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# FACE-2 DATA REDUCTIONS AND ANALYSES (PRIOR TO DISCLOSURE OF THE TREATMENT DECISIONS): PART III. S- AND C-BAND RADAR OBSERVATIONS IN SUPPORT OF FACE-2

Raúl E. López
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Office of Weather Research and Modification
Boulder, Colorado
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## ABSTRACT

The two radar systems used in FACE-2 (WSR-57 and MPS-4) are described, together with the data acquisition procedures that were employed in the experiment and the schemes that were developed to process and analyze the raw data collected. Then, a data catalog and a list of the principal parameters used to process the data for each day are presented. Finally, the principal products of the analysis scheme are displayed for each of the GO days of the experiment.

# FACE-2 Data Reductions and Analyses (Prior to Disclosure of the Treatment Decisions)
## Part III: S- and C-Band Radar Observations in Support of FACE-2

Raul E. Lopez, David O. Blanchard, Daniel Rosenfeld[1],

Marjorie J. Casey, and William L. Hiscox[2]

## I. Data Acquisition

### RADARS IN FACE-2

The Florida Area Cumulus Experiment 2 (FACE-2) was performed in South Florida during the summers of 1978, 1979 and 1980. The principal objective of the experiment was to confirm the results of FACE I which indicated that rainfall was increased over a large area (13,000 $km^2$) by selectively treating active cumulus clouds with silver iodide (Woodley et al. 1977, 1982). The principal tool for determining rainfall amounts over the target area consisted of a Weather Service digitized S-Band radar adjusted with a cluster of rain gages. The techniques and procedures used in making the rain estimates are discussed in another report of this series (Barnston, 1981).

It was another objective of the experiment to use the digitized reflectivity data of this same radar to study the overall characteristics and growth processes of the convective clouds in the FACE region and to see if the seeding affected these features. Because of the operational limitations of this S-Band radar, which restricted the scanning to a low antenna elevation, another radar capable of volume scanning was added to the

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experimental setup in order to accomplish this other objective. This was a C-Band digitized system belonging to the University of Miami.

This report contains a description of both radar systems, the data acquisition procedures used, the data processing and analysis schemes that have been developed, a data catalog, tables of the principal parameters used to process the data, and general products of the analyses performed so far. The main idea is to set down explicitly the basic analysis techniques and parameters, and to provide benchmarks in the form of initial analysis products, for the future tests and intercomparisons of the data in advance of the disclosure of the FACE-2 seed/no seed decisions. It is hoped that this report will also prove useful in the investigation of the characteristics and growth processes of the population of convective clouds in the FACE region and the exploration of the possible effects of dynamic seeding on these.

## CHARACTERISTICS OF THE RADARS

The locations of the radars in relation to the FACE target area are seen in Fig. 1. During 1978 and 1979 the two radars were virtually colocated but in 1980 the S-Band set was moved to a position .401 nmi (.743 km) from the C-Band site. The characteristics of the WSR-57 radar are listed in Table 1. This set is owned and operated by the U.S. Weather Service in conjunction with the National Hurricane Center. The radar was maintained to Weather Service standards throughout the FACE effort which means that 90% of the operating systems should have been

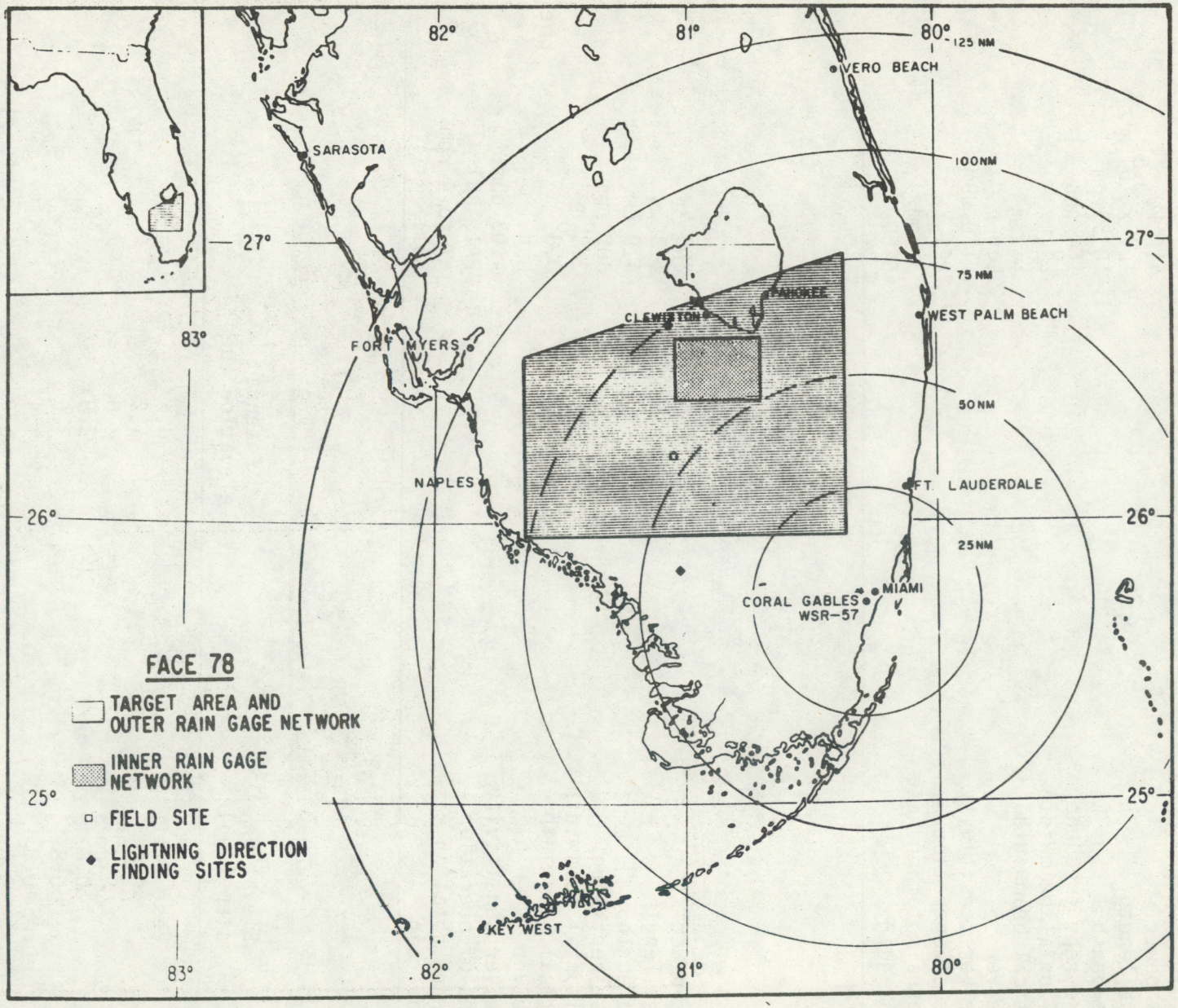



*Figure 1. Location of the two radars used in FACE-2 in relation to the target area.*

*Table 1. Characteristics of WSR-57 Radar*

| | |
|---|---|
| Peak power | 410 kW |
| Pulse length | $1.2 \times 10^3$ m |
| Wavelength | 10.53 cm |
| Pulse rep. frequency | 164 pps |
| Horizontal beamwidth | $2^o$ |
| Vertical beamwidth | $2^o$ |
| Receiver | Log |
| Receiver sensitivity | -110 dBm |
| Mode of operation | PPI |
| Antenna rotation rate | 3 rpm |
| Radar gain | 6460 |

*Table 2. Characteristics of MPS-4 Radar*

| | |
|---|---|
| Peak power | 208 kW |
| Pulse length | 1.3 μs |
| Wavelength | 4.6 cm |
| Pulse rep. freq. | 300 pps |
| Horizontal beamwidth | $3.8^o$ |
| Vertical beamwidth | $0.8^o$ |
| Receiver | Log |
| Receiver sensitivity | -103 dBm |
| Modes of operation | PPI, RHI |
| Antenna rotation rates | ~1 to 4 rpm |
| Radar gain | 8511 |

*Table 3. Radar Antenna Elevations at Which PPI's Were Recorded*

| Elevation step (deg) | Antenna elevation (deg) |
|---|---|
| Base Tilt | 0.4 |
| 0.8 | 1.2 |
| 0.8 | 2.0 |
| 0.8 | 2.8 |
| 0.8 | 3.6 |
| 0.8 | 4.4 |
| 0.8 | 5.2 |
| 0.8 | 6.0 |
| 0.8 | 6.8 |
| 1.2 | 8.0 |
| 1.2 | 9.2 |
| 1.6 | 10.8 |
| 2.0 | 12.8 |
| 2.4 | 15.2 |
| 2.8 | 18.0 |

within ±1 dB of the values in the table. However, ranging and location errors were already present since 1978 and became quite significant in the latter part of the program. Corrections for these errors have been developed and are discussed in subsequent sections. The characteristics of the MPS-4 radar are presented in Table 2. This radar is owned and operated by the Remote Sensing Laboratory of the University of Miami and was made available to FACE through a contract with the University. During 1978 the sensitivity of the radar was very low and only the intense cores of echoes were measured. This problem was corrected in 1979 and 1980. However, difficulties with the recording system of the digitized reflectivity values resulted in considerable data losses in 1979. The MPS-4 had a narrow half power beamwidth of 0.8 deg in the vertical that made it well suitable for echo height determinations. However, the horizontal beamwidth of 4 deg in the horizontal resulted in a loss of resolution in the scanning plane.

## DATA ACQUISITION PROCEDURES

WSR-57. The S-Band radar was operated continuously from 0900 to 2100 EDT and during all the days of FACE-2 except for down time due to malfunction. Data were collected for all days even when seeding operations were not conducted. This data set thus provides a unique opportunity to establish a climatology of the characteristics of the cloud population in the region as seen by radar. The antenna was kept at around 0.5 deg of elevation except for short intervals of time when Weather Service operations required a change in elevation. A full 360$^{o}$ scan was recorded

every five minutes. The data were digitized and recorded on magnetic tape.

The details of the digitization and recording of the return signal are contained in Wiggert and Andrews (1974). For convenience some of the most pertinent details are repeated here: The raw digitized output is written on a 9-track tape at 800 bpi. One record consists of 200 frames of data, 16 frames for housekeeping information, another 200 frames of range bin data and their 16 housekeeping frames, followed by an inter-record gap as seen in Figure 2. Each of the 200 range bins consists of one track for parity (odd) and eight tracks that contain the binary equivalent of a number (from 0 through 255) representing the averaged power received by the radar within one range bin; the radial distance of the first bin from the radar and the length of the range bins are specified in the housekeeping frames. Of the latter the first 11 are allocated for the day number, hour (Eastern Daylight Time), minute, second, antenna azimuth and elevation angles (degrees and tenths), elevation error indicator, gate length, time constant, and range delay. The remaining five frames allocated for housekeeping are unused. The first bin of data then contains a number representing the average power returned from the specified azimuth and range delay; and all the remaining 199 bins lie radially outward from that one at increments specified by the gate length. For FACE-2, a 16 nmi (30 km) range delay, a 1/2-nmi gate length and a time constant setting of 31 pulses were chosen as a reasonable compromise between spatial resolution, areal accuracy in processed results,

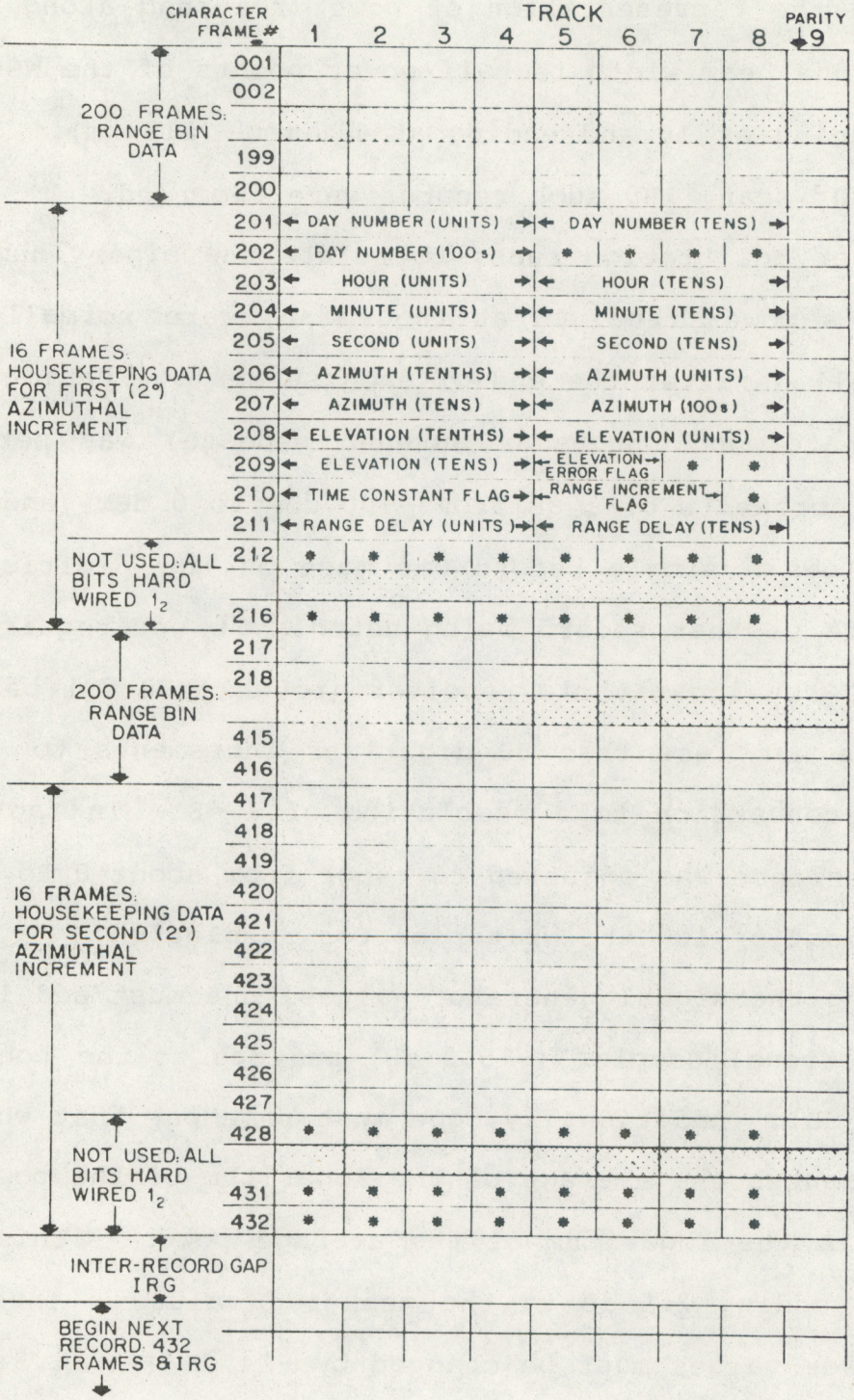



*Figure 2. Siting of one record of WSR-57 digitized data on nine-track tape.*

and desired geographical coverage. Therefore, the 200 frames of data contain the representation of power returned along one $2^{o}$ sector (antenna beam width to half-power points of the WSR-57) at ranges beginning at 16 and ending at 116 nmi (215 km). To cover an entire $360^{o}$ scan, 180 such records were recorded.

Digitizer calibration runs, to relate the binary number in each bin to a power received at the radar, were normally made before as well as after the end of each summer's experiment. The signal generator at the radar antenna pedestal was set at successive increments of 1 dB from -100 dBm to 0 dBm, and for each of these values a single record was made on the digitizer tape with the time of that record being noted. It was required that the range of the logarithmic receiver (roughly 80 dB) be spread over a range not less than 80 digitizer increments to allow unambiguous conversion to a resolution of 1 dB. In fact, the digitizer response was adjusted to range from about 0 to about 255 units, thus satisfying the criterion for resolution.

In using the signal generator values, one must add losses due to the directional coupler (-15.0 dB) and due to the connecting cable (-1.5 dB). Additionally, one must remember that whereas the receiver measures the average of the logarithm of the power, what is desired is the logarithm of the average power. This can be achieved by adding 2.5 dB to the measured values. Thus, all measured power values must be changed by -14 dB (-15-1.5+2.5). A third-order polynomial was fit to the calibration data set. The parameters of this curve were used as input for the programs that process the raw radar data.

