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NAVAL UNDERWATER SYSTEMS CENTER
NEW LONDON LABORATORY
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Technical Memorandum

MORPHOLOGY OF THE IONOSPHERE DURING THE MAP/WINE CAMPAIGN ENERGETIC PRECIPITATING PARTICLE FLUX AS INTERPRETED THROUGH TIROS AND DMSP SATELLITE OBSERVATIONS

DATE: 11 September 1985

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ABSTRACT

An assessment of the general extent of the auroral activity where available in conjunction with various rocket launch times will be presented as part of the campaign in support of the MAP/WINE (Middle Atmosphere Program/Winter in Northern Europe 1983-1984) in which a number of rocket probes were launched from the Andøya Rocket Range in Norway. The level of activity and its distribution will be viewed from two somewhat different perspectives. The first presents the geographic distribution of the auroral boundary and the associated relative auroral activity, while the second indicates the precipitating energy flux entering the ionosphere during specific rocket launch times. For the majority of the rocket probes, the Andøya Rocket Range was considerably south of the diffused auroral boundary. In none of the cases presented were precipitating particles capable of producing substantial ionization and energy deposition below about 90 km.

PREFACE

As way of background, the Middle Atmosphere Program (MAP) is an international program to study the global characteristics of the stratosphere and mesosphere. The program will run for a period of three years, from 1982 through 1985, and will be followed by the program "Middle Atmosphere Cooperation" (MAC). As part of MAP, the campaign "Winter in Northern Europe" (MAP/WINE) took place during the winter of 1983-84. This campaign concentrated on middle atmosphere conditions in winter at high latitudes, with particular emphasis on the phenomenon known as a "stratospheric warming". A stratospheric warming is a sudden temperature increase in the stratosphere, associated with a break-up of the winter circulation pattern in the polar stratosphere and mesosphere. The causes of the major changes which occur in the mesosphere and lower ionosphere during such an event are not well understood, and the MAP/WINE campaign was designed to improve this understanding. As part of MAP/WINE, studies of the lower ionospheric particle composition as well as turbulence were made, both with rockets and ground based techniques.

During this period, and in concert with the campaign, Code 3411 monitored ELF signals in northern Scandinavia. This provided the first ever simultaneous and collocational measurements of electron and ion densities and ELF field strengths. The middle atmosphere, or lower ionosphere, is a region of critical importance to the propagation of ELF signals as it is the region where reflection occurs. To date, this is one of the least understood and is perhaps the most complex region of the atmosphere. The MAP effort will undoubtedly will provide the ELF community, among others, with some basic scientific information about air chemistry, partical dynamics, neutral atmosphere/disturbed atmosphere interaction.

INTRODUCTION

The impingement of auroral electron fluxes on the atmosphere constitutes a major part of the auroral morphology. It has generally been accepted that electrons with energies from 0.1 to 20 keV are most responsible for auroral forms in the visible and near-infrared wavelengths. In a recent paper, Lyons and Evans[1] have extended this morphology by noting the identification of discrete aurora by large, spatially structured energy fluxes ($>$10 erg per cm^2 sec ster) which are carried almost exclusively by precipitating electrons in this energy range. They further noted that such regions of auroral precipitation were generally spatially associated with significant changes in the intensity of medium energy (20 to 800 keV) protons filling the atmospheric loss cone. These changes in turn are often collocated with changes in the energetic ($<$30 keV) electron precipitation.

While it is not the purpose of this study to provide a detailed examination of the morphology, an assessment of particle precipitation into the ionosphere and the general extent of the auroral activity where available in conjunction with various rocket launch times will be presented as part of the campaign in support the MAP/WINE (Middle Atmosphere Program/Winter in Northern Europe 1983-1984) in which a number of rocket probes were launched from the Andøya Rocket Range in Norway.

The level of activity and its distribution will be viewed from two somewhat different perspectives. The first introduces the geographic distribution of the auroral boundaries and a description of the relative auroral activity as derived from DMSP satellite information during a nominal six hour time window centered about the actual launch times, while the second indicates the energy flux from NOAA-8 satellite tracks somewhat time coincident with specific rocket launch times.

SATELLITE OBSERVATIONS

The Energetic Particle Sensors (EPS) onboard the NOAA-8 satellite are part of instrumentation maintained by the Space Environment Laboratory of the National Oceanic and Atmospheric Administration (NOAA). The NOAA-TIROS satellites are a series of low-altitude, polar-orbiting, sun synchronous satellites. The EPS are comprised of three detector assemblies designed to measure the flux of protons (ions) and electrons mirroring above and precipitating into the high latitude ionosphere. In this paper, only those detectors from which data will be presented will be described. A more complete description of the EPS will be found in Hill et al.[2]

For more than a decade, the Defense Meteorological Satellite Program (DMSP) has provided a succession of multi-missioned weather satellites. The DMSP consists of two satellites in sun-synchronous circular polar orbits at 99° inclination and at altitudes ranging between 815 and 850 km. One of the satellites is in a noon-midnight plane, while the other is in a dawn-dusk plane. In both cases the orbital period is approximately 102 minutes.

Over the years, one feature of DMSP has been its contribution to our understanding of auroral phenomena. Beginning with the first DMSP study of this type by Meng[3] in 1974, its dual instrument capability, simultaneously providing low energy electron precipitation and optical information, has increased our understanding of the inter-relationships of various auroral forms, their characteristic energy spectra, distribution, and relationship to other phenomena.

The optical payload provides auroral images resulting from a scanner system[4] which relies on the forward motion of the satellite and a rotating mirror to provide a two-dimensional image. Resolution is about 3.7 km at subtrack. The scanner operates in the spectral region 4000-11000 Å, peaking near 8000 Å as determined by calibration against the solar spectrum. Pitch and yaw errors are uncorrected, but these correspond to errors of less than 4.7 km on the earth.

Table 1 presents a general summary[5] of the auroral activity for each of the various MAP/WINE rocket probes as interpreted from DMSP optical imagery. Included in this table are the nominal rocket flight time, the time of equatorial crossing for the image frame, the longitude of equatorial crossing and an assessment of the general level of auroral activity and image availability over northern Europe. The final column in Table 1 is an assessment[6] of the activity level based on the NOAA-8 Total Energy Detector (TED) payload.

Although specific locations of aurora for all periods were not available at the time of this reporting, it can be seen from Table 1 that visual auroras were present in Northern Europe during a few of the rocket launch periods. In the future, it would be worth comparing any All Sky Camera observations at the launch site with the information provided in Table 1. This would be particularly interesting for launches MT-3 (13 January 1984) and MT-6 (10 February 1984). As will be seen from the information to follow, the equatorward boundary of the diffuse auroral zone was considerably south of the Andoya Rocket Range for the launches MT-4 (25 January 1984) and MT-5 (31 January 1984). These launch times were also the only periods of moderate auroral activity. There is medium energy, precipitating ion data that suggests that there might have also been an expansion of the boundary to over the launch site for MT-6 (10 February 1984), however, the DMSP image shows optical aurora only well north of Norway.

From both visual imagery (DMSP) and the Activity Level Index (NOAA-8), Table 1 indicates the general low level of auroral activity during the launch periods. The two significant exceptions being MT-4 and MT-5. During these periods, the total power entering the ionosphere is approximately 2 to 4 dB greater[6] than during the other launch times. In the 0.3 to 20.0 keV energy band, these observations are further reinforced by precipitating particle measurements made onboard the DMSP satellites.

An associate sensor onboard the DMSP satellite provides information on the location of the equatorward boundary of the auroral zone for each of the orbital passes. This estimate is provided by the SSJ/4 electro-sensor, also known as the J sensor.[7] Particles with the proper energy to produce aurora are measured in counts per unit time. When the satellite moves from the magnetic field lines of the trapped radiation belts to those of the auroral region, this sensor records a sudden upward jump. This information is then processed to produce the equatorward edge of the diffuse aurora. This location of the auroral oval edge is also used to compute an equivalent Q index, Q_e, although this estimate is actually valid only near geomagnetic midnight.

