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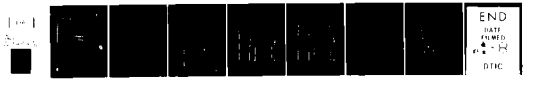

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Search coil magnetometer
Travelling disturbance
Solar flare

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An SSC, following a solar flare of importance 3B, is seen to travel across the AFGL Magnetometer Network from west to east. The disturbance flattens and decays of it propagates like a plane wave with the stations responding in order of their distance from the sub-solar point.

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HIGH-TIME RESOLUTION STUDY OF THE SEPTEMBER 21, 1977 SUDDEN COMMENCEMENT USING AFGL MAGNETOMETER DATA

by

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INTRODUCTION

In this paper the data of Knecht, Hutchinson, and Tsacoyeanes from the AFGL magnetometer network are used to study the sudden commencement of 21 September 1977. The network consists of seven stations producing digital information and returning it to a central collection point at AFGL in Bedford, MA. There are five northern stations at about 55° corrected geomagnetic latitude and roughly equally spaced across the country. From west to east they are in the states of WA, SD, WI, MI, and MA. There are also two southern stations at about 40° CGL, in CA and FL, but the CA station had not been completed by September 1977 and the Wisconsin station was inoperative on 21 September.

Each station has identical instrumentation: a fluxgate magnetometer measuring X, Y, Z, once each second and a coil system measuring $\dot{X}$, $\dot{Y}$, and $\dot{Z}$, five times each second ($\dot{X} = dX/dt$). Z is vertical down, X is along a magnetic meridian pointing north, and Y is orthogonal to X and Z, measuring essentially the D element.

RESULTS

Figure 1 shows an ssc on day 7264, September 21, 1977, at about 2040 UT. Five stations are superimposed. In the X component (bottom panel) there is a sudden decrease followed by a much larger sudden increase. The Y component shows a small increase followed by a large decrease. On this time scale, the X and Y components show nearly simultaneous deflections.

Figure 2 zooms in on the same event in a slightly different format. Each panel shows a different station as indicated by the 2-character codes on the right side. The X component is plotted as a dotted line. Each point is a one second observation. Also shown is the $\dot{X}$ component as a solid line (actually 5 points/sec are plotted). Concentrating attention on the northern stations; WA, SD, MI, and MA, it is evident that the disturbance depicted is traveling across the country from west to east in the sequence WA, SD, MI, and MA. The numbers on the left-hand axis following the word "gamma" are the scale factors for X and $\dot{X}$ respectively. Thus the distance between tick-marks is 23 γ and 258 units of $\dot{X}$. At Washington, ΔX between the minimum and maximum is over 50 γ. Notice that $\dot{X}$ takes on an extreme value whenever $\dot{X}$ passes through zero. This verifies that the zero for $\dot{X}$ has been chosen correctly. Note that the disturbance is sharpest at WA and flattens out and attenuates as we go east.

Figure 3 shows Y and $\dot{Y}$ in an identical format for the same event. In this case the disturbance in Y is smaller than that in X, with scale factors of 12 γ for Y and 211 for $\dot{Y}$. Here again the disturbance is traveling from west to east and flattening out and decaying as it goes, in agreement with the corresponding results for X.

This particular ssc was produced by a very large solar flare of class 3B. Figure 4 gives the details and shows that the shock wave from the sun traveled with an average velocity of 714 km/sec.

Figure 5 shows the location of the stations in a plot looking down on the ecliptic plane over the north pole. Noon is at the top and 1800 UT is on the left. It is the dusk side.

If the disturbance is sweeping across the earth from the sun, we might expect the stations to respond in the order of their distance from the sub solar point, that is WA, SD, FL, MI, and MA, that is, in an easterly direction exactly as observed.

The AFGL magnetometer network was constructed and is operated under the direction of David J. Knecht, Charles W. Tsacoyeanes, and Robert O. Hutchinson. Their cooperation is gratefully acknowledged.