MPS-4. The C-band radar program was designed to operate on all GO days from approximately 1300 EDT to at least 6 hours after the first seeding pass, or until the floating target disappeared (usually 1900-2000 EDT). Due to problems with the digitizer and recorder, however, this goal was not completely achieved except in 1980 when data for all GO days were obtained. Data were normally not collected during days when no seeding operations were conducted except for a few days when special projects were being carried on. The radar was operated in a volume scan mode where 15 PPI scans were made and recorded at successive antenna elevations from 0.5° to 18°. The antenna was rotated at about one revolution per 26 sec, producing a complete volume scan in about 7 min. One additional scan was necessary for the antenna to return from top to bottom ( 26 sec). This return scan was also recorded on tape and flagged as such. The start of the antenna motion to new elevations occurred at 120° and ended at about 138° (about 1 sec) on up steps or about 156° (or 26 sec) on the down step.

Table 3 shows the antenna elevations at which PPI's were recorded. This particular scheme was devised so that a minimum vertical resolution of about 8,500 ft was maintained at all ranges up to 100 nmi and at all heights up to 50,000 ft. This minimum resolution is the approximate chord length of the 0.8° beam of the MPS-4 radar at 100 nmi. At closer ranges and lower elevations, the vertical distance between successive PPI cones is much better than 8,000 ft. Data were collected continuously, except during magnetic tape changes and down time. Data for each full PPI scan (360°) were recorded.

The returned power signal was nominally integrated for volumes of 1/2 nautical mile range, $2^{o}$ azimuth and $0.8^{o}$ elevation (vertical beam width). At 300 pulses per second, 31 pulses were integrated over an azimuth segment of $1.9^{o}$. The data were digitized on a scale of 0 to 255 with 8 binary digits. Two-hundred such volumes were integrated and digitized along a given $2^{o}$ azimuth sector. A range delay of 14 nmi was used in 1978, so that data were obtained from 14 to 114 nmi. During 1979, a range delay of 18 nmi was used, and during 1980, it was 16 nmi. The integration and digitization were done over the entire PPI scan, so that 180 groups of 200 data words (of 8 bits) were obtained for each of the 15 antenna elevation positions.

The data words were recorded on nine-track magnetic tape, which was run at 800 bpi. The 200 words along a given $2^{o}$ azimuth sector and the corresponding housekeeping information (16 additional words) constituted a logical record. Two such records were written together as the basic physical record element. The detailed format for these records is shown in figure 3.

To reduce down time for tape changes, as well as tape usage and processing time, a Clear Air Elimination (CAE) circuit was incorporated into the system. This circuit eliminated individual $2^{o}$ logical records that had no valid precipitation data. A variable threshold for digitized power (corresponding to the noise level in the system) was used so that records that did not contain at least one word with the value of this threshold or more were not recorded. The noise level in the digitized data was monitored with a Range Bin Contents Indicator. This device examined and

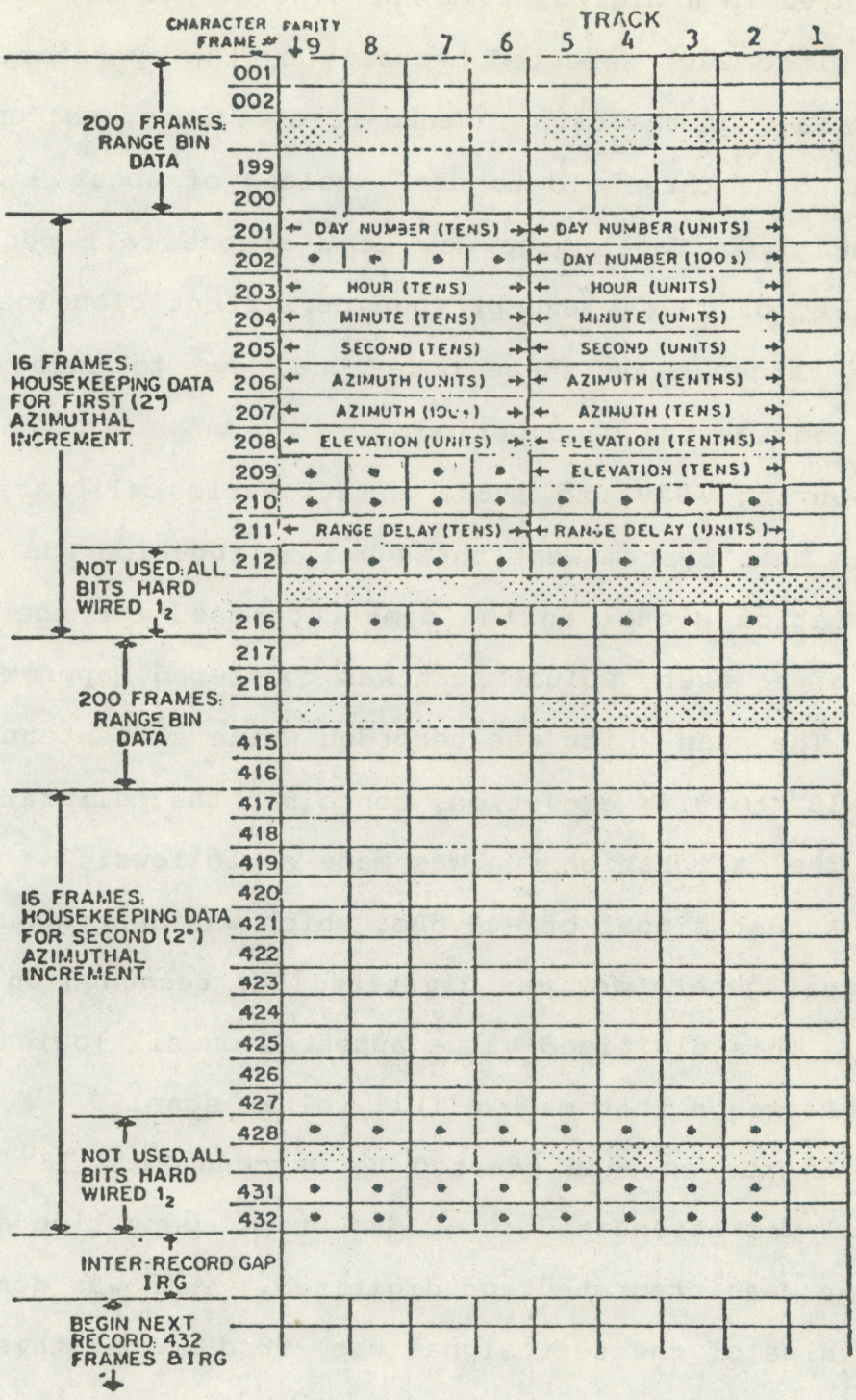



*Figure 3. Siting of one record of MPS-4 digitized data on nine-track tape.*

displayed in a digital form the contents of any range bin or data word (1 to 200) selected manually by the operator. By watching the values of the data in echo-free regions, the operator decided which noise threshold to use. Values of about 9 were used most frequently. Tape usage was kept at one roll per 6 hr in the majority of cases, except when persistent cloudiness existed at close ranges. On these occasions, two to three tapes were required for the same period.

During 1979 and 1980, an automatic calibration system was used. This system went through a calibration run and recorded the calibration signal on the same tape used for the regular video data after every volume scan was completed, approximately every 7 min. The scan which was recorded while the antenna was returning from $18^{o}$ to $0.4^{o}$ elevation, contained the calibration data.

The calibration run was made as follows:

A test signal of -60 dBm, which was continuously applied from a signal generator, was digitized and recorded on the 198th data word. This digitized value appeared on all logical records of the 15 PPI sweeps that made a full volume scan.

As the antenna started to descend from $18^{o}$ to $0.4^{o}$, the signal was attenuated in -2 dBm steps every time a new $2^{o}$ azimuth sector was integrated and digitized. This was done 19 times until the value of the test signal was -98 dBm. At this time the signal returned to -60 dBm on the next $2^{o}$ sector and stayed at that value for all remaining $2^{o}$ words for that and successive PPI sweeps of the next volume scan.

During 1980 the automatic calibration system was improved. As the antenna started down from 18°, the test signal went up to -50 dBm and was subsequently attenuated in -1 dBm steps every time a new 2° azimuth sector was processed. This was done 60 times instead of 19 until the value of the test signal was -110 dBm. At that time the test signal returned to -60 dBm as before. The calibration data were stored as in 1979 but were contained in 60 instead of 20 azimuth records, from 121° to 241°.

The attenuated value of the test signal for every calibration step was repeated and recorded every 20 data words within the corresponding 2° azimuth record, starting with data word number 32. Care was taken to "peak" the signal generator frequently by monitoring the digitized contents of data word 198 where the test signal was applied.

## II. Processing of the radar data

### INTRODUCTION

This chapter explains the steps by which the raw information was eventually converted into echo reflectivity and height data. The first step consisted in determining what was noise and what was valid data. Then the proper calibration curve was determined and applied to obtain returned power values. The radar equation was subsequently evaluated to obtain reflectivity information. It was important to correct the reflectivity values for attenuation of the radar signals and for biases introduced by the configuration of the system and anomalous propagation. The data were further corrected for positioning errors, especially as they pertain to the location of echoes within the target area. Echo height computations involving an elaborate algorithm completed the processing.

### NOISE

Noise in the returned power that was digitized and recorded can be attributed to a number of factors. Spurious returns from clear air were indeed a source of noise, but the major contributions to noise probably came from the radar and digitizer electronics. True noise is expected to fluctuate randomly around a small value. A frequency distribution of digitized, returned-power values should show an approximately normal curve for the low values and scattered smaller frequency peaks for the much higher real returns.

In order to determine the noise level, the data were processed to obtain a frequency distribution of the digitized values. Base scans (i.e., ~ 0.5 deg tilt) were examined for the WSR-57; for the MPS-4, both base scans and 18.0° tilt scans were examined. Noise was generally defined to be all digitized values less than or equal to the mean plus three standard deviations of the approximately normal distributions of the small digitized values. For the MPS-4, there were occasionally differences between the determined noise level for the base scan and the 18.0° scan. In these cases, an average of the two values was used. On days exhibiting widespread, weak-to-moderate rainfall, the standard deviation was large, giving an inaccurate value for the noise. On these days the frequency distribution was carefully examined and a value that was felt to more accurately represent the extent of the noise was selected. In some cases, the noise for the MPS-4 radar was noted to increase substantially at the middle and high tilt angles. This effect was not seen to be related to meteorological factors. In order to account for this effect, an increased noise level was used for non-base scan tilts. Best results were obtained when the noise level was five digital counts above the low tilt angle. Once determined, the noise thresholds were placed in the radar data software to set to zero all those values assumed to be noise.

## CALIBRATION DETERMINATION

The procedure in 1979 and 1980 for determining which calibration to use for the MPS-4 was as follows. The test signals

for all recorded azimuths at 0.4° elevation of each volume scan were averaged. The same procedure was followed for each 18.0° scan. Thus, two time series of the average test signal were obtained for each day. The 0.4° and 18.0° elevation scans were used because they came before and after the calibrations. The resulting information was examined to determine those time intervals when the signal generator was peaked with respect to the radar. The calibrations corresponding to these time intervals were used. If the calibrations showed only slight differences during the course of the day, only one representative calibration was used. However, if the changes were significant, different calibrations were used for different time intervals. Most days, however, required only one calibration. In addition, the day-to-day variation of the calibrations was small; nevertheless, each day was assigned its own calibration.

The procedure was different for the 1978 MPS-4 data. No automatic calibrations were taken, nor was a test signal present. Calibrations were generally taken prior to and just after data collection. Calibrations were also taken any time adjustments were made to the radar system. The calibration data were extracted and plotted. If the calibration curves showed only slight differences from the beginning to the end of the day, the average calibration was used. However, if the changes were significant, different calibrations were used for different time intervals. The determination of the correct calibration for each interval was made with reference to the operators' log and detailed inspection of the data. In general, the calibrations

varied more from day to day in 1978, than in either 1979 or 1980. Having determined which calibration to use, a third order polynomial was fit to the data pairs (DVIP, dBm). The resulting coefficients were then used as part of the input stream in the data processing programs.

## COMPUTATION OF RADAR REFLECTIVITY AND RAINFALL AMOUNTS

A radar reflectivity was computed for every video data point whose digitized value was above the noise level. The first step in this computation consisted in the assignment of a returned power to the digitized value recorded. This was done through the use of the proper calibration curve. At the beginning of the processing of each day's data (or portions of a day if different calibrations were used), the equation of the calibration curve was evaluated for all possible digitized values (0 to 255). The matrix of the resultant power values was stored and used for the quick transformation of each of the non-noise data points to the corresponding returned-power value (in dBm) which was originally detected at the radar. At this step a correction of 16.5 dBm for power losses in the wave guides was introduced in the case of the WSR-57. The calibration data for the MPS-4 already accounts for those losses.

The second step involved the computation of the radar reflectivity corresponding to the measured returned power value. This was done using the radar equation in the form

$$Z\ (\text{dBz}) = \overline{P}_r\ (\text{dBm}) + 20 \log r\ (\text{km}) + C, \qquad (1)$$

where C=70.7 for the MPS-4 and C=72.9 for the WSR-57 radar.

This equation was obtained from

$$\bar{P}_r = \frac{\pi^3 P_t G^2 \Theta \phi h /K^2/}{1024 \ln 2 \lambda^2 r^2} Z_e , \qquad (2)$$

where $\bar{P}_r$ is the returned and $P_t$ the transmitted power both in m watts, G the gain of the radar, $\Theta$ and $\phi$ the horizontal and vertical half-power beamwidths in radians, h is the pulse length in meters, $/K^2/$ the dielectric constant, $\lambda$ the radar's wavelength in meters, r the range in meters, and $Z_e$ the equivalent target reflectivity in cubic meters ($m^6/m^3$). The values used to obtain the first equation were as given in Tables 1 and 2. This equation contains a correction of 2.5 dBm to account for the fact that the receivers of both radars are logarithmic and the digitizers average the logarithm of power instead of power itself.

The resulting value was then compared with the reflectivity threshold used to eliminate the range bias in reflectivity as discussed in the following sections. If it was equal or greater than the threshold it was saved; otherwise it was discarded. In case of different noise values for different antenna elevations, a corresponding reflectivity threshold was used. The saved values were put into a matrix which amounted to a reflectivity map of the region of interest (either the northwest quadrant or the target area). Usually the 1.2-deg scan was chosen for this map in the case of the MPS-4. The reflectivity of non-noise data points of scans at other elevations was also computed in order to determine if the height information should be used according to whether the reflectivity of the elevated point was above the threshold for

that elevation or not. Except in the case where an RHI section was desired, the reflectivity information of higher scans was not saved. In the case of the WSR-57, the reflectivity map corresponded to an antenna elevation of 0.5 deg. No other antenna elevations were used in the normal operating mode of this radar. The reflectivity maps for either radar formed the basic data set used for subsequent computations.

In cases when a rainfall rate was needed the FACE Z-R relationship was used, namely

$$Z_e = 300\ R^{1.4}, \tag{3}$$

where $Z_e$ is the equivalent reflectivity in $mm^6/m^3$ and R the rainfall rate in mm/hr.

## ATMOSPHERIC ATTENUATION CORRECTIONS

The reflectivity values for the MPS-4 radar were corrected for the attenuation produced by atmospheric water vapor and oxygen. The correction was computed using the Van Vleck (1947a, b) theory of absorption as updated by Bean et al. (1970).

The oxygen absorption in decibels per kilometer for standard temperature and pressure ($T=293^{o}$ K, P=1013.25 mb) is given by

$$\gamma_1 = \frac{0.34}{\lambda^2}\left[\frac{\Delta\nu_1}{1/\lambda^2 + \Delta\nu_1^2} + \frac{\Delta\nu_2}{(2 + 1/\lambda)^2 + \Delta\nu_2^2} + \frac{\Delta\nu_2}{(2 - 1/\lambda)^2 + \Delta\nu_2^2}\right], \tag{4}$$

where $\lambda$ is the radar wavelength in cm, and $\Delta\nu_1$ and $\Delta\nu_2$ are line-width factors of oxygen absorption lines in the range of 100 to 50,000 MHz in units of $cm^{-1}$.

The water-vapor absorption in dB/km at 293 K is, in addition, given by two terms

$$\gamma_2 = \frac{3.5 \times 10^{-3}}{\lambda^2} \rho \left[ \frac{\Delta\nu_3}{(1/\lambda - 1/1.35)^2 + \Delta\nu_3^2} + \frac{\Delta\nu_3}{(1/\lambda + 1/1.35)^2 + \Delta\nu_3^2} \right] \quad (5)$$

$$\gamma_3 = \frac{0.05\ \rho}{\lambda^2}\ \Delta\nu_4, \quad (6)$$

where $\rho$ is the absolute humidity in $g/m^3$, $\Delta\nu_3$ is the line-width factor of the 1.35 cm water-vapor absorption line, and $\Delta\nu_4$ is the effective line width of the absorption bands above the 1.35 cm line.

