER.	YEAR		MONTH	DATE		HOUR		MINUTE		AURORA		MOTION	COLOR		CHANGES	SEQ. →		SPECIAL FORMS						
R	20	20			DEC					ALL HOUR	NO OBS.		SCAT CLDS	N				HA	HA							R
X	10	10			NOV								?	S				RA	RA							X
0				0	OCT	0	0	0	0	0	0	0	0	0	O	SCAT		HB	HB	[symbol]	N4					0
1	1	1	1	1	JAN	1	1	1	1	1	1	T	LN	TO EAST	G	N3	→R	RB	RB	[symbol]	N3					1
2	2	2	2	2	FEB	2	2	2	2	2	2	M	E	SLOW	YG	N2	PULS BEG	DS	DS	[symbol]	N2					2
3	3	3	3	3	MAR	3	3		3	3	3	T+M	W	FAST	RL	N1	PULS END	V	V	[symbol]	N1					3
4	4	4	4	4	APR	DATE CHANGE AT MIDNIGHT	4		4	4	4	INTERFERENCE BY ↓	LS	TO WEST	RU	Z	F BEG	D	D	[symbol]	Z					4
5	5	5	5	5	MAY		5	MIDNIGHT IS 2400	5	5	5		AUR	SLOW	R	S1	F END	R	R	[symbol]	S1					5
6	6	6	6	6	JUN		6		6	00	6		+N	FAST	BL	S2	PEAK	PS	PS	[symbol]	S2					6
7	7	7	7	7	JUL		7		7	15	7	T	+S		VGr	S3		F	F	[symbol]	S3					7
8	8	8	8	8	AUG		8		8	30	8	M	+NS					C	C	DARK	S4					8
9	9	9	9	9	SEP		9		9	45	9	T+M	X	RAND		ALL	SEQ.									9

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	
	N4		N3		N2		N1				ZENITH						S1				S2		S3		S4		MF	
R	2	St	2	St	2	St	2	St	2	St	2	St	2	St	2	St	2	St	2	St	2	St	2	St	2	St	R	R
X	HA	?	HA	?	HA	?	HA	?	HA		HA	?	HA		HA		HA	?	HA		HA	?	HA	?	HA	?		X
0	RA	O	RA	O	RA	O	RA	O	RA		RA	O	RA		RA		RA	O	RA		RA	O	RA	O	RA	O	?	0
1	HB	1	HB	1	HB	1	HB	1	HB	1	HB	1	HB	1	HB	1	HB	1	HB	1	HB	1	HB	1	HB	1	1	1
2	RB	2	RB	2	RB	2	RB	2	RB	2	RB	2	RB	2	RB	2	RB	2	RB	2	RB	2	RB	2	RB	2	2	2
3	DS	3	DS	3	DS	3	DS	3	DS	3	DS	3	DS	3	DS	3	DS	3	DS	3	DS	3	DS	3	DS	3	3	3
4	V	4	V	4	V	4	V	4	V	4	V	4	V	4	V	4	V	4	V	4	V	4	V	4	V	4	4	4
5	D	5	D	5	D	5	D	5	D	5	D	5	D	5	D	5	D	5	D	5	D	5	D	5	D	5	5	5
6	R		R		R		R		R		R		R		R		R		R		R		R		R		6	6
7	PS		PS		PS		PS		PS		PS		PS		PS		PS		PS		PS		PS		PS		7	7
8	F	SC	F	SC	F	SC	F	SC	F		F	SC	F		F		F	SC	F		F	SC	F	SC	F	SC	8	8
9	C	X	C	X	C	X	C	X	C		C	X	C		C		C	X	C		C	X	C	X	C	X	9	9