TABLE 1

SUMMARY OF AURORAL ACTIVITY (DMSP IMAGERY)
AND
LOW-ENERGY PRECIPITATING PARTICLE INFLUX INTO THE IONOSPHERE
DURING MAP/WINE ROCKET LAUNCH PERIODS

ROCKET LAUNCH TIME		DMSP EQUATORIAL CROSSING		NORTHERN EUROPEAN AURORAL ACTIVITY (DMSP IMAGERY)[5]	ACTIVITY LEVEL[6] BASED ON THE TIROS-N TOTAL ENERGY DETECTOR ALONG NOAA-8 SATELLITE TRACK
DATE	TIME (UT)	TIME (UT)	LONGITUDE		
6 JANUARY 1984	2155	2021	149.03 E	Aurora	Low Activity
MT-2		2136	171.42 W	Aurora:image available (Fig 6)	(No Northern Scandinavian Track)
		2202	123.70 E	Aurora:small patch	
13 JANUARY 1984	2000	1753	173.91 W	Aurora	Low Activity
MT-3		2115	135.36 W	Aurora	(No Northern Scandinavian Track)
		2257	110.00 E	Aurora	
25 JANUARY 1984	1639	1520	135.82 W	Aurora	Moderate Activity
MT-4		1654	100.94 W	Aurora:poor image	(Northern Scandinavian Track)
		1702	161.18 W	Aurora:image available (Fig 7)	
31 JANUARY 1984	1831	1816	121.45 W	Aurora:uncertain	Moderate Activity
MT-5		1817	179.86 E	Aurora:image available (Fig 8)	(Northern Scandinavian Track)
		1957	146.80 W	Aurora:good	
10 FEBRUARY 1984	0240	0115	75.44 E	Aurora	Low Activity
MT-6		0257	50.11 E	Aurora:image available (Fig 9)	(No Northern Scandinavian Track)
		0438	111.56 W	Aurora	
16 FEBRUARY 1984	0120	0050	81.84 E	None	Low Activity
MT-7		0103	136.72 E	None	(No Northern Scandinavian Track)
		0231	56.50 E	None	
18 FEBRUARY 1984	0022	0007	92.42 E	None	Low to Moderate Activity
MT-8		0023	146.81 E	None	(No Northern Scandinavian Track)
		0149	67.09 E	Aurora:small patch	

Figures 1 through 5 present the general position[8] of the auroral boundary during a six hour window centered on the respective launch times for MT-2 through MT-6. Depicted on each of the figures is the equatorwards boundary for each of the passes occurring within this time window. For clarity, the longitudinal extent of each boundary marking has been exaggerated. The marking also has the time in UT of each declaration. Finally the edge has been further delimited according to the observed level of auroral activity.

Figures 6 through 9 present the available images noted in Table 1, provided by USAFETAC through the National Geophysical Data Center, Boulder, Colorado. These figures show the DMSP images obtained nearly simultaneously with launches MT-2, MT-4, MT-5, and MT-6. As suggested in Table 1 and Figures 3 and 4, Figures 7 and 8 show auroral activity extending well south of the launch site during launches MT-4 and MT-5. In addition, the auroral activity has increased to a level which was moderate to moderately active. Information available for the launches of MT-7 and MT-8 indicates there was very little auroral activity.

The dynamics of the atmosphere over the auroral zone and polar region are controlled by the particle precipitation and by the electrical current flows in the ionosphere above 90 km. Occasionally this influence extends itself to even lower latitudes. A measure of the integrated directional energy flux carried into the atmosphere by these particles is made onboard the NOAA satellites by means of one of its sensors, the electron spectrometer, also referred to as the total energy detector (TED) which looks outward along the earth's radius vector (zenith), and measures separately the electron and proton total energy flux precipitating into the high latitude ionosphere in the energy range 300 eV $<$ E $<$20,000 eV. The energy range of this instrument is in eleven contiguous bands as shown in Table 2 which also indicates the altitude at which these energies will be deposited.

TABLE 2

Energy Band Number	Edges of Band (eV)	Altitude at Which Energy Will be Deposited (km)
1	300-458	300
2	458-773	215
3	773-1088	190
4	1088-1718	165
5	1718-2349	145
6	2349-3610	130
7	3610-4870	120
8	4870-7392	115
9	7392-9914	108
10	9914-14957	105
11	14957-20000	104

The resulting differential energy fluxes are integrated by an onboard data processor to provide the total electron and proton energy flux below 20 keV precipitating into the upper atmosphere. The instrument sensitivity is such that directional energy fluxes ranging from 0.01 to 100 erg per cm^2 sec ster can be reliably measured within the two second integration period. The method suppresses the location of the energy fluxes. Thus, energy flowing into the polar cap from solar particles counts the same as auroral precipitation, although typically the total proton energy flux is less than 10% of the electron energy flux.

In Figures 10 through 14, the particle energy flux and the principal characteristic electron energy as a function of satellite position is illustrated. This information provided by Evans[6] is derived from TED data. Unfortunately this series of figures is not as concurrent with the launch times as one would like, but nevertheless they illustrate a level of auroral activity consistent with previous data.

The figures contain several features. The solid lines perpendicular to the satellite track are measures of the auroral precipitated energy flux. Estimates of the actual energy at any position on this track is easily obtained by logarithmically scaling a particular line against the appropriate solid vertical arrow present in each corner. The dotted lines perpendicular to the track represents the energy at which the energy bin is the highest; the more dots, the higher the dominate electron energy ($0.3 < E < 20.0$ keV). The radial arrow points to the direction of the sun and can be used to diagnose, as in Figures 12 and 14, the presence of sunlight contamination in one of the detectors.

Correspondingly at intermediate energy levels, the MEPED (Medium Energy Proton and Electron Detector contains two zenithally directed telescope detector assemblies which measure proton fluxes 30 keV $< E_p <$ 2,500 keV in four differential channels and electron fluxes from 30 keV to greater than 300 keV in three integral channels, as they precipitate into the high latitude ionosphere. Table 3 provides the channel designations and corresponding energy response.

TABLE 3

NOAA-8 EPS Data Channels

Data Channel	Specie	Energy	Mean Energy
P_1	Proton	30 - 80 keV	55 keV
P_2	Proton	80 - 250 keV	155 keV
P_3	Proton	250 - 800 keV	525 keV
P_4	Proton	800 -2500 keV	1550 keV
E_1	Electron	30 keV	
E_2	Electron	100 keV	
E_3	Electron	300 keV	
TE	(Total Electron Energy Flux)	300 eV - 20 keV	

Of the seven rocket launches from the Andøya Rocket Range in Norway in early 1984 (Table 4), only three were concurrent with a NOAA-8 northern polar pass within fifteen minutes of flight time. In addition, these passes were separated by less than 90° in longitude from Andøya whose location is at geographic 69° 17' North Latitude and 16° 01' East Longitude, with approximate corrected geomagnetic latitude of 66.2 N.[9] The Universal time and longitude of those three NOAA-8, 60° geomagnetic crossings are also noted in Table 4.

TABLE 4

Flight and Data Times (1984)

Rocket Launch	NOAA-8	
6 Jan 21:55 UT	22:02 UT	312° E. Longitude
13 Jan 20:00 UT		
25 Jan 16:39 UT	16:52 UT	25° E. Longitude
31 Jan 18:31 UT		
10 Feb 02:40 UT	02:48 UT	97° E. Longitude
16 Feb 01:20 UT		
18 Feb 00:22 UT		

The adopted time difference maximum between rocket launch and satellite crossing time was set at fifteen minutes because of the variability of auroral zone precipitation. The NOAA-8 satellite has a period of approximately 102 minutes, so that the time difference might be as much as 50 minutes.

Figure 15 presents the energetic particle fluxes observed by NOAA-8 on its northern pass, crossing the 60° geomagnetic latitude on 6 January at 22:02 UT at a geographic longitude of 312° East, 64° to the west of the rocket launch site and approximately seven minutes after launch time. The traces displayed in the data plots are in the order from top to bottom as presented in Table 3. It should be noted that the legend on the lower right edges of the data frames denote the power of ten scale factors applied to each trace in plotting, in the same order as the presentation order. For example, Figure 14 top, displays the electron integral fluxes observed by NOAA-8 at the times given in the abscissae. The curves from top to bottom represent the electron fluxes $>$ 30 keV, $>$ 100 keV, $>$ 300 keV and total energy flux with scale factors 10^2 (E2), 10^1 (E1), 10^0 (E0), and 10 (E1) respectively.

It will be noted from Figure 15 that the total electron energy deposition did not exceed 0.01 ergs/cm^2 sec below about 73° geomagnetic with the peak energy deposition (0.15 erg/cm^2 sec) occurring at about 72° geomagnetic well north of the latitude of Andenes. The electron flux greater than 300 keV is seen to remain close to instrument threshold throughout the pass. Even the greater than 30 keV electron flux increases only about one order of magnitude beyond 60° geomagnetic, indicating a very small additional particle precipitation into the atmosphere.

Figure 16 shows the corresponding NOAA measurements during the third listed launch. In this case, the NOAA pass occurred some thirteen minutes after launch and at 9^o east of the launch site. The position of the auroral zone, as indicated by the total energy flux, is in this instance considerably southward, exceeding 0.01 ergs/cm^2 sec at 65^o geomagnetic and peaking at approximatley 2 erg/cm^2 sec at about 69^o geomagnetic. The fluxes of electrons greater than 30 keV also sharply increase at 63^o geomagnetic, peaking to spectrum representable as $J(>E) = 1.1 \times 10^{12} E^{-4.4}$. However by 66^o geomagnetic, the $E > 100$ keV fluxes have fallen to their background levels. In the same figure, it will be seen that the proton fluxes are quite enhanced, and may be characterized by a power law spectrum of $J = 3 \times 10^6 E^{-1.7}$.