The line-width factors depend on the temperature, pressure, and water vapor density. The following expressions are given by Bean et al. (1970):

$$\Delta\nu_1 = 0.018 \frac{P}{1013.25} \left(\frac{293}{T}\right)^{3/4} \quad (7)$$

$$\Delta\nu_2 = 0.049 \frac{P}{1013.25} \left(\frac{300}{T}\right)^{3/4} \quad (8)$$

$$\Delta\nu_3 = 0.087 \frac{P}{1013.25} \left(\frac{318}{T}\right)^{1/2} (1 + 0.0046\ \rho) \quad (9)$$

$$\Delta\nu_4 = 0.087 \frac{P}{1013.25} \left(\frac{318}{T}\right)^{1/2} (1 + 0.0046\ \rho) \quad (10)$$

Similarly, the multiplying factor in the expressions for $\gamma_1$, $\gamma_2$, and $\gamma_3$ are temperature and pressure dependent as follows:

$$\frac{0.34}{\lambda^2} \frac{P}{1013.25} \left(\frac{293}{T}\right)^2 \quad (11)$$

$$\frac{0.0318\ \rho}{\lambda^2} \left(\frac{293}{T}\right)^{5/2} e^{-644/T} \quad (12)$$

$$\frac{0.05\ \rho}{\lambda^2} \left(\frac{293}{T}\right) \quad (13)$$

Using the above formulation, the 2-way gas attenuation was computed for each of the 200 radial positions of the reflectivity data taken in the base scan (normally at an antenna elevation of $1.2^{\circ}$). The height of each of the 200 data positions was calculated and the pressure, temperature, and absolute humidity of that height were interpolated from the average Miami sounding for the summer (Jordan, 1957). An attenuation increment is computed for a path of 0.5 nmi (the data-bin length) at each position. The total gas attenuation for each data point is then obtained by summing up the doubled attenuation increments from the radar location up to the point in question. This correction is added subsequently to the reflected power (in dBm) of the data bins as obtained from the raw data.

In the case of RHI cross sections derived from the volume scan data, the attenuation was computed for each of the 200 data positions of each of the 15 antenna elevations. The appropriate temperature, pressure, and absolute humidity corresponding to the height of each data point was obtained from the mean Miami summer sounding.

INTERVENING RAINFALL ATTENUATION CORRECTION

Because of the relatively small wavelength (4.7 cm) of the MPS-4 a correction was introduced to try to account for the attenuation produced by intervening rainfall between the radar and the point being analyzed.

The 2-way attenuation due to hydrometeor particles in dB per km can be written as

$$\gamma = .8686 \sum_{vol} \sigma_i \quad , \tag{14}$$

where $\sum_{vol} \sigma_i$ is the scattering cross section due to the particles present in a unit vol (in units of $cm^2/m^3$). This cross section can be obtained by adding up the cross sections of all particles present in one $m^3$. When the size frequency distribution and the scattering cross section are known for each particle class, the calculation can be made.

The cross sections can be calculated for water drops of different sizes using Mie theory. In particular, Stephens (1961) has evaluated radar cross sections for water spheres of different diameters, using the complete Mie theory for wavelengths ranging from 0.43 to 16.23 cm and a temperature of $18^{\circ}$ C. His values for a radar wavelength of 5 cm have been used to compute hydrometeor attenuation.

The drop size distribution, however, is dependent on the type of cloud intercepted and on the intensity of the precipitation. Typical drop size distribution for clouds in the South Florida area during the summer were used, stratified by different rainfall/radar reflectivity classes.

The size distributions were obtained during previous FACE experiments, and their characteristics have been discussed by Cunning (1976). Ten different rainfall classes were used ranging from a few mm/hr to more than 70 mm/hr. A mean distribution was obtained for each rainfall class (normally of a 5-mm/hr spread). The particle diameter intervals of the distributions were .025 cm wide. The cross section for the mid-point diameter of each interval was interpolated from Stephens' tables, and the total attenuation of the rainfall class obtained by summing up the products of the number of particles per $m^3$ in each size class and its corresponding particle cross section.

The result of this exercise was a table of unit attenuation values (dB/km) versus rainfall/reflectivity amounts. A logarithmic function was fitted to this table, producing the equation

$$A = 3.07 \times 10^{-5} Z^{.83}, \qquad (15)$$

where A is the 2-way attenuation (dB/km), Z the radar reflectivity in $mm^6/m^3$, and the rainfall rate is related to the reflectivity by

$$Z = 365 R^{1.41}. \qquad (16)$$

With this formula the unit attenuation produced by a shower of a given reflectivity can be found.

For every nonzero reflectivity data point along a given radial an attenuation increment was computed for a path of 0.5 nmi (the data-bin length) according to the uncorrected reflectivity of the point. The total rainfall attenuation for a given point was obtained by summing up the attenuation increments in the interval

from the radar location up to the point in question. This total correction is added to the reflected power (in dBm) that has been initially obtained from the raw data.

The corrected reflectivities were not used to estimate the attenuation of the next points along the radial. Rather the uncorrected estimates of the reflectivity were held fixed while the attenuation corrections were made. This procedure may underestimate the true effect of rainfall attenuation; however, this method can avoid unrealistically large corrections that can occur if the adjusted value (always upward) at one point is used to compute the attenuation correction of the next point and so on. This could be so because small errors in the correction formulation can result in significant errors in the estimates of reflectivity at remote ranges since the error accumulates with distance from the radar.

## RANGE BIAS CORRECTION

The next step in processing the data was to correct the range bias of the reflectivity. This range bias results mainly from the fact that the intensity of the returned power from weak, distant targets falls either below the level of the minimum detectable signal or within the noise level of the system. As a result, only moderate and strong targets at large distances were detected, and a plot of dBz values versus range showed the average dBz increasing with range.

The correction procedure used the radar equation, calibration, and noise as input. The minimum reflectivity value

at the most distant data bin that would have produced a return signal just above the noise level was calculated. Any echo whose reflectivity fell below this value was neglected. Although some valid data were rejected in this procedure, the range bias was eliminated and the final data set was more statistically reliable. For the MPS-4 radar, in which two different noise values were used (one for the base scan, another for higher elevations) two corresponding reflectivity thresholds were used to correct for the reflectivity range bias.

Similarly, owing to curvature of the earth, a range bias in the minimum detectable target height was present. This situation was corrected by rejecting echo heights below the minimum height that could possibly be detected at the farthest range of interest. A uniform height threshold of 3 kilometers was employed.

## ANOMALOUS PROPAGATION

Especially in the latter part of the afternoon, and on occasions when divergent downdrafts from large mature clouds are occurring, anomalous propagation (AP) of the radar waves can obliterate considerable parts of the echo field. Under these conditions, large ground return areas can be seen beyond the usual ground clutter region. Normally, data were not used within 30 nmi of the radar location to eliminate ground clutter. On the occasions when AP was detected, however, this minimum range was extended to exclude questionable or contaminated data.

AP is normally confined to PPI scans taken at low elevation. The WSR-57, operating at a 0.5-deg antenna elevation, was affected

considerably. The MPS-4 usually was not affected when operating at an antenna elevation of 1.2 deg or more (the elevation used for base scan). A comparison of the base scans of the two radars provided a guide in determining the presence and extent of AP in the WSR-57 data. This was done whenever there were simultaneous observations from both radars. On other occasions the base scans of the WSR-57 were inspected visually for signs of AP. At that time a determination was made of the minimum range that should be used in order to eliminate questionable echoes. The values used for each day are contained in Table 7 (see sec. IV).

## WSR-57 POSITION ERRORS

It was discovered in 1980 that the WSR-57 data had position errors, both in range and azimuth. Further investigation revealed similar errors for all three years of FACE II. The azimuth errors differed from year to year and were noted to be at least partly related to the direction of antenna rotation. The range error generally increased in time until the radar was recalibrated. Corrections for GO days and certain other days were calculated (Barnston et al., 1981). These corrections in both azimuth and range were then inserted into the input stream for data processing.

## TARGET AREA PROCESSING

In order to determine the effects of dynamic seeding, only data lying within the target area were processed. To accurately determine the boundaries of the target area, the ranges of the

borders of the area were calculated from the basic fiducial points defining the target area. These values were then bracketed with a buffer of 1/2 nautical mile (one data bin). Data not falling within the prescribed area were not processed.

## HEIGHT COMPUTATIONS

Equations used. The MPS-4 scanned the FACE region at 15 different elevation angles. From this information it is possible to reconstruct the three-dimensional structure of the echo field. In order to do that, two basic parameters are needed: the height of each data point in each of the 15 scans that contains a non-noise return, and its vertically projected position along the surface of the earth. In that way, slanted PPI sections through an echo can be colocated and the maximum height and vertical structure of the echo determined.

If a radar ray propagated in free space its path would be a straight line. However, the radar refractive index of the atmosphere decreases with height, and a radar ray propagating through the atmosphere becomes curved, concave downward. A correction for this ray bending becomes necessary. Apart from the geometry of the problem, the major complication lies in the specification of the refractive index of the particular atmosphere with height. There are two basic approaches to this problem: either to construct a simple model atmosphere, or to calculate the refractive index profile from a mean atmosphere for the region and time interval of operations. In view of the uncertainties associated with the side lobes problem, noise fluctuations of

higher scans, the large horizontal width of the radar beam, and the large day-to-day fluctuations in the temperature and moisture profile, it was felt that a simple model atmosphere would be sufficient to compute the ray-bending corrections. It should also be stressed that the main use of these data is to ascertain differences between seeded and unseeded clouds and not so much to determine absolute parameters for them. Accordingly, it was assumed that the refractive index is a function only of height above the surface of a smooth spherical earth and that the vertical gradient of the index of refraction ($\frac{dn}{dh}$) is linear and equal to $-4 \times 10^{-8} m^{-1}$, corresponding to the standard atmosphere (Battan, 1973).

If an echo is detected at a data point located at an apparent range R and elevation $\alpha$, the apparent height $H_a$ above the surface of the earth can be obtained by applying the law of cosines to the triangle defined by the apparent straight ray from the radar to the target R (assuming the radar is on the surface), the line segment from the target to the center of the earth (of length $H_a + r_o$), and a radius from the center of the earth to the radar (length $r_o$). The apparent height would thus be

$$H_a = \text{SQRT}\left[r_o^2 + R^2 + 2 r_o R \cos(90^o + \alpha)\right] - r_o. \qquad (17)$$

In this equation R corresponds to the center of the region represented by the data point. The height error due to bending can be approximated (Moreland, 1965) by

$$E_H = \left(\frac{R^2 - H_a^2}{2}\right)\left(\frac{1}{r_o} - \frac{1}{r_e}\right) = H_a - H\,, \qquad (18)$$

where $r_e$ is the fictitious effective earth radius over which the

curved rays would appear as straight lines and H is the true height. This effective radius can be calculated (Battan, 1973) as

$$\frac{1}{r_e} = \frac{1}{r_o} + \frac{dn}{dh} . \tag{19}$$

Under the assumption of the linear model made before,

$$r_e = \frac{r_o}{1+r_o\left(\frac{dn}{dh}\right)} \doteq \frac{4}{3} r_o . \tag{20}$$

The corrected height can thus be obtained as

$$H = H_a + \frac{H_a^2 - R^2}{8r_o} . \tag{21}$$

The true range to the target along the curved ray also differs from the apparent slant range R. This correction, however, is usually very small (maximum error would be of the order of 200 m for the typical ranges encountered), and was neglected in the computations. Applying the law of cosines to the corrected triangle represented by the center of the earth, the radar, and the true target portion (assuming true range equals apparent range), one can compute the angle sustained by the earth surface from the radar to a point directly underneath the target as

$$\alpha = \arccos\left[(r_e^2 + (r_e+H)^2 - R^2)/2r_e(r_e+H)\right]. \tag{22}$$

From this, the distance S from the radar to the vertically projected position of the target along the surface of the earth can be obtained from

$$S = \phi \cdot r_o , \tag{23}$$

where $\phi$ is expressed in radians.

The height that is calculated for a data point in equation (21) corresponds to the height of the center of the radar beam at that particular elevation and range. In the case when an echo is not recorded in the data point directly above, it can be said that the maximum height of that echo is probably between the lowest limit of the beam at the elevation in question and the lowest limit of the beam at the next higher elevation. The most likely height is probably the midpoint between those two positions. If the two vertically adjacent beams were separated by only one beamwidth, the most likely height would fall in the center of the lower beam. In order to estimate the midpoint height in the general case it is necessary to compute also the height of the low edge of the beam (0.4 deg lower than the antenna elevation) at a position vertically underneath the data point in question. The position of the desired point is determined by the elevationangle $\alpha'=\alpha-0.4$ deg and its vertically projected distance along the surface of the earth S. A fast and accurate way of obtaining this height is to use the integration of the equation for the path of the beam (Battan, 1973) in terms of the equivalent earth radius:

$$H_{low} = \frac{S^2}{2r_e} + S\alpha' , \qquad (24)$$

where $\alpha'$ is expressed in radians.

Computation procedures. For every valid data point a height H and a distance S along the surface of the earth were initially computed. Each point was assigned to a particular data bin along a radial leg, according to its S value. Each bin was 1 km long and 2 degrees wide lying on the surface of the earth. The height

of the position on the lower side of the beam that falls vertically underneath the data point was computed using eq. 24 together with the height of the position on the lower side of the next beam directly above the point in question. The average height of these two vertically stacked positions was used as the temporary most-likely height of the echo represented by the data point being processed. If no other valid data points were assigned to this particular bin, the temporary height was used as the final most-likely height of the echo over that position. If during the processing of the next-elevation scan, a data point is assigned to a data bin already containing a height, the newly computed (and tallest) height supplants the previous temporary (and lower) height. In the case when points along one ray are assigned to the same bin, the average of the temporary heights from the two points is attributed to the bin. After processing the entire volume scan, the collection of all data bins and their heights constituted a map of maximum echo heights projected onto the surface of the earth. This map can be viewed as a height contour map of the echo field.

## III. Data Analysis Procedures

### ANALYSIS PROBLEMS

Basic analysis tools have been developed for the examination of the radar data. The main difficulty in the analysis of extensive digital radar data is to reduce the many dimensions and parameters to a simpler set that can be easily handled and that summarizes the salient features of the data. For example, one of the volume scans of the MPS-4 taken every 7-8 minutes contains 200 data points for every one of 180 radials (taken at 2-deg intervals) and for each of 15 different antenna elevations--540,000 data points in all. One solution to this problem consisted in the preparation of echo height maps that represent the maximum echo height above each point of the earth's surface in a given location. Similar maps were constructed for the reflectivity in the base scan.

Another problem has to do with time-space representation. In this case time series of the key average parameters of the echo and cell populations, and of average radar echo quantities over the target area, were prepared. These time series portray the variation of mean properties but obliterate the cell and echo population characteristics. To avoid this, frequency distributions of key parameters were prepared. These distributions were stratified by time periods or echo types.

The following sections contain a brief description of each of the basic analysis procedures mentioned already. The principal products resulting from these analyses, however, are presented for each day in Chapter V.

## HEIGHT AND REFLECTIVITY MAPS

These maps were basic to the further analysis of the data. Their preparation has been described in the data processing chapter. Basically they consisted of arrays representing positions along the surface of the earth and containing the radar reflectivity field of the lower scan used and the maximum height of echoes over the particular position. Although the vertical structure was lost, these maps provided a convenient summary of the height characteristics of the echo field and its rain producing ability.

The maps were arranged on a polar grid that resembled closely the original data grid of the lower scans: the data were assigned to bins having a radial length of 0.5 nmi and a breadth of 2 degrees in azimuth. For display purposes these maps were reduced to bins 1.0 nmi long. For most applications only the northwest quadrant of the scans or the target area were processed. These maps provided the basic data files used in the other analyses.

## TIME SERIES OF AVERAGE CLOUD FIELD PROPERTIES

The basic radar parameters in the height and reflectivity maps were area-averaged over the region of interest and arranged in various time series. The main variables used were reflectivity, area cover, height, and rainfall rate. In addition, series were constructed of the maximum reflectivity, height, and rainfall rate which were observed in the region during each particular scan. These series were useful in providing an overall

description of the day and of the diurnal development of the convection in the area.

