DAYTIME IONOGRAMS

QUIET

VOSTOK 1970 22 JAN 1015 LT
(105° EMT)

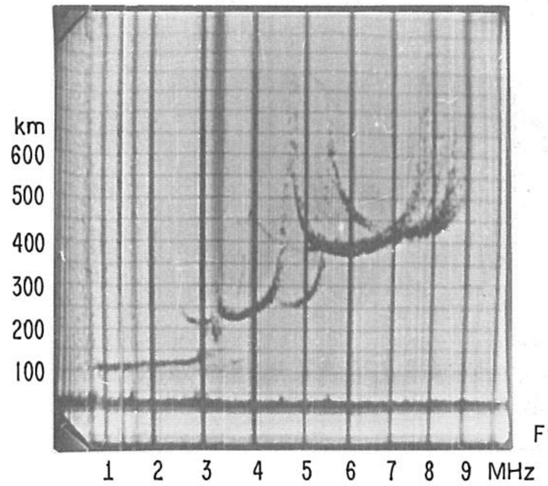


Fig. 1.1

DISTURBED

VOSTOK 1970 23 JAN 1405 LT

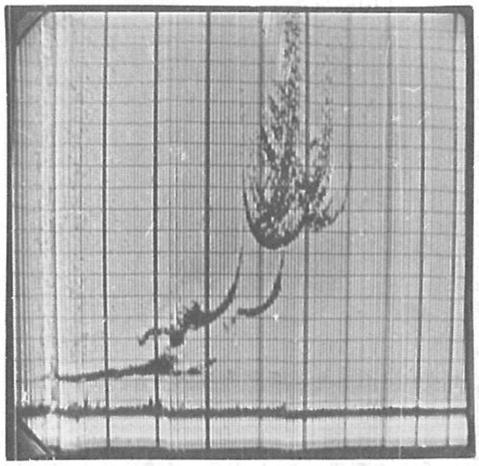


Fig. 1.2

MIRNY 1970 25 JAN 1300 LT
(90° EMT)

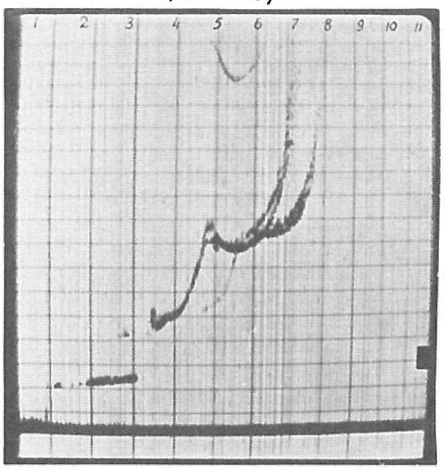


Fig. 1.3

MIRNY 1970 24 JAN 1500 LT

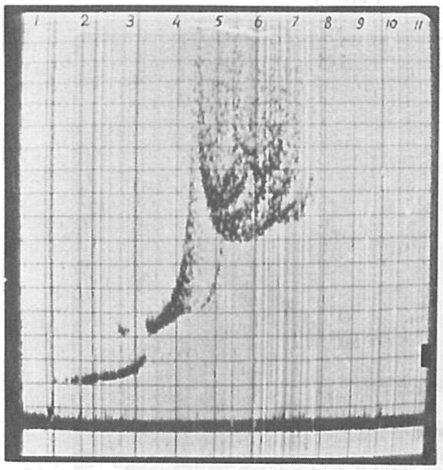


Fig. 1.4

HEISS 1970 7 JUL 1100 LT
(45° EMT)

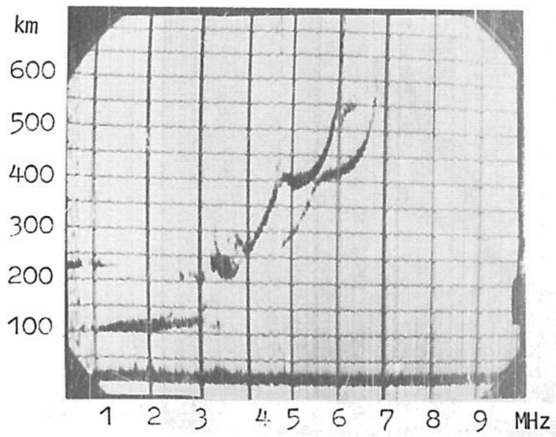


Fig. 1.5

HEISS 1970 27 JUL 1230 LT

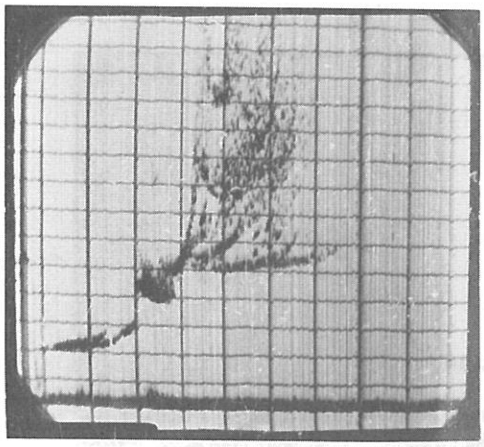


Fig. 1.6

NIGHTTIME IONOGRAMS

QUIET

VOSTOK 1970 11 JAN 0400 LT
(105° EMT)

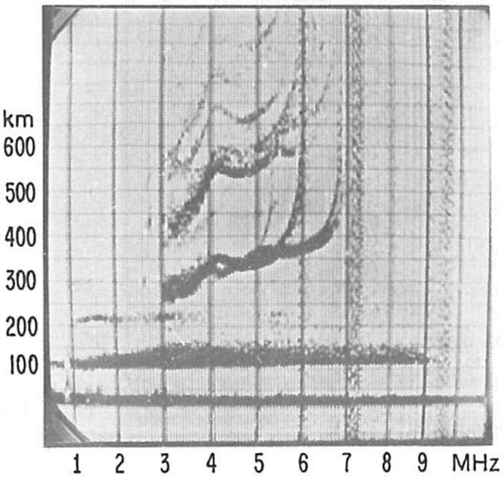


Fig. 1.7

MIRNY 1970 26 JAN 0045 LT
(90° EMT)

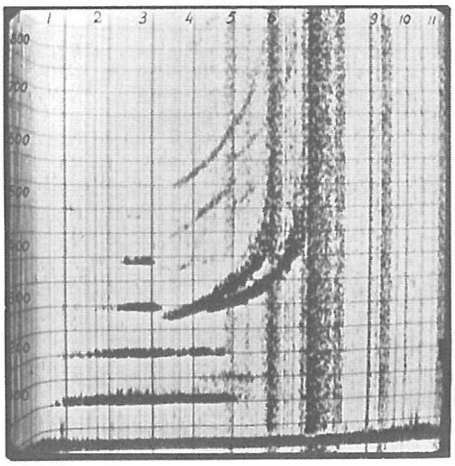


Fig. 1.9

HEISS 1970 7 JUL 0200 LT
(45° EMT)

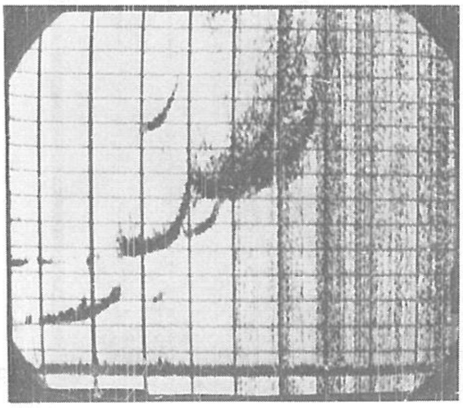


Fig. 1.11

DISTURBED

VOSTOK 1970 13 JAN 0355 LT

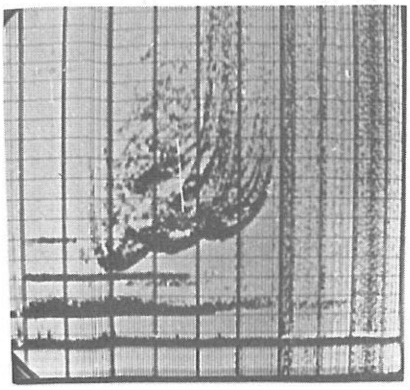


Fig. 1.8

MIRNY 1970 24 JAN 0055 LT

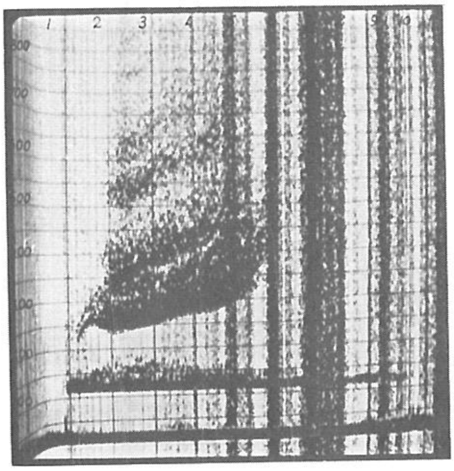


Fig. 1.10

HEISS 1970 27 JUL 0045 LT

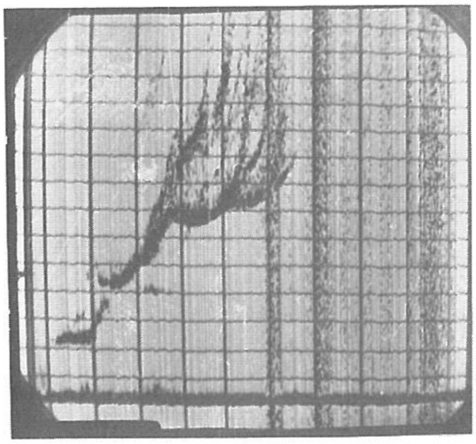


Fig. 1.12

DAYTIME IONOGRAMS

QUIET

DISTURBED

HEISS 1970 4 JAN 1055 LT
(45° EMT)

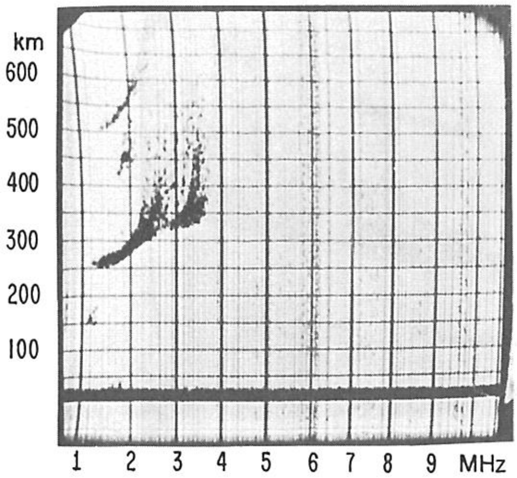


Fig. 1.13

HEISS 1970 2 JAN 1215 LT

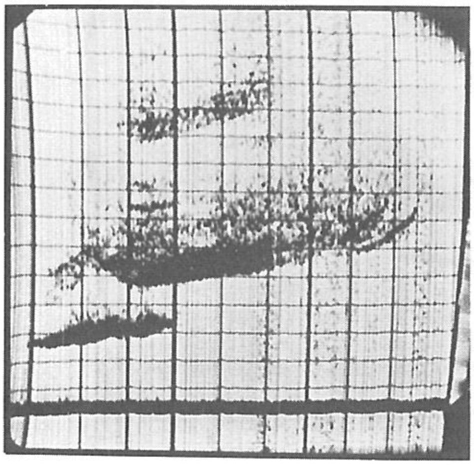


Fig. 1.14

DIXON 1970 7 JUL 1200 LT
(105° EMT)

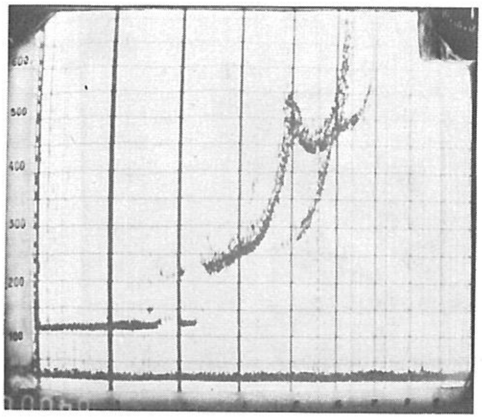


Fig. 1.15

DIXON 1970 29 JUL 1315 LT

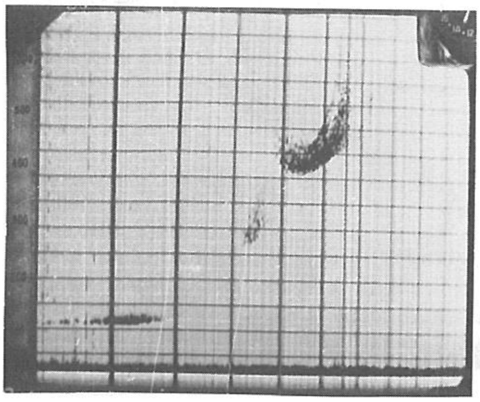


Fig. 1.16

DIXON 1969 3 JAN 1505 LT

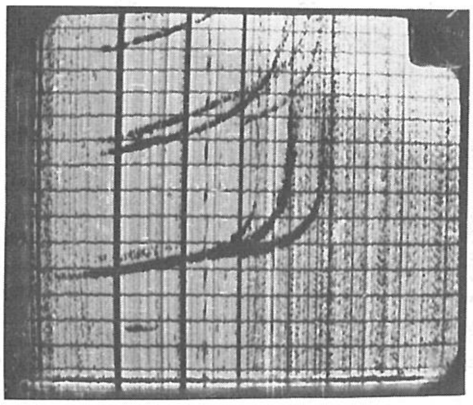


Fig. 1.17

DIXON 1970 2 JAN 1430 LT

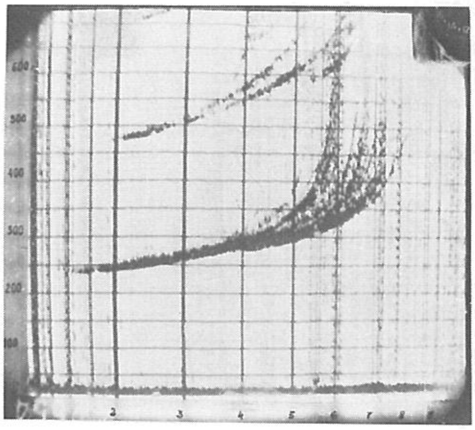


Fig. 1.18

NIGHTTIME IONOGRAMS

QUIET

DISTURBED

HEISS 1970 3 JAN 1950 LT
(45° EMT)

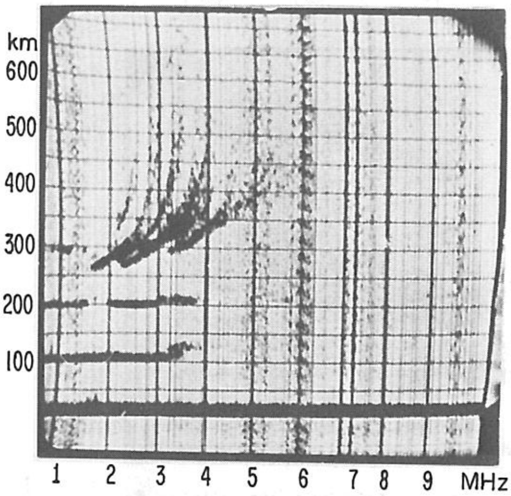


Fig. 1.19

HEISS 1970 1 JAN 2130 LT

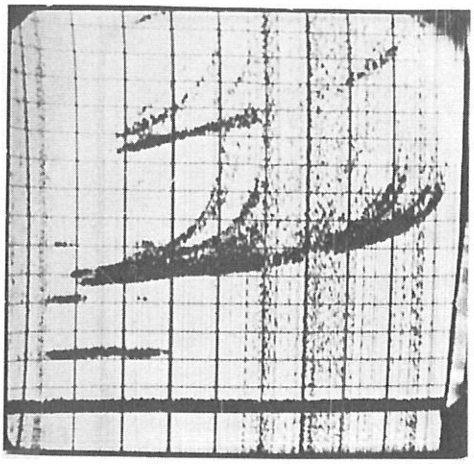


Fig. 1.20

DIXON 1970 7 JUL 0100 LT
(105° EMT)

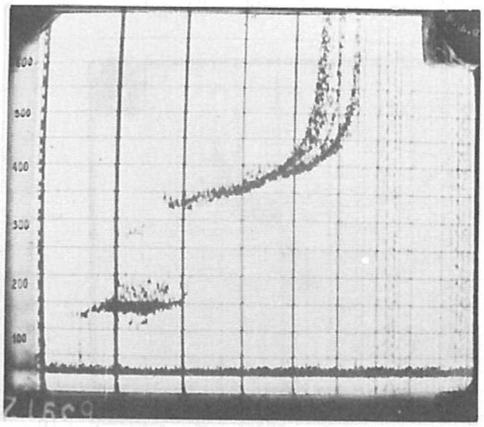


Fig. 1.21

DIXON 1970 13 JUL 0145 LT

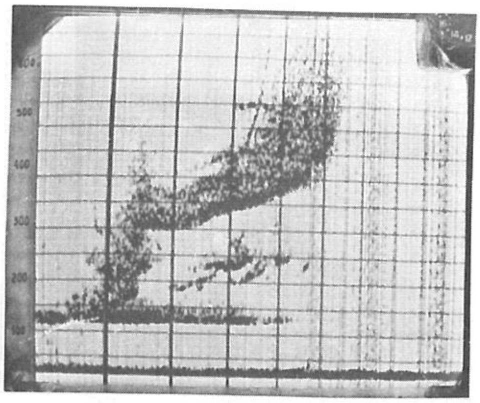


Fig. 1.22

DIXON 1969 3 JAN 0330 LT

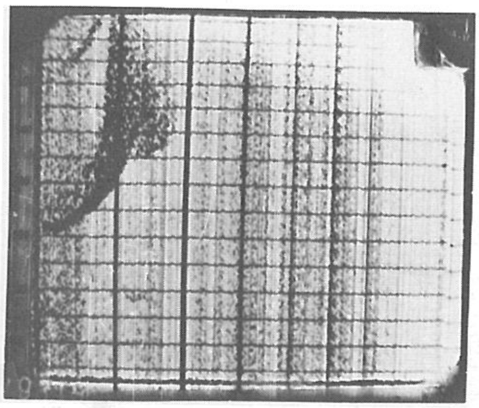


Fig. 1.23

DIXON 1969 8 JAN 0130 LT

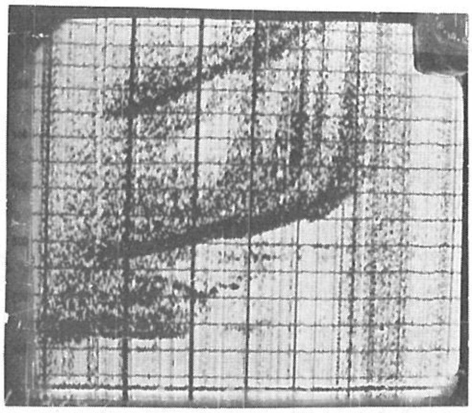


Fig. 1.24

LACUNA

MIRNY 1970 23 JAN 1105 LT
(90° EMT)

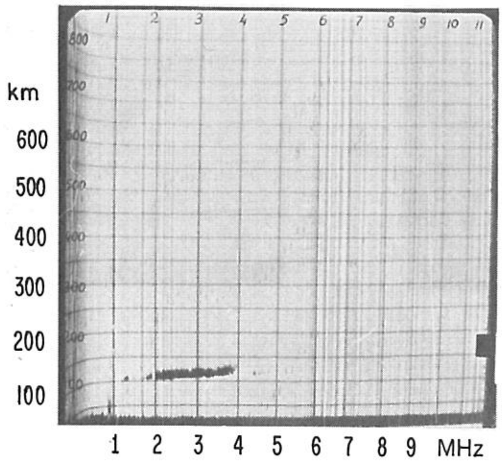


Fig. 1.25a

foE= Y foF1=Y foF2=Y

HEISS 1970 27 JUL 0530 LT
(45° EMT)

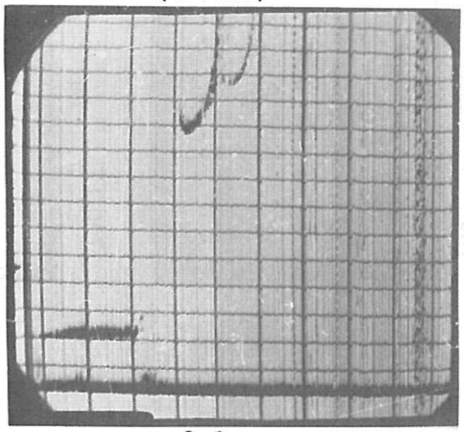


Fig. 1.26

● o
fo fF2 foE=Y

MIRNY 1970 23 JAN 1115 LT

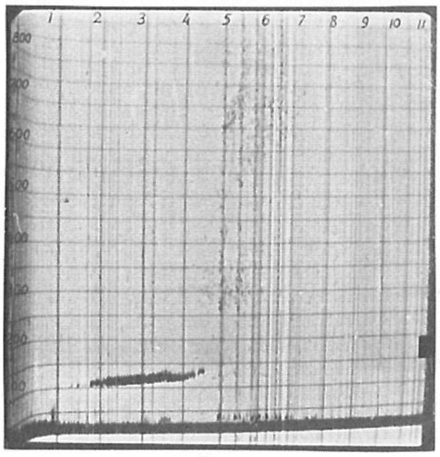


Fig. 1.25b

● —
foE foF1 foF2=Y

HEISS 1970 29 JUL 0550 LT

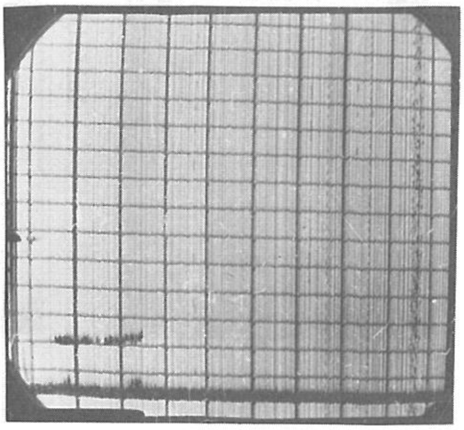


Fig. 1.27

foE=Y foF1=Y foF2=Y

MIRNY 1970 23 JAN 1130 LT

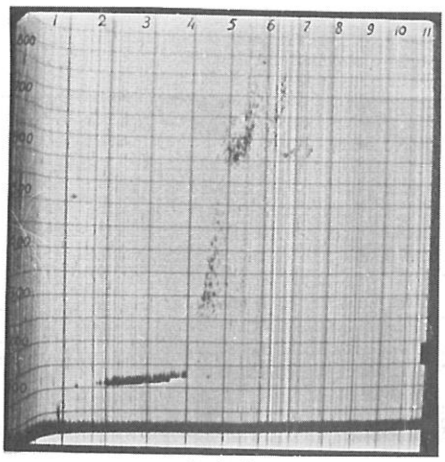


Fig. 1.25c

● ●- ●-
foE foF2
foF1

DIXON 1969 25 JAN 1655 LT
(105° EMT)