The NOAA-8 data for the 10 February launch period are presented in Figure 17. Here, the NOAA pass occurred eight minutes after launch at 81^o east of the launch site. Appreciable fluxes of $E > 30$ keV (2×10^5 per cm^2 sec ster) were present north of 64^o geomagnetic, while the total energy flux implies that Andøya lay under the auroral zone at this time. However, fluxes of electrons and ions above 100 keV were nominal during this period.

SUMMARY

During the MAP/WINE campaign, the Andøya Rocket Range was considerably south of the diffuse auroral boundary for the majority of the rocket launches. Rocket launches designated MT-4 and MT-5, for which the equatorward boundary of the diffused aurora had expanded considerable outward, were during periods of moderate auroral activity. Based on medium energy, precipitating electron data, this might have also been the situation for launch MT-6.

NOAA-8 passes over the northern polar cap were available for three of the seven rocket launches. These data were obtained within fifteen minutes of launch and separated in longitude by less than 90^o. In none of the cases were any appreciable fluxes of electrons or protons above 1 MeV observed or inferrable. None of the cases examined were precipitating particles observed capable of producing substantial ionization and energy deposition below about 90 km.[10]

ACKNOWLEDGEMENTS

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AURORAL ACTIVITY
6 JANUARY 1984
FOR A SIX HOUR PERIOD CENTERED ABOUT 2155 UT
RAW DATA SOURCE: DMSP SATELLITE (USAFETAC)

LONGITUDINAL EXTENT HAS BEEN EXAGGERATED

○–○ EQUATORWARD LIMIT OF VERY QUIET TO QUIET AURORA

■–■ EQUATORWARD LIMIT OF MODERATELY ACTIVE TO ACTIVE AURORA

●–● EQUATORWARD LIMIT OF VERY ACTIVE AURORA

1271

FIGURE 1

AURORAL ACTIVITY
13 JANUARY 1984
FOR A SIX HOUR PERIOD CENTERED ABOUT 2000 UT
RAW DATA SOURCE: DMSP SATELLITE (USAFETAC)

LONGITUDINAL EXTENT HAS BEEN EXAGGERATED

○–○ EQUATORWARD LIMIT OF VERY QUIET TO QUIET AURORA

■–■ EQUATORWARD LIMIT OF MODERATELY ACTIVE TO ACTIVE AURORA

●–● EQUATORWARD LIMIT OF VERY ACTIVE AURORA

FIGURE 2

AURORAL ACTIVITY
25 JANUARY 1984
FOR A SIX HOUR PERIOD CENTERED ABOUT 1639 UT
RAW DATA SOURCE: DMSP SATELLITE (USAFETAC)

LONGITUDINAL EXTENT HAS BEEN EXAGGERATED

○–○ EQUATORWARD LIMIT OF VERY QUIET TO QUIET AURORA
■–■ EQUATORWARD LIMIT OF MODERATELY ACTIVE TO ACTIVE AURORA
●–● EQUATORWARD LIMIT OF VERY ACTIVE AURORA

FIGURE 3

AURORAL ACTIVITY
31 JANUARY 1984
FOR A SIX HOUR PERIOD CENTERED ABOUT 1831 UT
RAW DATA SOURCE: DMSP SATELLITE (USAFETAC)

LONGITUDINAL EXTENT HAS BEEN EXAGGERATED
○—○ EQUATORWARD LIMIT OF VERY QUIET TO QUIET AURORA
■—■ EQUATORWARD LIMIT OF MODERATELY ACTIVE TO ACTIVE AURORA
●—● EQUATORWARD LIMIT OF VERY ACTIVE AURORA

FIGURE 4

AURORAL ACTIVITY
10 FEBRUARY 1984
FOR A SIX HOUR PERIOD CENTERED ABOUT 0240 UT
RAW DATA SOURCE: DMSP SATELLITE (USAFETAC)