## CELL AND ECHO TRACKING

In order to assess the effect of seeding on the scale of individual cloud elements and small cloud conglomerates, it is imperative that echoes and echo cells be identified and tracked throughout their lifetimes. This has been accomplished by developing a series of programs that, starting from the basic height and reflectivity maps, isolate the different echo areas present, divide them into their individual convective cells, and track the cells from origin to dissipation. The programs can apply to data from either radar or a combined data set.

The cell identification is based on the presence of reflectivity peaks within the area of an echo. The details of the procedure are described in Appendix A. The end result of the series of programs is a tabulation for every scan of the characteristics of every cell present in that scan, a cross reference to the continuation of the cells in the next scan, and the lifetime properties of each cell. A similar tabulation for every echo is also included in the resulting data files.

In order to determine the properties of treated (AgI or sand) cells, a file was produced for each GO day with the coordinates and time of the seeding passes. This file was incorporated into the input stream of the tracking system. The cell that was closest in space and time to each cloud pass was tagged as treated. This information appeared together with the other cell

characteristics in the output file described above. The specific details of the way in which these determinations were made are contained in Appendix B.

## TIME SERIES OF CELL AND ECHO CHARACTERISTICS

Frequency distributions, time series, and bivariate distributions of the basic cell and echo characteristics were constructed using the basic data files of cell and echo entities. The frequency distributions provided information about the nature of the population of these entities while the time series of average cell and echo properties indicated the diurnal development of the cloud field. The bivariate distributions provided information about the relationships between cell characteristics.

## IV. Data Processing Parameters

### RADAR DATA CHARACTERISTICS

In the following tables, important parameters for both the MPS-4 and WSR-57 radars are given. Some of these parameters are part of the input stream for processing the data; others define certain characteristics of the data.

Table 4 lists the parameters for the MPS-4 digitized radar data. The first column gives the date. If, during the course of a day, one or more parameters changed, multiple entries for that date are made, and the letters A, B, C, etc. are used to denote each entry. The second column gives the time (EDT) for each set of parameters. The third column gives the type of GO day, either "A" or "B". A blank indicates the day was a non-GO day. The next four columns are the calibration coefficients. (Note that the coefficients are given in FORTRAN data format.) The eighth column is the noise threshold used for that day and time. This noise value was used only for base scans. Higher tilts used a higher noise--in all cases it was set equal to the base tilt noise threshold plus five. The next two columns give the reflectivity thresholds in dBz. The first threshold corresponds to the base tilt and the second threshold is for the higher tilts. The last column contains comments deemed to be useful, such as times of missed data, radar problems, etc.

Table 5 contains the calibration coefficients for the WSR-57.

Table 6 contains entries for the WSR-57 in a format similar to the MPS-4. The first column gives the date. The second column gives the tape number. If more than one tape was used during the

day, each tape has its own entry. The third column states the type of GO day, either "A" or "B", or "0" for a non-GO day. The next two columns give the start/stop time of data collection followed by the approximate footage of tape used. The next two columns give the recording start/stop azimuths. Columns 9-12 have entries only for those days that were processed. Column 9 gives the noise threshold used, and Column 12 gives the corresponding reflectivity threshold in dBz. Columns 10-11 give the position correction for the WSR-57 radar. Column 10 is the azimuth correction, and column 11 is the size of the range bin. (Range bins were to be .5 nmi for all days and times.) The azimuth error was, in part, a function of rotation direction. Both the azimuth and range correction were calculated on a day-by-day basis for GO days and for a few selected non-GO days, using the MPS-4 radar for comparison (Barnston, 1981). For non-GO days and GO days for which no MPS-4 data were available, the correction was interpolated from the closest GO days. The last column contains comments about the data, and the data systems. Table 7 lists the minimum range that was used in order to eliminate data contaminated with anomalous propagation. For every day these ranges are specified together with the corresponding time periods for which they apply.

DATA QUALITY

MPS-4. During the 1978 field program, the digitizer portion of the system was not in operation until 25 July 1978. This period included the first eight GO days of the project. The radar

*Table 4. Log of MPS-4 Radar Data*

1978

| DATE | TIME (EDT) | GO | CALIBRATION COEFFICIENTS A | B | C | D | Noise | Threshold (dBz) | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 7/25/78 A | 1539-2121 | B | -9.96760E+01 | +2.84640E-01 | -1.42590E-03 | +3.83190E-06 | 8 | 24.2 | 25.5 | No data from 2020 to 2052 due to equipment problems. |
| 7/29/78 A | 1452-1716 | B | -9.91780E+01 | +4.46990E-01 | -2.82820E-03 | +7.61940E-06 | 6 | 25.1 | 27.1 | |
| B | 1721-1917 | | -9.91780E+01 | +4.46990E-01 | -2.82820E-03 | +7.61940E-06 | 7 | 25.5 | 27.5 | |
| C | 1922-2046 | | -9.91780E+01 | +4.46990E-01 | -2.82820E-03 | +7.61940E-06 | 8 | 25.9 | 27.9 | |
| 8/4/78 A | 1453-1634 | B | -9.42690E+01 | +4.07860E-01 | -2.51460E-03 | +7.15400E-06 | 7 | 30.2 | 32.0 | |
| B | 1637-1736 | | -9.93460E+01 | +3.23260E-01 | -1.71080E-03 | +4.51660E-06 | 7 | 24.5 | 26.0 | |
| 8/5/78 A | 1417-1550 | A | -1.00430E+02 | +5.35860E-01 | -4.30110E-03 | +1.42690E-05 | 7 | 24.8 | 27.1 | |
| B | 1557-1814 | | -1.00430E+02 | +5.35860E-01 | -4.30110E-03 | +1.42690E-05 | 8 | 24.8 | 27.1 | |
| 8/10/78 A | 1357-1430 | B | -8.78200E+01 | +4.75680E-01 | -3.56990E-03 | +1.59550E-05 | 5 | 36.2 | 38.3 | |
| B | 1431-1934 | | -9.66880E+01 | +5.34340E-01 | -4.44930E-03 | +1.72380E-05 | 6 | 27.6 | 29.9 | |
| 8/11/78 A | 1350-1848 | B | -9.45860E+01 | +4.09210E-01 | -3.03760E-03 | +1.21740E-05 | 7 | 29.8 | 31.6 | |
| 8/12/78 A | 1329-1701 | B | -9.54160E+01 | +6.00160E-01 | -6.10330E-03 | +2.69090E-05 | 6 | 29.7 | 32.2 | Receiver problems especially during first hour. Data gap from 1725-1740. |
| B | 1708-1957 | | -9.54160E+01 | +6.00160E-01 | -6.10330E-03 | +2.69090E-05 | 7 | 30.2 | 32.7 | |
| 8/13/78 A | 1355-1411 | B | -9.15760E+01 | +7.76700E-01 | -1.09640E-02 | +6.78520E-05 | 6 | 34.4 | 37.4 | |
| B | 1412-2000 | | -9.46380E+01 | +5.47370E-01 | -5.30020E-03 | +2.65830E-05 | 6 | 30.2 | 32.5 | |
| 8/14/78 A | 1315-2001 | B | -1.00930E+02 | +9.28220E-01 | -9.91540E-03 | +4.23370E-05 | 6 | 26.0 | 29.8 | Tape runaway around 2000 Cloud Physics day |
| 8/15/78 A | 1518-1701 | | -9.16340E+01 | +5.38510E-01 | -5.29580E-03 | +2.47720E-05 | 6 | 33.1 | 35.4 | |
| 8/16/78 A | 1343-1951 | | -9.68390E+01 | +5.57450E-01 | -4.58790E-03 | +1.86420E-05 | 7 | 28.5 | 30.9 | |
| 8/17/78 A | 1330-1438 | B | -9.34010E+01 | +2.88900E-01 | -1.00770E-03 | +4.35350E-06 | 5 | 29.7 | 31.1 | |
| B | 1439-1959 | | -9.62070E+01 | +4.00000E-01 | -2.97830E-03 | +1.22270E-05 | 8 | 28.5 | 30.2 | |
| 8/18/78 A | 1400-1805 | A | -9.54940E+01 | +2.42360E-01 | -1.00730E-03 | +2.71440E-06 | 5 | 27.4 | 28.5 | |
| 8/20/78 A | 1326-1334 | | -9.29950E+01 | +1.98470E-01 | -7.93920E-04 | +3.23120E-06 | 4 | 29.5 | 30.4 | |
| B | 1335-1617 | | -9.44150E+01 | +2.03400E-01 | -7.60800E-04 | +2.27750E-06 | 5 | 28.3 | 29.2 | |
| 8/29/78 A | 1330-1936 | B | -1.01920E+02 | +6.54880E-01 | -5.22220E-03 | +1.73650E-05 | 6 | 23.5 | 26.4 | Receiver problems around 1810-1820 and 1930-1951. |
| 8/30/78 A | 1330-1445 | | -1.03280E+02 | +7.16670E-01 | -6.25060E-03 | +2.20780E-05 | 7 | 23.1 | 26.2 | |

*Table 4. Log of MPS-4 Radar Data (continued)*

1979

| DATE | TIME (EDT) | GO | CALIBRATION COEFFICIENTS A | B | C | D | Noise | Threshold (dBz) | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 7/02/79 A | 1335-1923 | (B) | -1.02781E+02 | +3.16502E-01 | -1.28457E-03 | +3.64343E-06 | 15 | 23.4 | 24.8 | Disqualified GO day |
| 7/09/79 A | 1303-2027 | B | -1.02126E+02 | +2.88724E-01 | -7.27154E-04 | +1.70545E-06 | 14 | 23.5 | 24.8 | Incorrect data after about 1820 |
| 8/20/79 A | 1304-2002 | B | -1.06287E+02 | +3.93037E-01 | -1.57738E-03 | +4.16261E-06 | 7 | 18.1 | 19.9 | |
| 8/25/79 A | 1333-1625 | A | -1.06642E+02 | +3.60394E-01 | -1.42270E-03 | +4.00129E-06 | 6 | 17.2 | 18.9 | |
| 8/28/79 A | 1259-1315 | B | -1.07523E+02 | +3.49396E-01 | -1.18581E-03 | +3.05747E-06 | 7 | 16.6 | 18.2 | |
| B | 1316-1917 | | -1.06747E+02 | +4.00867E-01 | -1.62704E-03 | +4.10515E-06 | 7 | 17.7 | 19.5 | |
| 8/29/79 A | 1259-1858 | B | -1.06953E+02 | +3.14133E-01 | -0.93421E-03 | +2.57144E-06 | 7 | 16.9 | 18.4 | |
| 8/30/79 A | 1259-1937 | | -1.07226E+02 | +3.22330E-01 | -1.00631E-03 | +2.74533E-06 | 8 | 17.0 | 18.5 | Non GO day |

*Table 4. Log of MPS-4 Radar Data (continued)*

1980

| DATE | TIME (EDT) | GO | CALIBRATION COEFFICIENTS A | B | C | D | Noise | Threshold (dBz) | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 6/18/80 A | 1350-1530 | | -1.0353E+02 | +3.3290E-01 | -1.6330E-03 | +4.6343E-06 | 7 | 20.4 | 21.9 | Non-GO day |
| 6/20/80 A | 1402-1742 | | -1.0547E+02 | +3.1471E-01 | -7.0288E-04 | +1.8476E-06 | 11 | 19.8 | 21.4 | Deliberate Seed day; Bad Elevation word |
| 6/22/80 A | 1259-1707 | A | -1.0590E+02 | +3.1738E-01 | -9.1732E-04 | +2.6399E-06 | 12 | 19.5 | 20.9 | Bad Elevation word |
| 6/23/80 A | 1257-1701 | B | -1.0577E+02 | +3.2603E-01 | -8.3670E-04 | +2.1675E-06 | 12 | 19.7 | 21.2 | Bad Elevation word |
| B | 1709-2040 | | -1.0647E+02 | +4.3757E-01 | -2.2629E-03 | +6.6189E-06 | 11 | 19.8 | 21.7 | |
| 6/24/80 A | 1330-1757 | B | -1.0516E+02 | +2.8455E-01 | -6.7826E-04 | +1.7132E-06 | 11 | 19.3 | 20.7 | Bad Elevation word; DAY word reads 177 instead of 176 until 1420 hrs. |
| B | 1804-2131 | | -1.0516E+02 | +2.8455E-01 | -6.7826E-04 | +1.7132E-06 | 10 | 19.3 | 20.7 | |
| 6/25/80 A | 1330-2108 | B | -1.0474E+02 | +3.0038E-01 | -9.2511E-04 | +2.4496E-06 | 10 | 19.9 | 21.3 | |
| 6/28/80 A | 1333-1632 | B | -9.7974E+01 | +2.8304E-01 | -1.0480E-03 | +3.0979E-06 | 12 | 27.0 | 28.3 | DAY word reads 182 instead of 180 until 1423 hrs. |
| B | 1637-1951 | | -9.8792E+01 | +2.8486E-01 | -9.2055E-04 | +2.5970E-06 | 12 | 26.2 | 27.5 | |
| 7/04/80 A | 1332-2005 | B | -1.0450E+02 | +4.0102E-01 | -1.9038E-03 | +5.0597E-07 | 10 | 21.0 | 22.8 | |
| 7/07/80 A | 1332-1752 | B | -1.0366E+02 | +3.9021E-01 | -1.7722E-03 | +4.6865E-06 | 12 | 22.5 | 24.2 | |
| B | 1757-2021 | | -1.0366E+02 | +3.9021E-01 | -1.7722E-03 | +4.6865E-06 | 11 | 22.1 | 23.8 | Bad Elevation word |
| 7/08/80 A | 1329-2035 | B | -1.0034E+02 | +2.2590E-01 | -3.6293E-04 | +1.2295E-06 | 10 | 24.7 | 25.7 | |
| 7/09/80 A | 1330-2035 | B | -1.0287E+02 | +3.7310E-01 | -1.4378E-03 | +3.3170E-06 | 10 | 22.4 | 24.1 | |
| 7/10/80 A | 1403-1810 | B | -9.6424E+01 | +2.5297E-01 | -6.1329E-04 | +1.3750E-06 | 10 | 27.7 | 28.9 | |
| 7/12/80 A | 1330-1907 | B | -1.0394E+02 | +3.7823E-01 | -1.3587E-03 | +2.9923E-06 | 10 | 21.4 | 23.1 | |
| 7/14/80 A | 1330-1707 | A | -1.0501E+02 | +3.5969E-01 | -1.2738E-03 | +2.9519E-06 | 10 | 20.2 | 21.8 | |
| 7/16/80 A | 1304-1831 | B | -1.0366E+02 | +3.6408E-01 | -1.3739E-03 | +3.3157E-06 | 12 | 21.5 | 23.2 | |
| B | 1844-2130 | | -1.0403E+02 | +3.7526E-01 | -1.4677E-03 | +3.5637E-06 | 11 | 21.6 | 23.3 | |
| 7/25/80 A | 1330-1948 | B | -1.0445E+02 | +3.3960E-01 | -1.2095E-03 | +3.0930E-06 | 10 | 20.5 | 22.1 | |
| 7/28/80 A | 1406-1823 | | -1.0460E+02 | +3.6892E-01 | -1.4469E-03 | +3.7474E-06 | 10 | 20.6 | 22.3 | Deliberate Seed day |
| 7/29/80 A | 1330-2144 | B | -1.0513E+02 | +4.1412E-01 | -1.8552E-03 | +4.6403E-06 | 10 | 20.5 | 22.4 | |
| 7/31/80 A | 1300-1937 | B | -1.0537E+02 | +4.1511E-01 | -1.7708E-03 | +4.3662E-06 | 11 | 20.7 | 22.5 | |
| 8/01/80 A | 0930-1715 | | -1.0507E+02 | +3.6004E-01 | -1.3549E-03 | +3.4646E-06 | 10 | 20.1 | 21.7 | Sea-Breeze experiment day |
| 8/02/80 A | 1335-1943 | B | -1.0516E+02 | +4.0740E-01 | -1.7845E-03 | +4.6737E-06 | 11 | 19.8 | 21.6 | |
| 8/03/80 A | 1358-2013 | B | -1.0480E+02 | +3.9877E-01 | -1.7264E-03 | +4.5709E-06 | 11 | 21.1 | 22.9 | |
| 8/04/80 A | 1334-1837 | B | -1.0515E+02 | +3.8894E-01 | -1.5331E-03 | +3.6297E-06 | 11 | 20.6 | 22.4 | |
| 8/15/80 A | 1300-1646 | | -1.0400E+02 | +4.4673E-01 | -2.0919E-03 | +5.1727E-06 | 9 | 21.6 | 23.6 | Deliberate Seed day |
| 8/18/80 A | 1334-2024 | B | -1.0467E+02 | +4.0293E-01 | -1.7142E-03 | +4.3235E-06 | 10 | 20.9 | 22.7 | |
| 8/21/80 A | 1304-1552 | | -1.0432E+02 | +3.8494E-01 | -1.6657E-03 | +4.3659E-06 | 10 | 21.1 | 22.8 | |
| 8/22/80 A | 1314-1727 | A | -1.0452E+02 | +3.7807E-01 | -1.4970E-03 | +3.6602E-06 | 10 | 20.8 | 22.5 | |
| 8/26/80 A | 1355-2112 | B | -1.0445E+02 | +3.8096E-01 | -1.5762E-03 | +4.0651E-06 | 10 | 20.9 | 22.6 | |
| 8/28/80 A | 1404-2012 | | -1.0377E+02 | +4.2055E-01 | -1.7929E-03 | +4.4030E-06 | 9 | 21.6 | 23.5 | NASA flights |
| 8/29/80 A | 1304-1934 | B | -1.0381E+02 | +4.5611E-01 | -2.2632E-03 | +5.8964E-06 | 10 | 22.2 | 24.2 | |
| 8/30/80 A | 1434-1825 | | -1.0525E+02 | +3.7902E-01 | -1.5023E-03 | +3.7973E-06 | 11 | 20.4 | 22.1 | NASA flights |
| 8/31/80 A | 1447-1827 | | -1.0495E+02 | +3.8989E-01 | -1.6296E-03 | +4.1124E-06 | 10 | 20.5 | 22.2 | NASA flights |
| 9/06/80 A | 1503-1815 | | -1.0483E+02 | +3.3373E-01 | -1.1519E-03 | +2.6922E-06 | 9 | 19.8 | 21.3 | NASA flights |