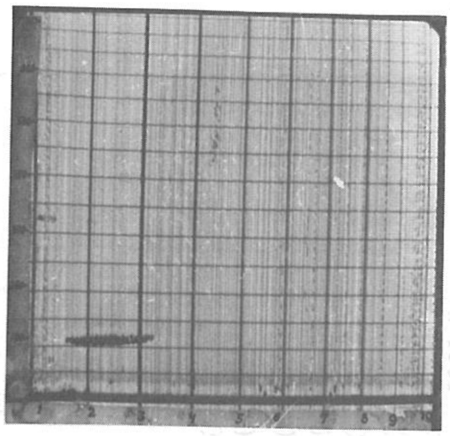


Fig. 1.28

●
foE=Y foF1=UY foF2= ..EG

DEVELOPMENT OF LACUNA

DIXON 1970 9 JUL 1530-1715 LT

(105° EMT)

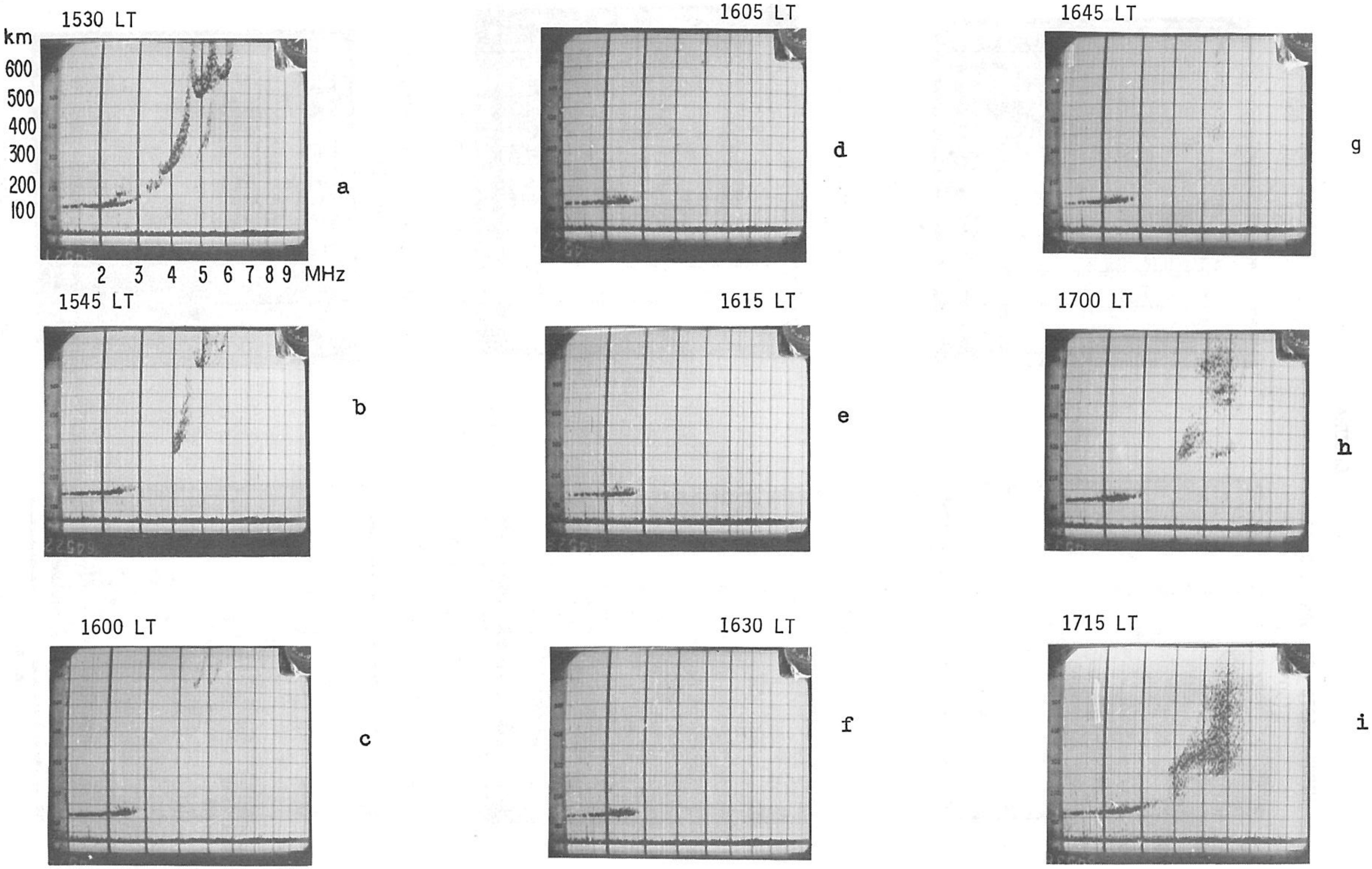


Fig. 1.29

DIXON 1969 7 JAN 2055 LT
(105° EMT)
a

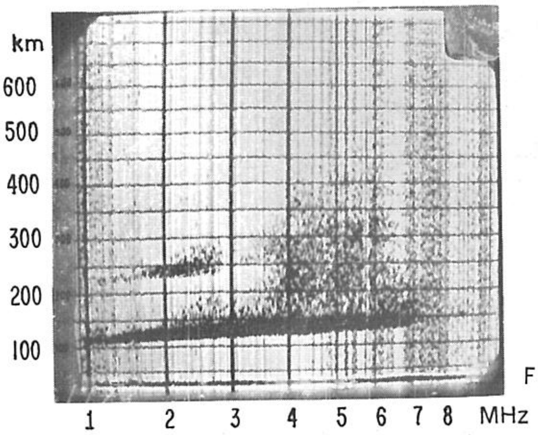


Fig. 1.30

DIXON 1970 10 JUL 0300 LT
a

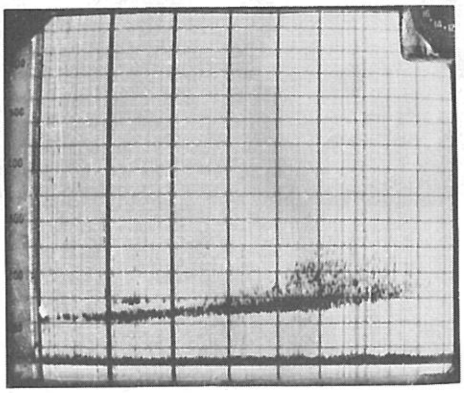


Fig. 1.31

DIXON 1970 2 JAN 2015 LT
c,a

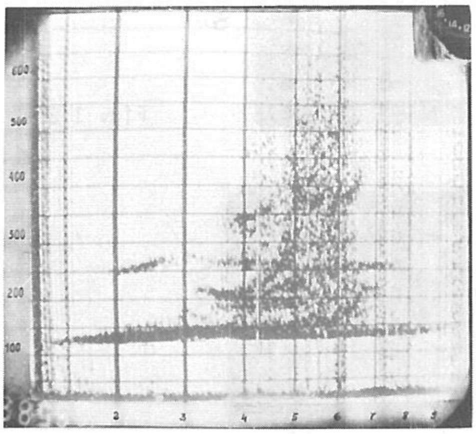


Fig. 1.32

DIXON 1970 29 JUL 1715 LT
a

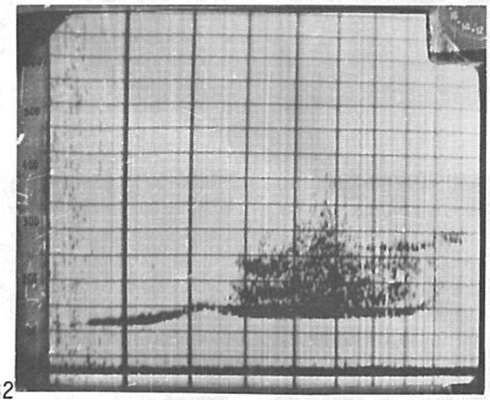


Fig. 1.33

HEISS 1970 27 JUL 1700 LT
(45° EMT)
a

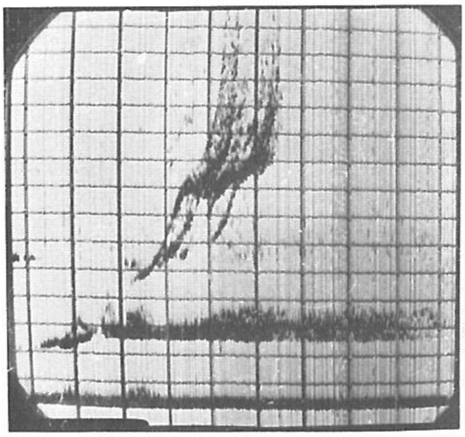


Fig. 1.34

HEISS 1970 29 JUL 1715 LT
r

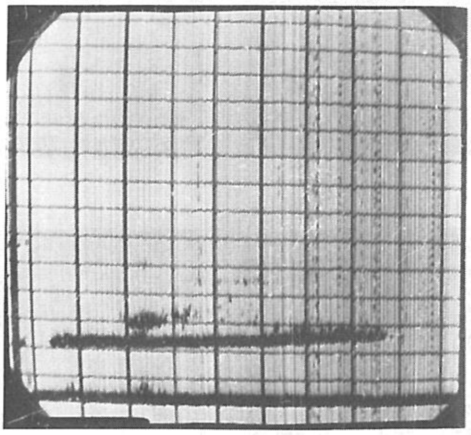


Fig. 1.35

SPORADIC E TYPE a and ASKAFILMS

TIXIE BAY 1958 10 NOV 1920 LT

(135° EMT)

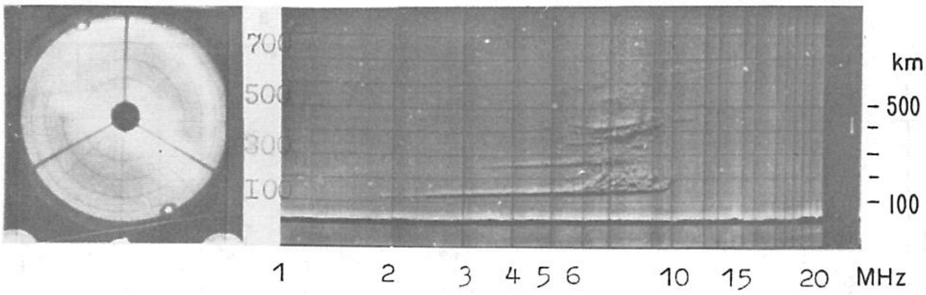


Fig. 1.36

TIXIE BAY 1958 19 NOV 0000-0230 LT

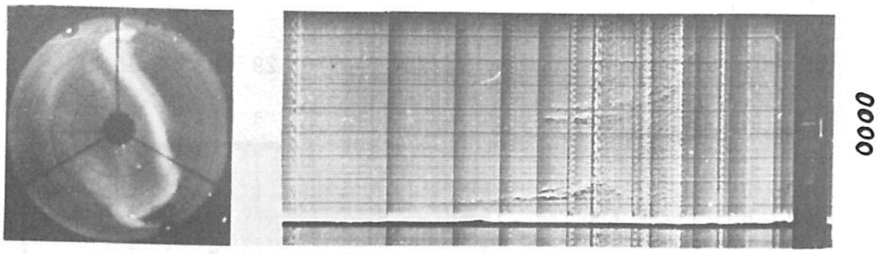


Fig. 1.36a

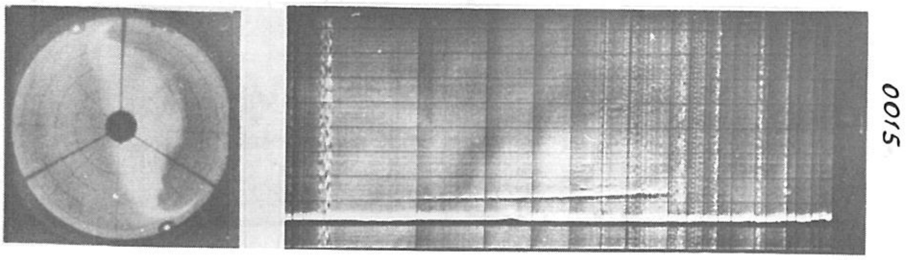


Fig. 1.36b

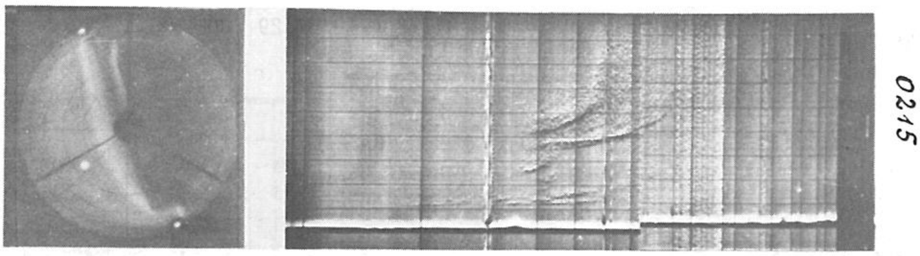


Fig. 1.36c

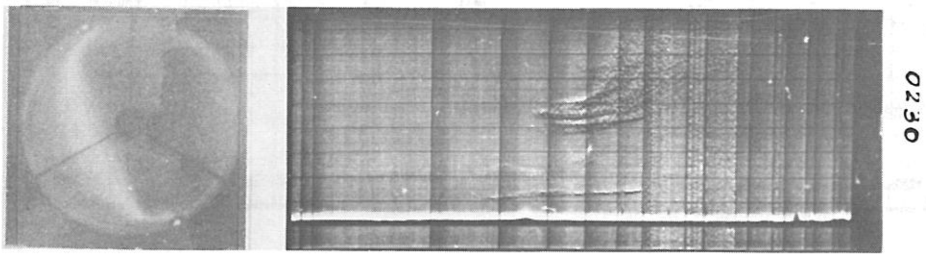


Fig. 1.36d

TIXIE BAY 1958 7 SEP 1155 LT

(135° EMT)

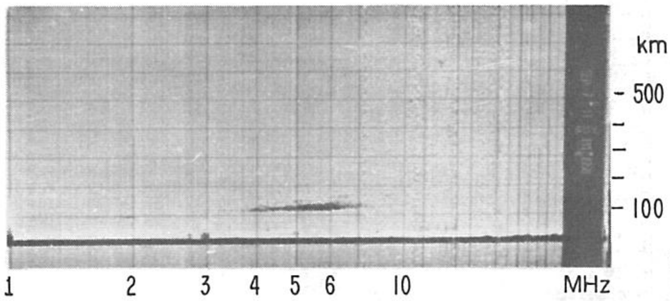


Fig. 1.37

Es under high absorption conditions (Es-a)

TIXIE BAY 1958 5 SEP 1200 LT

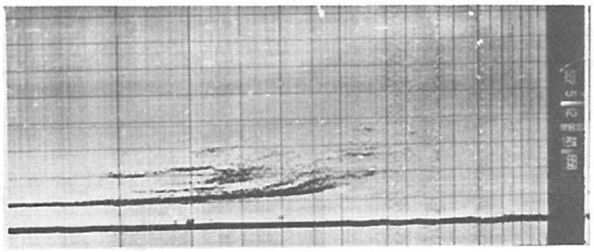


Fig. 1.38

Es-a

TIXIE BAY 1958 7 SEP 0845 LT

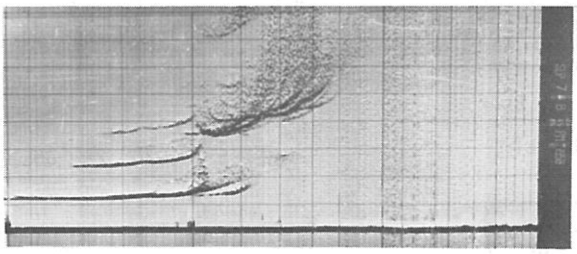


Fig. 1.39

Particle E (night E) (Es-k)

TIXIE BAY 1958 30 JUN 1600 LT

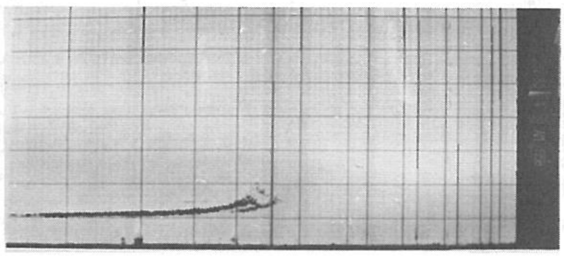


Fig. 1.40

Es-r

Es TYPE k, r, c, ℓ

HEISS 1970 4 JAN 0545 LT
(45° EMT)

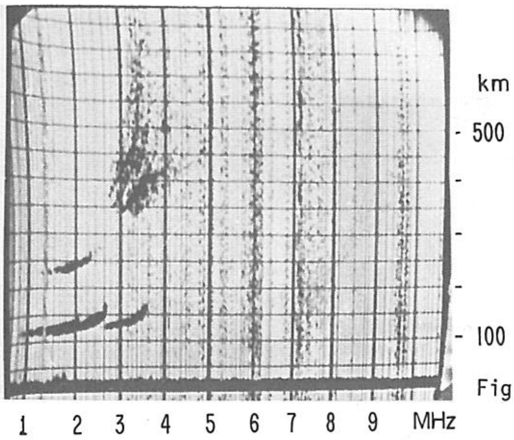


Fig. 1.41

Particle E (Es-k)

DIXON 1970 3 JAN 2005 LT
(105° EMT)

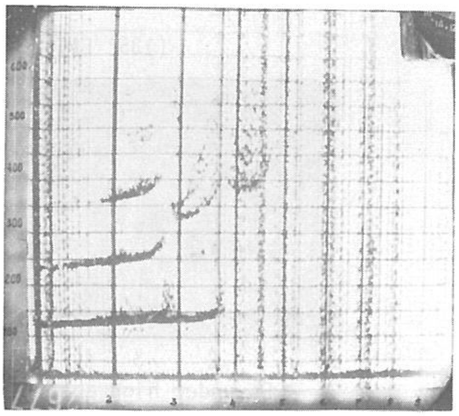


Fig. 1.42

Particle E (Es-k)

HEISS 1970 3 JAN 1245 LT

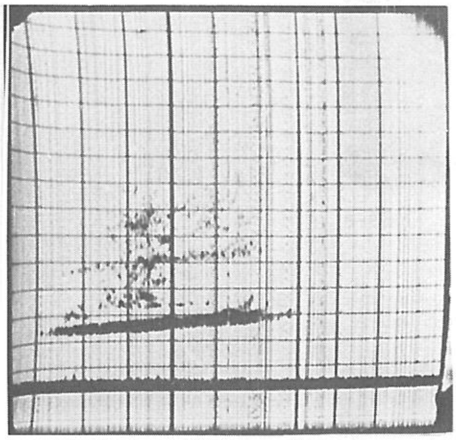


Fig. 1.43

Es-r

DIXON 1969 9 JAN 0345 LT

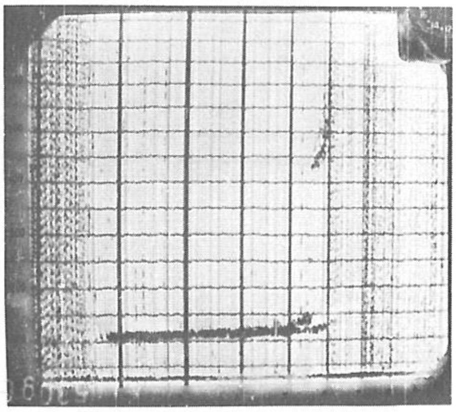


Fig. 1.44

Es-r

MIRNY 1970 4 JAN 1945 LT
(90° EMT)

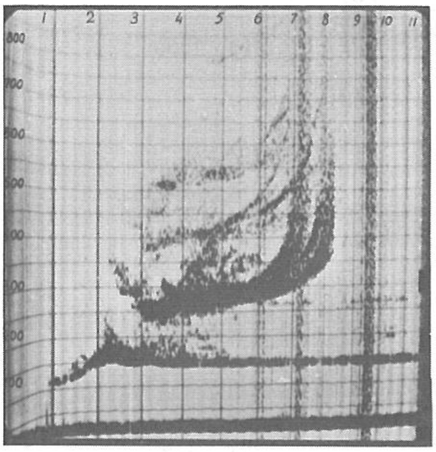


Fig. 1.45

Es-c

HEISS 1970 29 JUL 2045 LT

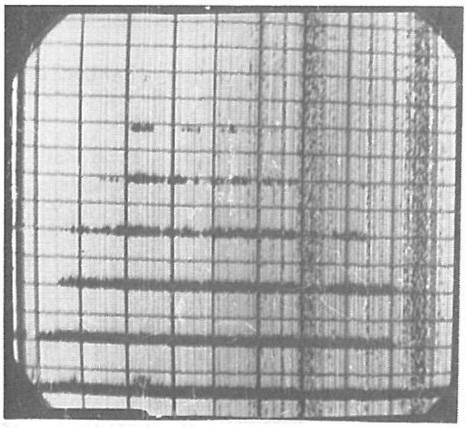


Fig. 1.46

Es-ℓ

IONOGRAM SEQUENCE. Es TYPES CHANGING IN TIME

DIXON   1970 2 JANUARY 1800-1930 LT
(105° EMT)