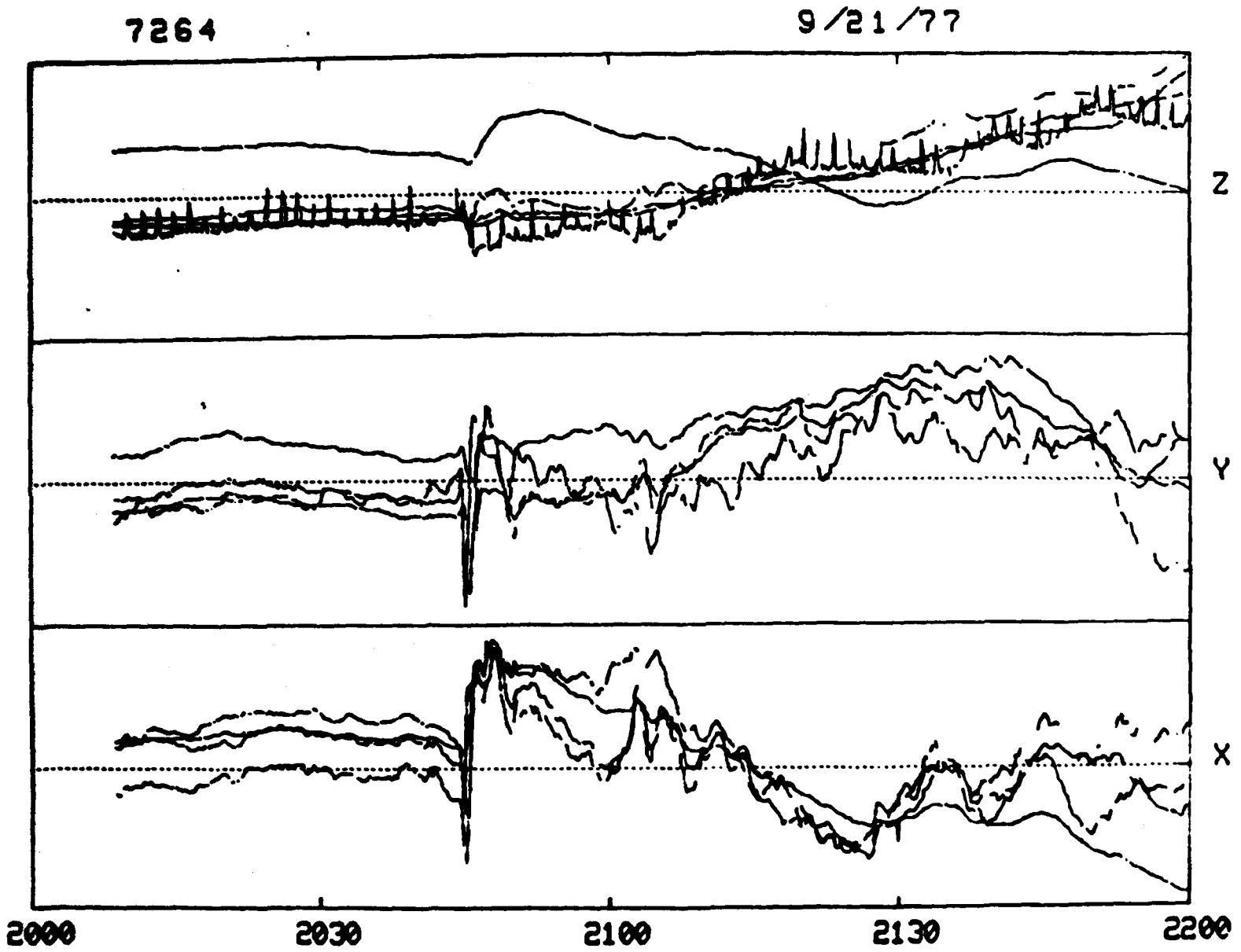

FIGURE 1

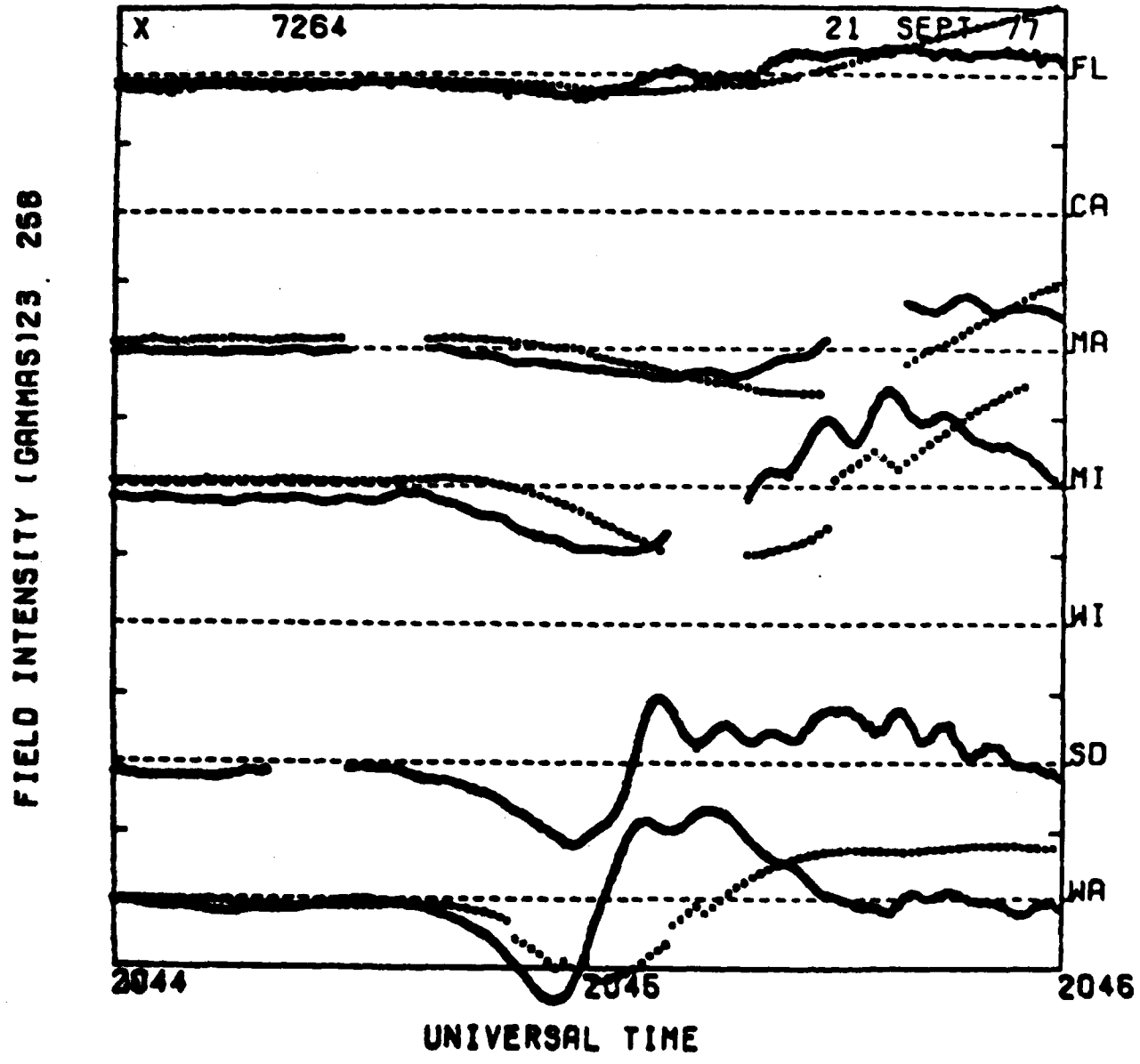
X
7264
21 SEPT 77
FL
CA
MA
MI
WI
SD
WA
FIELD INTENSITY (GAMMAS)23 258
2044
2045
2046
UNIVERSAL TIME