*Table 5. WSR-57 Radar Calibrations*

CALIBRATION COEFFICIENTS

| | A | B | C | D |
|---|---|---|---|---|
| 1978 | -9.06397E+01 | +3.50787E-01 | -5.0006E-04 | +1.45675E-06 |
| 1979 | -8.80969E+01 | +2.6647E-01 | -5.09862E-04 | +1.33928E-06 |
| 1980 | -9.13486E+01 | +2.89361E-01 | -8.21715E-04 | +1.91531E-06 |

*Table 6. Daily Log of WSR-57 radar data*

| Date | Tape No. | Go | Time (EDT) On | Off | Feet | Start | Stop | Noise | Position Correction Az. | Range | Threshold (dBz) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/15/78 | EM8166 | 0 | 0830 | 2101 | 1400 | 136 | 138 | ---- | ---- | ---- | ---- | At 2059 found ω reversed, went to 136/134; NHC says rotation was changed at 2000. |
| 6/16/78 | EM8167 | 0 | 0843 | 2105 | 1200 | 136 | 134 | ---- | ---- | ---- | ---- | Tape slipping on drive hub 0843-0923, fixed by repositioning the tape; ω = 0 from 1100-1130, bad card in VIP replaced about 1230 EDT. |
| 6/17/78 | EM8168 | 0 | 0835 | 2117 | 1250 | 136 | 134 | ---- | ---- | ---- | ---- | |
| 6/18/78 | EM8169 | 0 | 0830 | 2116 | 1400 | 136 | 134 | ---- | ---- | ---- | ---- | Clock 1 sec slow at 2128 EDT. |
| 6/19/78 | EM8170 | 0 | 0830 | 2111 | 1600 | 136 | 134 | ---- | ---- | ---- | ---- | At 1323 found that inhibit switch does not inhibit; illogical, long records result. |
| 6/20/78 | EM8171 | 0 | 0827 | 1931 | 1600 | 136 | 134 | ---- | ---- | ---- | ---- | At 1736 started taking alternate sweeps with AP remover on/off/on/off, every minute (At 1737-off, 1738-on, 1739-off, etc). At 1820 resumed recording at one sweep every 5 min with AP remover on; At 1904-1911 APR (on and off); 1925 steadily off; the AP remover seems to partially remove cores of strong (VIP 3 or 4) echoes. |
| 6/21/78 | EM8172 | 0 | 0849 | 2121 | 1300 | 136 | 134 | ---- | ---- | ---- | ---- | |
| 6/22/78 | EM8173 | 0 | 0844 | 2106 | 1300 | 136 | 134 | ---- | ---- | ---- | ---- | Clock 6 sec fast at 1613. |
| 6/23/78 | EM8174 | 0 | 0815 | 2107 | 1450 | 134 | 136 | ---- | ---- | ---- | ---- | |
| 6/24/78 | EM8175 | 0 | 0816 | 2106 | 1400 | 134 | 136 | ---- | ---- | ---- | ---- | At 1223 stopped recording because digitizing while NHC observation in process. |
| 6/25/78 | EM8176 | 0 | 0924 | 2110 | 0200 | 134 | 136 | ---- | ---- | ---- | ---- | Radar down most of the day from radar power unit failure; inhibits 0900-0923, 0930-1130 and 1140-2040. |
| 6/26/78 | EM8177 | 0 | 0837 | 2106 | 1200 | 134 | 136 | ---- | ---- | ---- | ---- | Inhibit about 0900-0928, because of NHC radar maintenance. |
| 6/27/78 | EM8178 | 0 | 0843 | 2105 | 1300 | 134 | 136 | ---- | ---- | ---- | ---- | During the night, second version of AP remover installed. |
| 6/28/78 | EM8179 | 0 | 0828 | 2102 | 1700 | 134 | 136 | ---- | ---- | ---- | ---- | At 1256 APR manually alternated on/off; recording at 1 per minute. Using 1 per minute with APR on during even minutes, off on odd minutes during 1302-1315; sweep every 5 min with APR off during (1315-1338, 1345-1350, 1355-1405, 1415-1424 and 1434-2100); sweep every minute with APR on during even minutes (1338-1345, 1350-1355, 1406-1415 and 1424-1434). |
| 6/29/78 | EM8180 (1st tape) | B | 0836 | 1635 | 1300 | 134 | 136 | ---- | -1.25 | 0.492 | ---- | From 0836-1139 APR on; at 1155 and 1200 elevation < 0°; 1206 APR on; at 1253 power failure for about ½ sec. Clock 5 sec fast; at 1401 APR on; at 1500 one sweep every minute with APR on at 1501, 1503, 1506, 1507, and 1510; at 1529 used 1 per 5 min. At 1605-1615 used 1 per minute with APR on odd minutes, at 16 APR on; at 1617 used 1 per 5 min with APR off. Runaway at 1635, new tape mounted. Runaway caused by manual intervention on tape drive. |
| | EM8180 (2nd tape) | | 1641 | 2114 | 500 | 134 | 136 | ---- | -1.25 | 0.492 | ---- | At 1704 used one sweep every minute; APR on even minutes; at 1715 used 1 per 5 min. APR off; at 1856 one sweep every minute with APR on even minutes; Radar down at 1926-2100. |
| 6/30/78 | EM8181 | B | 0815 | 2101 | 1700 | 136 | 134 | 12 | -2.40 | 0.492 | 15.9 | Inhibition at 0940, found tape advancing instead of recording; inhibit off 0943; at 1424 1 EOF, digitizing while NHC observation in progress; used 1 per minute at 2002-2014 with APR on during even minutes; 1 per 5 min used at 2015, APR off. |

*Table 6. Daily Log of WSR-57 radar data (continued)*

| Date | Tape No. | Go | Time (EDT) On | Off | Feet | Start | Stop | Noise | Position Correction Az. | Range | Threshold (dBz) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/01/78 | EM8182 | B | 0827 | 2101 | 1300 | 136 | 134 | 13 | -2.40 | 0.491 | 16.9 | AP in TA at 2100 (VIP 5) and along S. border TA. |
| 7/02/78 | EM8183 | B | 0856 | 2101 | 1550 | 136 | 134 | 12 | -2.40 | 0.491 | 15.9 | At 0856 APR on; APR off at 0858; processed video checked at 1253 and 1858. At 1410 recorded at 2.2°; 1412 recorded at 0.2°. Inhibit at 1920-1930. At 1930 on, but inhibit switched down. 1 per minute at 2032; APR on 2032, 2034, 2035, APR off 2033 and 2036; APR on at 2037-2101 during odd minutes. |
| 7/03/78 | EM8184 | B | 0852 | 2147 | 1300 | 146 | 144 | 13 | -2.40 | 0.491 | 16.3 | |
| 7/04/78 | EM8185 | 0 | 0854 | 2108 | 1300 | 146 | 144 | 12 | ---- | ---- | 15.9 | Processed video checked at 1324. At 1327 clock ½ sec fast. APR on at 2105 and 2107. |
| 7/05/78 | EM8186 | A | 0847 | 2101 | 1300 | 146 | 144 | 14 | -2.40 | 0.491 | 16.6 | At 1320 recorded scan at short pulse. At 1321 recorded scan OK; at 1922 1 EOF installed because recording under way when antenna was stopped for RHI. |
| 7/06/78 | EM8187 | 0 | 0858 | 2101 | 1200 | 146 | 144 | 12 | ---- | ---- | 15.9 | Radar down 0928-1011. AP seen south of TA: VIP 6 at 1900 and 2100. |
| 7/07/78 | EM8188 | 0 | 0824 | 2101 | 1300 | 144 | 146 | 13 | ---- | ---- | 16.3 | Radar down at 0835-0920. At 1319 processed video checked. At 1322 clock ½-sec error. |
| 7/08/78 | EM8189 | 0 | 0827 | 2101 | 1300 | 144 | 146 | 13 | ---- | ---- | 16.3 | |
| 7/09/78 | EM8190 | 0 | 0852 | 2108 | 1400 | 144 | 146 | ---- | ---- | ---- | ---- | At 1513 clock < ½-sec error. At 1513 processed video checked OK. |
| 7/10/78 | EM8191 | B | 0853 | 2101 | 1200 | 124 | 126 | 13 | -1.25 | 0.491 | 16.3 | At 1758 processed video checked OK; no recorded PPI scan at 1910; at 1930 elevation tilt was 4.4°, sweep at 1933. |
| 7/11/78 | EM8192 | 0 | 0849 | 2104 | 1250 | 124 | 126 | 11 | ---- | ---- | 15.6 | At 1300 processed vido checked OK. At 1312 clock 1 sec fast. Using 1 per minute with APR on at 1559, 1601 and 1603; APR off at 1600, 1602, 1604 and 1605. At 1605 APR off and taking sweep every 5 min. Sweep every minute at 1705-1711, APR on during even minutes. At 1711 APR off and sweep every 5 min. |
| 7/12/78 | EM8193 | 0 | 0851 | 2101 | 1100 | 124 | 126 | 11 | ---- | ---- | 15.6 | Radar down at 0830-0924. |
| 7/13/78 | EM8194 | 0 | 0846 | 2102 | 1200 | 124 | 126 | 13 | ---- | ---- | 16.3 | At 1230, APR changed back to version used thru 27 June 1978. |
| 7/14/78 | EM8195 | 0 | 0844 | 2101 | 1200 | 126 | 124 | ---- | ---- | ---- | ---- | |
| 7/15/78 | EM8196 | 0 | 0843 | 2101 | 1400 | 126 | 124 | 13 | ---- | ---- | 16.3 | At 1308-1317, one record per minute with APR off during even-numbered nimutes and on during odd-numbered minutes. 1 per 5 min. used at 1318 with APR off. APR off at 1347, 1349, 1351, 1353 and 1355; APR on 1348, 1350, 1352, 1354 and 1357; 1 per 5 min. used at 1358 with APR off. At 1654-1705 APR off during even minutes and on during odd minutes. At 1705 used 1 per 5 min. |
| 7/16/78 | EM8197 | 0 | 0859 | 2102 | 1200 | 126 | 124 | 13 | ---- | ---- | 16.3 | At 1105 processed video checked OK; At 1113 clock 1 sec fast. High tilt at 1430, recorded scan at 1433; At 1540-1630 radar transmitter off, on line at 1645. |
| 7/17/78 | EM8198 | 0 | 0845 | 2101 | 1500 | 148 | 146 | 13 | ---- | ---- | 16.3 | At 1555 processed video checked OK. |

*Table 6. Daily Log of WSR-57 radar data (continued)*

July, 1978 (continued)

| Date | Tape No. | Go | Time (EDT) On | Off | Feet | Start | Stop | Noise | Position Correction Az. | Range | Threshold (dBz) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/18/78 | EM8199 | A | 0847 | 2103 | 1250 | 148 | 146 | 13 | -2.40 | 0.490 | 16.3 | Radar down at 0847-0930 and 1145-1222; reason unknown. Processed video checked at 1303; clock about ½ sec fast. APR on at 1924. |
| 7/19/78 | EM8200 | 0 | 0850 | 2101 | 1250 | 148 | 146 | ---- | ---- | ---- | ---- | |
| 7/20/78 | EM8201 | 0 | 0852 | 2101 | 1200 | 148 | 146 | ---- | ---- | ---- | ---- | Noted at 2040 ω had been reversed, at 2041 went to 146/148. |
| 7/21/78 | EM8202 | 0 | 0853 | 2101 | 1250 | 146 | 148 | 11 | ---- | ---- | 15.6 | At 1106 processed video checked. At 1109 clock checked 1 sec fast. |
| 7/22/78 | EM8203 | 0 | 0816 | 2101 | 1300 | 146 | 148 | 12 | ---- | ---- | 15.9 | |
| 7/23/78 | EM8204 | 0 | 0848 | 2105 | 1300 | 146 | 148 | 11 | ---- | ---- | 15.6 | At 1309 processed video checked. At 1311 clock 3 sec slow. |
| 7/24/78 | EM8205 | 0 | 0848 | 2103 | 1200 | 129 | 131 | 12 | ---- | ---- | 15.9 | |
| 7/25/78 | EM8206 | B | 0845 | 2104 | 1300 | 129 | 131 | 12 | -1.25 | 0.487 | 15.9 | At 1408 clock 2 sec fast. Processed video checked at 1414. |
| 7/26/78 | EM8207 | 0 | 0851 | 2117 | 1200 | 129 | 131 | 11 | ---- | ---- | 15.6 | |
| 7/27/78 | EM6208 | 0 | 0843 | 2101 | 1500 | 129 | 131 | 11 | ---- | ---- | 15.6 | Radar down until about 0900. Processed video checked at 1737. Clock 2 sec slow at 1738. |
| 7/28/78 | EM8209 | 0 | 0826 | 2101 | 1250 | 131 | 129 | 12 | ---- | ---- | 15.9 | At 1137 processed video checked. |
| 7/29/78 | EM8210 | B | 0831 | 2101 | 1200 | 131 | 129 | 15 | -2.40 | 0.487 | 16.9 | 25 EOF's at the beginning of the tape. |
| 7/30/78 | EM8211 | 0 | 0844 | 2106 | 1200 | 131 | 129 | 12 | ---- | ---- | 15.9 | At 1115 processed video checked. At 1116 clock checked about ½ sec slow. |
| 7/31/78 | EM8212 | 0 | 0844 | 2101 | 0600 | 121 | 119 | 12 | ---- | ---- | 15.9 | At 1136 processed video checked. At 1136 clock 1 sec fast. Used only 600' tape. This start/stop seems not to function; reason unknown. |