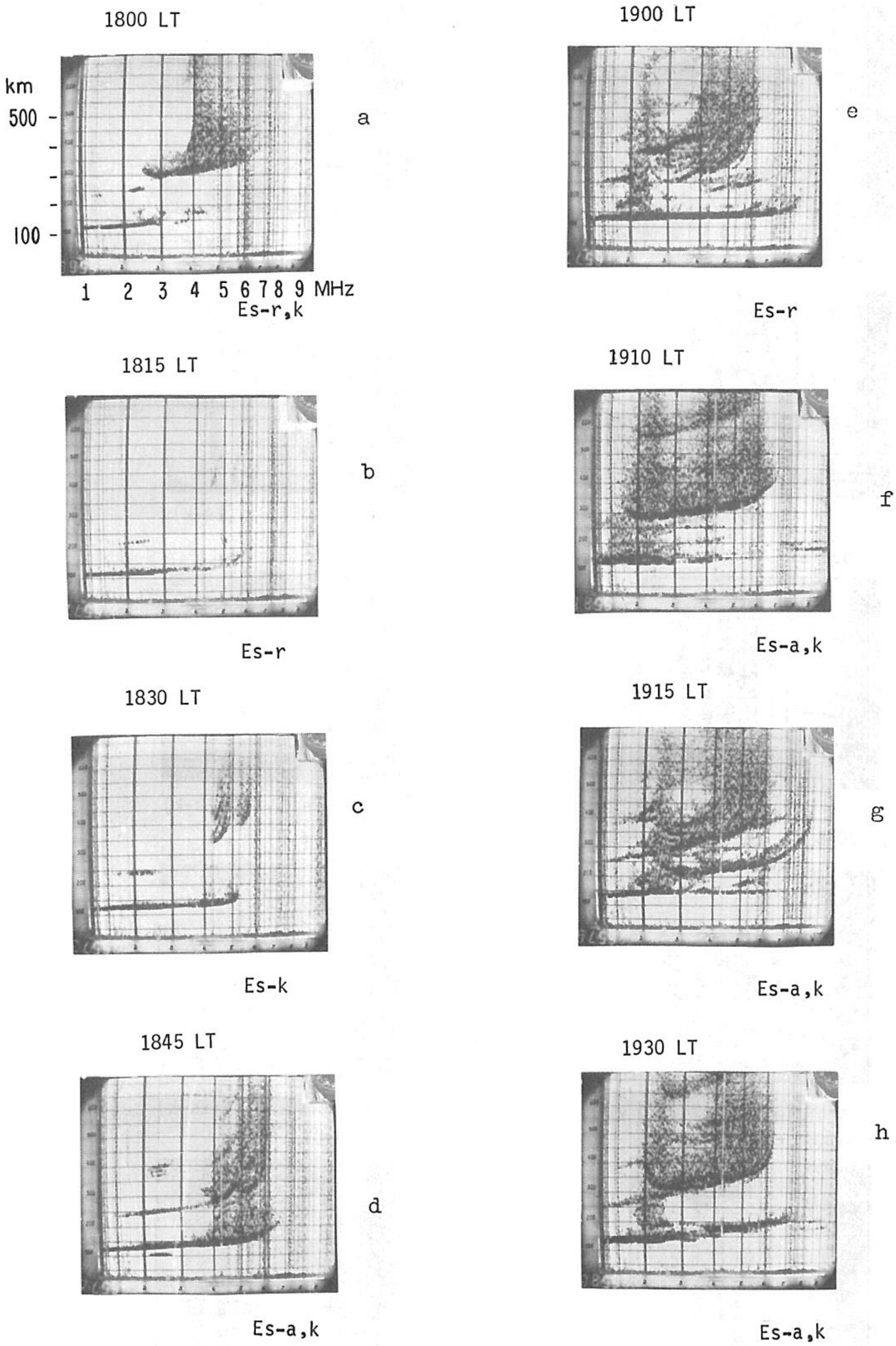


Fig. 1.47

IONOGRAM SEQUENCE. Es TYPES CHANGING IN TIME

DIXON 1970 1 JANUARY 0605-0755 LT
(105° EMT)

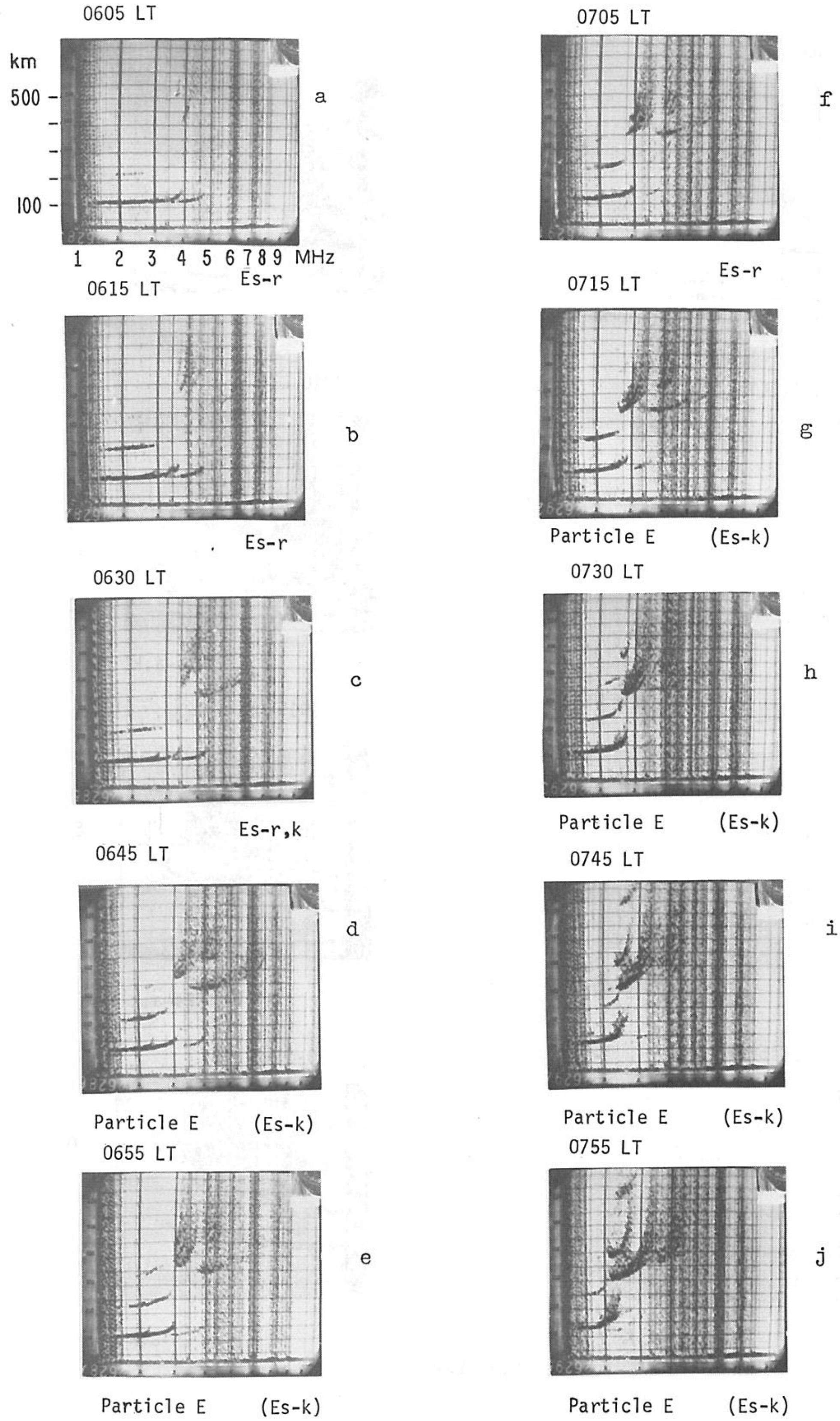


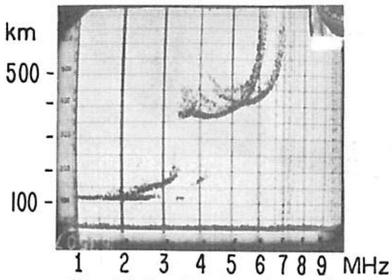
Fig. 1.48

IONOGRAM SEQUENCE WITH THE CHANGE OF PARTICLE E INTO E LAYER

DIXON 1970 5 JULY 0400-0530 LT

(105° EMT)

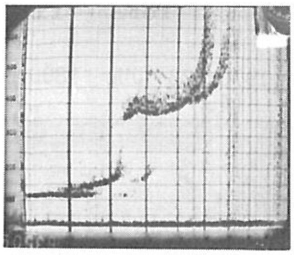
0400 LT



a

Particle E (Es-k)

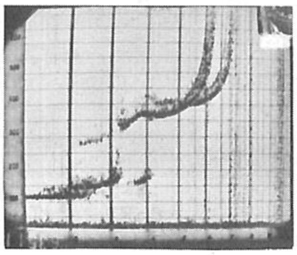
0405 LT



b

Particle E (Es-k)

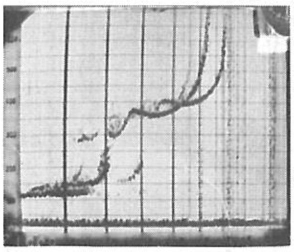
0415 LT



c

Particle E (Es-k)

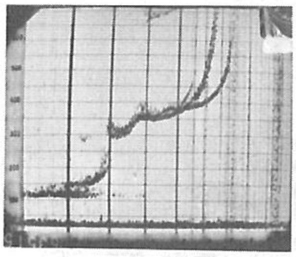
0430 LT



d

Particle E (Es-k)

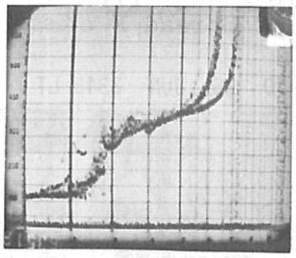
0445 LT



e

Particle E (Es-k)

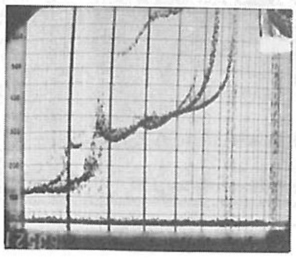
0500 LT



f

Particle E (Es-k)

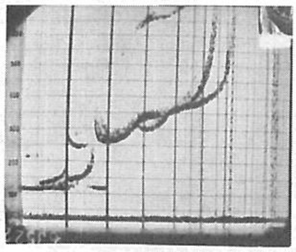
0515 LT



g

Particle E (Es-k)

0530 LT



h

Normal E Layer

Fig. 1.49

SPREAD F CLASSIFICATIONS

VOSTOK 1970 25 JUN 0915 LT
(105° EMT)

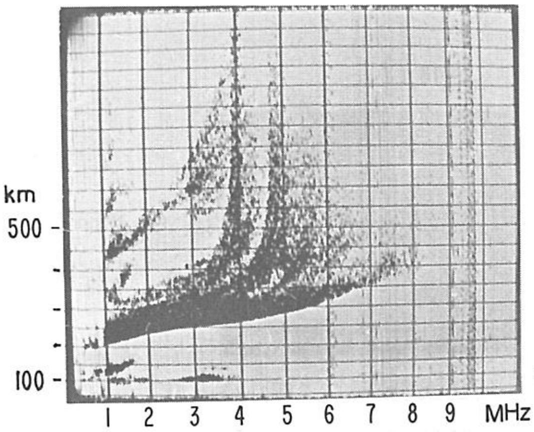


Fig. 1.50

foF2 fxI
Spread F classification P

MIRNY 1970 21 JUN 1215 LT
(90° EMT)

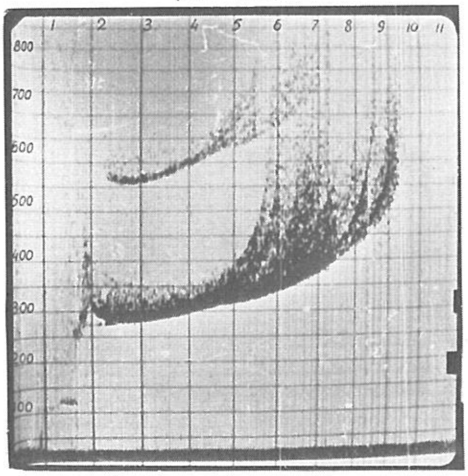


Fig. 1.53

foF2 fxI classification F

MIRNY 1970 28 JUN 2345 LT

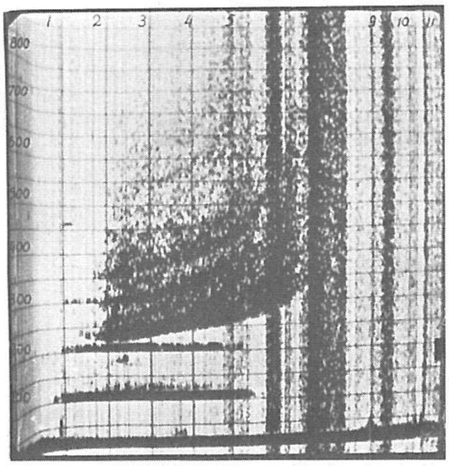


Fig. 1.51

q fxI q classification Q

HEISS 1970 28 JUL 1800 LT
(45° EMT)

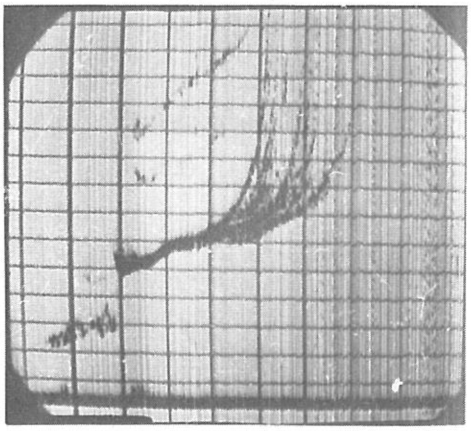


Fig. 1.54

foF2 x fxI classification F

DIXON 1969 9 JAN 0445 LT
(105° EMT)

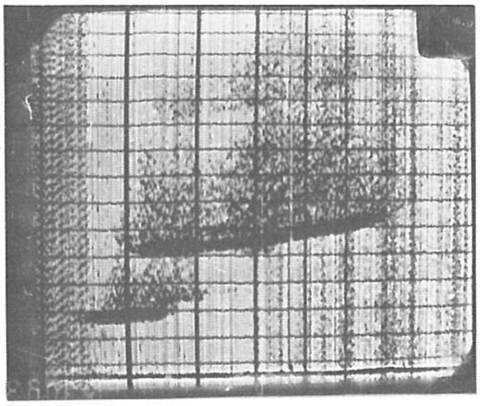


Fig. 1.52

q q
fxI classification Q

HEISS 1970 2 JAN 1845 LT

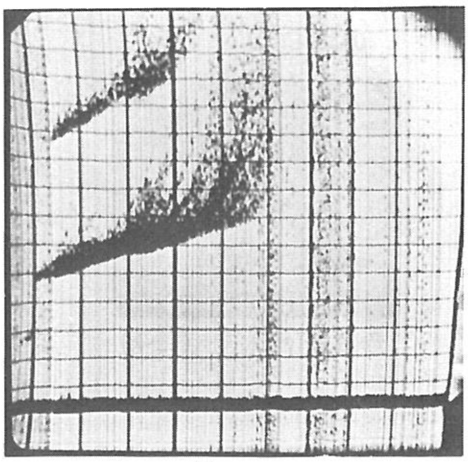


Fig. 1.55

foF2 fxI classification F

"THICK" F2 LAYER

VOSTOK 1970 28 JUN 0955 LT
(105° EMT)

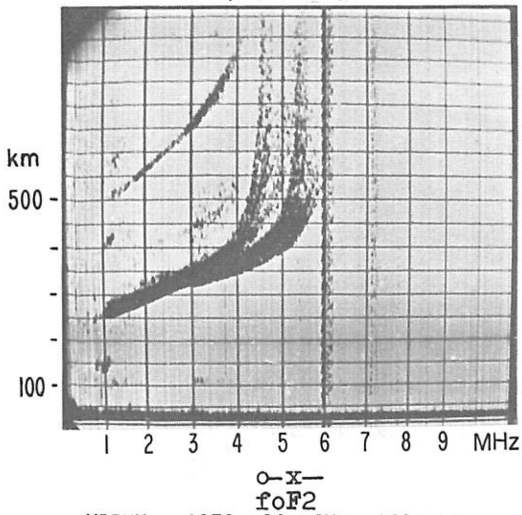


Fig. 1.56

"THIN" F2 LAYER (FLIZ)

VOSTOK 1970 23 JUN 1400 LT

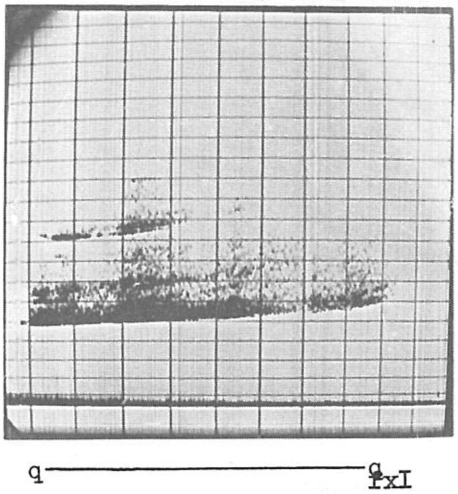


Fig. 1.57

MIRNY 1970 24 JUN 1600 LT
(90° EMT)

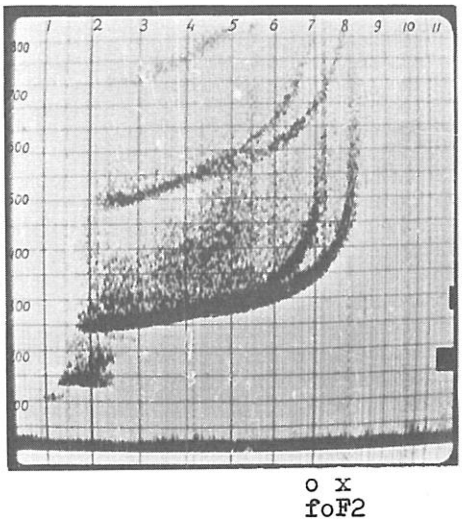


Fig. 1.58

MIRNY 1970 29 JUN 1255 LT

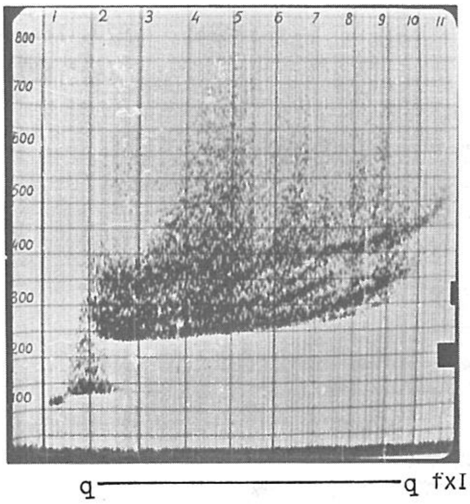


Fig. 1.59

MIRNY 1970 1 JAN 2305 LT

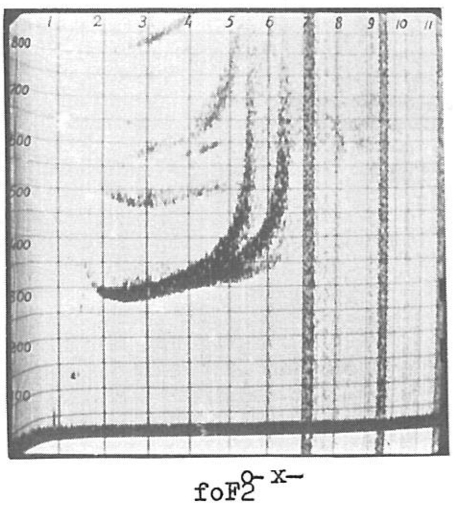


Fig. 1.60

MIRNY 1970 2 JAN 0155 LT

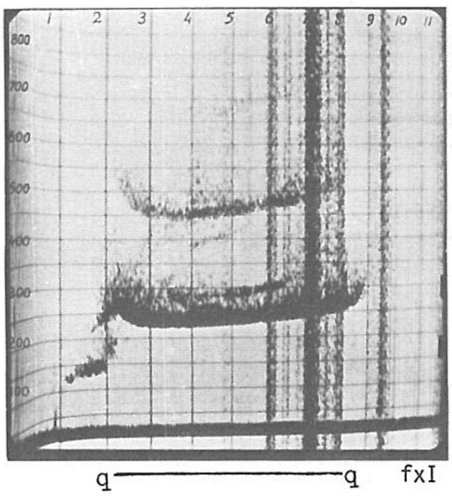


Fig. 1.61

FLIZ PHENOMENON AT HIGH LATITUDES, WINTER

"THICK" F2 LAYER

HEISS 1970 16 JAN 1845 LT

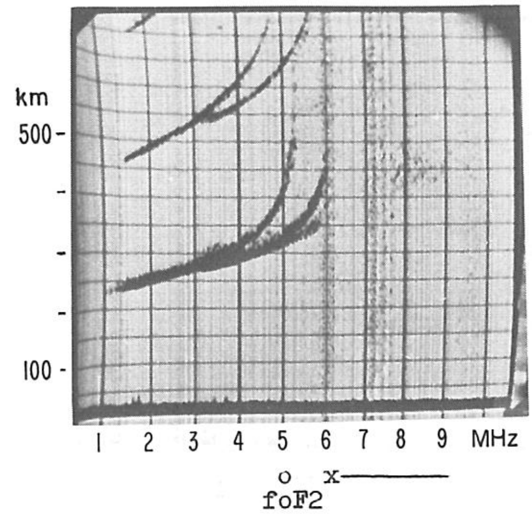


Fig. 1.62

"THIN" F2 LAYER

HEISS 1970 16 JAN 2230 LT

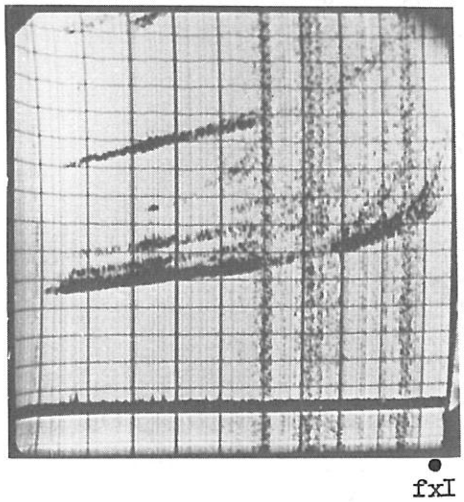


Fig. 1.63

IONOGRAM SEQUENCE SHOWING FLIZ PHENOMENON, WINTER

HEISS 1970 16 JANUARY 1915-2005 LT

(45° EMT)