FIGURE 2

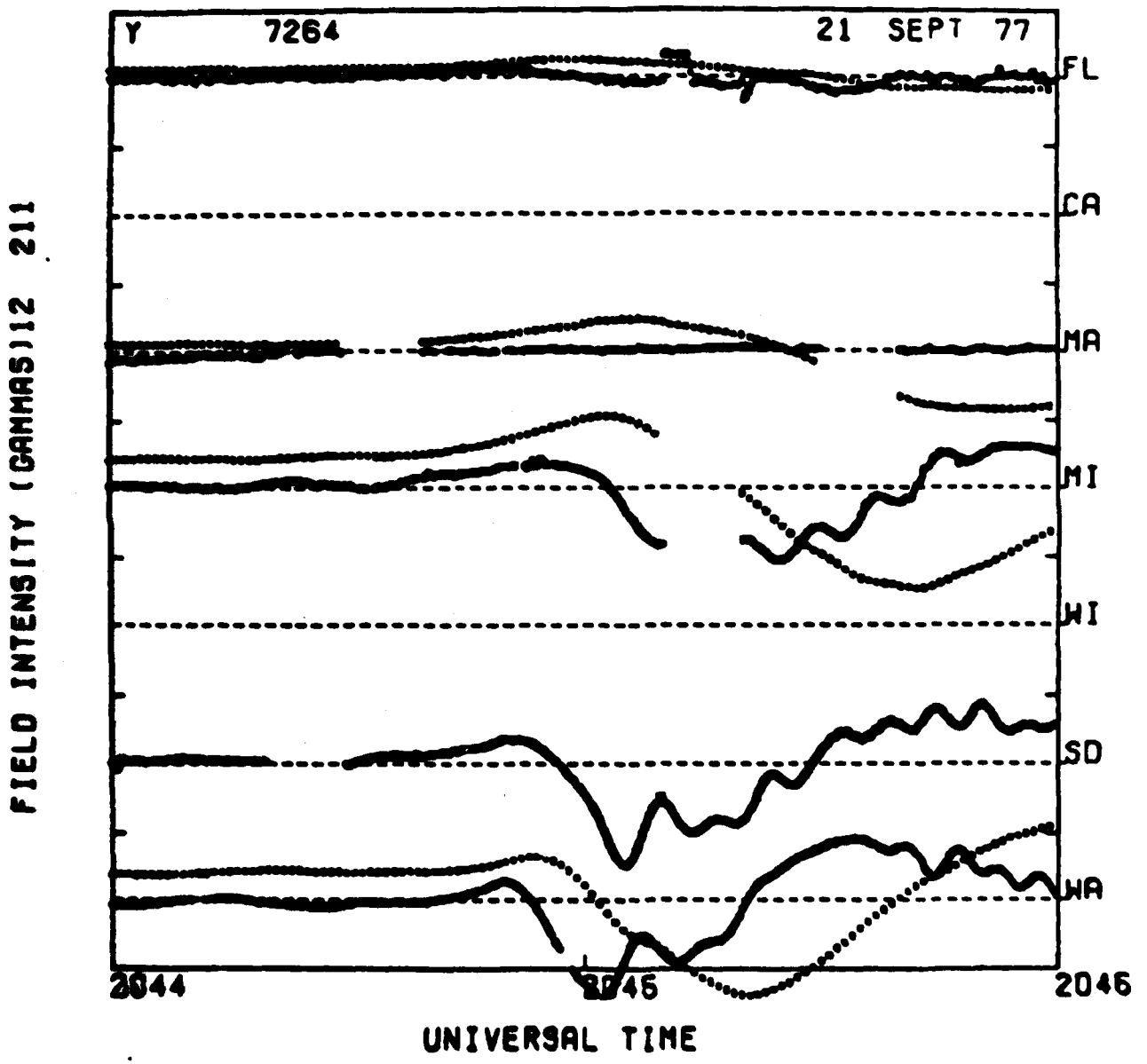
Y 7264
21 SEPT 77
FL
CA
MA
MI
WI
SD
WA
FIELD INTENSITY (GAMMAS)12 211
2044
2045
2046
UNIVERSAL TIME

FIGURE 3

3 B FLARE

19 SEPT 1026Z

REGION 889; N8; L = 197

NEAR WEST LIMB

SSC 21 SEPT 2045Z

$\Delta T \sim 58.32$ h

$$\therefore \text{MEAN VEL} \sim \frac{1.5 \times 10^8 \text{ km}}{58.32 \times 3600} =$$