*Table 6. Daily Log of WSR-57 radar data (continued)*

| Date | Tape No. | Go | Time (EDT) On | Off | Feet | Start | Stop | Noise | Position Correction Az. | Range | Threshold (dBz) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/01/78 | EM8213 | O | 0841 | 2103 | 1200 | 131 | 129 | 12 | ---- | ---- | 15.9 | |
| 8/02/78 | EM8214 | O | 0854 | 2102 | 1200 | 131 | 139 | 15 | ---- | ---- | 16.9 | |
| 8/03/78 | EM8215 | O | 0840 | 2101 | 1250 | 131 | 129 | 13 | ---- | ---- | 16.3 | At 1152 processed video checked. At 1153 clocked checked ½ sec fast. At 1720 ½ sweep recorded during short pulse. Record taken at 1722. |
| 8/04/78 | EM8216 | B | 0836 | 2101 | 1200 | 139 | 141 | 14 | -1.25 | 0.490 | 16.6 | At 1235 processed video checked. Clock 3 sec slow at 1240. |
| 8/05/78 | EM8217 | A | 0837 | 2101 | 1250 | 139 | 141 | 15 | -1.25 | 0.490 | 16.9 | |
| 8/06/78 | EM8218 | O | 0852 | 2105 | 1250 | 139 | 141 | 11 | ---- | ---- | 15.6 | Processed video checked at 1443. |
| 8/07/78 | EM8219 | O | 0840 | 2101 | 1250 | 139 | 141 | 11 | ---- | ---- | 15.6 | |
| 8/08/78 | EM8220 | O | 0831 | 2102 | 1250 | 139 | 141 | 12 | | | 15.9 | At 1046 processed video checked. At 2100 clock checked 3 sec fast. Record at 2101 with APR on. |
| 8/09/78 | EM8221 | O | 0845 | 2101 | 1200 | 139 | 141 | 11 | ---- | ---- | 15.6 | At 1026 short pulse. At 1526 recording during NHC obs. |
| 8/10/78 | EM8222 | B | 0840 | 2107 | 1800 | 139 | 141 | 13 | -1.25 | 0.488 | 16.3 | At 0845-0915 radar down, NHC maintenance. At 1109 clock checked < ½ sec fast. At 1110 processed video checked. At 1320 recording during short pulse, sweep at 1322. At 2005 ω reversed, changes S/S to 141/139. APR on 2105; APR off 2106. |
| 8/11/78 | EM8223 | B | 0828 | 2101 | 1200 | 141 | 139 | 14 | -2.40 | 0.489 | 16.6 | Radar down 0828-0850. At 1717 processed video checked. |
| 8/12/78 | EM8224 | B | 0829 | 2101 | 1200 | 141 | 139 | 13 | -2.40 | 0.489 | 16.6 | |
| 8/13/78 | EM8225 | B | 0844 | 2200 | 1400 | 141 | 139 | 13 | -2.40 | 0.490 | 16.3 | At 1149 processed video checked. Clock 2 sec slow at 1221. |
| 8/14/78 | EM8226 | B | 0845 | 2101 | 1200 | 141 | 139 | 13 | -2.40 | 0.484 | 16.3 | Clock 5 sec slow at about 1200. |
| 8/15/78 | EM8227 | O | 0844 | 2135 | 1300 | 141 | 139 | 11 | ---- | ---- | 15.6 | At 1030 processed video checked. At 1034 Clock checked 1 sec fast. |
| 8/16/78 | EM8228 | B | 0928 | 2112 | 1200 | 131 | 129 | 15 | -2.40 | 0.486 | 16.9 | Only VIP level 2 seen until about 1406; VIP trouble (level 3 and 4 seen after 1406). |
| 8/17/78 | EM8229 | B | 0840 | 2101 | 1200 | 131 | 129 | 14 | -2.40 | 0.483 | 16.6 | At 0925 processed video checked. At 2059 used 129/131. |
| 8/18/78 | EM8230 | A | 0836 | 2101 | 1200 | 129 | 131 | 13 | -1.25 | 0.487 | 16.3 | At 0928 clock checked 1 sec fast. |
| 8/19/78 | EM8231 (1st tape) | O | 0836 | 1407 | 0400 | 129 | 131 | 14 | ---- | ---- | 16.6 | At 1340 radar down, close lightning strike. At 1345 radar up, but on short pulse. At 1350 short pulse. At 1355 no video. At 1358 regular sweep recorded. At 1407 radar and digitizer down; another close lightning strike. At 1407 second tape mounted. |
| | EM8231 (2nd tape) | O | 1407 | 2101 | 0800 | 129 | 131 | 14 | ---- | ---- | 16.6 | At 1416 digitizer up, but radar down. At 1432 radar up, regular sweep recorded. |
| 8/20/78 | EM8232 | O | 0839 | 2102 | 1200 | 129 | 131 | 13 | ---- | ---- | 16.3 | At 1025 clock checked 1 sec fast. At 1512 processed video checked. |
| 8/21/78 | EM8233 | O | 0841 | 2103 | 1250 | 129 | 131 | 14 | ---- | ---- | 16.6 | At 1103 clock checked 2 sec fast. |
| 8/22/78 | EM8234 | O | 0853 | 2101 | 1300 | 129 | 131 | 14 | ---- | ---- | 16.6 | |
| 8/23/78 | EM8235 | O | 0854 | 2101 | 2000 | 129 | 131 | 13 | ---- | ---- | 16.3 | At 0854-0902 used 1 per minute with APR-ALT on. At 0902 used 1 per 5 min. APR-ALT on. At 1316 APR-ALT off and APR off. At 1316-1000 tape used. At 1800 APR=ALT on. |
| 8/24/78 | EM8236 | O | 0837 | 2104 | 2100 | 129 | 131 | 13 | ---- | ---- | 16.3 | 0837-1254 APR-ALT on. 1255-1737 APR off. At 1738 APR-ALT on. At 2000 ω reversed. At 2010 used 129/127. |
| 8/25/78 | EM8237 | O | 0831 | 2106 | 1850 | 130 | 128 | 13 | ---- | ---- | 16.3 | 0831-1156 APR-ALT on. 1156-1800 APR off. At 1800 APR-ALT on. |

*Table 6. Daily Log of WSR-57 radar data (continued)*

August, 1978 (continued)

| Date | Tape No. | Go | Time (EDT) On | Time (EDT) Off | Feet | Start | Stop | Noise | Position Correction Az. | Position Correction Range | Threshold (dBz) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/26/78 | EM8238 | 0 | 0836 | 2101 | 1200 | 130 | 129 | 15 | ---- | ---- | 16.9 | 0836-1200 APR-ALT on; 1200-1610 APR off; at 1610 APR-ALT on. Radar down 0836-0920, 1028-1108 and 1125-1604 still down, time up ? ? ? |
| 8/27/78 | EM8239 | 0 | 0830 | 2020 | 2400 | 130 | 128 | 12 | ---- | ---- | 15.9 | APR-ALT on. Tape exhausted before 2020. No EOF's. |
| 8/28/78 | EM8240 | 0 | 0837 | 2020 | ---- | 130 | 128 | ---- | ---- | ---- | ---- | At 0837-1013 APR-ALT on. Failure of chips discovered about 1145, video check of digital ouput indicates no echoes while VIP presents echoes (005°-060°/60-100 n mi). |
| 8/29/78 | EM8241 | B | 0839 | 0740 | 2400 | 130 | 128 | 13 | -2.40 | 0.485 | 16.3 | APR off. Processed video checked at 1225 and 1310. At 1225 $\omega = 0$. At 1226 clock $< \frac{1}{2}$ sec fast. Recorded sweep at 1227. At 1720-1724 NHC obs. Actual end time of data unknown. |
| 8/30/78 | EM8242 | 0 | 0825 | 2101 | 1850 | 130 | 128 | 12 | ---- | ---- | 15.9 | APR-ALT on 0825-1230. At 1012 processed video checked. At 1014 clock checked 2.5 sec fast. 1230-1749 APR off. At 1310 recorded at 2.3° tilt. At 1749 APR-ALT on. |
| 8/31/78 | EM8243 | 0 | 0833 | 2220 | 1600 | 130 | 128 | 11 | --- | ---- | 15.6 | APR-ALT on. At 1115 processed video checked. APR-ALT off at 1116. At 1117 clock checked $< \frac{1}{2}$ sec fast. At 1415 sweep 2.4° tilt. $\omega$ reversed probably about 2000 EDT. |

*Table 6. Daily Log of WSR-57 radar data (continued)*

| Date | Tape No. | Go | Time (EDT) On | Off | Feet | Start | Stop | Noise | Position Correction Az. | Range | Threshold (dBz) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/02/79 | EM9183A | 0 | 0830 | 1458 | 1700 | 81 | 79 | ---- | ---- | ---- | ---- | Inhibit at 1040-1053 during NHC observations; processed video checked at 1105 (OK); changed tape at 1458 because of high tape consumption. Buffer boards believed to be bad. Tape was computer dumped; data is unrecoverable trash. On 1 July, power down .8 dB; need new radar equation. |
| | EM9183B | | 1504 | 2106 | 1300 | 81 | 79 | ---- | ---- | ---- | ---- | Data are recording but very high tape consumption. |
| 7/03/79 | EM9184A | 0 | 0842 | 1423 | 1700 | 81 | 79 | ---- | ---- | ---- | ---- | Used two tapes, because of high tape consumption. |
| | EM9184B | | 1438 | 2105 | 1900 | 81 | 79 | ---- | ---- | --- | ---- | |
| 7/04/79 | EM9185 | 0 | 0832 | 2110 | 2200 | 81 | 79 | ---- | ---- | ---- | ---- | At 1132 the recording interval switch set for one sweep every 10 min. |
| 7/05/79 | EM9186A | 0 | 0844 | 1126 | 0500 | 81 | 79 | 5 | ---- | ---- | 15.6 | At 0583-0944 radar down, NHC maintenance; at 0958-1004 inhibit, NHC observation. At 1130 circuit board was replaced. |
| | EM9186B | 0 | 1158 | 2105 | 1000 | 81 | 79 | 5 | ---- | ---- | 15.6 | Recording rate now back to normal. |
| 7/06/79 | EM9187 | B | 1105 | 2105 | 1200 | 79 | 81 | 5 | -0.88 | 0.4942 | 15.6 | Tape that was mounted at 0904 was removed for test runs. Same tape remounted at 1105. Tape dump reveals that azimuth and hour data badly flawed. |
| 7/07/79 | EM9188 | 0 | 0845 | 1135 | Unknown | 79 | 81 | ---- | ---- | ---- | ---- | After adjustments were made on the digitizer, no tape mounted. |
| 7/08/79 | EM9189 | B | 0842 | 2150 | 2000 | 79 | 81 | 6 | -1.40 | 0.4936 | 15.9 | Inhibit at 1725-1727. |
| 7/09/79 | EM9190 | B | 0831 | 2130 | 1100 | 79 | 81 | 7 | -0.63 | 0.4933 | 16.2 | Radar still .8 dB down in power. At 0900-1351 radar down, NHC maintenance and calibrations (MDS). At 1310 applied 2 EOF's inhibit at 1313; at 1534 time checked (3 seconds fast); inhibit at 1725-1729. |
| 7/10/79 | EM9191 | 0 | 0855 | 2105 | 1300 | 79 | 81 | 8 | ---- | ---- | 16.4 | Sweep at 1230 was recorded at 4.8° tilt, manual sweep at 1232; the EOF light came on and 5 EOF's were applied. NHC replaced the preamplifier. |
| 7/11/79 | EM9192 | 0 | 0837 | ---- | ---- | 79 | 81 | 8 | ---- | ---- | 16.4 | Inhibits at 0915-0917 and 1124-1134; at 0945 and 1141 processed video checked OK. At 0830-1029 the radar scope was very insensitive, showed only VIP 1. At 0950-1039 radar down, NHC replaced preamplifiers. |
| 7/12/79 | EM9193 | 0 | 0837 | 2105 | 1400 | 79 | 81 | 9 | ---- | ---- | 16.7 | At 0837-1036 radar down, NHC replaced preamplifiers. |
| 7/13/79 | EM9194 | 0 | 0839 | 2105 | 1500 | 81 | 79 | 12 | ---- | ---- | 17.5 | Calibration 0700-0830 on EC9194. At 0912 processed video checked OK. Inhibit at 0925-0927 (NHC obs.). |
| 7/14/79 | EM9195 | A | 0852 | 2106 | 1500 | 81 | 79 | 11 | -2.68 | 0.4918 | 17.2 | At 1212 processed video checked OK. |
| 7/15/79 | EM9196 | 0 | 0836 | 2105 | 1600 | 81 | 79 | 12 | ---- | ---- | 17.5 | At 0851 and 1142 processed video checked OK; time checked at 0926, (3 seconds slow); inhibits at 1125-1127 and 1425-1429 (NHC obs.); manual sweeps at 1127 and 1429. |
| 7/16/79 | EM9197 | 0 | 0836 | 2105 | 1600 | 81 | 79 | 12 | ---- | ---- | 17.5 | At 0841 and 1109 processed video checked OK; at 0915 time checked 3 seconds slow. |
| 7/17/79 | EM9198 | 0 | 0851 | 2105 | 1900 | 81 | 79 | 10 | ---- | ---- | 16.9 | At 0900 processed video checked OK. |
| 7/18/79 | EM9199 | 0 | 0849 | 2106 | 1500 | 81 | 79 | 10 | ---- | ---- | 16.9 | At 0853 and 1125 processed video checked OK; at 0900-1017 radar down, NHC maintenance; sweeps at 0945-0953 and 1007-1015. |
| 7/19/79 | EM9200A | 0 | 0842 | 1300 | 0400 | 81 | 79 | ---- | ---- | ---- | --- | At 0847 processed video checked OK; time checked at 0850 (1 sec slow); tape changed at 1300 because the digitizer was recording at half speed. Dumped tape on NHC Varian. Alternate pairs of azimuths are being skipped and not recorded. |
| | EM9200B | | 1308 | 2105 | 0400 | 81 | 79 | ---- | ---- | ---- | ---- | At 1338-1341 the antenna rotation rate was reduced to check out the digitizer which was recording at half speed; hardware problems with the digitizer. At 2000 start/stop azimuth changed to 79/81. Power supply disconnected. |

*Table 6. Daily Log of WSR-57 radar data (continued)*

July, 1979 (continued)

| Date | Tape No. | Go | Time (EDT) On | Off | Feet | Start | Stop | Noise | Position Correction Az. | Range | Threshold (dBz) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/20/79 | EM9201 | 0 | 0853 | 2110 | 2400 | 79 | 81 | 10 | ---- | ---- | 16.9 | At 0900 and 1600 processed video checked OK; tape runaway discovered at 2110, but time of last recording unknown. |
| 7/21/79 | EM9202 | 0 | 0831 | 1220 | 0 | 79 | 81 | -- | ---- | ---- | ---- | At 0842 processed video checked OK; data on this day is unrecoverable; tape runaways at 1000-1155; tape remounted each time; there are also multiple writings on tape. |
| 7/22/79 | EM9203A | 0 | 0832 | 1256 | 0600 | 79 | 81 | 9 | ---- | ---- | 16.7 | Runaways at 0832 and 0835, (remounted tape at 0837); at 0900 and 1139 processed video checked OK; at 1030 inhibited, manual sweep at 1033; tape was at 1256 removed to repair power supply in Digi-Data tape transport. |
| | EM9203B | | 1356 | 2105 | 1100 | 79 | 81 | 9 | ---- | ---- | 16.7 | At 1430 down for obs. digitizer was left on; inhibited at 1530, NHC obs; no sweep at 1535. |
| 7/23/79 | EM9204 | 0 | 0841 | 2105 | 1600 | 79 | 81 | 12 | ---- | ---- | 17.5 | At 0843 and 1142 processed video checked OK. |
| 7/24/79 | EM9205 | 0 | 0833 | 2105 | 1600 | 79 | 81 | 8 | ---- | ---- | 16.4 | At 0839 processed video checked OK. |
| 7/25/79 | EM9206 | 0 | ---- | ---- | 0 | -- | -- | -- | ---- | ---- | ---- | Radar down all day; NHC changed the radar magnetron and filament leads. Back to full transmitter power about 1600 EDT. |
| 7/26/79 | EM9207A | 0 | 0850 | 1055 | 0 | 79 | 81 | 9 | ---- | ---- | 16.7 | At 0900 processed video checked OK; at 1019 runaway due to slamming the digitizer's panel door; at 1020 back on line, same tape remounted, morning data overwritten. |
| | EM9207B | 0 | 1057 | 2105 | 1300 | 79 | 81 | 9 | ---- | ---- | 16.7 | Inhibited at 1921, digitizing during observations; no sweep at 1925, sweep at 1926. |
| 7/27/79 | EM9208 | 0 | 0852 | 2055 | 0700 | 79 | 81 | 8 | ---- | ---- | 16.4 | At 0853 and 1325 processed video checked OK; at 1109 runaway occurred reason unknown; at 0855 power failure. NHC worked on radar from 1830 until about 2000; radar showed two levels off. |
| 7/28/79 | EM9209A | B | 0853 | 1320 | 0600 | 81 | 79 | 9 | -2.42 | 0.4874 | 16.7 | At 0855 processed video checked OK; changed due to runaway caused by the light from flash bulb of photographer. |
| | EM9209B | | 1337 | 1740 | Unknown | 81 | 79 | 9 | -2.42 | 0.4874 | 16.7 | At 1356 power failure; at 1740 runaway occurred, unable to stop tapes; mounted new tape. |
| | EM9209C | | 1745 | 2136 | 0700 | 81 | 79 | 9 | -2.42 | 0.4874 | 16.7 | Runaway at 1912, stopped within a short distance, data collection normal afterwards. |
| 7/29/79 | EM9210 | 0 | 0833 | 2105 | 1600 | 81 | 79 | 10 | ---- | ---- | 16.9 | At 0855 and 0940 processed video checked OK; at 0901 time check 2 sec fast; at 0918 opened the door on digitizer and caused a runaway. Applied 1 EOF, took a manual sweep; no sweep at 0925, tape skipping, took another manual sweep OK, sweep at 0930 OK; inhibited at 1120, NHC obs. manual sweep at 1127; no sweeps at 1320, 1325, and 1330. |
| 7/30/79 | EM9211 | B | 0844 | 2105 | 1500 | 81 | 79 | 10 | -1.69 | 0.4868 | 16.9 | At 0848 and 1206 processed video checked OK; inhibits at 1220-1222 and 1400-1406, NHC obs; manual sweeps at 1222 and 1407; at 1318 runaway; appeared to be writing rapidly, turn to CONT. to stop, applied 1 EOF at 1319. |
| 7/31/79 | EM9212 | B | 0855 | 2139 | 1500 | 81 | 79 | 10 | -2.01 | 0.4865 | 16.9 | At 0855 processed video checked OK; radar down at 0951-1004 and 1155-1241, NHC working on radar. |