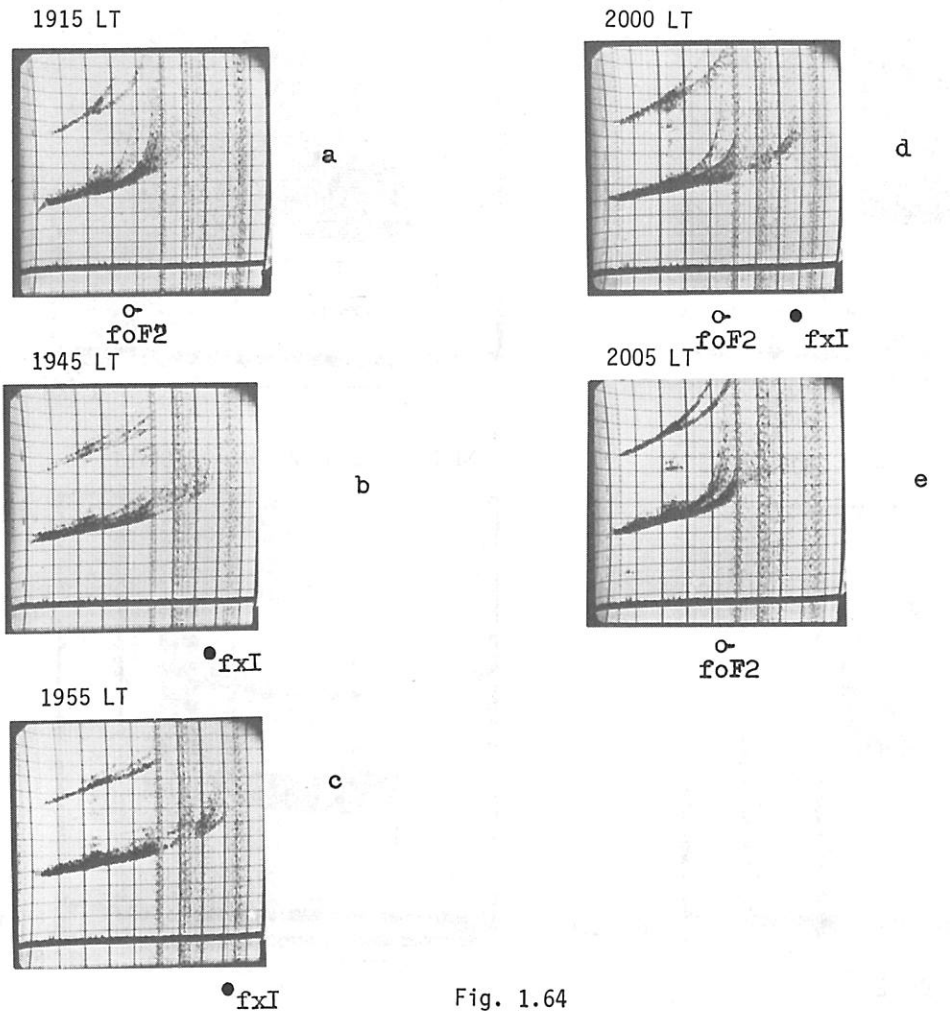


Fig. 1.64

IONOGRAM SEQUENCE SHOWING FLIZ PHENOMENON, WINTER

VOSTOK 1970 27 JUN 1905-2055 LT

(105° EMT)

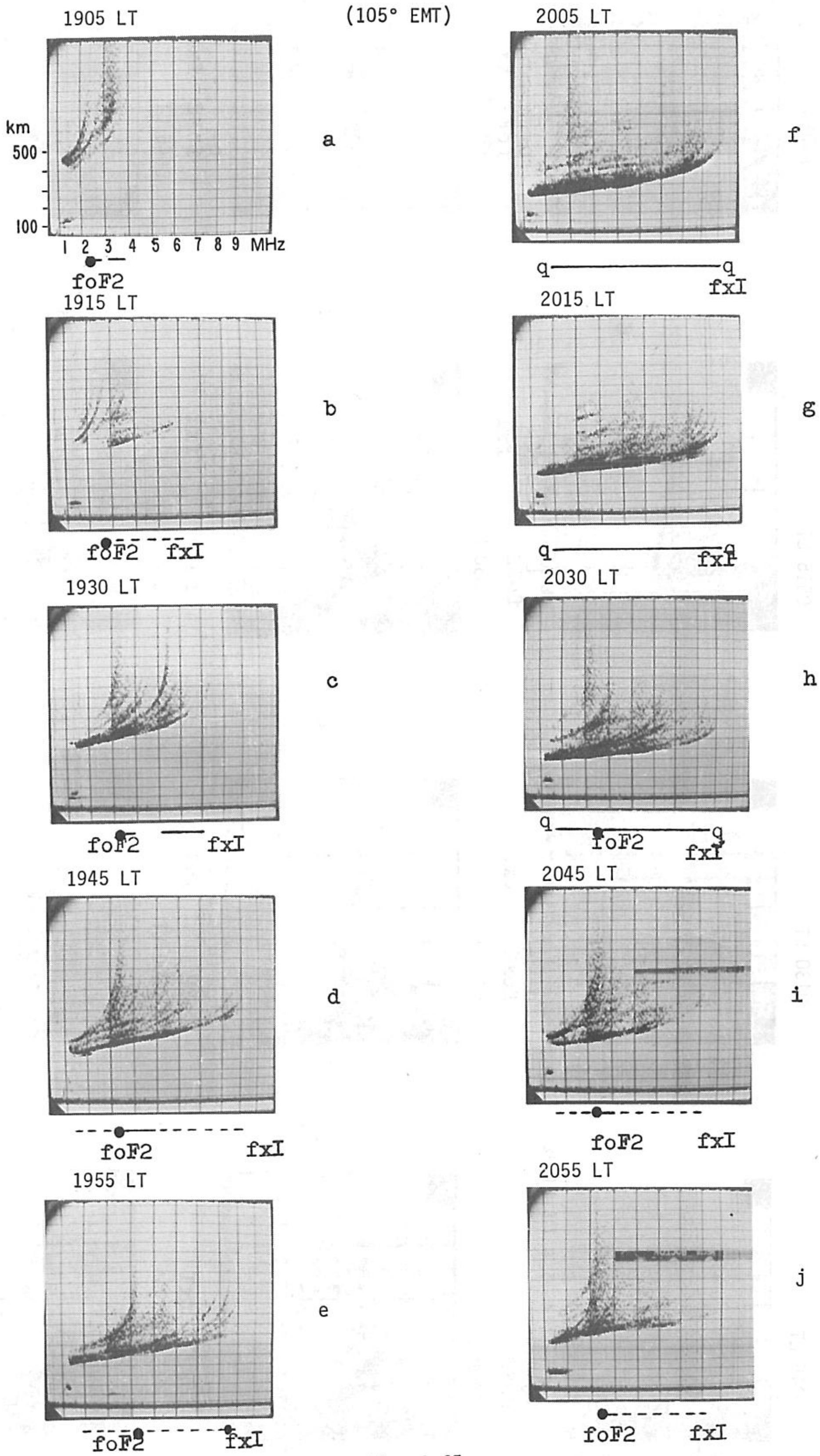


Fig. 1.65

IONOGRAM SEQUENCE IN THE NIGHT SECTOR OF THE AURORAL OVAL, MAGNETICALLY QUIET PERIOD, WINTER

DIXON 1969 4 JANUARY 0345-0645 LT
(105° EMT)

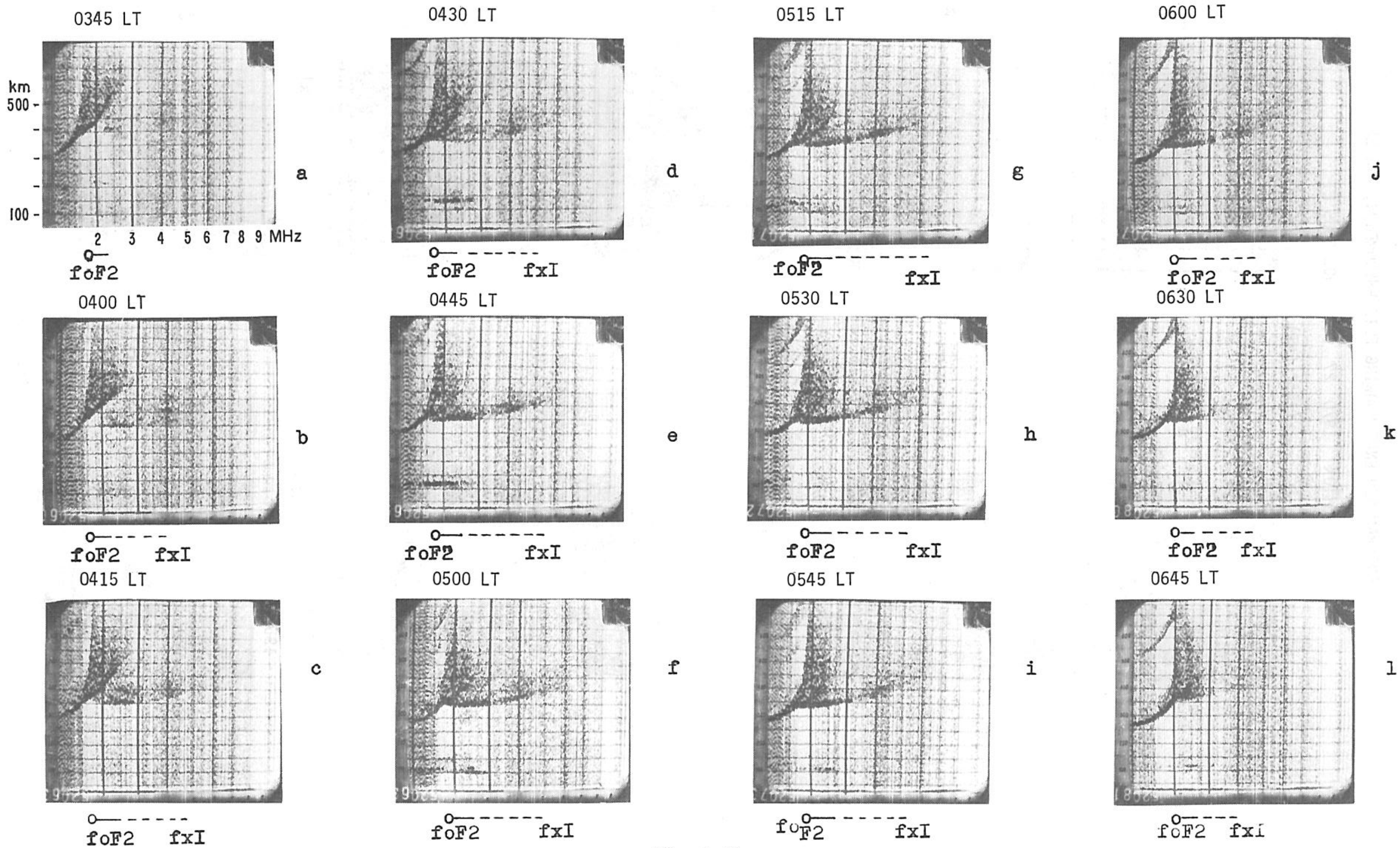


Fig. 1.66

IONOGRAM SEQUENCE IN THE NIGHT SECTOR OF THE AURORAL OVAL, MAGNETICALLY DISTURBED PERIOD, WINTER

DIXON 1969 24 JANUARY 0530-0930 LT

(105° EMT)

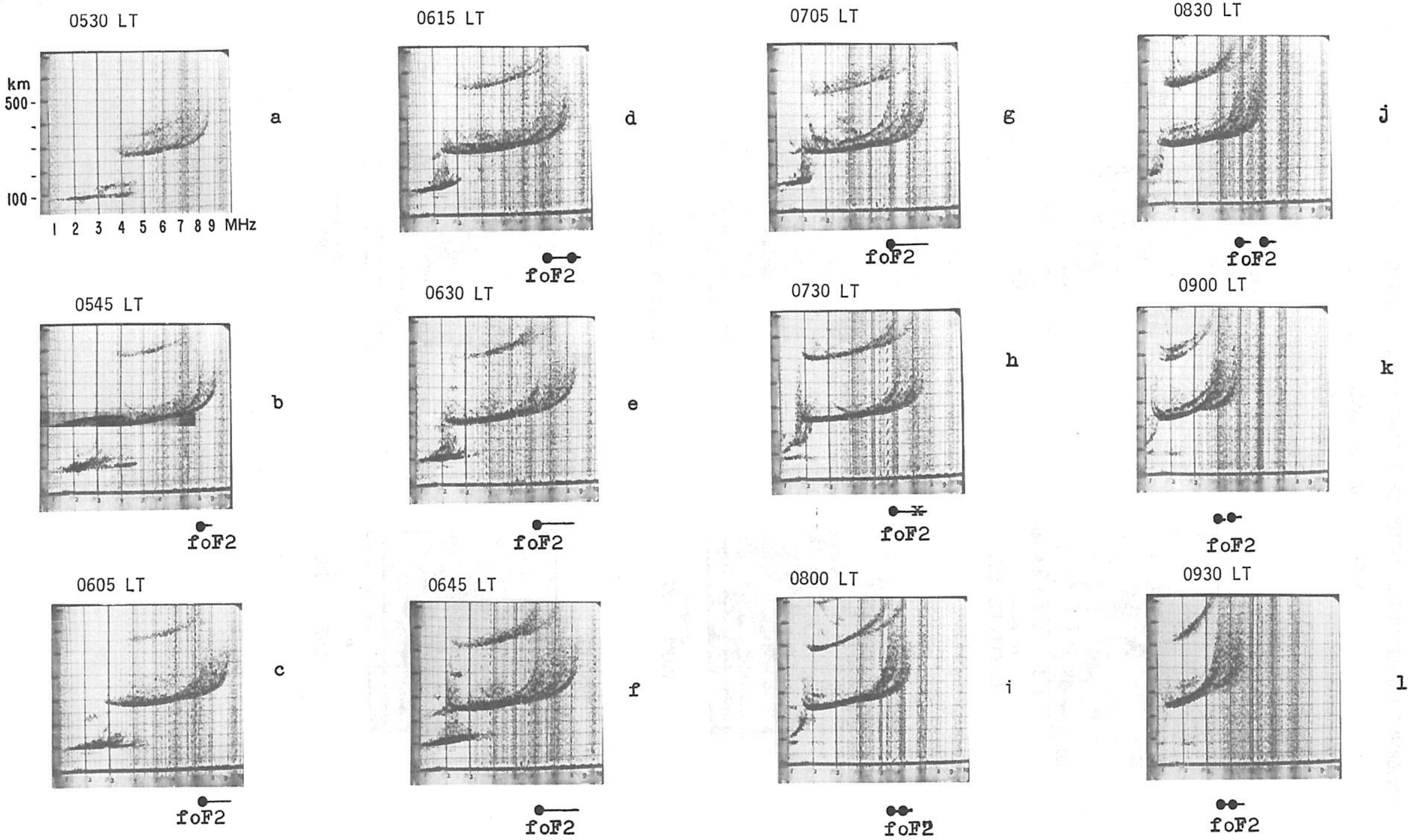


Fig. 1.67

IONOGRAM SEQUENCE IN DAY SECTOR OF AURORAL OVAL, MAGNETICALLY QUIET PERIOD, SUMMER

VOSTOK 1970 22 JANUARY 1905-2015 LT

(105° EMT)

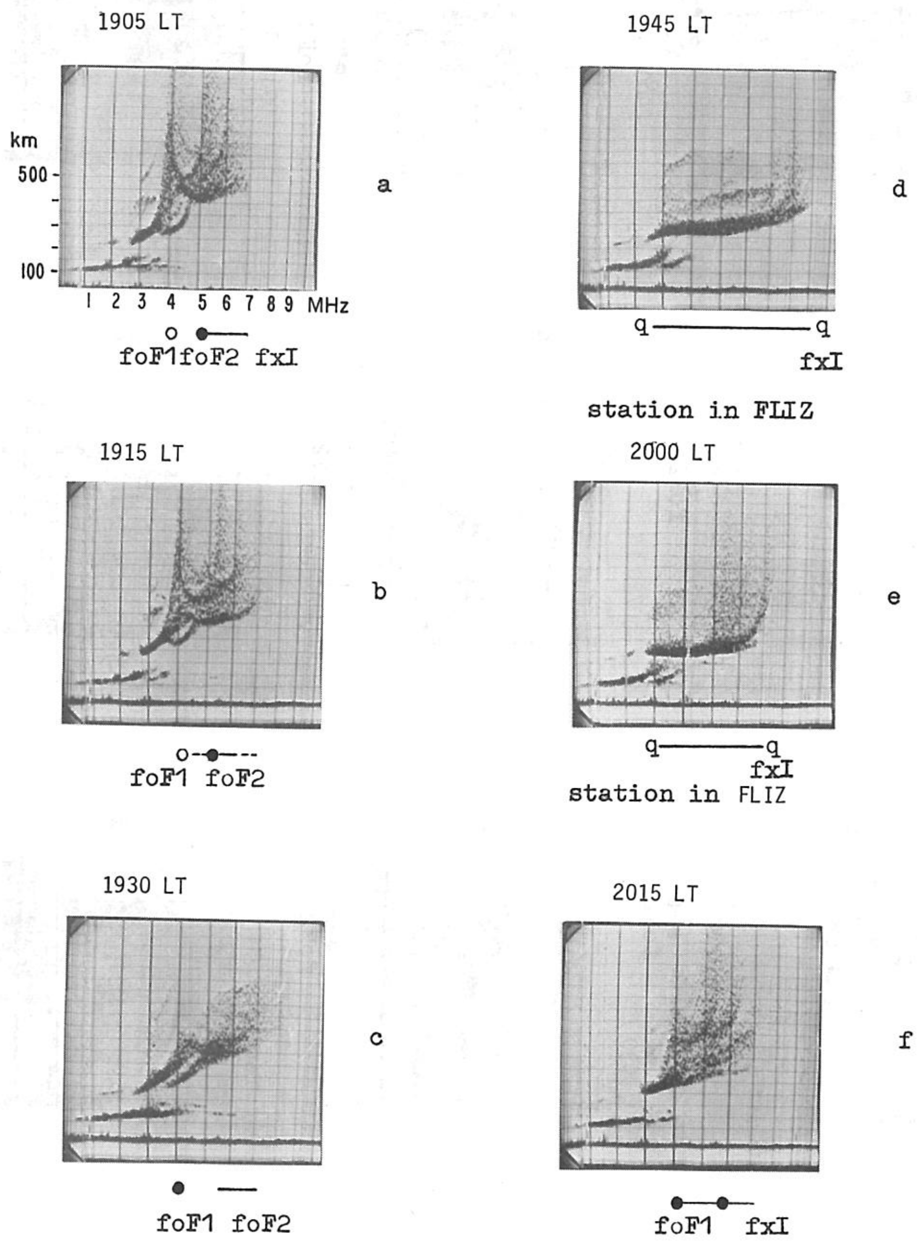


Fig. 1.68

IONOGRAM SEQUENCE IN DAY SECTOR OF AURORAL OVAL, MAGNETICALLY DISTURBED PERIOD, SUMMER

VOSTOK 1970 24 JANUARY 1745-1830 LT

(105° EMT)

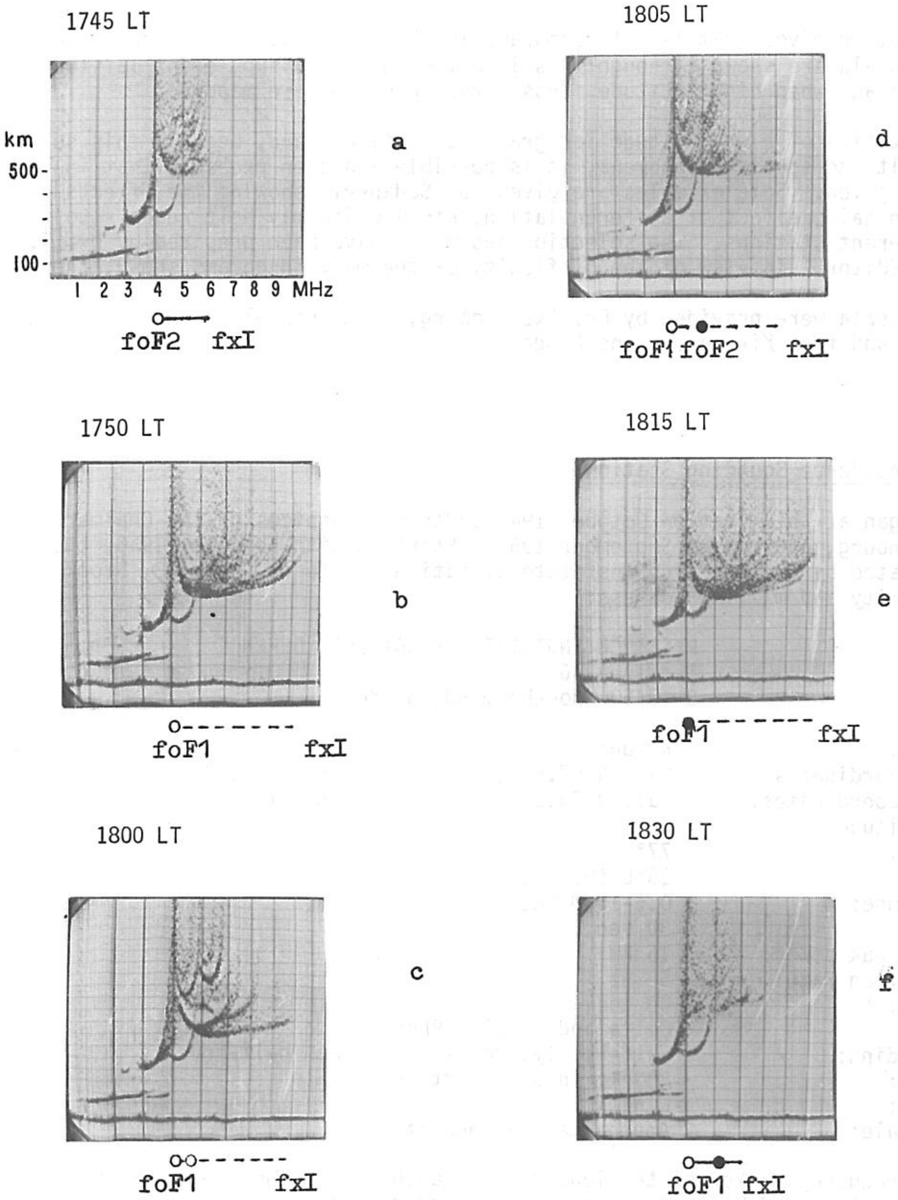


Fig. 1.69

SECTION 2. SCANDINAVIAN AND GREENLAND STATIONS

Part A. Scandinavian Stations

Kiruna, Sodankylä, Lycksele and Uppsala

Preface

This contribution gives examples of ionograms in the Scandinavian longitude sector. Some normal ionograms from Uppsala are shown although this is not within the "supplement latitudes". The station is, however, important when high latitude ionospheric phenomena are mapped.

The interpretation of high latitude ionograms is difficult and, because this selection consists mainly of difficult and special phenomena, it is possible and even probable that in some cases a wrong interpretation is given. Some examples are given for Sodankyla showing the effects of different types of recording (high gain, effect of differentiation, etc.) which may help readers to recognize similar phenomena at different stations. The selection and notes have been prepared by Dr. T. Turunen and shortened by the Editor. In view of the difficulty of the many ionograms shown, the Editor has added notes.

Data from Uppsala were provided by Dr. Ake Hedberg, from Lycksele by Mr. Oueklang, from Sodankyla by Dr. T. Turunen and from Kiruna by Rune Lindquist.