FIG. 15

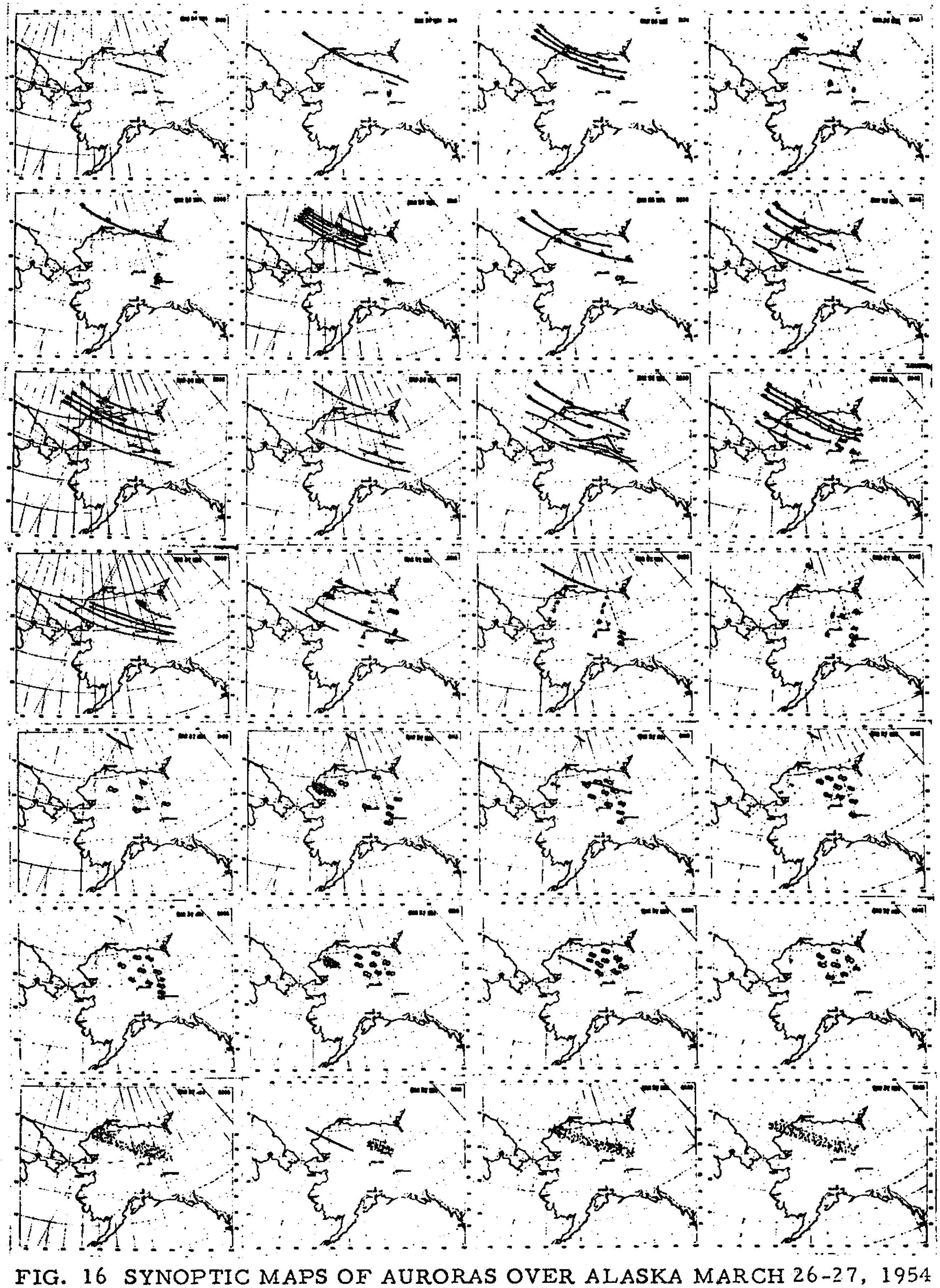


FIG. 16 SYNOPTIC MAPS OF AURORAS OVER ALASKA