LONGITUDINAL EXTENT HAS BEEN EXAGGERATED

○–○ EQUATORWARD LIMIT OF VERY QUIET TO QUIET AURORA

■–■ EQUATORWARD LIMIT OF MODERATELY ACTIVE TO ACTIVE AURORA

●–● EQUATORWARD LIMIT OF VERY ACTIVE AURORA

FIGURE 5

Figure 6
DMSP Auroral Image
6 January 1984
2136 UT

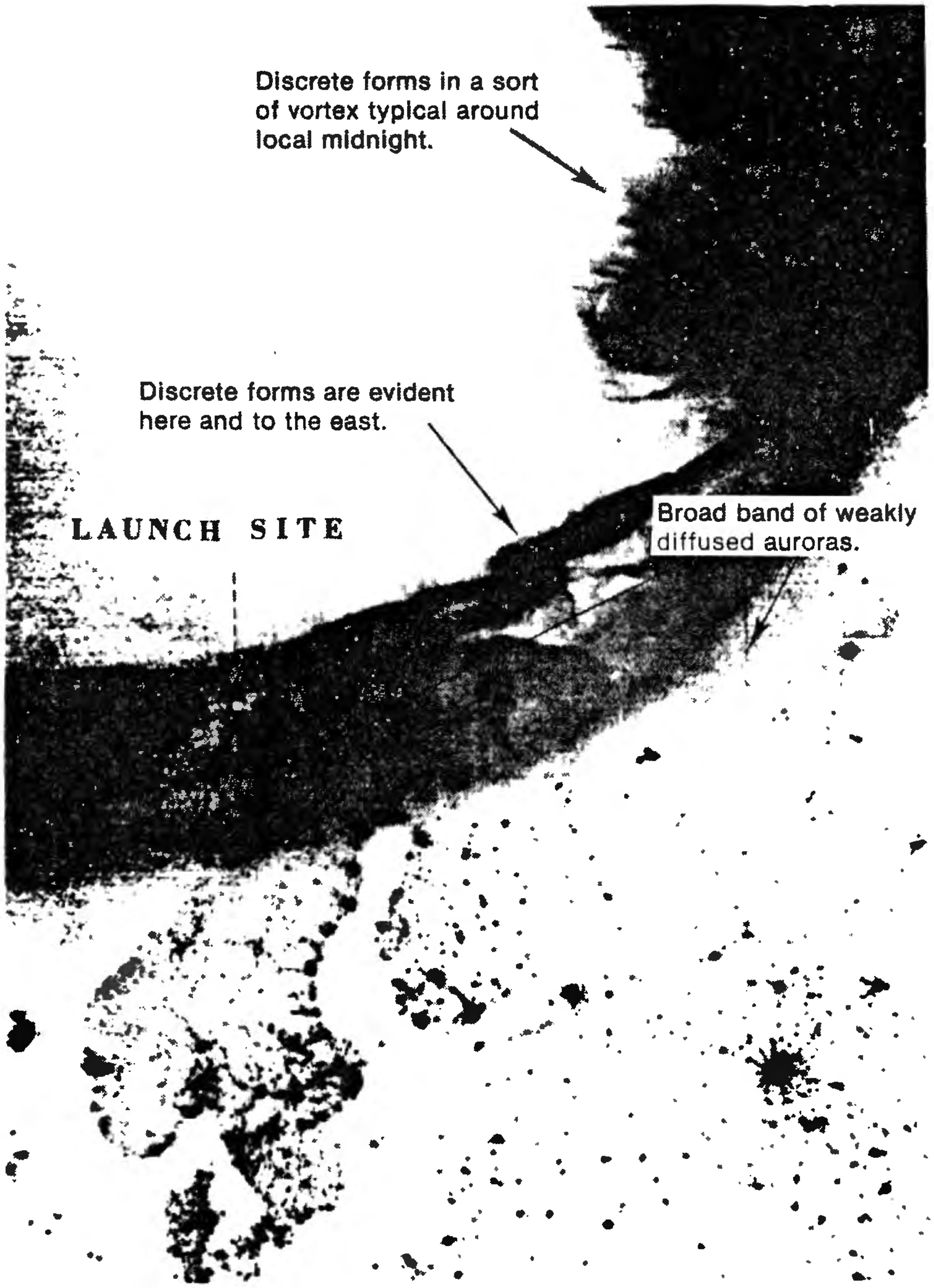


Figure 7
DMSP Auroral Image
25 January 1984
1702 UT

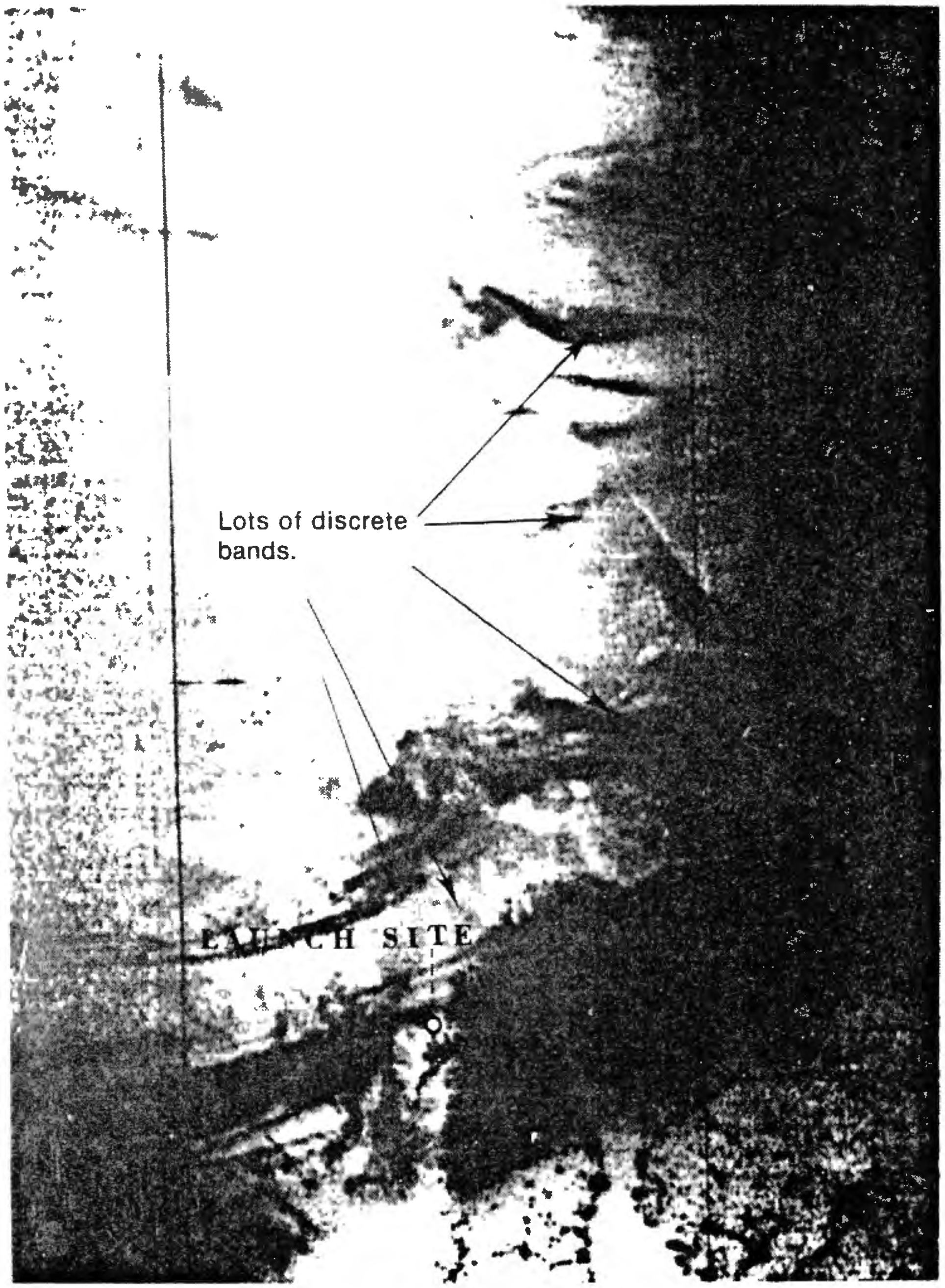


Figure 8
DMSP Auroral Image
31 January 1984
1817 UT

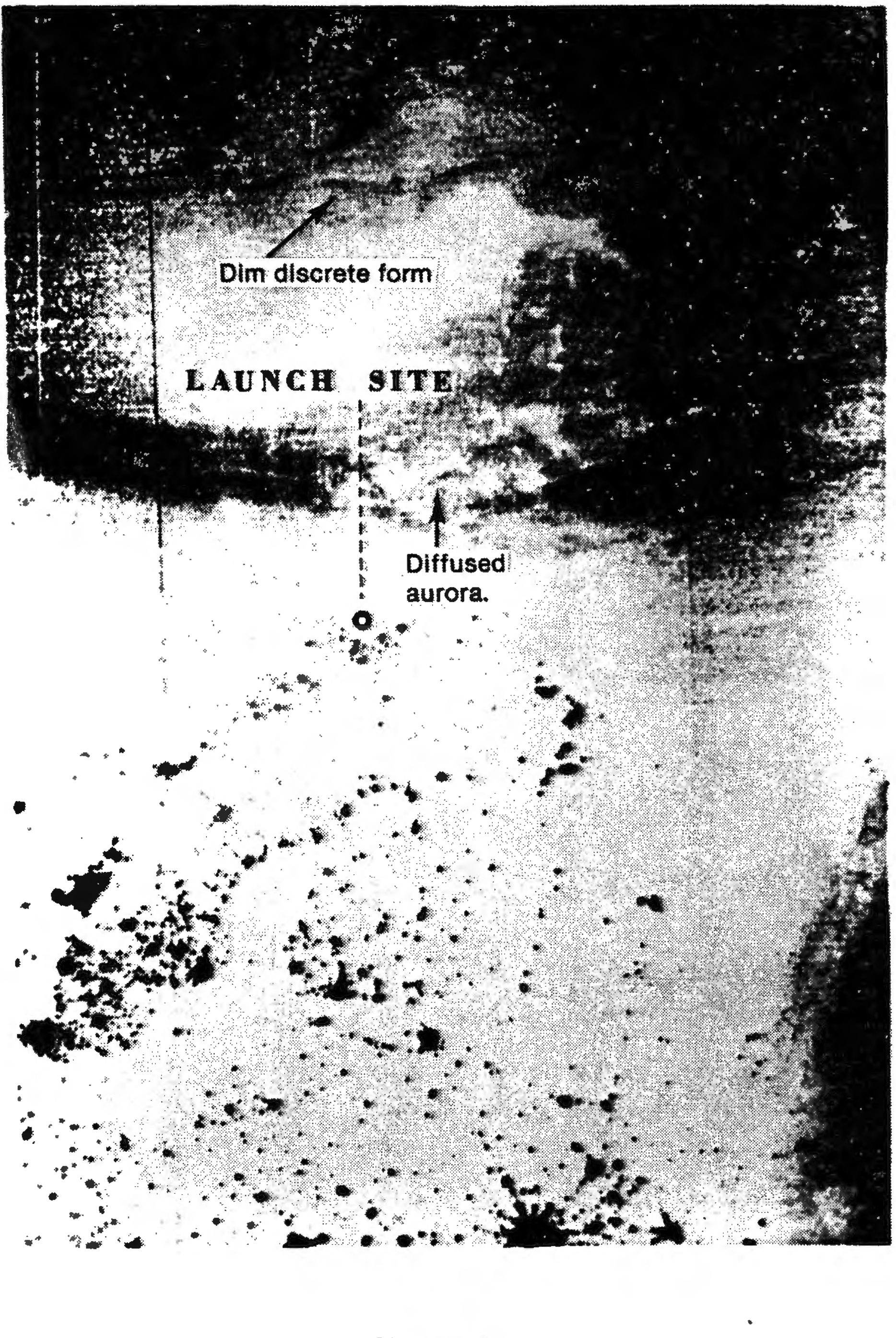
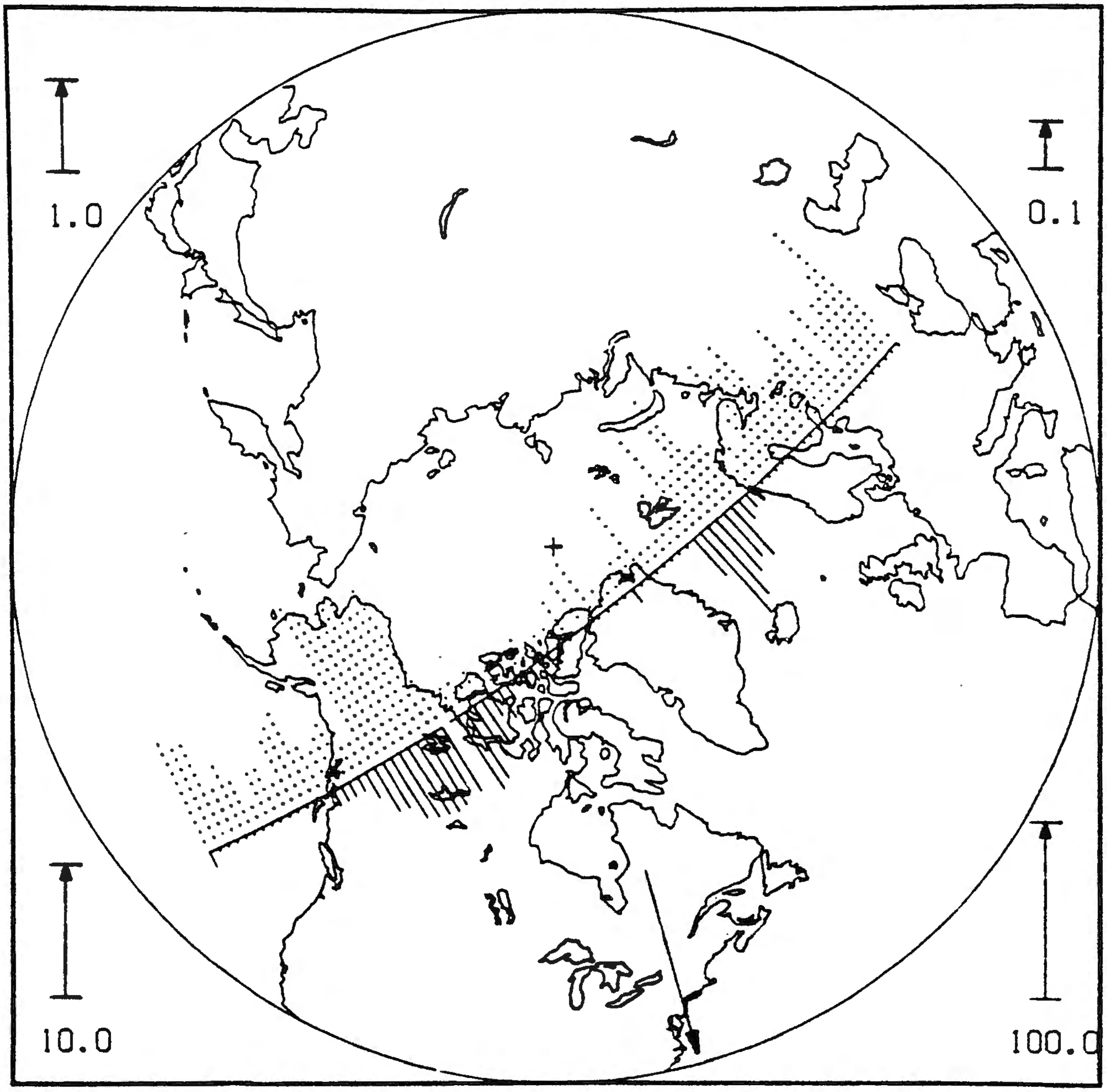