2A.1 KIRUNA

Vertical Incidence Sounding Station

Operation began at this station October 1948 under the auspices of the Chalmers University of Technology, Gothenburg, and ceased September 1955. Starting with February 1956, the station reopened and has been operated by the Research Institute of National Defence, Dept. 3, Stockholm, Sweden. Responsible authority and mailing address:

RESEARCH INSTITUTE OF NATIONAL DEFENCE
Section 346
S-10450 Stockholm 80, Sweden

Station Name:	Kiruna	
Geographic coordinates:	Lat. N 67.8°	E Long. 20.4°
Geomagnetic coordinates:	Lat. N 65.2°	E Long. 115.7°
Magnetic latitude:	65°	
Magnetic dip:	77°	
Time used:	15°E (UT + 1 hour)	
Frequency range:	0.6-15.0 MHz in 1 band	
Sweep time:	30 sec.	
Approximate peak power:	16 kW	
Pulse repetition rate:	50 Hz	
Pulse length:	50 µsec	
Aerial type:	Delta and special Rhombic	
Routine sounding:	Half-hourly, centered on each half-hour	
Height range:	800 km in 50 km intervals	
Height scale:	Linear	
Frequency scale:	Approximately logarithmic	

There is a frequency marker on the ionogram for each MHz of the range. Nominal frequency difference of x- and o-components: 0.7 MHz. Ionograms are recorded on 16 mm film.

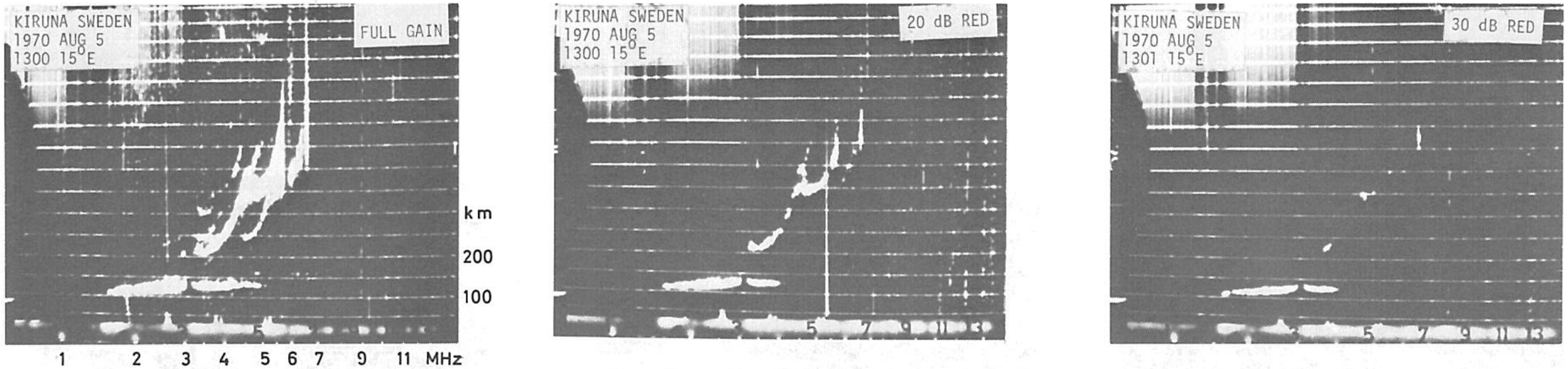
Most of the ionospheric data are published in FA-series booklets of U.S. Department of Commerce.

Terminology conforms with that recommended in the *URSI Handbook of Ionogram Interpretation and Reduction*, Second Edition, edited by W. R. Piggott and K. Rawer, *Report UAG-23*, World Data Center A for Solar-Terrestrial Physics, U. S. Department of Commerce, NOAA, November 1972.

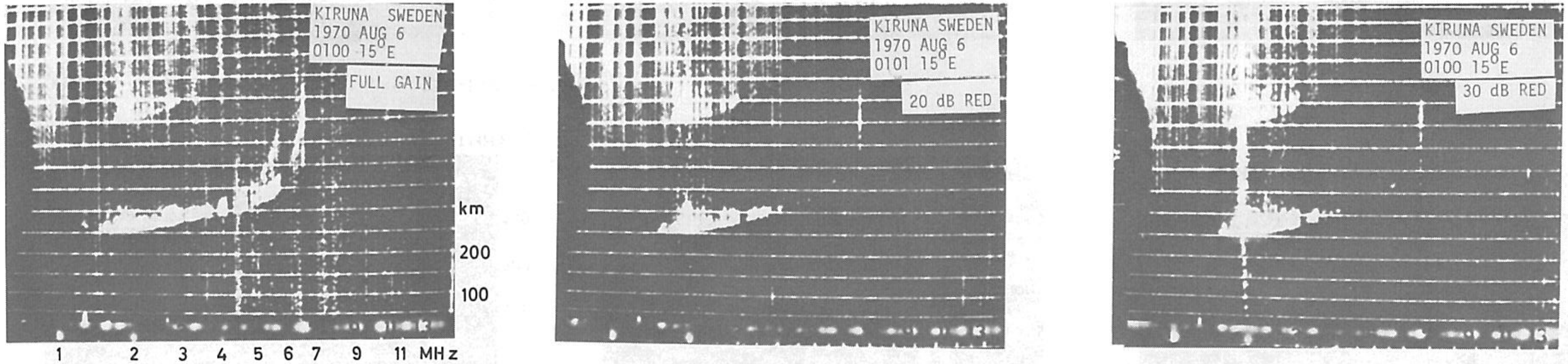
Editor's Notes: This station departs from normal practice in that the normal gain used is the highest available. The gain runs are therefore normal, minus 20 dB and minus 30 dB. The normal gain is often slightly too high for optimum analysis.

Comments on the ionograms have been added by the Editor.

Many additional ionograms have had to be left out due to lack of space, but will be used in discussions in the INAG Bulletin.



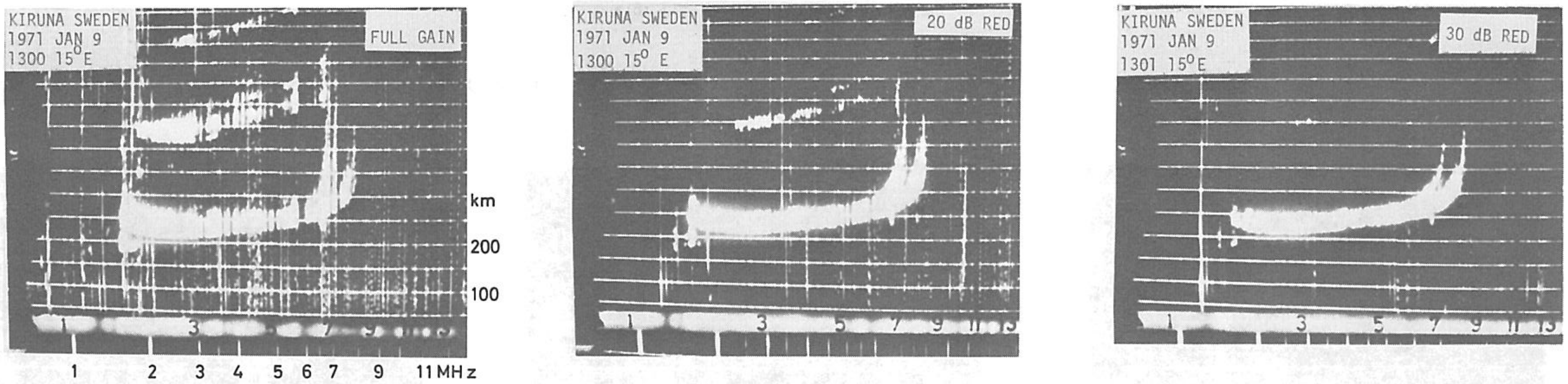
KIRUNA - Quiet Summer Day 1970 Aug. 5 1300-1301 LT (15°E)



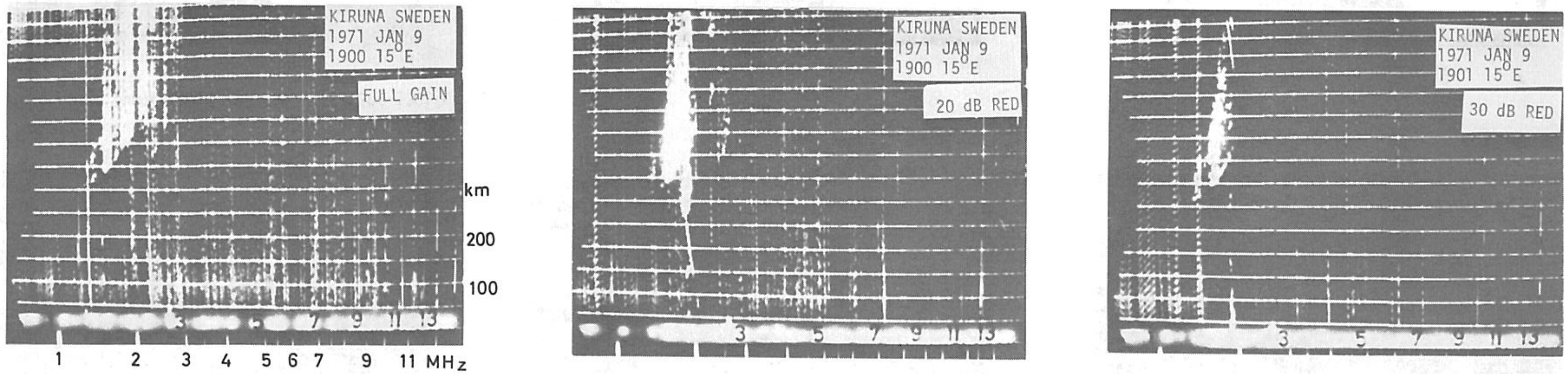
KIRUNA - Quiet Summer Night 1970 Aug. 6 0100-0101 LT (15°E)

Fig. 2.1 QUIET IONOGRAMS AT KIRUNA

Three gain runs for every hour.

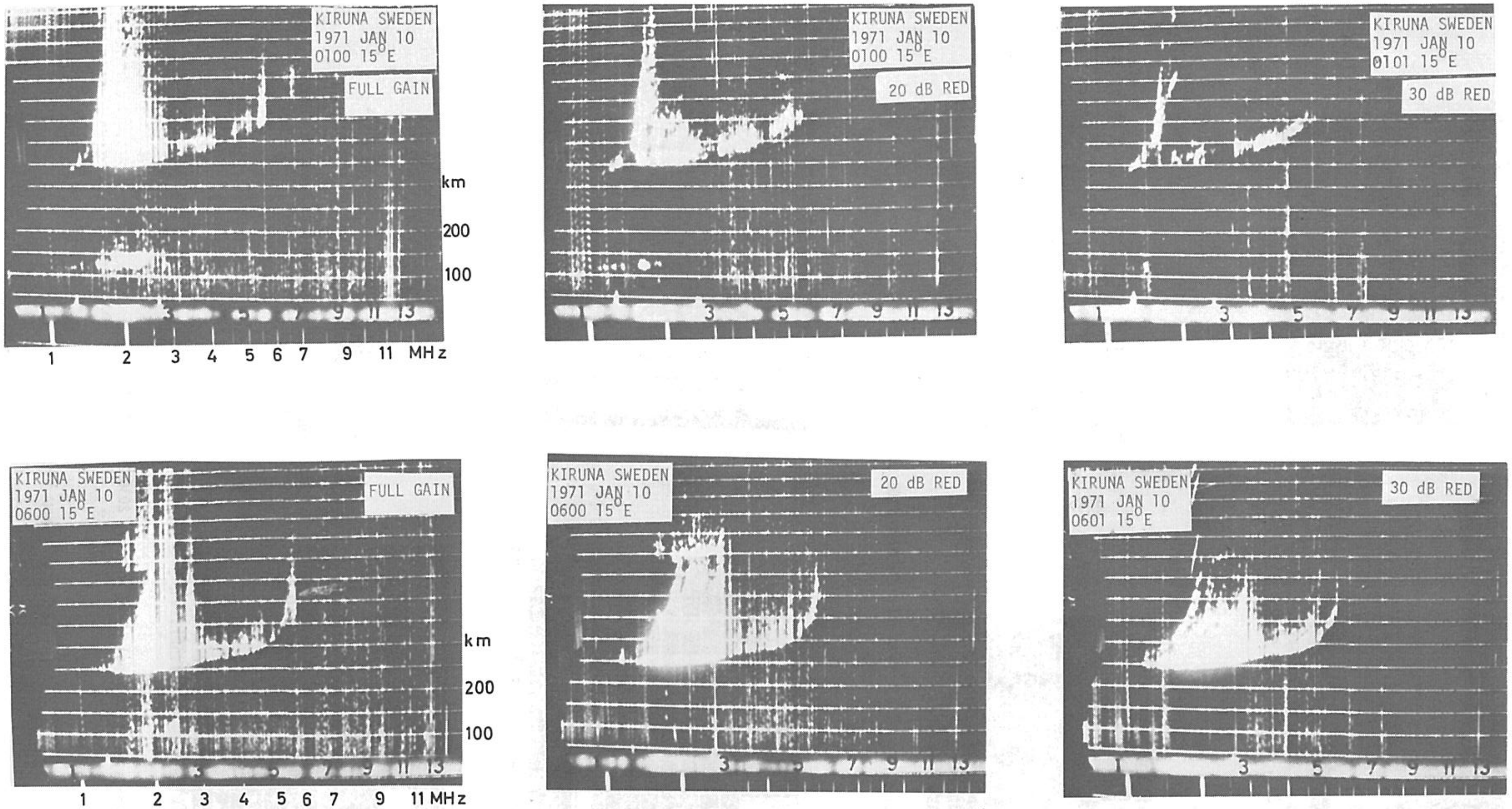


KIRUNA - Quiet Winter Day 1971 Jan. 9 1300-1301 LT (15°E)



KIRUNA - Quiet Winter Night 1971 Jan. 9 1900-1901 LT (15°E)

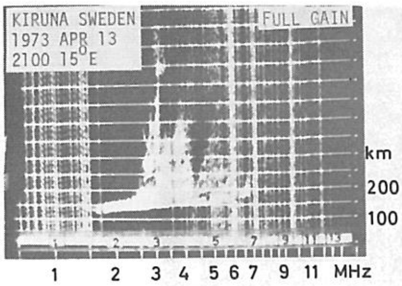
Fig. 2.2 QUIET IONOGRAMS AT KIRUNA

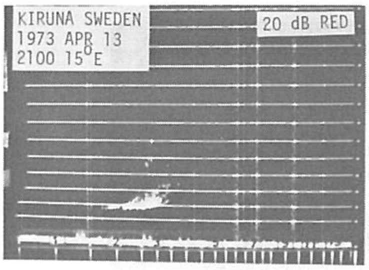


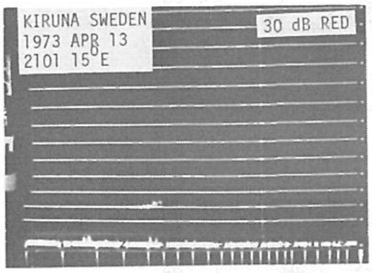
KIRUNA - Quiet Winter Night 1971 Jan. 10 0100-0101 LT (15°E)
0600-0601 LT (15°E)

Fig. 2.3 QUIET IONOGRAMS AT KIRUNA

Editor's Note: Quiet winter night - trough position constant. Kiruna 1971 Jan. 10, 0100 and 0600 LT. This is a good example of simultaneous traces from trough (small foF2) and from ridge structure (replacement layer - polar spur) when station is in trough. Note second order shows layer not horizontal. Large differences foF2 (about 020) and fxI (about 060) can be used to recognize days on which this occurs.

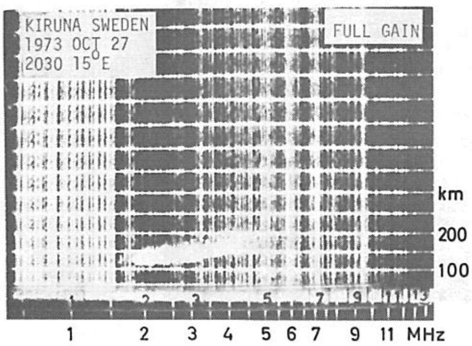


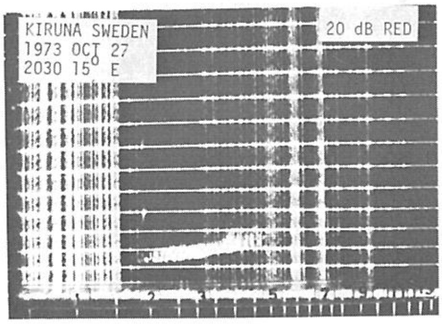


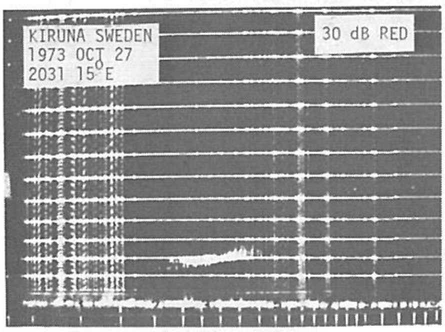


fmin ...	014	foF1 ...		h'Es ...	120
foEs ...	063JA	foF2 ...	A	h'E ...	
fbEs ...	063AA	fzF2 ...		h'E2 ...	
foE ...		fxI ...		h'F1 ...	A
foE2 ...		M(3000)F2	A	h'F2 ...	
Es type	a				

KIRUNA - Typical Auroral - Es 1973 Apr. 13 2100-2101 LT (15°E)



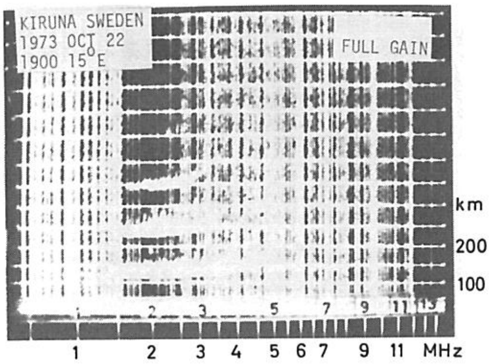


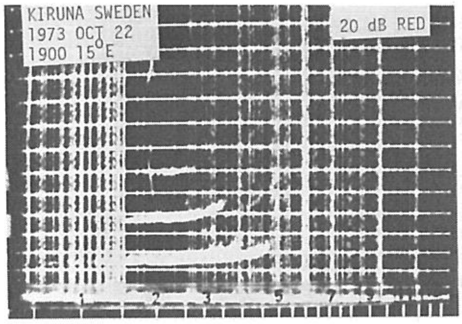


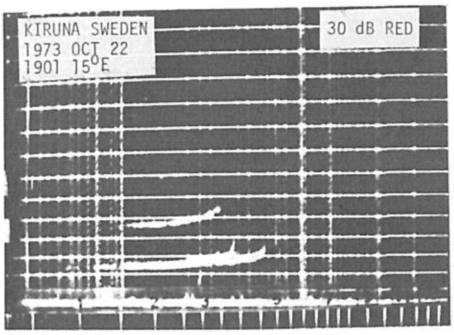
fmin ...	016	foF1 ...		h'Es ...	110
foEs ...	040JA	foF2 ...	A	h'E ...	
fbEs ...	040JA	fzF2 ...		h'E2 ...	
foE ...		fxI ...	A	h'F1 ...	A
foE2 ...		M(3000)F2	A	h'F2 ...	
Es type	a				

KIRUNA - Es Type a (Sloping Type) 1973 Oct. 27 2030-2031 LT (15°E)

Fig. 2.4 KIRUNA - Es Type a



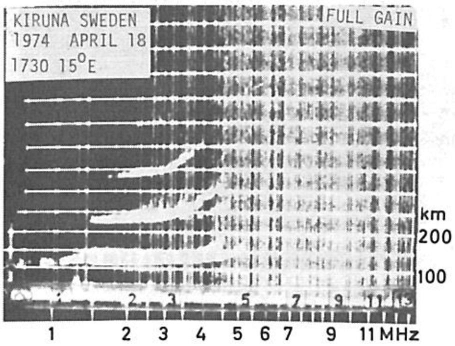


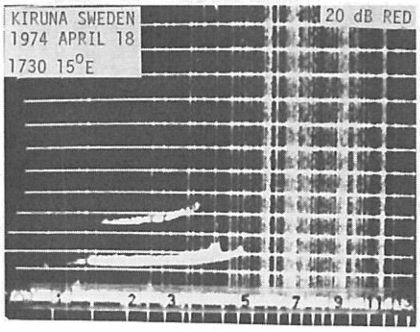


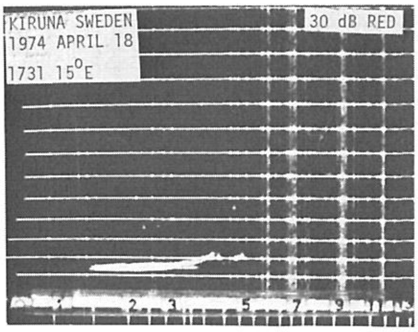
fmin ...	006	foF1 ...		h'Es ...	110
foEs ...	040-K	foF2 ...	G	h'E ...	
fbEs ...	035AA	fzF2 ...		h'E2 ...	
foE ...	400-K	fxI ...	G	h'F1 ...	G
foE2 ...		M(3000)F2	G	h'F2 ...	
Es type	k3				

KIRUNA - Particle E - Es-k 1973 Oct. 22 1900-1901 LT (15°E)

Editor's Note: The low gain shows foE clearly so this is Es-k. Layer is not horizontal so higher orders do not confirm either foE or h'E.