$\bar{V} \approx 714$ km/sec

FIGURE 4

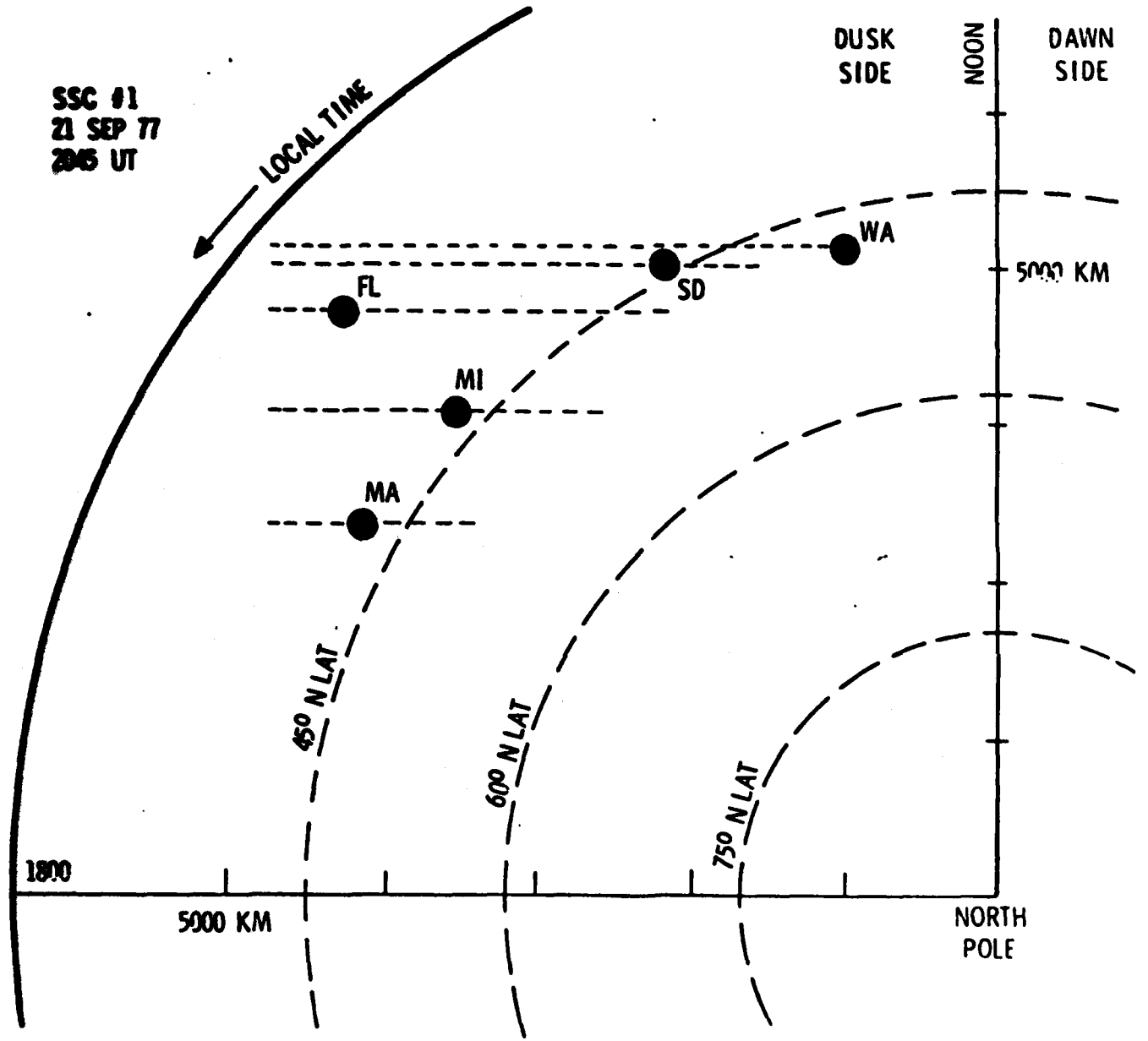
SSC #1
21 SEP 77
2045 UT
LOCAL TIME
DUSK SIDE
NOON
DAWN SIDE
WA
SD
FL
MI
MA
5000 KM
45° N LAT
60° N LAT
75° N LAT
1800
5000 KM
NORTH POLE

FIGURE 5