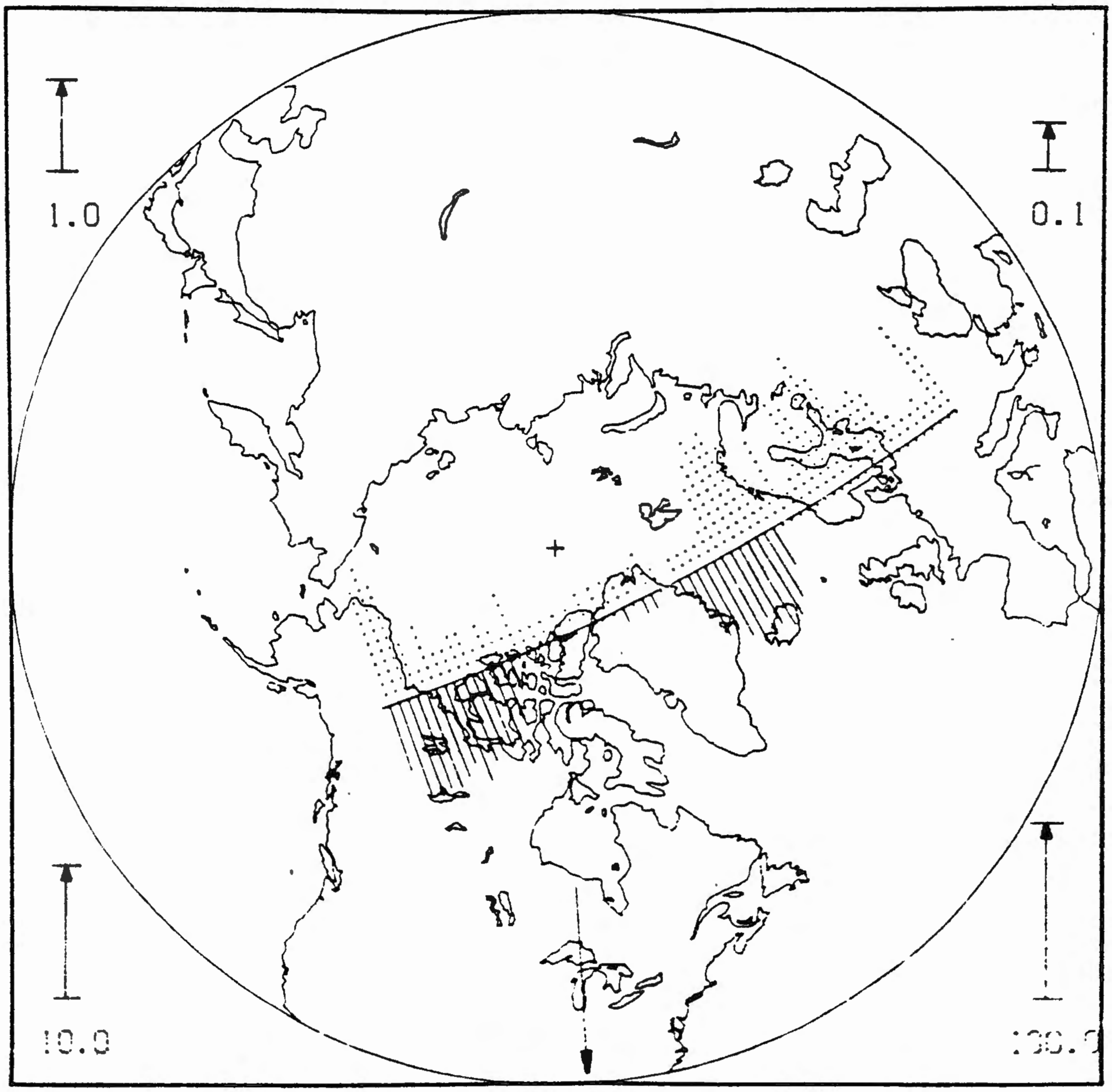
Figure 9
DMSP Auroral Image
10 February 1984
0257 UT