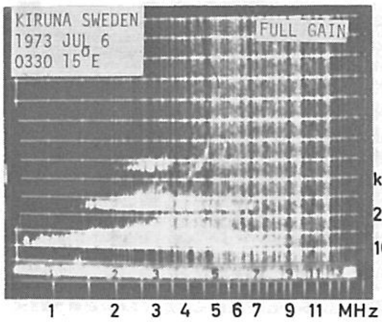


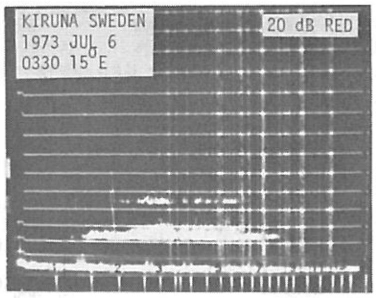


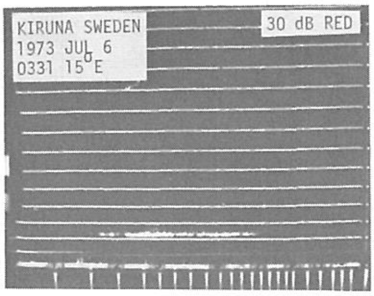
fmin ...	005EE	foF1 ...		h'Es ...	105
foEs ...	045-K	foF2 ...	G	h'E ...	105
fbEs ...	045-K	fzF2 ...		h'E2 ...	
foE ...	450-K	fxI ...	G	h'F1 ...	G
foE2 ...		M(3000)F2	G	h'F2 ...	
Es type	k3				

KIRUNA - Es Type k -- Particle E 1974 Apr. 18 1730-1731 LT (15°E)

Fig. 2.5 KIRUNA - Particle E (Es-k)



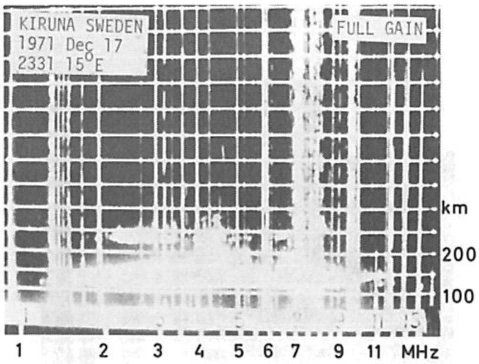


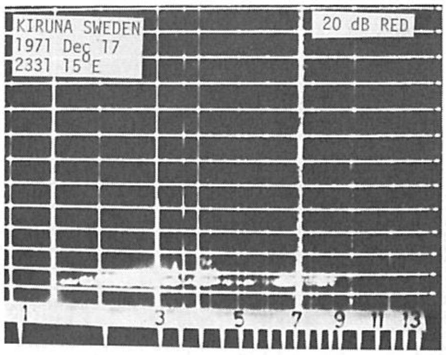


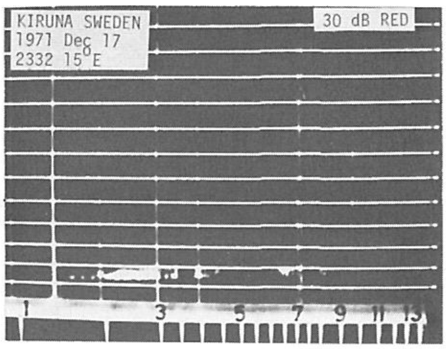
fmin ... 005EE	foF1 ... A	h'Es ... 105 F
foEs ... 085JA	foF2 ... 048	h'E ... A
fbEs ... 040	fzF2 ...	h'E2 ...
foE ... A	fxI ... 055 X	h'F1 ... A
foE2 ...	M(3000)F2	h'F2 ... A
Es type f3 a1		

KIRUNA - Flat Es with Scatter Above It 1973 Jul. 6 0330-0331 LT (15°E)

Editor's Note: Main Es is f3. Question is whether scatter sufficient to justify "a" entry also. Borderline case but pattern sufficiently like "a" to make entry f3, a1. Should use h'Es = 105-F.





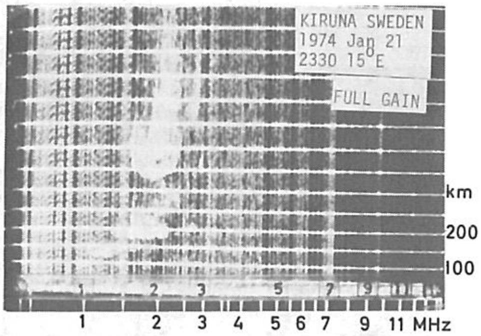


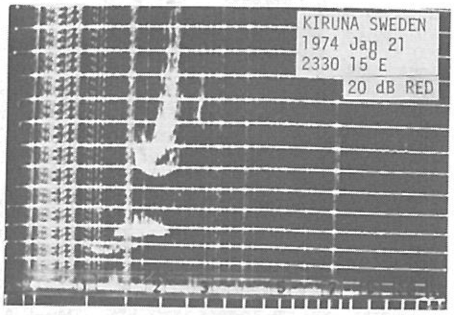
fmin ... 012	foF1 ...	h'Es ... 110
foEs ... 113JA	foF2 ... A	h'E ...
fbEs ... 080AA	fzF2 ...	h'E2 ...
foE ...	fxI ...	h'F1 ... A
foE2 ...	M(3000)F2 A	h'F2 ...
Es type a		

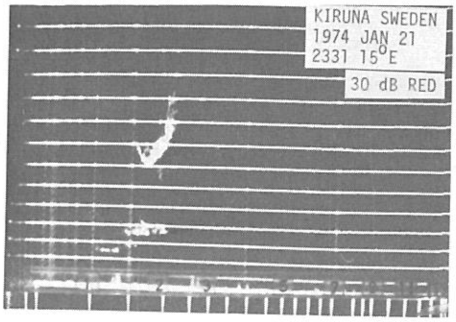
KIRUNA - Complex Es-a,f Pattern 1971 Dec. 17 2331-2332 LT (15°E)

Editor's Note: The F trace is blanketed which suggests not purely an Es-a. Second order present confirms this. Best interpretation probably a,f2. Second order suggests fbEs about 080AA.

Fig. 2.6 KIRUNA - Es Types a and f



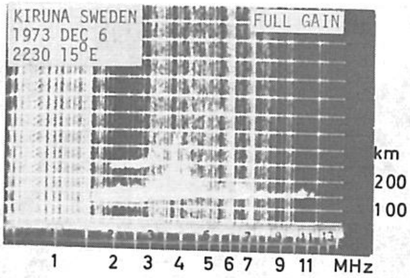


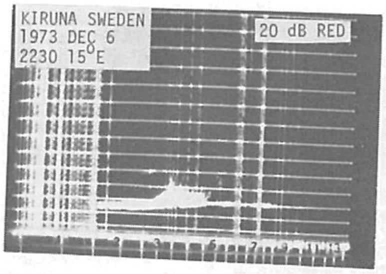


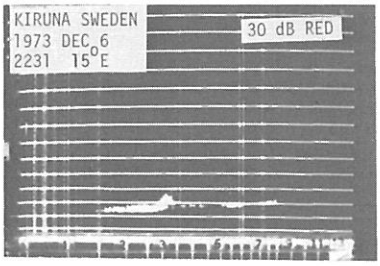
fmin ...	010ES	foF1 ...		h'Es ...	110 K
foEs ...	022	foF2 ...	021UF	h'E ...	110 K
fbEs ...	015 K	fzF2 ...		h'E2 ...	
foE ...	150 K	fxI ...	029	h'F1 ...	325 H
foE2 ...		M(3000)F2	F	h'F2 ...	
Es type	a k	fmI	019		

KIRUNA - Es Types k and a 1974 Jan. 21 2330-2331 LT (15°E)

Editor's Note: The Es-a structure is seen at oblique incidence (fbEs from F = foEs-K from E) but fbEs on "a" trace smaller. Gain change leaves main "a" still visible and confirms Es-k not r. Strict application of type rules is k,a as foEs measured on k trace, but this is clear from the Es entry so a,k as written preferable. Rule needs clarification at Lima. The foF2 trace is weak and no scatter seen on it. Hence strictly fxI = 029-X. o trace shows strong scatter so more useful alternative 032OB.





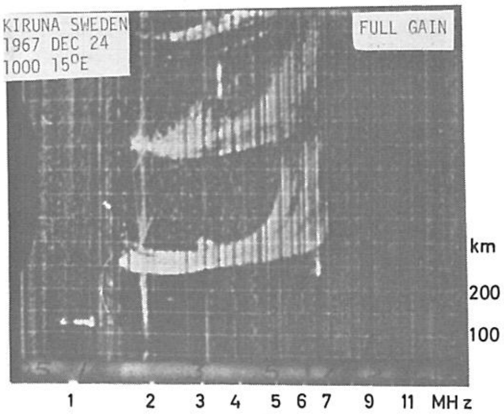


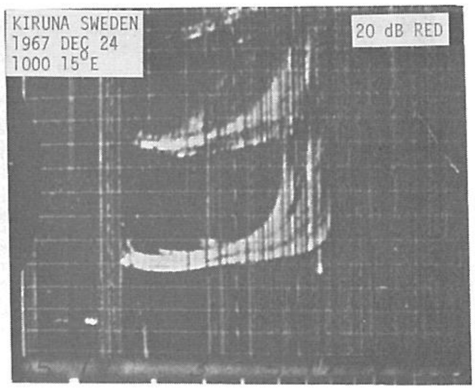
fmin ...	015	foF1 ...		h'Es ...	105
foEs ...	110JA	foF2 ...	G	h'E ...	
fbEs ...	033-K	fzF2 ...		h'E2 ...	
foE ...	330-K	fxI ...	G	h'F1 ...	G
foE2 ...		M(3000)F2		h'F2 ...	
Es type	a k2				

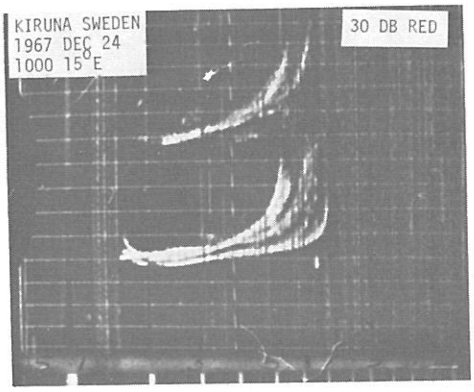
KIRUNA - Es Types k and a 1973 Dec. 6 2230-2231 LT (15°E)

Editor's Note: Es-a does not blanket as it is oblique. fbEs therefore given by particle E trace. Low gain record shows good echo to foE so not an r trace. Retardation at cusp very gain sensitive with r, not k. G is better than A when blanketing by particle E (Es-k).

Fig. 2.7 Kiruna - Es Type k and a



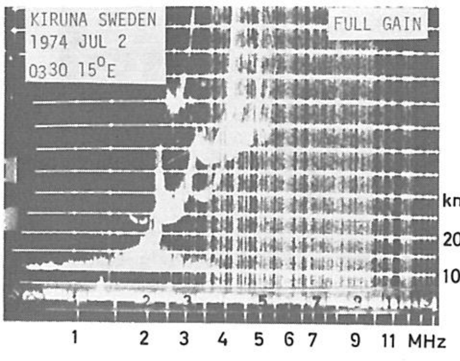


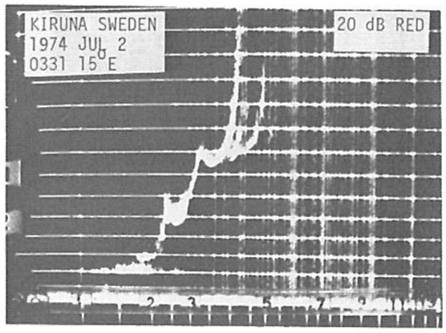


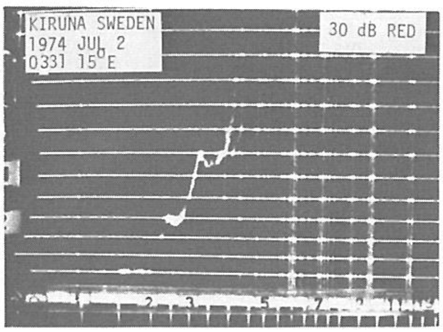
fmin ...	007	foF1 ...		h'Es ...	115 K
foEs ...	014UK	foF2 ...	052 F	h'E ...	115 K
fbEs ...	014UK	fzF2 ...		h'E2 ...	
foE ...	140UK	fxI ...	071	h'F1 ...	235 Q
foE2 ...		M(3000)F2	F	h'F2 ...	
Es type	k	fmI ...	052		

KIRUNA - Particle E (Es-k) - Range and Frequency Spread 1967 Dec. 24 1000 LT (15°E)

Editor's Note: foE must be less than 160 (150 if x trace extrapolated) and greater than 120. It is just allowed to use U, alternately the same information could be given by foEs = 120DK, fbEs = 160EK, or foE = 140UK.





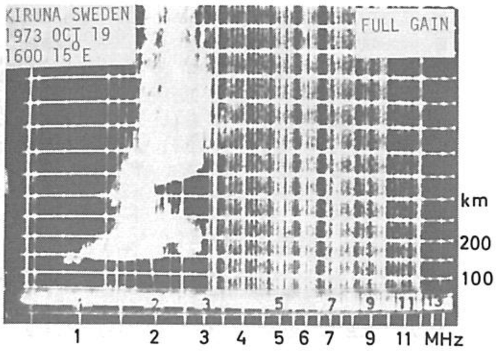


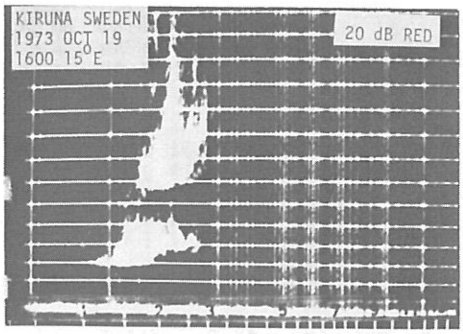
fmin ...	005EE	foF1 ...	330	h'Es ...	100
foEs ...	033JA	foF2 ...	041 F	h'E ...	100UA
fbEs ...	017	fzF2 ...		h'E2 ...	
foE ...	220 H	fxI ...	054	h'F1 ...	230
foE2 ...		M(3000)F2	F	h'F2 ...	370
Es type	ℓ	fmI ...	040		

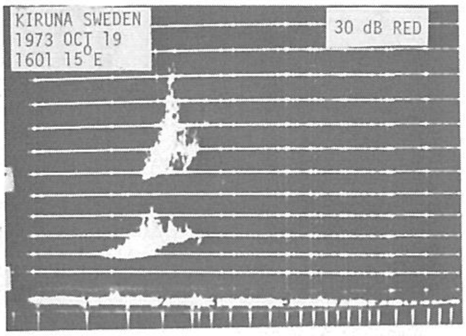
KIRUNA - Es - Type ℓ 1974 Jul. 2 0330-0331 LT (15°E)

Editor's Note: An unusually dense Es-ℓ trace.

Fig. 2.8 KIRUNA - Es Types k and ℓ



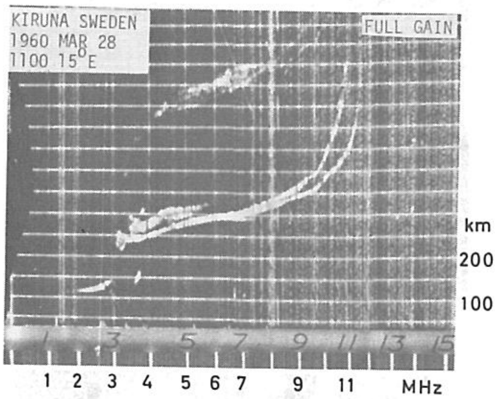


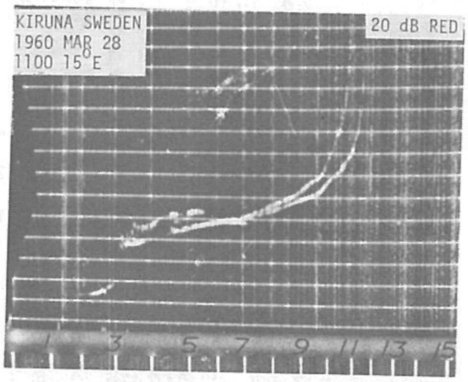


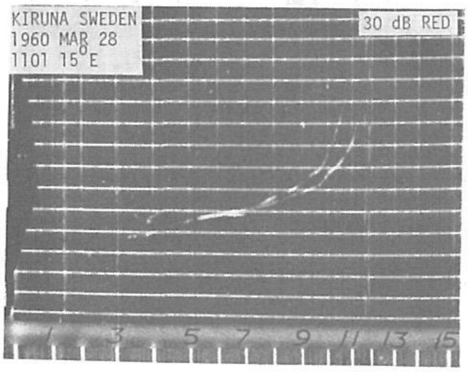
fmin ...	008	foF1 ...		h'Es ...	130
foEs ...	023JA	foF2 ...	021UF	h'E ...	A
fbEs ...	015	fzF2 ...		h'E2 ...	
foE ...	A	fxI ...	031	h'F1 ...	325 A
foE2 ...		M(3000)F2	F	h'F2 ...	
Es type	a	fmI ...	017		

KIRUNA - Clarification of Interpretation by Gain Runs 1973 Oct. 19 1600-1601 LT (15°E)

Editor's Note: foF2 is sufficiently well defined on low and medium gain records to be given unqualified. Main Es pattern also confirmed as type Es-a. Another example of the help one has when making gain runs.



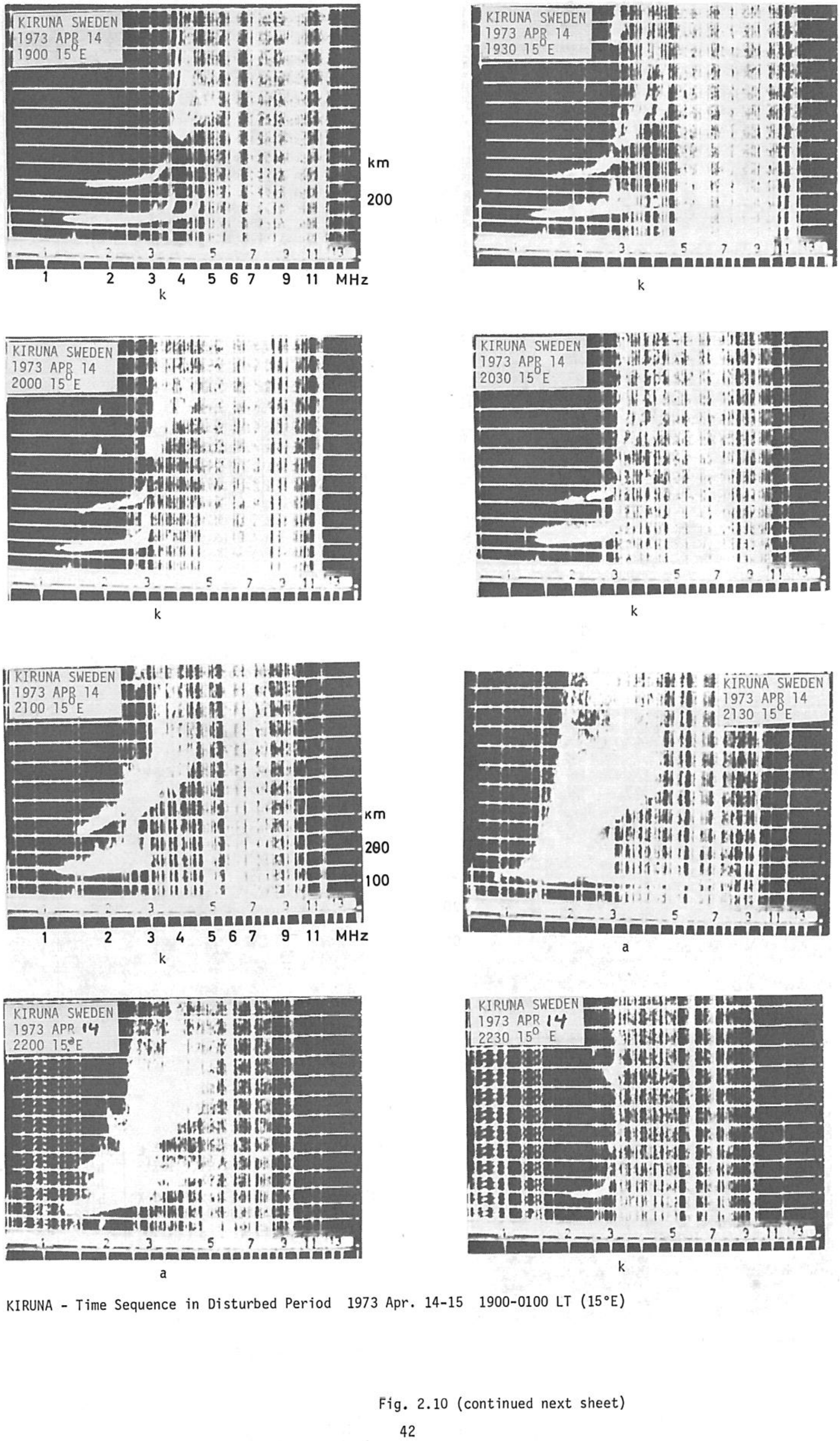




fmin ...	012--	foF1 ...	L	h'Es ...	G
foEs ...	030EG	foF2 ...	107	h'E ...	110--
fbEs ...	030EG	fzF2 ...		h'E2 ...	
foE ...	300	fxI ...	113 X	h'F1 ...	235 H
foE2 ...		M(3000)F2		h'F2 ...	L
Es type					

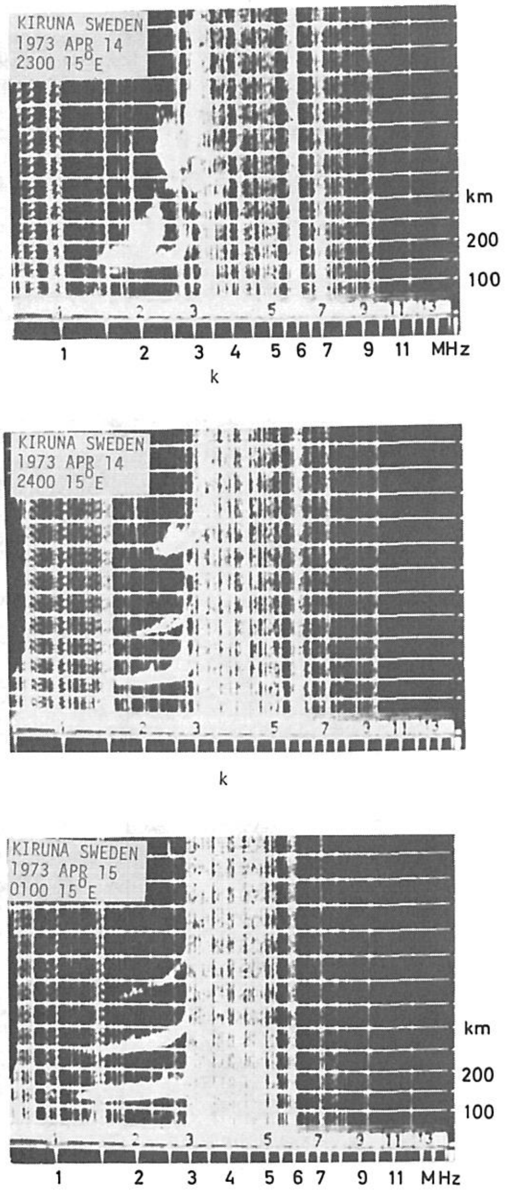
KIRUNA - Equinox Showing Traveling Disturbance Effects 1960 Mar. 28 1100-1101 LT (15°E)

Fig. 2.9 KIRUNA - Clarification of Interpretation by Gain Runs; Equinox Showing Traveling Disturbance Effects



KIRUNA - Time Sequence in Disturbed Period 1973 Apr. 14-15 1900-0100 LT (15°E)

Fig. 2.10 (continued next sheet)



KIRUNA - Time Sequence in Disturbed Period 1973 Apr. 14-15 1900-0100 LT (15°E)

Editor's Note: Sequence on disturbed period showing particle E (Es-k) and auroral Es (Es-a). F layer shows rapid changes with much tilting. Note at 2330 LT F layer severely tilted so that overlap with Es trace is not significant. Retarded trace at 200 km, sequence and cleanness of Es trace suggests also Es-k with foE = 280UK (U to show doubt in interpretation).