MARCH 26-27, 1954

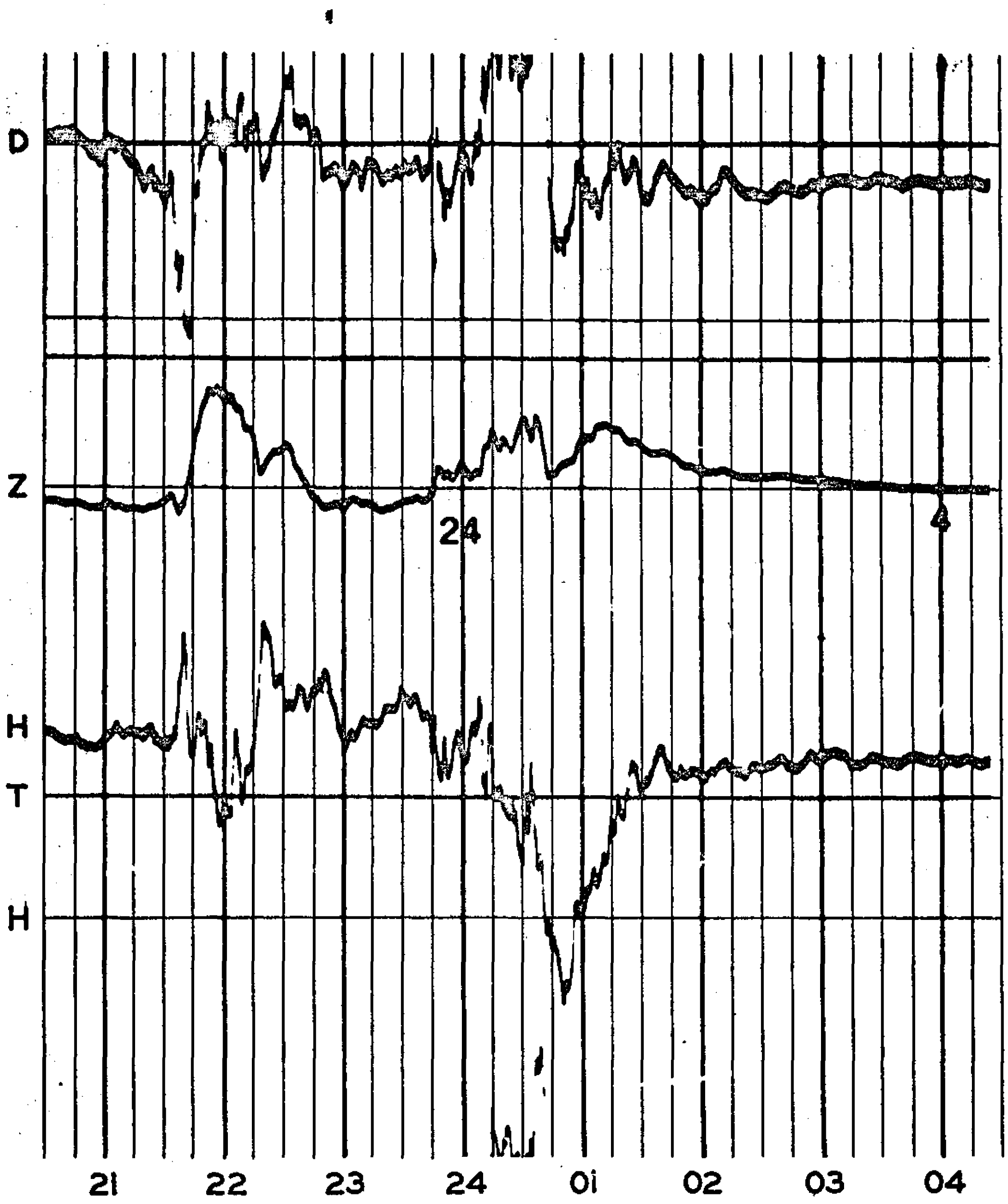


FIG. 17 COLLEGE ALASKA MAR. 26 1954