NOAA-8
NORTHERN HEMISPHERE AURORAL PARTICLE ENERGY INFLUX
PASS STARTED AT 1657 UT ON 06 JAN, 1984 ENDED AT 1724



REFERENCE SCALES ARE IN UNITS OF ERGS/CM2/SEC

FIGURE 10

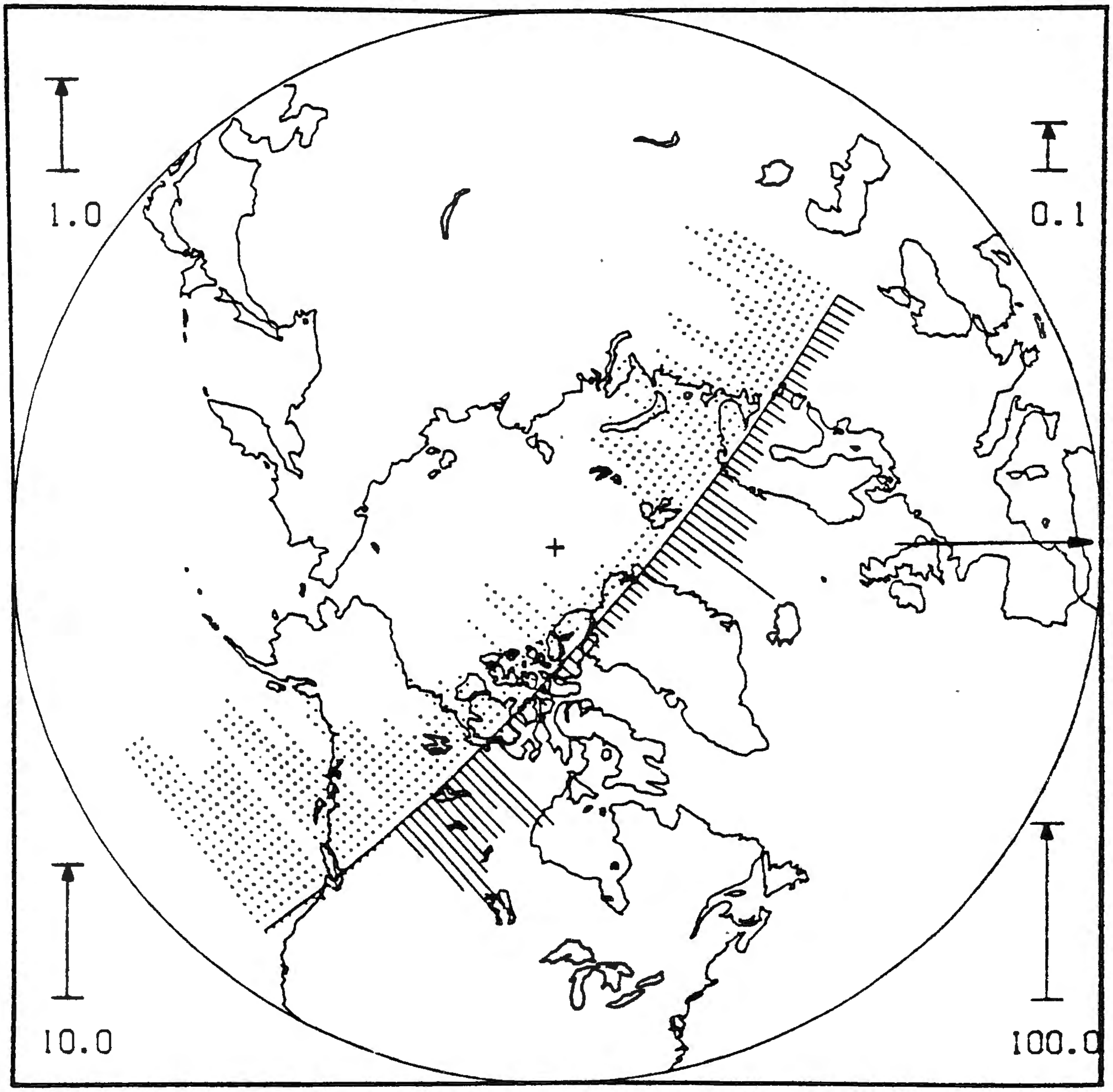


NOAA-8
NORTHERN HEMISPHERE AURORAL PARTICLE ENERGY INFLUX
PASS STARTED AT 1746 UT ON 13 JAN, 1984 ENDED AT 1806

REFERENCE SCALES ARE IN UNITS OF ERGS/CM2.SEC

FIGURE 11

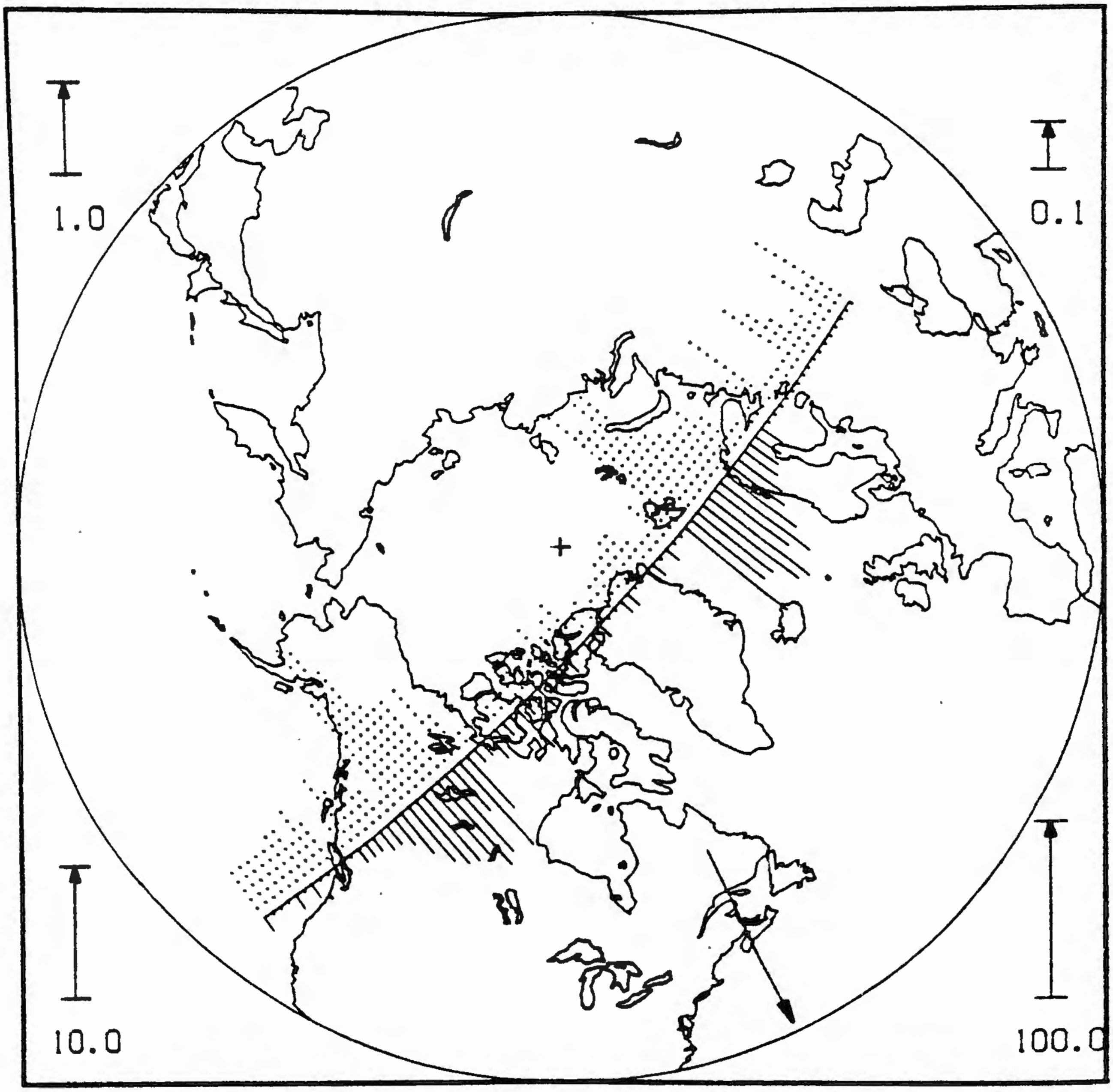
NOAA-7
NORTHERN HEMISPHERE AURORAL PARTICLE ENERGY INFLUX
PASS STARTED AT 1157 UT ON 25 JAN, 1984 ENDED AT 1224



REFERENCE SCALES ARE IN UNITS OF ERGS/CM2/SEC

FIGURE 12

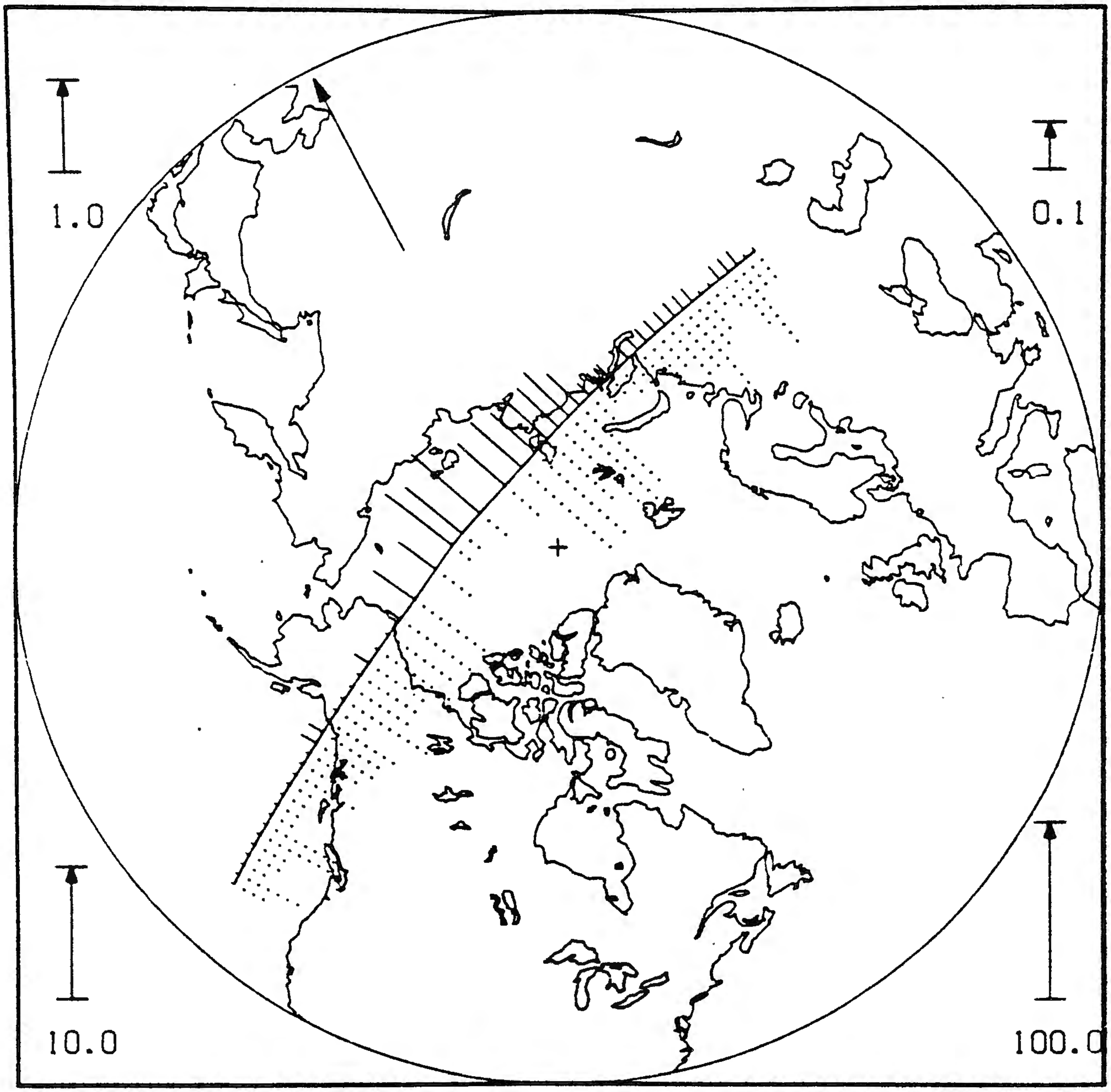
NOAA-8
NORTHERN HEMISPHERE AURORAL PARTICLE ENERGY INFLUX
PASS STARTED AT 1618 UT ON 31 JAN, 1984 ENDED AT 1644