Fig. 2.10

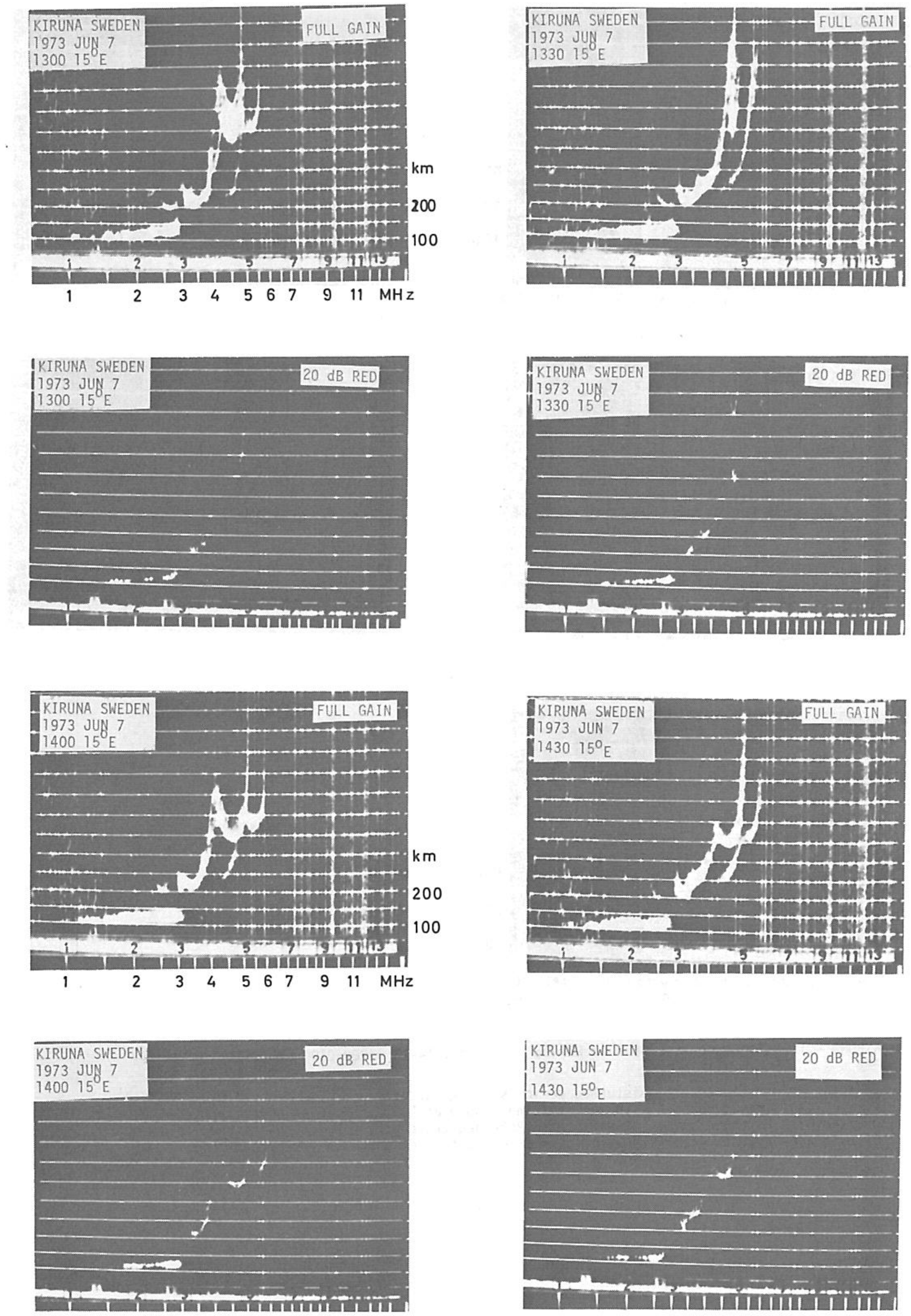


Fig. 2.11 (continued next sheet)

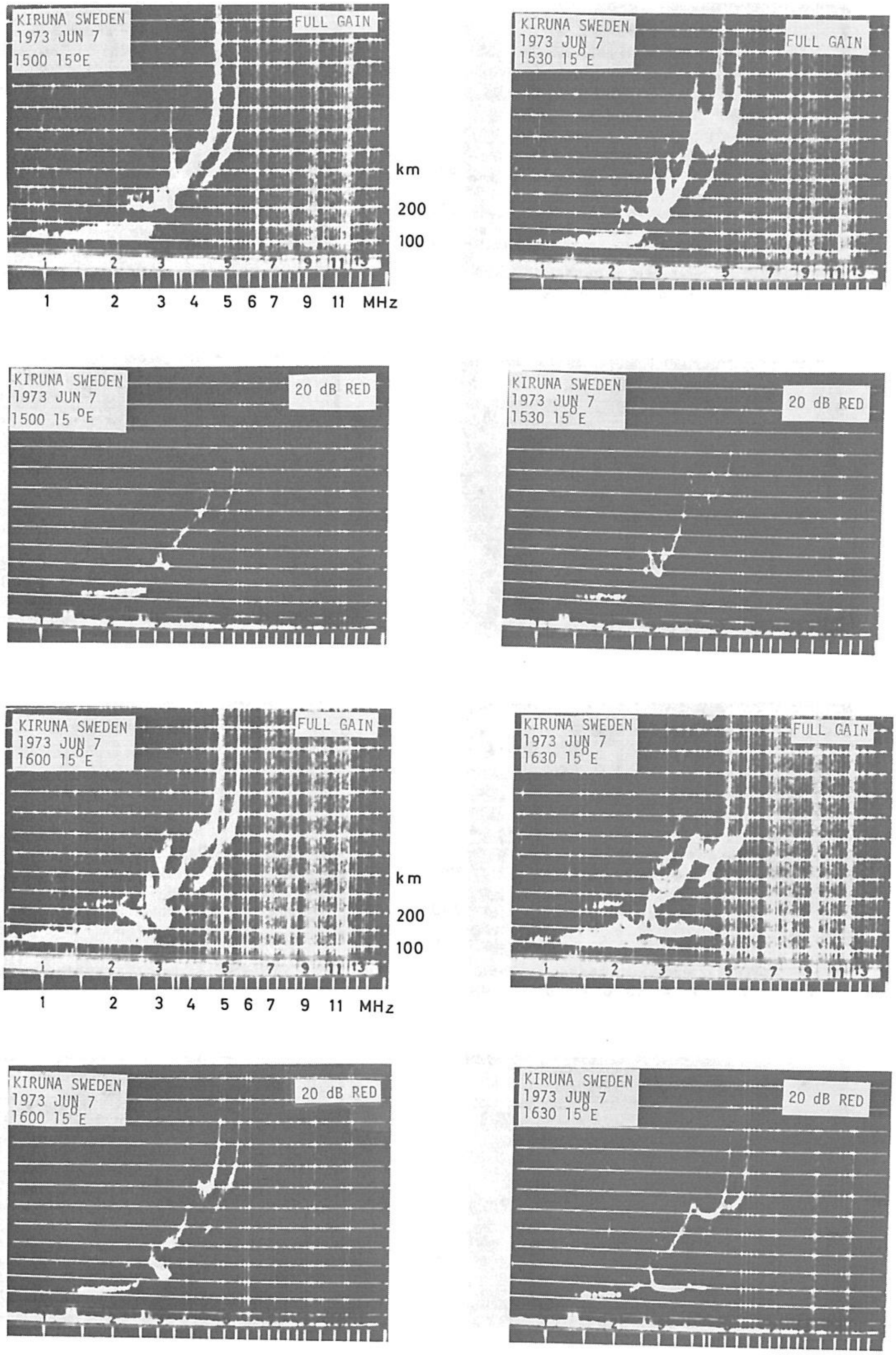


Fig. 2.11 (continued next sheet)

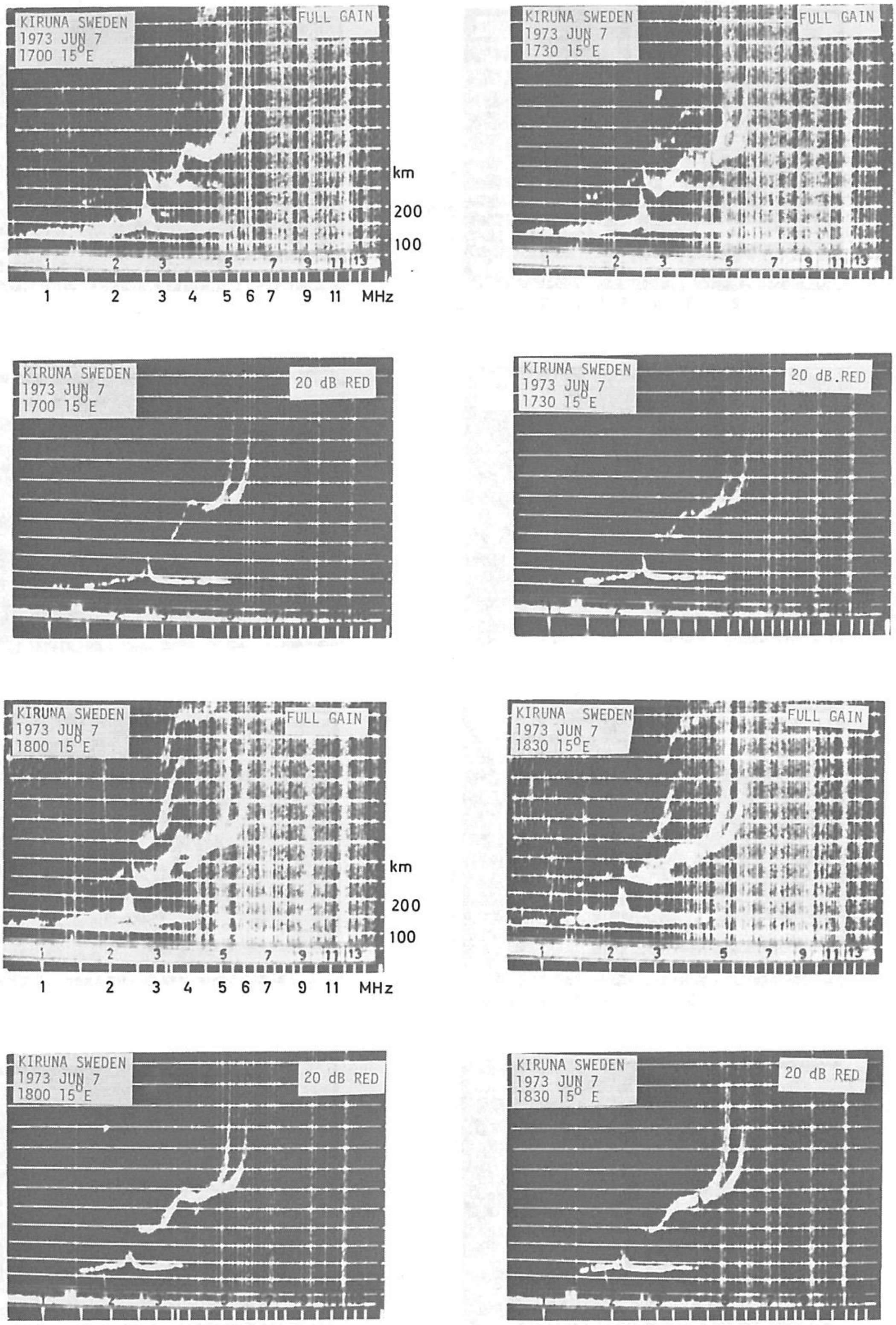


Fig. 2.11 (continued next sheet)

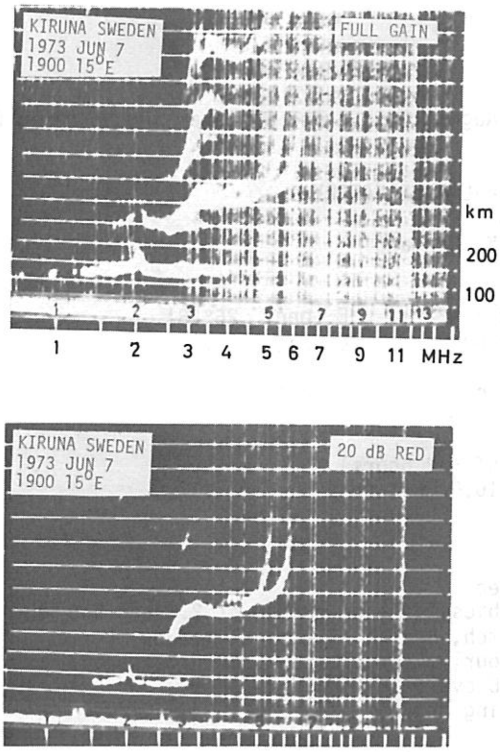


Fig. 2.11

KIRUNA - F2 and Es Changes on Summer Day 1973 Jun. 7 1300-1900 LT (15°E)

Editor's Note: Shows recordings made at half-hour intervals and with receiver operating at normal gain and attenuated 20 dB. Note a violent change in F1 layer between 1500 and 1530 LT.

2A.2 SODANKYLÄ

Ionospheric Vertical Sounding Station

This station has been in operation since August 1957. The Observer-in-charge is Dr. Tauno Turunen, and the station mailing address is:

GEOPHYSICAL OBSERVATORY
SF-99600
Sodankylä, Finland

Station name:	Sodankylä	
Geographic coordinates:	Lat. N 67°22'	E Long. 26°38'
Geomagnetic (dipole) coordinates:	Lat. N 63.8°	E Long. 120.0°
Geomagnetic coordinates: (corrected)	Lat. N 63.4°	E Long. 108.9°
Magnetic latitude:	63.59°	
Geomagnetic dip:	76.7°	
Time Used:	30°E (UT + 2 hours)	
Frequency range:	1.0 - 16.0 MHz, in 8 bands	
Sweep time:	8 min	
Peak power:	10 kW	
Pulse repetition rate:	50 Hz	
Pulse length:	100 μsec	
Aerial types:	3 rhombics, antenna change at 2.8 and 5.6 MHz TR-switch, height of mast 64 meters	
Routine sounding:	half-hourly, centered at 2.8 MHz passage (on RWD every 10 minutes) recording on 35 mm film	
Height range:	900 km	
Height scale:	linear, height markers every 50 km	
Frequency scale:	logarithmic, frequency markers every 0.5 MHz	

For terminology used, see *URSI Handbook of Ionogram Interpretation and Reduction*, Second Edition, edited by W. R. Piggott and K. Rawer, *Report UAG-23*, November 1972, World Data Center A for Solar-Terrestrial Physics, (U. S. Dept. of Commerce, Boulder, Colorado 80302, USA).

Sodankylä Ionograms with Gain Curve and Integration

Editor's Note: As Sodankylä ionograms will differ significantly from standard ones and include a gain curve, an explanation by Dr. T. Turunen is included. The technique described has considerable advantages at high latitude stations. The method of recording at several gains makes the traces look fuzzy in reproduction. A number of comparable ionograms taken with different ionosonde characteristics are also shown in Figures 2.12 through 2.16. Note in some cases the ionogram is recorded simultaneously on two different ionosondes, in others in close sequence on one.

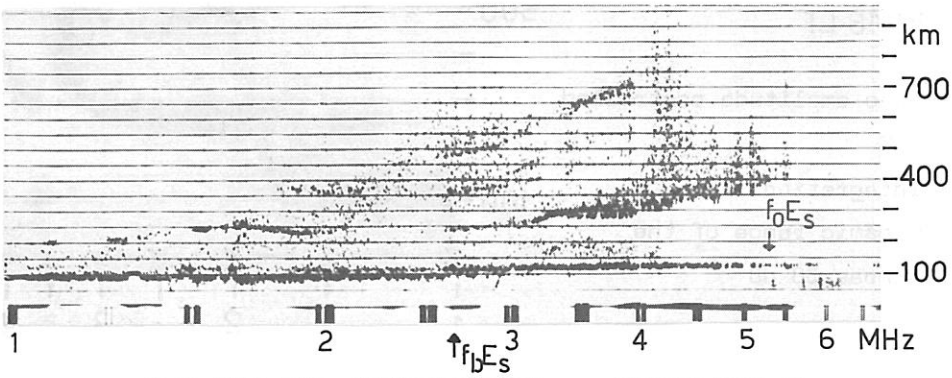
These ionograms are included not only for scaling examples, but also to show how my best possible ionograms look. The integration time constant is roughly equivalent to integration over 100 echoes. There are 100 channels and the channel width is 40 μsec. When the gain curve is not at constant level but shows more or less continuous shift downwards with increasing frequency, it means that the dynamic range of echoes at that frequency is 26 dB and the discriminators are showing the levels -6, -16, and -26 dB. (The density changes showing these have not reproduced clearly.) After the frequency at which the ionosonde starts to use fixed gain (gain curve remains at constant level), the amplitudes are measured relative to the echo amplitude at the frequency where the gain was locked at constant level. Usually this locking happens a little before foF2, but it can happen sometimes around any other critical frequency, or in the case of total blanketing, at the frequency where the real blanketing frequency is approximately. The criteria by which the gain is locked is that the echo amplitude decreases rapidly with increasing frequency by an amount which is greater than the range of normal fading. The gain which is used after locking is roughly the median gain which was used at some hundred kilohertz of frequency sweep just before the locking command. In this kind of system there are, of course, some approximations but the system works surprisingly well, is technically straightforward and fairly simple. The approximate component cost of the gain control unit is $20.00 (plus the mechanical parts, cables, connectors, etc.).

One can use the ionosonde to give a very good absorption measurement by using the gain curve. It is, however, more important that one really knows the dynamic range of the echoes and the amplitude at the frequency where the value for the gain sensitive parameters is given. This system could work with all conventional ionosondes except the types where the frequency sweep is very fast. I do not, however, claim that it is the best possibility, but in any case it works, and it is quite cheap and is physically correct. No technical failures occurred during the one year testing period.

Data from Sodankylä will be based on this gain control system beginning with the 1.4.74 (1 April 1974) data.

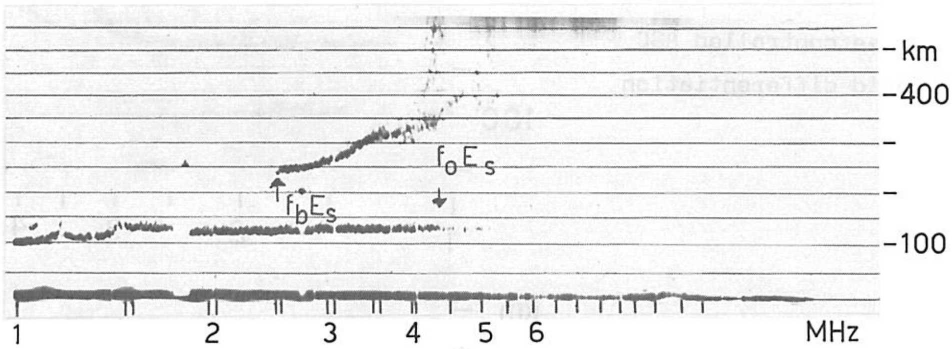
SODANKYLÄ 20.6.1973 20.40 LT

(a)



very high gain, differentiation auroral type Es

(b)



low gain, no differentiation high type Es

Fig. 2.12

SODANKYLÄ - Sporadic E Layer

20.6.1973 (20 June 1973) 2040 LT (30°E)

In the first ionogram (a) of 20.6.1973, 20.40 LT, an auroral type sporadic E (Es-a) is seen and the marks indicating foEs and fbEs values are also shown in the example.

The second ionogram (b) of 20.6.1973, 20.40 LT, has an Es which is not an auroral type Es, but a high type Es. The cusp between E layer and Es is not well-developed but it exists, and the virtual height of the Es is about 20 km higher than the virtual height of the E layer (which has small cusp activity at 1.2 MHz). The frequency parameters are quite straightforward to scale and the accuracy is better than 0.2 MHz. The virtual height is also easy to scale. The real difficulty is that these two ionograms are simultaneous and measured by using the same transmitted pulses. In ionogram (a) the gain is very high with rapid differentiation favoring steep gradients in the echoes while in ionogram (b) low fixed gain is used and only the strongest echoes are seen.