*Table 6. Daily Log of WSR-57 radar data (continued)*

| Date | Tape No. | Go | Time (EDT) On | Off | Feet | Start | Stop | Noise | Position Correction Az. | Range | Threshold (dBz) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/01/79 | EM9213 | 0 | 0841 | 2107 | 1500 | 81 | 79 | 10 | -2.11 | 0.4862 | 16.9 | At 0846 and 1300 processed vido checked OK; at 0946-1120 radar down, NHC maintenance. |
| 8/02/79 | EM9214 | 0 | 1010 | 2106 | 1400 | 81 | 79 | 10 | -2.82 | 0.4859 | 16.9 | Radar down until 1006, NHC routine maintenance; inhibited at 1025, (NHC obs.); manual sweep at 1028; at 1445-1450 insensitive scope, the range markings were double. At 1945 the rotation changed while recording; runaways occurred at 2101-2106 while operator was attempting to remove tape. |
| 8/03/79 | EM9215 | B | 0851 | 2136 | 1500 | 79 | 81 | 12 | -1.04 | 0.4856 | 17.5 | At 0851 processed video checked OK; first sweep at 0855; Calibration, from 0812-0838, on tape EC9215. |
| 8/04/79 | EM9216 | 0 | 0853 | 2107 | 1500 | 79 | 81 | 13 | -0.82 | 0.4853 | 17.7 | At 0855 processed video checked OK. |
| 8/05/79 | EM9217 | 0 | 0825 | 2120 | 1600 | 79 | 81 | 15 | ---- | ---- | 18.2 | At 0829 processed video checked OK; at 0832 time check 1 sec slow. |
| 8/06/79 | EM9218 | 0 | 0851 | 2105 | 1700 | 79 | 81 | 12 | ---- | ---- | 17.5 | At 0911 processed video checked OK; inhibited at 1020, NHC obs. manual sweep at 1024. |
| 8/07/79 | EM9219 | 0 | 0853 | 2105 | 1500 | 79 | 81 | 11 | ---- | ---- | 17.2 | At 0854 processed video checked OK. |
| 8/08/79 | EM9220 | 0 | 0838 | 2105 | 1400 | 79 | 81 | 11 | ---- | ---- | 17.2 | Radar down until 0917, NHC maintenance; first sweep around 0922. Inhibited at 1135-1137, manual sweep at 1137. At 1212 processed video checked OK. |
| 8/09/79 | EM9221 | A | 0904 | 2207 | 1500 | 79 | 81 | 11 | -1.30 | 0.4838 | 17.2 | Processed video checked OK at 0916. At 1025-1125 radar down, NHC maintenace; manual sweep at 1126. No sweep at 1725, applied 1 EOF, manual start, sweep at 1730. At 2023 start/stop azimuth changed to 81/79. |
| 8/10/79 | EM9222 | 0 | 0837 | 2106 | 1500 | 81 | 79 | 9 | ---- | ---- | 16.7 | At 0837 and 0841 manual sweeps. At 0844 processed video checked OK. |
| 8/11/79 | EM9223 | 0 | 0837 | 2209 | 1700 | 81 | 79 | 10 | ---- | ---- | 16.9 | First sweep at 0837; at 0839 processed video checked OK. At 0844-0845 runaway occurred when radio was turned on. Manual sweep at 0845. At 1225-1226 attempting to digitize during NHC obs. At 1227 applied 1 EOF, sweep at 1230. At 2209 a minor runaway occurred before applying the EOF's. |
| 8/12/79 | EM9224 | 0 | 0839 | 2105 | 1400 | 81 | 79 | 10 | -2.51 | 0.4829 | 16.9 | At 0839 processed video checked OK; time checked at 0833, (2 sec slow). |
| 8/13/79 | EM9225 | B | 0835 | 2101 | 1300 | 81 | 79 | 10 | -2.13 | 0.4826 | 16.9 | At 0839 processed video checked OK; at 0835 AP inside target area VIP 4; inhibited at 0929-1111, NHC calibrations. |
| 8/14/79 | EM9226 | B | 0844 | 2117 | 1500 | 81 | 79 | 10 | -2.69 | 0.4823 | 16.9 | Manual sweep at 0844; at 0846 processed video checked OK; at 2019-2023 inhibit, NHC obs. No sweep at 2025; manual start at 2029. |
| 8/15/79 | EM9227 | 0 | 1149 | 2105 | 1800 | 81 | 79 | 11 | -2.35 | 0.4820 | 17.2 | Radar down until 1145, NHC maintenance. At 1151 processed video checked OK. At 1309 runaway, sweep at 1310. Clock showed 2 sec slow. |
| 8/16/79 | EM9228 | B | 1229 | 2121 | 0900 | 81 | 79 | 9 | -2.17 | 0.4817 | 16.7 | Radar down until 1417, NHC changed the magnetron; the radar was operating on reduced power until 1400 EDT. At 2020 noticed antenna rotation had changed, the start/stop azimuth was changed to 79/81; sweeps at 2030, 2025 were lost; no echoes in target area at this time. No EOF's. |
| 8/17/79 | EM9229 | 0 | 0845 | 2106 | 1500 | 79 | 81 | 10 | -1.45 | 0.4814 | 16.9 | First sweep at 0845. At 0847 processed video checked OK. |
| 8/18/79 | EM9230 | B | 0844 | 2106 | 1500 | 79 | 81 | 10 | -1.66 | 0.4811 | 16.9 | At 0845 processed video checked OK. |

*Table 6. Daily Log of WSR-57 radar data (continued)*

August, 1979 (continued)

| Date | Tape No. | Go | Time (EDT) On | Off | Feet | Start | Stop | Noise | Position Correction Az. | Range | Threshold (dBz) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/19/79 | EM9231 | O | 0832 | 2108 | 1600 | 79 | 81 | 11 | ---- | ---- | 17.2 | At 0833 processed video checked OK; at 0834 time checked OK. |
| 8/20/79 | EM9232 | B | 0859 | 2107 | 1700 | 79 | 81 | 11 | -1.30 | 0.4806 | 17.2 | At 0858 processed video checked OK; at 0859 "AP" inside target area (VIP 5). |
| 8/21/79 | EM9233 | O | 0844 | 2106 | 1500 | 79 | 81 | 12 | ---- | ---- | 17.5 | Manual sweeps at 0844 and 0845. At 0850 processed video checked OK. |
| 8/22/79 | EM9234 | O | 0855 | 2107 | 1400 | 79 | 81 | 11 | ---- | ---- | 17.2 | Having problems getting the "enable write" light to stay on when mounting tape. At 0851 processed video checked OK. Radar down at 0859-1021, NHC maintenance. |
| 8/23/79 | EM9235A | O | 0852 | 1340 | 0700 | 79 | 81 | 11 | ---- | ---- | 17.2 | At 0854 processed video checked OK. Inhibited at 1000-1007 manual sweep at 1007. Morning tape was removed for instruction in tape mounting procedures. |
| | EM9235B | O | 1348 | 2108 | 1000 | 79 | 81 | 11 | ---- | ---- | 17.2 | At 2053 start/stop azimuth reversed to 81/79. |
| 8/24/79 | EM9236 | O | 0832 | 2106 | 1800 | 81 | 79 | 11 | -1.91 | 0.4794 | 17.2 | At 0933 processed video checked OK. |
| 8/25/79 | EM9237 | A | 0844 | 2106 | 1500 | 81 | 79 | 7 | -2.45 | 0.4791 | 16.2 | At 0848 processed video checked OK. At 0852 time checked 2 sec slow. |
| 8/26/79 | EM9238 | O | 0840 | 2106 | 2350 | 81 | 79 | 13 | ---- | ---- | 17.7 | At 1134 processed video checked OK. Time check at 1136 (4 sec slow). Reason for large tape consumption is unknown. |
| 8/27/79 | EM9239 | O | 0850 | 2106 | 1500 | 81 | 79 | 13 | ---- | ---- | 17.7 | At 0951 and 2103 processed video checked OK; inhibited at 0920, NHC obs; manual sweep at 0922. |
| 8/28/79 | EM9240 | B | 0914 | 2106 | 1300 | 81 | 79 | 11 | -2.39 | 0.4782 | 17.2 | Radar calibrations at 0800. First sweep at 1019 due to calibrations. At 1037 processed video checked OK. Manual sweep at 1612. |
| 8/29/79 | EM9241 | B | 0855 | 2106 | 1500 | 81 | 79 | 10 | -2.73 | 0.4779 | 16.9 | At 0855-0908 radar down, manual sweeps at 0855 and 0908. At 0930 processed video checked OK. |
| 8/30/78 | EM9242 | O | 0844 | 2106 | 2000 | 81 | 79 | 12 | ---- | ---- | 17.5 | Manual sweep at 0844; checked OK. Runaway at 0848, manual sweep at 0849. |
| 8/31/79 | EM9243 | O | 0846 | 2350 | Unknown | 81 | 79 | 11 | ---- | ---- | 17.2 | Manual sweep at 0846; at 0848 processed video checked OK. Power flux time??? Clock showed 2:20 day 365, at 2350. The ring and/or line light were off. |

*Table 6. Daily Log of WSR-57 radar data (continued)*

| Date | Tape No. | Go | Time (EDT) On | Off | Feet | Start | Stop | Noise | Position Correction Az. | Range | Threshold (dBz) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/16/80 | EMO168 | O | 1046 | 2105 | 1400 | 53 | 55 | -- | ---- | ---- | ---- | Calibration done 1000-1045 EDT. Scope not displaying digital video. Range rings corrected on a new video amplifier put in repeater scope 1200 EDT. First recorded sweep at 1113 EDT. |
| 6/17/80 | EMO169 | O | 0847 | 2105 | 600 | 53 | 55 | -- | ---- | ---- | ---- | No scans at 0915 or 0920; clock reset at 0921. Radar scope messed up after power fluctuation at about 0910. No scan at 0925. ElTechs monitoring NHC scope. FACE scope has a clean cursor sweep with no data. Scope OK at 0926. Range rings off. Tape rewound at 0929; the digitizer "on line" light was off. Sweep at 0931. At 0910 the antenna elevation read 84° due to power failure. At 1129 processed video checked OK. At 1345 it was noted that azimuth on digitizer stayed in the 300's until actual azimuth (from scanner on scope) got as low as 160°. At 1425 operator noted that scans are incomplete, going from 53° to 160° only. No sweeps at 1435, 1440, 1505 and 1510. Manual sweep at 1511. No sweep at 1520, manual sweep at 1522. No sweep at 1525, manual sweep at 1527. |
| 6/18/80 | EMO170 | O | 0826 | 2107 | 1600 | 53 | 55 | -- | ---- | ---- | ---- | Did not take first sweep on its own; manual sweep 0832. 0835 sweep OK. 0923 video checked OK. 1548 video checked OK. |
| 6/19/80 | EMO171 | O | 0850 | 2105 | 1500 | 53 | 55 | -- | ---- | ---- | ---- | |
| 6/20/80 | EMO172 | O | 0857 | 2106 | 1550 | 55 | 53 | -- | ---- | ---- | ---- | 0935 video checked OK. 0947 time checked 2 seconds slow. |
| 6/21/80 | EMO173 | O | 0859 | 2108 | 1500 | 55 | 53 | 12 | ---- | ---- | 14.4 | 0950 video checked OK. 0953 time checked OK. 2108 tape "ran away" during EOF procedure. 10-15 feet of blank tape separate the final scan from the six EOF's. |
| 6/22/80 | EMO174 | A | 0821 | 2105 | 1600 | 55 | 53 | 13 | -1.18 | 0.474 | 14.7 | Possibly 2 EOF's at start of tape. |
| 6/23/80 | EMO175 | B | 0842 | 2105 | 1500 | 55 | 53 | 15 | -1.18 | 0.478 | 15.2 | 1420 "inhibit' used since radar was down for observations. 1527 "inhibit" for same purpose. |
| 6/24/80 | EMO176 | B | 0852 | 2125 | 1600 | 55 | 53 | 14 | -1.18 | 0.481 | 15.0 | 0927 clock checked exactly. 1730 video checked OK. |
| 6/25/80 | EMO177 | B | 0856 | 2106 | 1550 | 55 | 53 | 14 | -1.18 | 0.478 | 15.0 | 0901 video checked OK. 1321-1322 "inhibit" for obs. 1325 failure to take sweep automatically; 1330 manual sweep taken. 1810-1811 "inhibit" for obs. 1830 AP began and suddenly increased. |
| 6/26/80 | EMO178 | O | 1043 | 2105 | 1400 | 55 | 53 | -- | ---- | --- | ---- | At 0830 radar was down for calibration (MDS). 1030 time checked 2 seconds slow. |
| 6/27/80 | EMO179 | O | 0909 | 2106 | 1430 | 55 | 53 | -- | ---- | ---- | ---- | 0919 video checked OK. 1010 time checked 4 minutes slow. 1317 "inhibit" on for one minute for obs. At 2037 radar scanner was discovered to be rotating in opposite direction, so "start" and "stop" azimuths were reversed. Consultation with NHC personnel revealed a lack of documentation of the exact rotation direction changeover time, since it was supposed to be done the previous evening but was not. 1930 was their crude estimation of that time, so an hour of lost data is likely. |

*Table 6. Daily Log of WSR-57 radar data (continued)*

| Date | Tape No. | Go | Time (EDT) On | Off | Feet | Start | Stop | Noise | Position Correction Az. | Range | Threshold (dBz) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/28/80 | EMO180 | B | 0835 | 2106 | 1400 | 53 | 55 | -- | 0.00 | 0.479 | ---- | 1316 "inhibit" for 1 minute for obs. At 1410 failure to take automatic sweep; manual sweep taken at 1411. At 1600 failure to take automatic sweep; manual sweep taken at 1601. 1826 "inhibit" for 1 minute for obs. AP became obvious in SE target starting 1745. At 1950 failure to take automatic sweep (EOF light was off); manual sweep taken at 1951. 2106 runaway during EOF procedure, there are about 6 feet of tape between the 2105 scan and the final 6 EOF's. |
| 6/29/80 | EMO181 | 0 | 0812 | 2105 | 1600 | 53 | 55 | -- | ---- | ---- | ---- | |
| 6/30/80 | EMO182 | 0 | 0951 | 2105 | 1400 | 53 | 55 | -- | ---- | ---- | ---- | |