REFERENCE SCALES ARE IN UNITS OF ERGS/CM2/SEC

FIGURE 13

NOAA-8
NORTHERN HEMISPHERE AURORAL PARTICLE ENERGY INFLUX
PASS STARTED AT 0410 UT ON 10 FEB, 1984 ENDED AT 0436



REFERENCE SCALES ARE IN UNITS OF ERGS/CM2/SEC

FIGURE 14

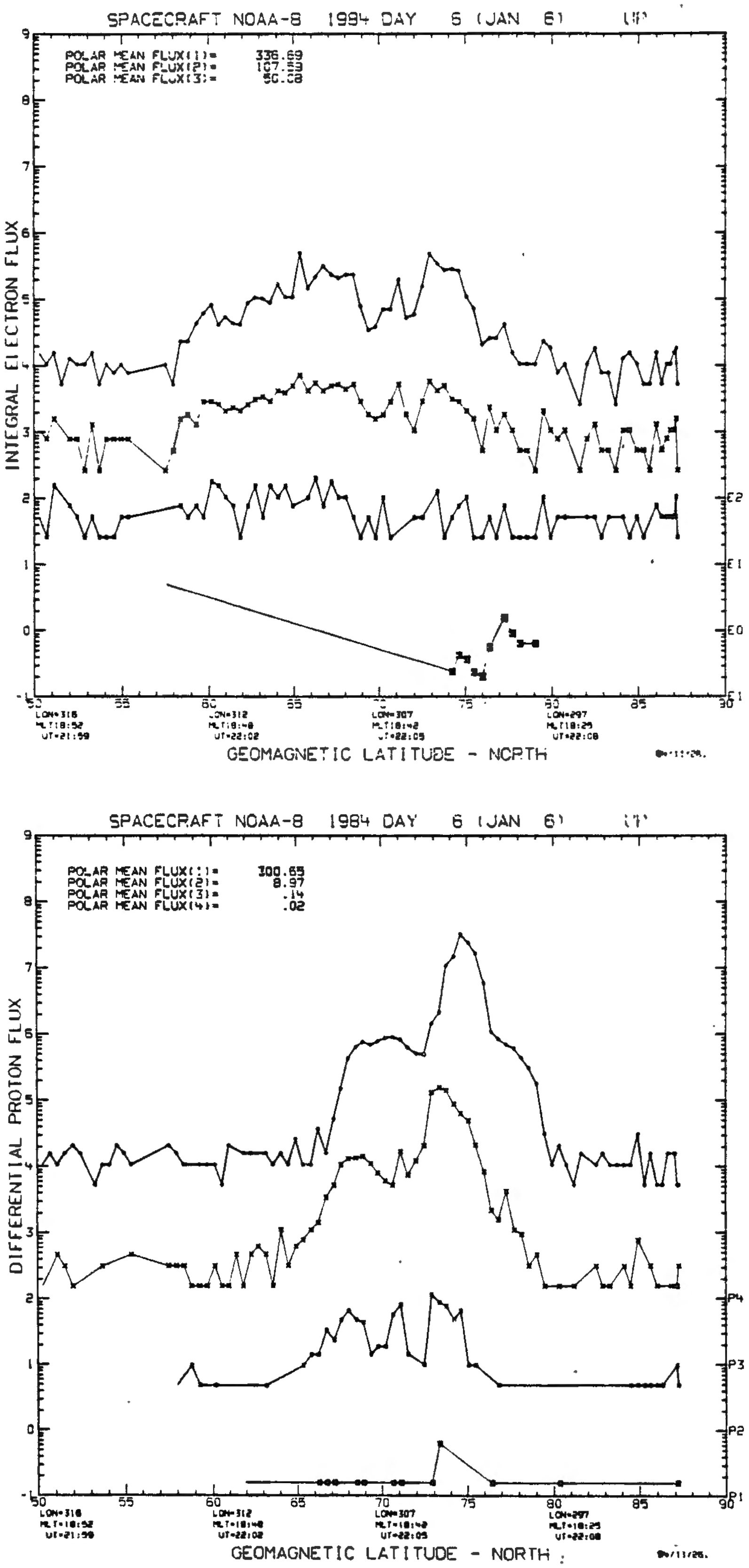

SPACECRAFT NOAA-8 1984 DAY 6 (JAN 6) UP
POLAR MEAN FLUX(1)= 336.69
POLAR MEAN FLUX(2)= 107.53
POLAR MEAN FLUX(3)= 50.08
INTEGRAL ELECTRON FLUX
9
8
7
6
5
4
3
2
1
0
-1
E2
E1
E0
E1
50
55
60
65
70
75
80
85
90
LON=316
MLT=18:52
UT=21:59
LON=312
MLT=18:48
UT=22:02
LON=307
MLT=18:42
UT=22:05
LON=297
MLT=18:25
UT=22:08
GEOMAGNETIC LATITUDE - NORTH
84/11/26.
SPACECRAFT NOAA-8 1984 DAY 6 (JAN 6) UP
POLAR MEAN FLUX(1)= 300.65
POLAR MEAN FLUX(2)= 8.97
POLAR MEAN FLUX(3)= .14
POLAR MEAN FLUX(4)= .02
DIFFERENTIAL PROTON FLUX
9
8
7
6
5
4
3
2
1
0
-1
P4
P3
P2
P1
50
55
60
65
70
75
80
85
90
LON=316
MLT=18:52
UT=21:59
LON=312
MLT=18:48
UT=22:02
LON=307
MLT=18:42
UT=22:05
LON=297
MLT=18:25
UT=22:08
GEOMAGNETIC LATITUDE - NORTH
84/11/26.