SODANKYLÄ

28.1.1974

10.46 LT

Echo amplitude controlled
AGC
Integration
Dynamic range of the
echoes 30 dB

10.53 LT

Noise controlled AGC
Rapid differentiation

11.00 LT

Noise controlled AGC
Slow differentiation

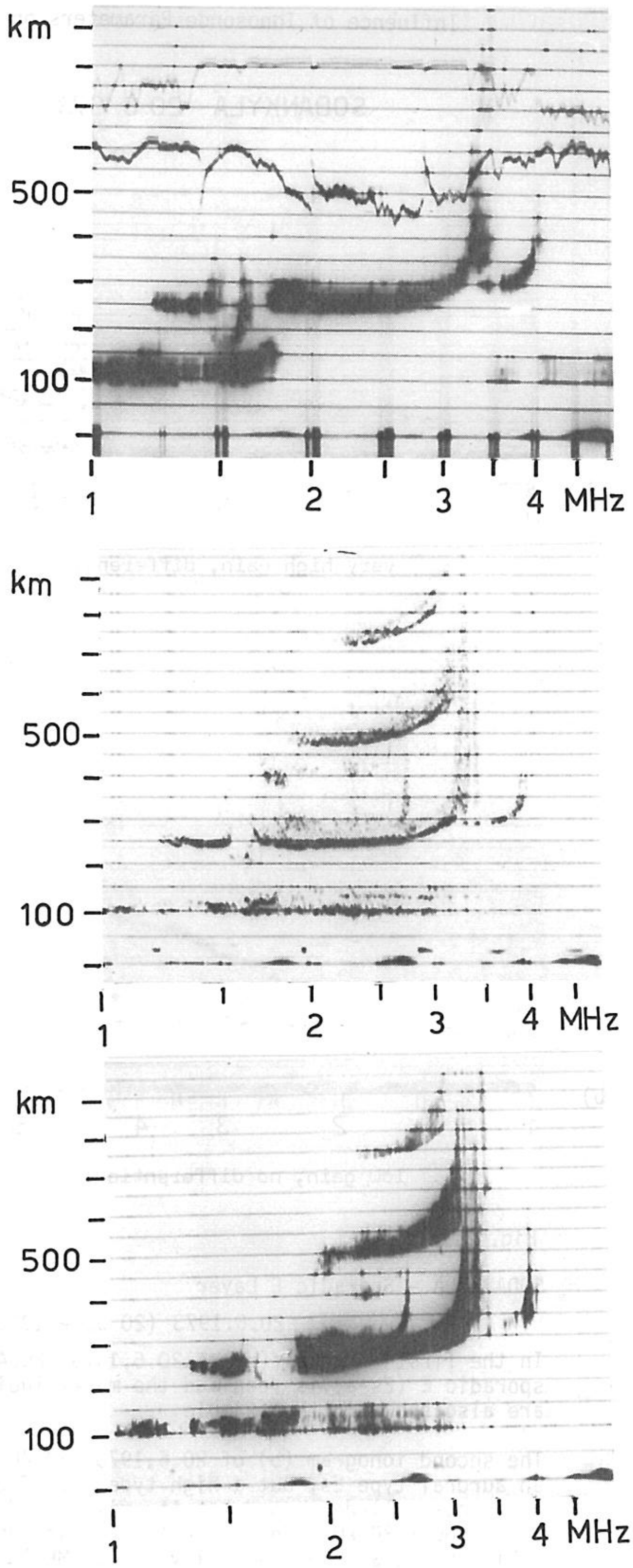


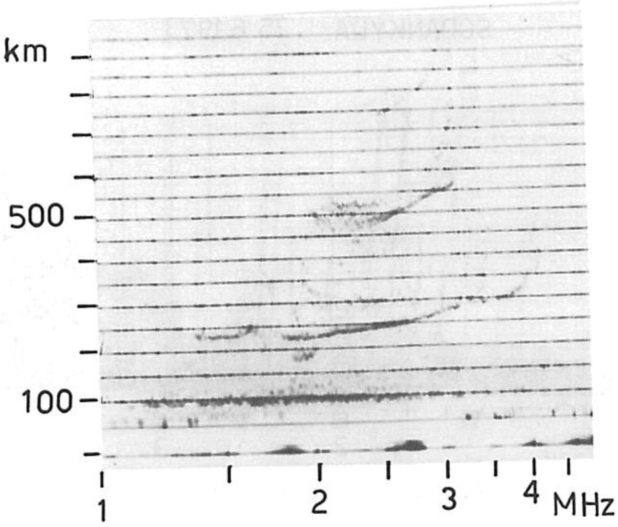
Fig. 2.13

SODANKYLÄ

28.1.1974

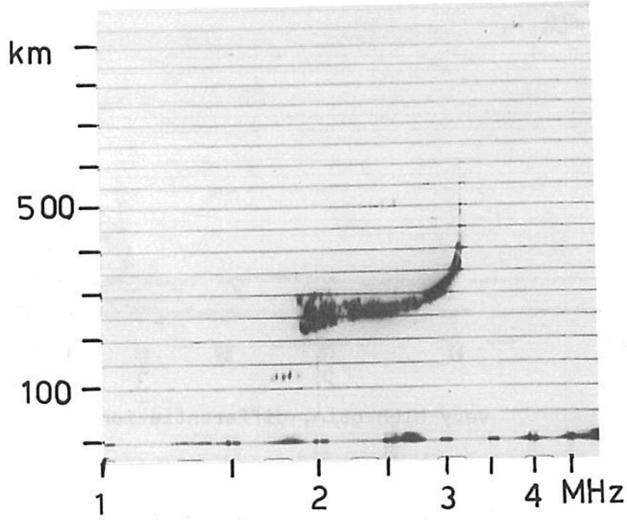
11.09 LT

High fixed gain
Rapid differentiation



11.16 LT

Low fixed gain
Slow differentiation



11.23 LT

Echo amplitude controlled
AGC
Slow differentiation

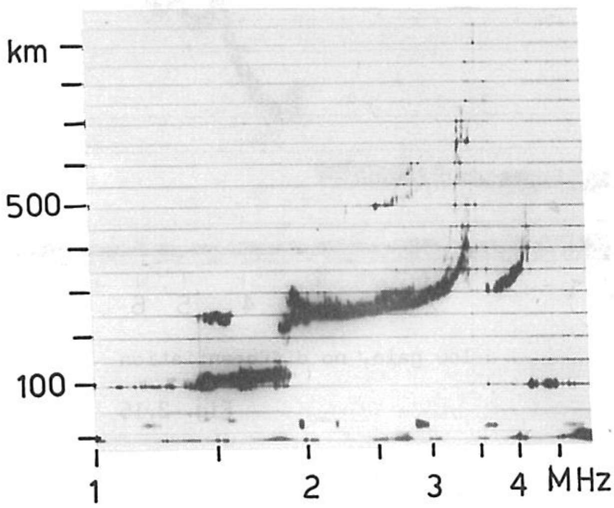
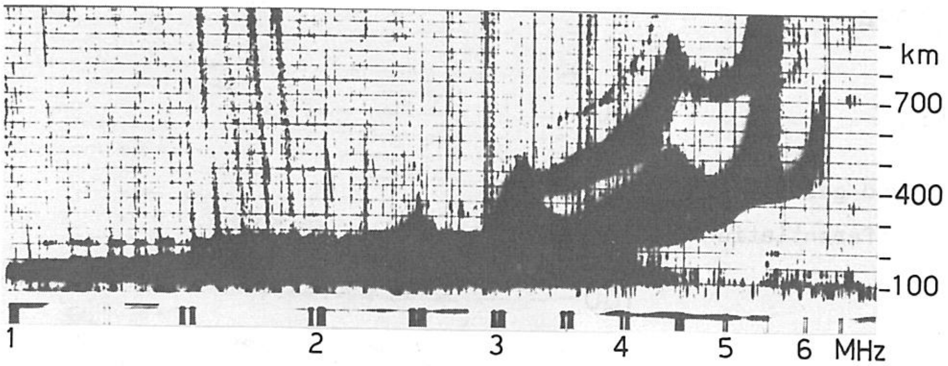
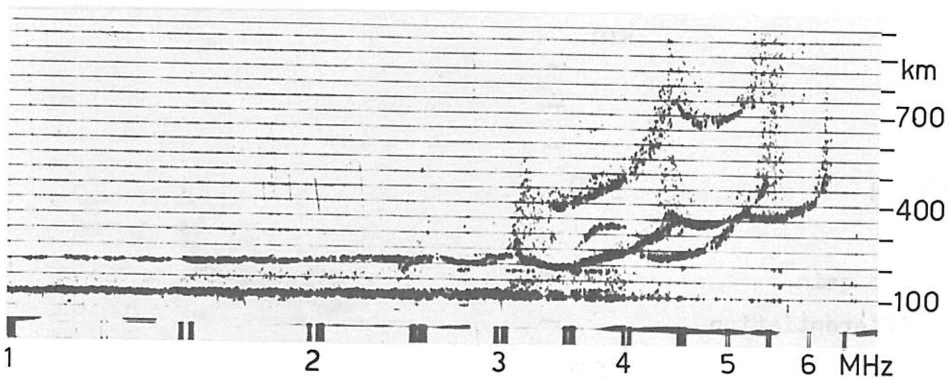


Fig. 2.14

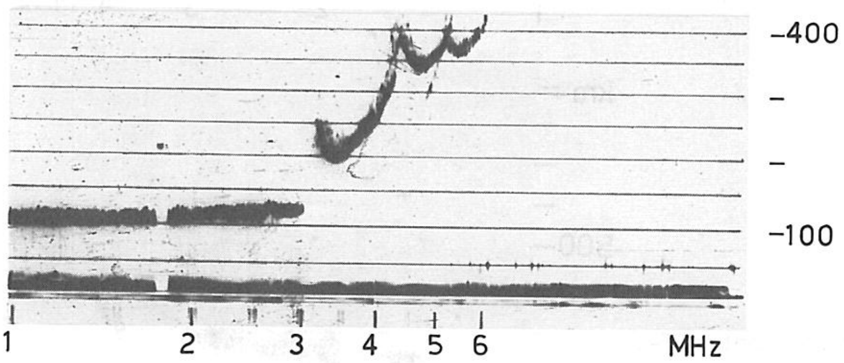
SODANKYLÄ 25.6.1973 13.40 LT



very high gain, no differentiation



very high gain, differentiation



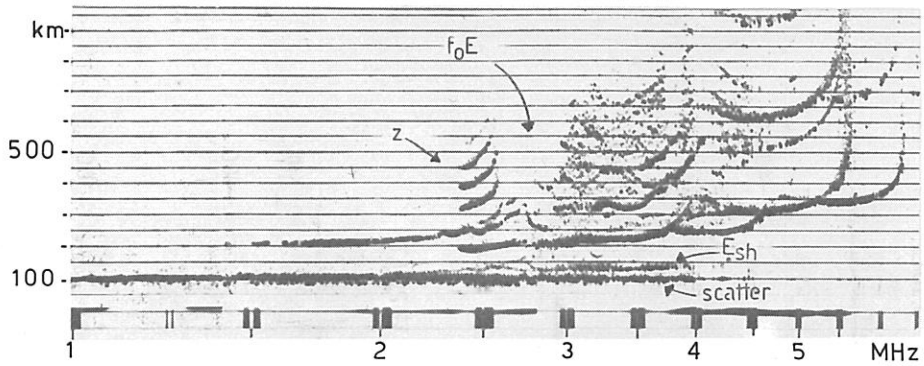
low gain, no differentiation

Fig. 2.15

SODANKYLÄ

6.7.1973

17.00 LT

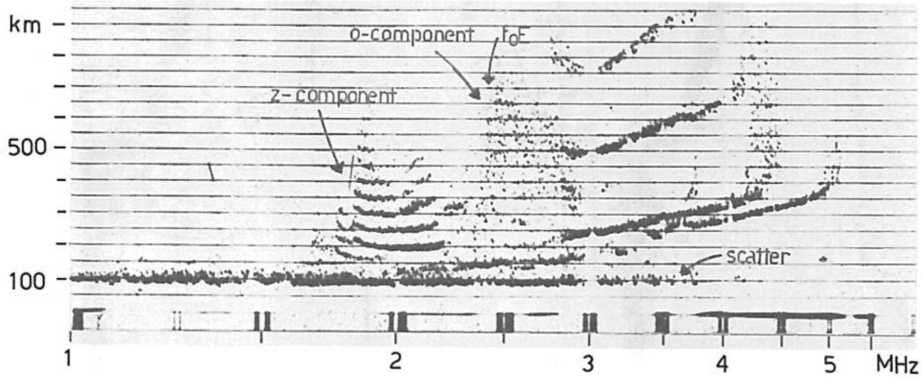


SODANKYLÄ

23.7.1973

18.30LT

very high gain



Simultaneous
low gain
ionogram,
expanded
height scale

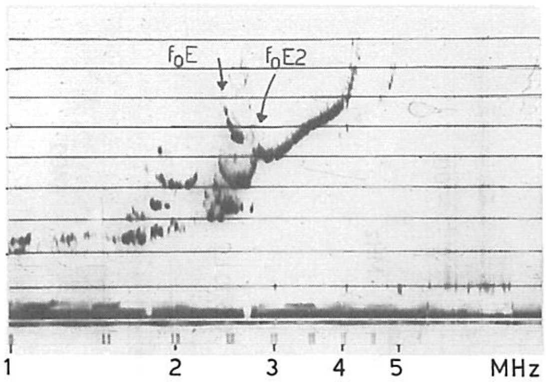


Fig. 2.16

SODANKYLÄ

6.7.1973 (6 July 1973)	1700 LT (30°E)
23.7.1973 (23 July 1973)	1830 LT (30°E)

Editor's Note: These ionograms illustrate a very common difficulty when the gain has been set too high -- the most common operating fault.

As I have already informed INAG, these echoes are seen by using extremely high gain about once per day in summer time.

The scatter above foE resembles Es-a. In my opinion, Es-a is often a similar but stronger scatter connected with the particle E. The layers at 100 km which look like Es-ℓ are not Es at all. They are really weak scatter or perhaps it is better to say gradient reflection, although one must remember that this "layer" seen on the film is only the lower boundary of scattered echoes. In 23.7.1973 the "foE scatter" is so strong that an inexperienced scaler could believe that blanketing Es is present because echoes disappear. It is however only an effect caused by saturation of the receiver. There is no Es-ℓ as can be seen from the low gain ionogram which is exactly simultaneous and made by using the same transmitted pulses.

The z-component groups are very nice phenomena. Sometimes there are more than ten multiples in the group. The phenomenon never causes scaling difficulties.

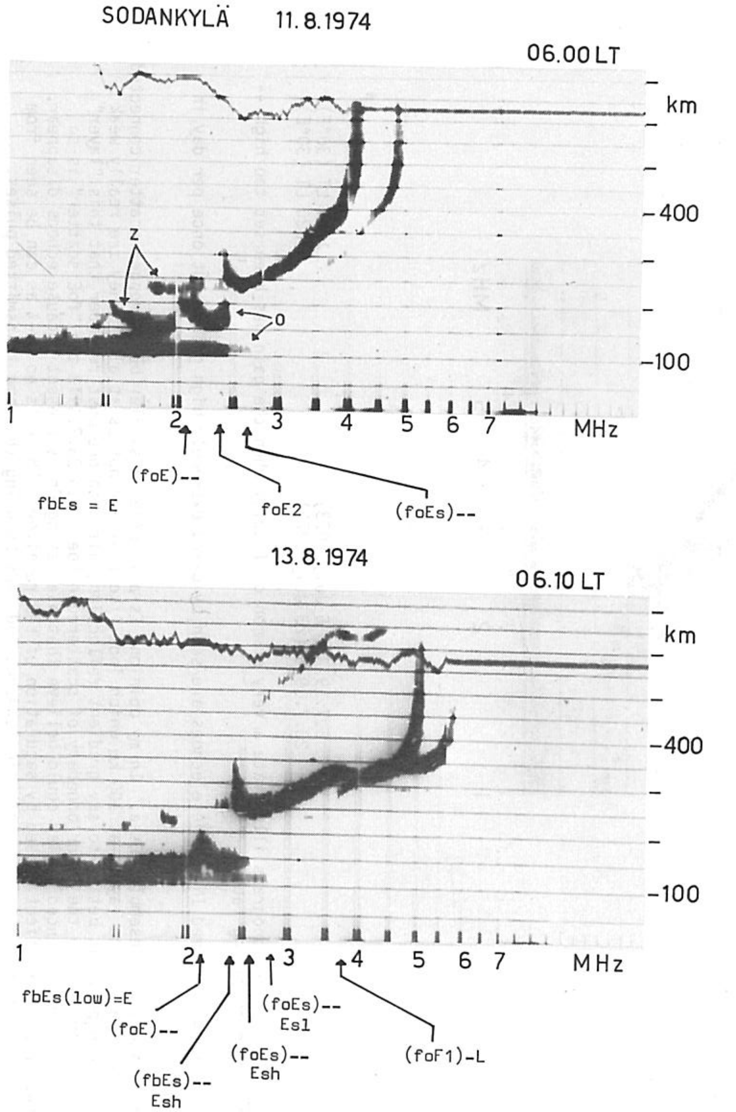


Fig. 2.17

SODANKYLÄ 11.8.1974 (11 Aug. 1974) 0600 LT (30°E)
13.8.1974 (13 Aug. 1974) 0610 LT (30°E)

Ionograms show Es-h, which in some cases is E2 or almost E2 layer. At Sodankylä the Es-h layers are usually developed from E2, although the so-called sequential Es is seldom clearly seen and the ℓ type is usually not reached (rarely during the morning time).

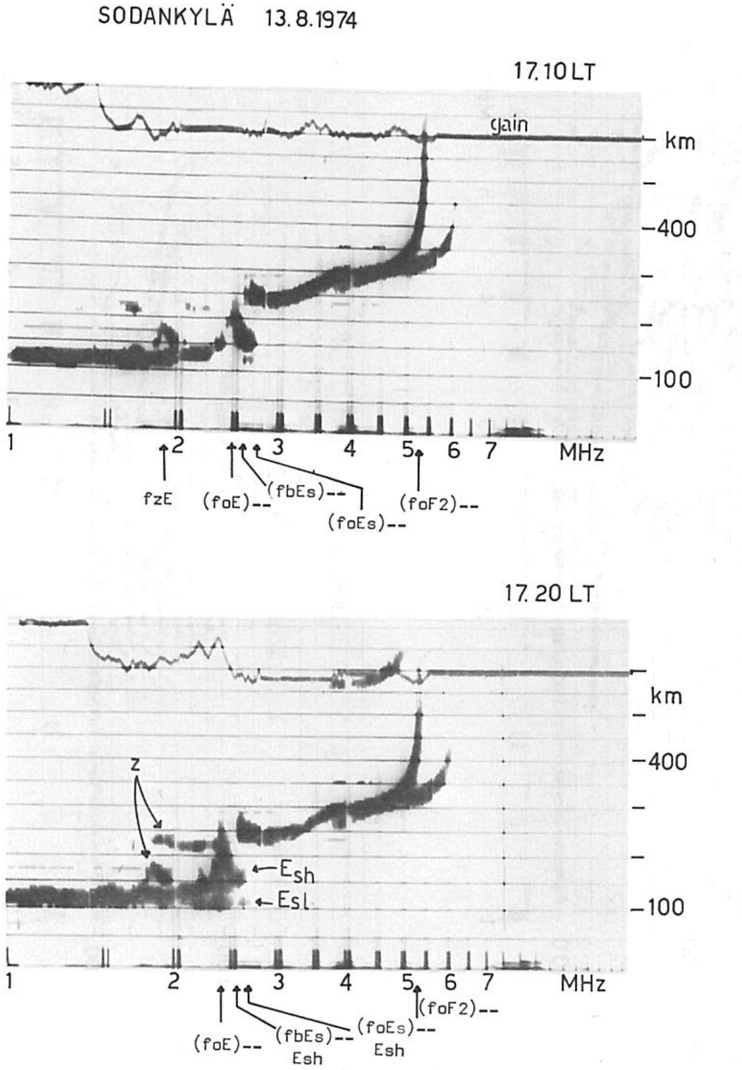


Fig. 2.18 13.8.1974 (13 Aug. 1974) 1710 LT (30°E)
1720 LT (30°E)

These ionograms show Es-ℓ which is very rare at normal gain. Es-ℓ reflections can usually be seen at higher gain (these are also present on Lycksele ionograms). These reflections are not now included in the Es type. Though this is against the basic rules, data from many stations show that this weak Es-ℓ is one of the basic reasons different station data vary so much.

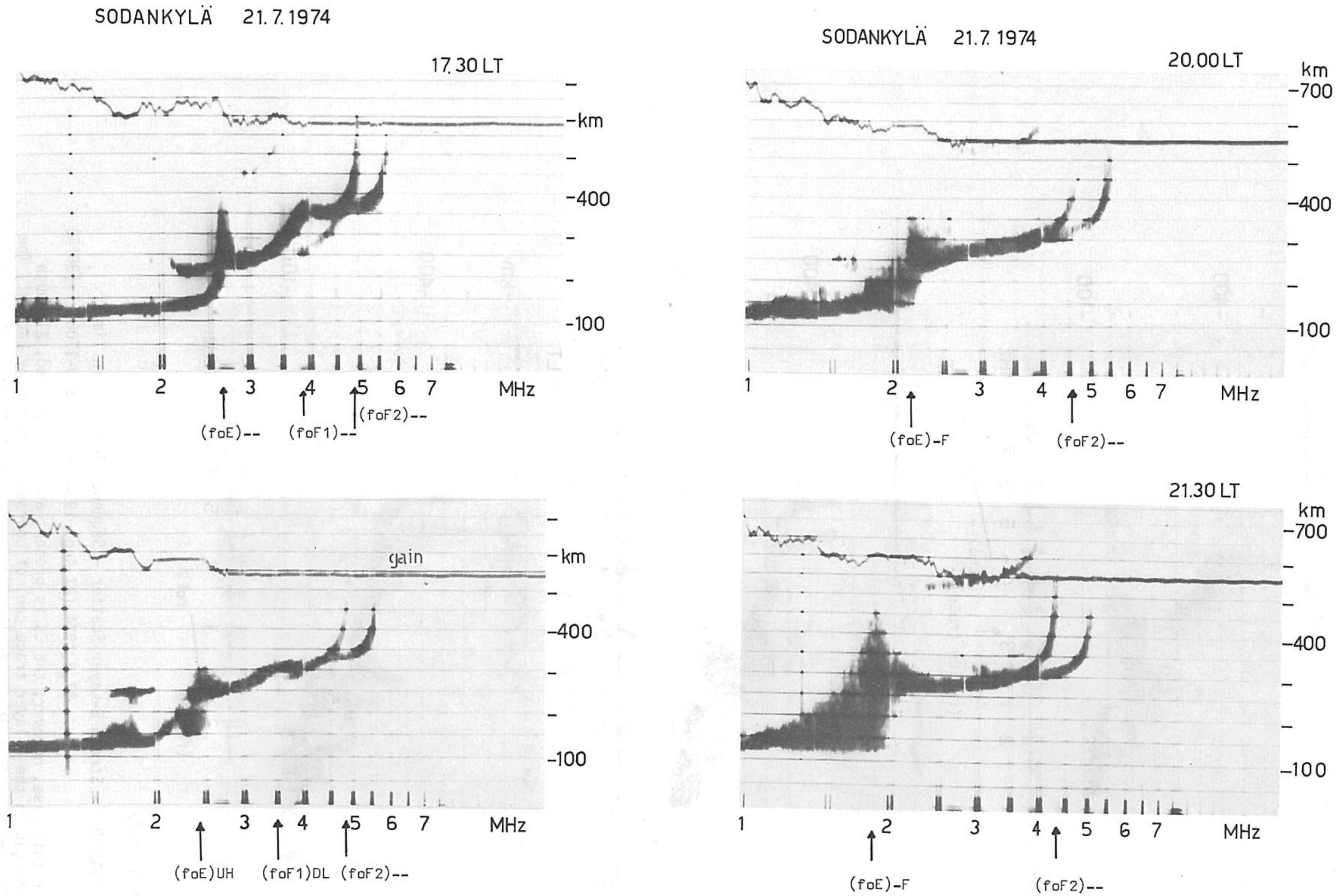


Fig. 2.19

SODANKYLÄ - Strong E-Layer Scatter

21.7.1974 (21 July 1974) 1730-2130 LT (30°E)

This sequence shows how one very usual type of E-layer scatter is formed around foE. foE-F in these cases describes the ionogram quite well. Discussions about the subject are needed. If E is present and one can see foE in the spread E, Es-a does not appear appropriate. However many stations would scale Es-a at least if high gain is used, and the scatter is the most pronounced feature in the ionogram.