FIGURE 15

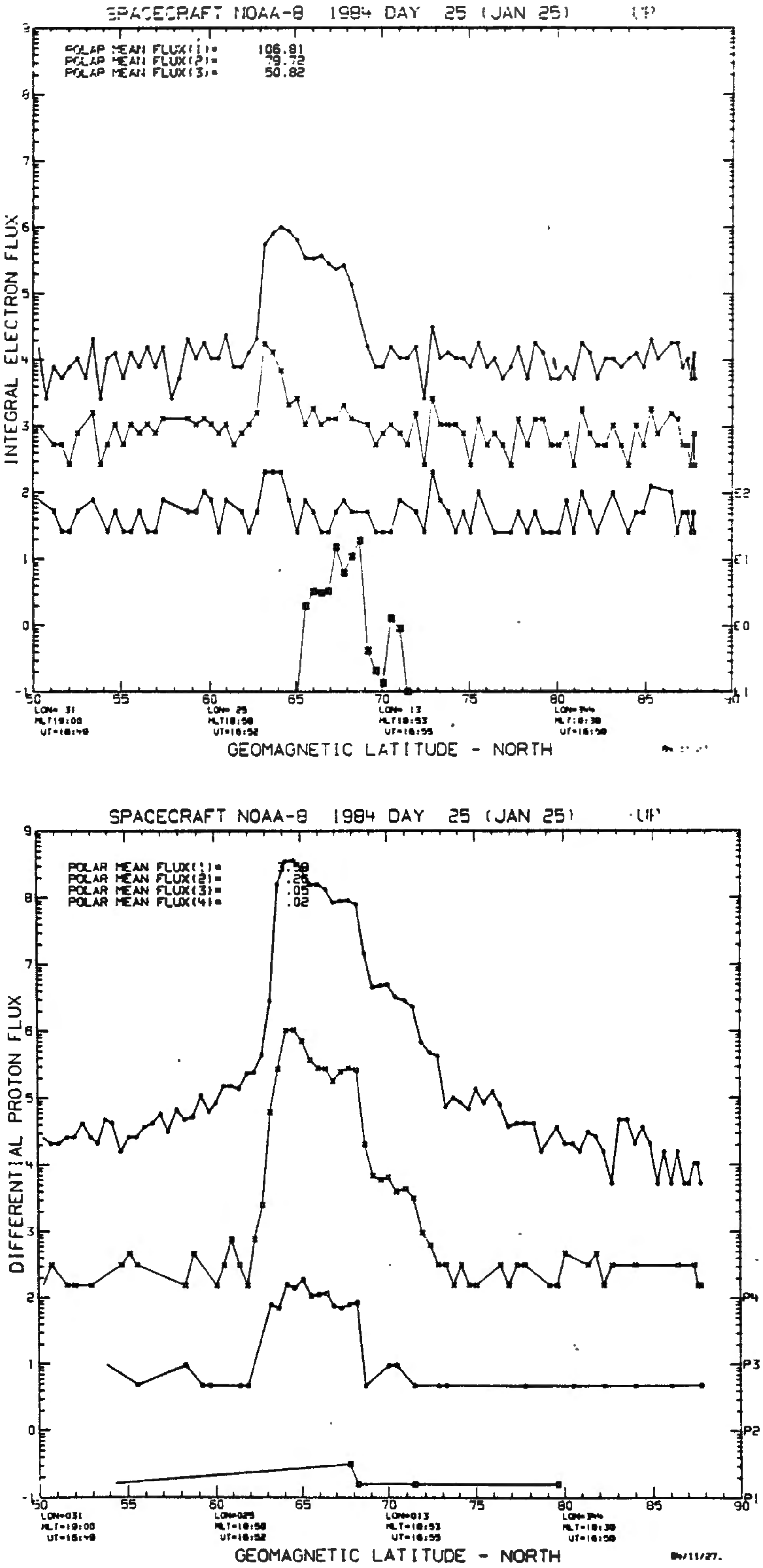

SPACECRAFT NOAA-8 1984 DAY 25 (JAN 25) UP
POLAR MEAN FLUX(1)= 106.81
POLAR MEAN FLUX(2)= 79.72
POLAR MEAN FLUX(3)= 50.82
INTEGRAL ELECTRON FLUX
E2
E1
E0
-1
0
1
2
3
4
5
6
7
8
9
50
55
60
65
70
75
80
85
90
LON= 31
MLT19:00
UT=16:49
LON= 25
MLT18:58
UT=16:52
LON= 13
MLT18:53
UT=16:55
LON=344
MLT:8:30
UT=16:58
GEOMAGNETIC LATITUDE - NORTH
SPACECRAFT NOAA-8 1984 DAY 25 (JAN 25) UP
POLAR MEAN FLUX(1)= 3.58
POLAR MEAN FLUX(2)= .26
POLAR MEAN FLUX(3)= .05
POLAR MEAN FLUX(4)= .02
DIFFERENTIAL PROTON FLUX
P4
P3
P2
P1
LON=031
MLT=19:00
UT=16:49
LON=025
MLT=18:58
UT=16:52
LON=013
MLT=18:53
UT=16:55
LON=344
MLT=18:30
UT=16:58
GEOMAGNETIC LATITUDE - NORTH
84/11/27.

FIGURE 16

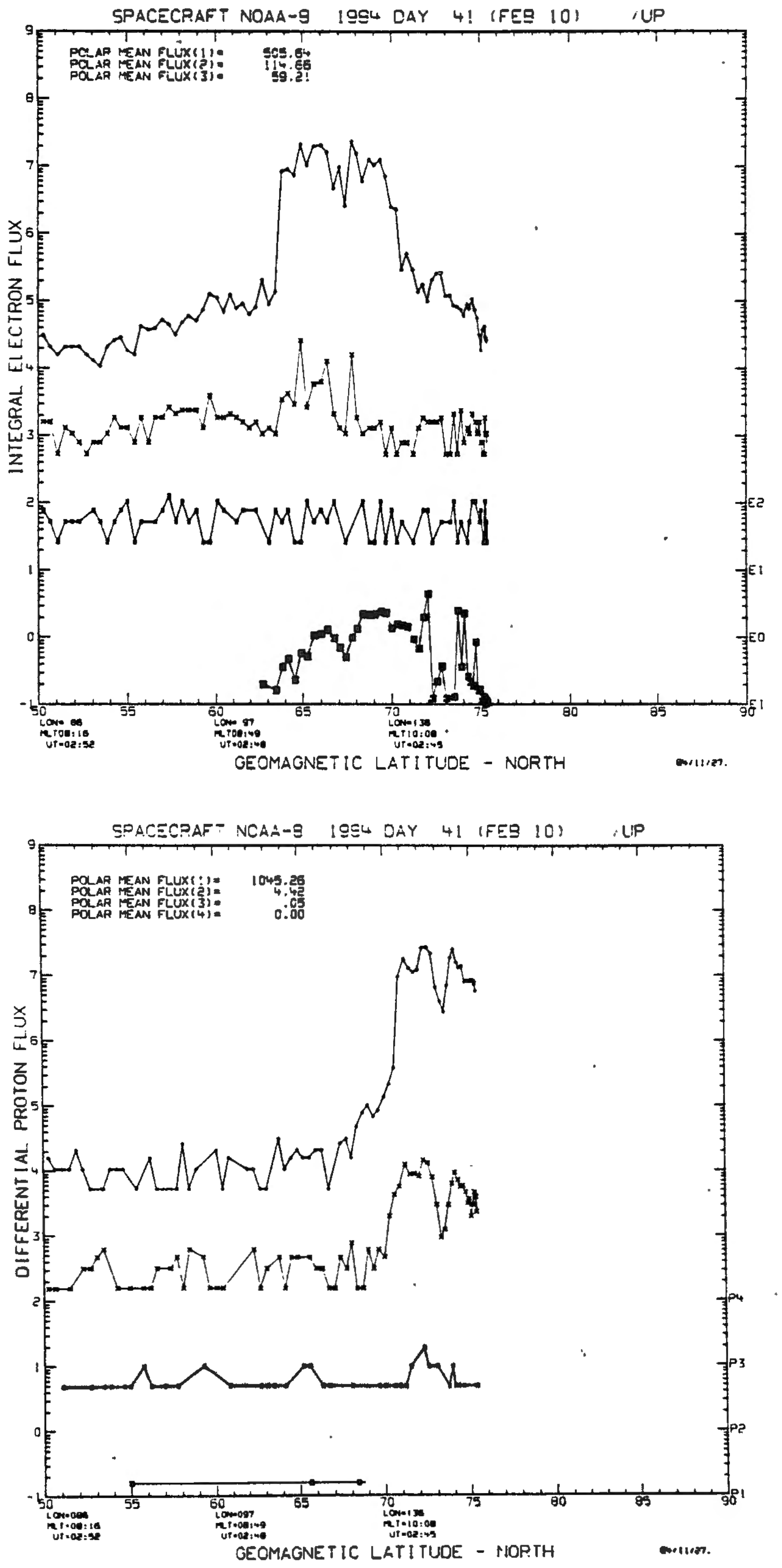

SPACECRAFT NOAA-9 1984 DAY 41 (FEB 10) /UP
POLAR MEAN FLUX(1)= 505.64
POLAR MEAN FLUX(2)= 114.66
POLAR MEAN FLUX(3)= 59.21
INTEGRAL ELECTRON FLUX
9
8
7
6
5
4
3
2
1
0
-1
E2
E1
E0
E1
50
55
60
65
70
75
80
85
90
LON= 86
MLT08:16
UT=02:52
LON= 97
MLT08:49
UT=02:48
LON=136
MLT10:08
UT=02:45
GEOMAGNETIC LATITUDE - NORTH
84/11/27.
SPACECRAFT NOAA-8 1984 DAY 41 (FEB 10) /UP
POLAR MEAN FLUX(1)= 1045.26
POLAR MEAN FLUX(2)= 4.42
POLAR MEAN FLUX(3)= .05
POLAR MEAN FLUX(4)= 0.00
DIFFERENTIAL PROTON FLUX
9
8
7
6
5
4
3
2
1
0
-1
P4
P3
P2
P1
50
55
60
65
70
75
80
85
90
LON=086
MLT=08:16
UT=02:52
LON=097
MLT=08:49
UT=02:48
LON=136
MLT=10:08
UT=02:45
GEOMAGNETIC LATITUDE - NORTH
84/11/27.

FIGURE 17

MORPHOLOGY OF THE IONOSPHERE DURING THE MAP/WINE CAMPAIGN ENERGETIC PRECIPITATING PARTICLE FLUX AS INTERPRETED THROUGH TIROS AND DMSP SATELLITE OBSERVATIONS
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TM No. 851153
11 September 1985
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