*Table 6. Daily Log of WSR-57 radar data (continued)*

| Date | Tape No. | Go | Time (EDT) On | Off | Feet | Position Start | Stop | Noise | Correction Az. | Range | Threshold (dBz) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/01/80 | EM0183 | 0 | 0845 | 2106 | 1550 | 53 | 55 | 14 | ---- | ---- | 15.0 | |
| 7/02/80 | EM0184 | 0 | 0854 | 2106 | 1550 | 53 | 55 | 14 | ---- | ---- | 15.0 | |
| 7/03/80 | EM0185 | 0 | 0840 | 2107 | 1500 | 53 | 55 | 14 | ---- | ---- | 15.0 | 1024 video checked OK. 1027 time checked 3 seconds slow. |
| 7/04/80 | EM0186 | B | 0846 | 2106 | 1550 | 55 | 53 | 13 | -1.18 | 0.479 | 14.7 | No significant AP up to 2030. |
| 7/05/80 | EM0187 | 0 | 0849 | 2109 | 1550 | 55 | 53 | -- | ---- | ---- | ---- | |
| 7/06/80 | EM0188 | 0 | 0822 | 2105 | 1600 | 55 | 53 | 14 | ---- | ---- | 15.0 | Possibly 2 EOF's at beginning of tape. |
| 7/07/80 | EM0189 | B | 0816 | 2105 | 1200 | 53 | 55 | 14 | 0.00 | 0.475 | 15.0 | 0900-1320 radar down for maintenance. At 1320 antenna rotation direction changed; new start/stop is 53/55. 1330 EOF light off when not digitizing as was early in day -- warm in room -- BAD DATA? |
| 7/08/80 | EM0190 | B | 0845 | 2106 | 1600 | 53 | 55 | 15 | 0.00[1] | | | 0846 video checked OK. 1610 rotation direction changed; new |
| | | | | | | | | | -1.18[2] | 0.479 | 15.2 | start/stop is 55/53; before this rotation rate slow. |
| 7/09/80 | EM0191 | B | 0838 | 2106 | 1575 | 55 | 53 | 14 | -1.18 | 0.477 | 15.0 | 0840 video checked OK. 1032 time checked 2 seconds slow. |
| 7/10/80 | EM0192 | B | 0854 | 2105 | 1200 | 55 | 53 | 14 | -1.18 | 0.475 | 15.0 | 0855 video checked OK. 1018 time checked 4 seconds slow. At 1220 radar down, ElTechs say for maintenance (MDS). PPI record at 1323. At 1832 "inhibit" while on obs. for 1 minute. However, digitizer never made any more automatic sweeps after this, and this failure was unnoticed. |
| 7/11/80 | EM0193 | 0 | 0857 | 2106 | 1450 | 53 | 55 | 14 | ---- | ---- | 15.0 | 0900 video checked OK. |
| 7/12/80 | EM0194 | B | 0846 | 2154 | 1700 | 53 | 55 | 13 | 0.00 | 0.478 | 14.7 | 1436 video checked OK. |
| 7/13/80 | EM0195 | 0 | 0849 | 1900 | 1400 | 53 | 55 | 12 | ---- | ---- | 14.4 | Fuse is out on our radar scope (no sweep). At 1110 ElTech Steve Fazekis fixed scope. At 1900 lightning strike put the radar down, digitizer down and clock down. At 1908 clock reset, tape removed (EOF's not possible). No new tape mounted since end of day near and radar down. |
| 7/14/80 | EM0196A | A | 0753 | 1608 | 1000 | 53 | 55 | 13 | 0.00 | 0.479 | 14.7 | Power failure at 1608: digitizer down. No EOF's possible. Radar down. |
| | EM0196B | | 1613 | 2105 | 700 | 53 | 55 | 13 | 0.00 | 0.479 | 14.7 | Radar down until 1630. Elevation messed up: stuck at 8.4 until 1641, when problem was solved by turning the digitizer off and then on again. |
| 7/15/80 | EM0197 | 0 | 0843 | 2105 | 1600 | 53 | 55 | 14 | ---- | ---- | 15.0 | 1015 video checked OK. 1018 time checked 5 seconds fast. |
| 7/16/80 | EM0198 | B | 1015 | 2119 | 1415 | 53 | 55 | 14 | 0.00 | 0.479 | 15.0 | NHC VIP calibration from 0845 to 1014. 1234 video checked OK. At 1500 the first indications of a problem showed up at several degrees in the NE portion of scope, becoming more widespread (affecting over 30 degrees) by 1620; also apparent at NHC radar console. |
| 7/17/80 | EM0199 | 0 | 0853 | 2105 | 1500 | 53 | 55 | 15 | ---- | ---- | 15.2 | 1627 time checked 2 seconds fast. 1628 processed video checked OK. Radar rotation changed at 2000, digitizer changed at 2045. |
| 7/18/80 | EM0200A | 0 | 0840 | 1201 | 200 | 55 | 53 | -- | ---- | ---- | ---- | 0843 video checked OK. Power failure at 1157, digitizer went down. Tape was rewound (no EOF's). Radar down. |
| | EM0200B | | 1201 | 2106 | 1200 | 55 | 53 | -- | ---- | ---- | ---- | Radar down until 1213. First scan record at 1213. Clock 10 seconds fast, reset at 1346. |

*Table 6. Daily Log of WSR-57 radar data (continued)*

| Date | Tape No. | Go | Time (EDT) On | Off | Feet | Start | Stop | Noise | Position Correction Az. | Range | Threshold (dBz) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/19/80 | EM0201 | 0 | 0847 | 2106 | 1350 | 55 | 53 | -- | ---- | ---- | ---- | Bright light was turned on during afternoon and evening for repair of lightning monitor. Digitizer seemed to function satisfactorily. |
| 7/20/80 | EM0202 | 0 | 0837 | 2106 | 1375 | 55 | 53 | -- | ---- | ---- | ---- | |
| 7/21/80 | EM0203 | 0 | 0758 | 2105 | 1700 | 55 | 53 | 13 | ---- | ---- | 14.7 | At 1658 removed log video connector from backside. At 1701 another record taken. At 1703 cable reinstalled (sweep at 1704). Cable removed at 1704, sweep taken at 1705. Cable reinstalled at 1706; sweep taken. |
| 7/22/80 | EM0204 | 0 | 0847 | 2105 | 1400 | 55 | 53 | -- | ---- | ---- | ---- | 1508 video checked OK. |
| 7/23/80 | EM0205 | 0 | 0909 | 2106 | 1550 | 55 | 53 | 15 | ---- | ---- | 15.2 | 0911 video checked OK. |
| 7/24/80 | EM0206A | 0 | 0848 | 1335 | 0800 | 55 | 53 | -- | ---- | ---- | ---- | Tape removed to get an immediate computer dump of it. |
| | EM0206B | | 1338 | 2105 | 0900 | 55 | 53 | -- | ---- | ---- | ---- | Antenna rotation changed at 2042; new start/stop 53/55. |
| 7/25/80 | EM0207A | B | 0855 | 1130 | 0400 | 53 | 55 | -- | 0.00 | 0.477 | ---- | Tape removed to allow George Andrews to work on digitizer. |
| | EM0207B | | 1330 | 2221 | 1200 | 53 | 55 | -- | 0.00 | 0.477 | ---- | Tape may have been mounted before 1330. At 1440 radar operator had been keeping elevation at 1.2 degrees; advised and he changed to 0.7, causing levels to increase by about one level in cores. At 1605 failure to take sweep automatically; manual sweep at 1606. Radar was down for obs. excessively this afternoon (about 4 times per hour). |
| 7/26/80 | EM0208 | 0 | 0855 | 2211 | 1450 | 53 | 55 | -- | ---- | ---- | ---- | 1315 video checked OK. |
| 7/27/80 | EM0209 | 0 | 0823 | 2105 | 1600 | 53 | 55 | 14 | ---- | ---- | 15.0 | |
| 7/28/80 | EM0210 | 0 | 0808 | 2105 | 1500 | 53 | 55 | -- | ---- | ---- | ---- | New radar operator; possibly more than normal missing sweeps due to practicing taking obs. |
| 7/29/80 | EM0211 | B | 0925 | 2117 | 1500 | 53 | 55 | 13 | 0.00 | 0.476 | 14.7 | At 0900 radar down; new vent being installed in radome. |
| 7/30/80 | EM0212 | 0 | 0854 | 2106 | 1575 | 53 | 55 | 13 | ---- | ---- | 14.7 | At 1002 operator noticed EOF light not lit; started by switch to CONT; any missed scans not known; OK at 1005. 1018 time checked OK. 1020 video checked OK. |
| 7/31/80 | EM0213 | B | 0857 | 2105 | 1600 | 53 | 55 | -- | 0.00 | 0.478 | ---- | 0917 video checked OK. 1445 to 1453 our scope looks peculiar: VIP levels not right; NHC reports no trouble. Rotation direction changed at 2000; new start/stop 55/53. |

[1] 0900-1630
[2] 1630-2100

*Table 6. Daily Log of WSR-57 radar data (continued)*

| Date | Tape No. | Go | Time (EDT) On | Off | Feet | Start | Stop | Noise | Position Correction Az. | Range | Threshold (dBz) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/01/80 | EM0214 | 0 | 0745 | 2106 | 1675 | 55 | 53 | 14 | ---- | ---- | 15.0 | 1026 video checked OK. |
| 8/02/80 | EM0215 | B | 0848 | 2106 | 1600 | 55 | 53 | 15 | -1.18 | 0.473 | 15.2 | 0850 video checked OK. |
| 8/03/80 | EM0216 | B | 0828 | 2105 | 1600 | 55 | 53 | 14 | -1.18 | 0.474 | 15.0 | |
| 8/04/80 | EM0217 | B | 0819 | 2105 | 1600 | 55 | 53 | 14 | -1.18 | 0.478 | 15.0 | 1119 clock checked exactly. 1120 contoured video checked OK. |
| 8/05/80 | EM0218 | 0 | 0822 | 2105 | 1600 | 55 | 53 | -- | ---- | ---- | ---- | |
| 8/06/80 | EM0219 | 0 | 0850 | 2152 | 1600 | 55 | 53 | 12 | ---- | ---- | 14.4 | |
| 8/07/80 | EM0220 | 0 | 0822 | 2123 | 1625 | 55 | 53 | 13 | ---- | ---- | 14.7 | 1032 processed video checked OK. Rotation direction changed at 2000; new start/stop 53/55. |
| 8/08/80 | EM0221 | 0 | 0853 | 2106 | 1575 | 53 | 55 | -- | ---- | ---- | ---- | 0932 processed video checked OK. |
| 8/09/80 | EM0222 | 0 | 0901 | 2107 | 1575 | 53 | 55 | -- | ---- | ---- | ---- | 1012 processed video checked OK. |
| 8/10/80 | EM0223 | 0 | 0819 | 2105 | 1450 | 53 | 55 | 14 | ---- | ---- | 15.0 | |
| 8/11/80 | EM0224 | 0 | 0802 | 2107 | 1500 | 53 | 55 | -- | ---- | ---- | ---- | |
| 8/12/80 | EM0225 | 0 | 0832 | 2106 | 1500 | 53 | 55 | 16 | ---- | ---- | 15.5 | |
| 8/13/80 | EM0226 | 0 | 0844 | 2106 | 1525 | 53 | 55 | -- | ---- | ---- | ---- | 0911 video checked OK. |
| 8/14/80 | EM0227 | 0 | 0852 | 2106 | 1300 | 53 | 55 | 15 | ---- | ---- | 15.2 | 0853 video checked OK. Rotation direction changed at 2000, start/stop azimuth changed to 55/53 at 2049. |
| 8/15/80 | EM0228 | 0 | 0900 | 2106 | 1585 | 55 | 53 | -- | ---- | ---- | ---- | Scope blank at 1040; jiggled tube and back on at 1150. |
| 8/16/80 | EM0229 | 0 | 0823 | 2106 | 1600 | 55 | 53 | 14 | ---- | ---- | 15.0 | 1031 video checked OK. |
| 8/17/80 | EM0230 | 0 | 0829 | 2106 | 1500 | 55 | 53 | 14 | ---- | ---- | 15.0 | |
| 8/18/80 | EM0231 | B | 0813 | 2106 | 1500 | 55 | 53 | 15 | -1.18 | 0.478 | 15.2 | |
| 8/19/80 | EM0232 | 0 | 0858 | 2115 | 1500 | 55 | 53 | 16 | ---- | ---- | 15.5 | 0900 video checked OK. Digitized at 2114, no data taken at 2115. |
| 8/20/80 | EM0233A | 0 | 0854 | 1113 | 0400 | 55 | 53 | -- | ---- | ---- | ---- | 1034 time checked OK. 1035 video checked OK. At 1045 power failure; Steve Fazekis reported radar will be down for about an hour. At 1113 power glitch, clock out and digitizer down. Tape rewound, no EOF's. |
| | EM0233B | | 1144 | 2138 | 1250 | 55 | 53 | -- | ---- | ---- | ---- | Redar still down at 1116 when tape B first came on line. At 1139 another power failure; radar had never come up. Tape B restarted at 1141; no scan recorded before 1139. Radar came up at 1205, first scan 1205. Until 1240, date was wrong on clock, was changed from 234 to 233. So, date was one day too high for data from 1205 to 1240. Sweep at 1345 was not exactly at 1345 since clock was being reset, but was close, back to exact time at 1346, and sweep was taken at that time. Problem was that at 1245 clock was incorrectly set at 1345, and this was corrected at 1306. A sweep was taken at 1307. Sweep at 1345 (mentioned above as being slightly off) was actually close to a whole hour off. |
| 8/21/80 | EM0234A | 0 | 0859 | 1056 | 0400 | 55 | 53 | -- | ---- | ---- | ---- | Tape removed at 1056 for testing on UMCC Univac. This testing was done to see whether the error-filled data found on the EM0233B tape (following all the power fluxes) is still found on EM0234A, or whether the digitizer has "cured" itself. 10 EOF's at end of tape. (Dump of tape EM0234A indicated self "cure" of digitizer.) |

*Table 6. Daily Log of WSR-57 radar data (continued)*

| Date | Tape No. | Go | Time (EDT) On | Off | Feet | Start | Stop | Noise | Position Correction Az. | Range | Threshold (dBz) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/21/80 | EM0234B | | 1059 | 2107 | 1200 | 55 | 53 | -- | ---- | ---- | ---- | First sweep for B tape at 1059. Antenna rotation direction changed at 2002; start/stop azimuth changed to 53/55. |
| 8/22/80 | EM0235 | A | 0900 | 2112 | 1550 | 53 | 55 | 15 | 0.00 | 0.476 | 15.2 | 1032 video checked OK. At 2110 an extra scan was accidentally recorded. |
| 8/23/80 | EM0236 | 0 | 0848 | 2106 | 1550 | 53 | 55 | 16 | ---- | ---- | 15.5 | |
| 8/24/80 | EM0237 | 0 | 0825 | 2111 | 1550 | 53 | 55 | 15 | ---- | ---- | 15.2 | |
| 8/25/80 | EM0238 | 0 | 0823 | 2106 | 1100 | 53 | 55 | -- | ---- | ---- | ---- | Radar down for maintenance from about 0900 to about 1300. At 1310 radar on line, but elevation reads 20 degrees higher than actual value. The explanation from ElTech Bill Pettyplace is "Radar in Miami being tied into KAVORAS; other stations receiving Miami radar could not get correct azimuths and elevations; thus Miami has changed the adjustments of synchro-servos to align with KAVORAS." Pettyplace then readjusted FACE azimuths. He attempted, but failed, to adjust to correct value of elevation; he found that elevation was anywhere from +12 to +32 degrees. Arbitrarily, an offset of +20.0 degrees is in elevation on display and on tape and will stay that way. 1350 processed video checked OK. |
| 8/26/80 | EM0239 | B | 0900 | 2112 | 1400 | 53 | 55 | 14 | -1.44 | 0.477 | 15.0 | Elevation on digitizer is 20.0 degrees higher than actual. 1031 video checked OK. |
| 8/27/80 | EM0240 | 0 | 0853 | 2221 | 1650 | 53 | 55 | -- | ---- | ---- | ---- | Elevation on digitizer is 20.0 degrees higher than actual. |
| 8/28/80 | EM0241 | 0 | 0852 | 2107 | 1600 | 53 | 55 | 16 | ---- | ---- | 15.5 | Elevation on digitizer is 20.0 degrees higher than actual. Digitizer recording data but scope out at 1520. 1547 video checked OK, but videocheck causes scope to go out when switched back to RAM. Also focus goes out or away (focus tube was changed last week); can see that when on video check, display is uncontoured, and then upon switchback to RAM, no signal at all. Antenna rotation direction changed at 2002; start/stop azimuth switched to 55/53. |
| 8/29/80 | EM0242 | B | 0858 | 2106 | 1525 | 55 | 53 | 15 | -2.64 | 0.476 | 15.2 | Elevation on digitizer is 20.0 degrees higher than actual. |
| 8/30/80 | EM0243 | 0 | 0818 | 2111 | 1600 | 55 | 53 | 15 | ---- | ---- | 15.2 | Elevation on digitizer is 20.0 degrees higher than actual. |
| 8/31/80 | EM0244 | 0 | 0840 | 2112 | 1650 | 55 | 53 | 16 | ---- | ---- | 15.5 | Elevation on digitizer is 20.0 degrees higher than actual. |

*Table 7. Minimum ranges used to eliminate AP contamination.*

| Date | AP Time Start | AP Time Stop | Range (nmi) | Comments |
|---|---|---|---|---|
| 6/29/78 | -- | -- | -- | Bad Data Tape |
| 6/30/78 | 1940 | 2100 | -- | No Processing |
| 7/01/78 | -- | -- | -- | No AP |
| 7/02/78 | 1932 | 1944 | 45 | |
| | 1945 | 2100 | 40 | |
| 7/03/78 | 0900 | 1809 | 45 | |
| | 1810 | 1950 | 40 | |
| | 1951 | 2100 | -- | No Processing |
| 7/05/78 | -- | -- | -- | No AP |
| 7/10/78 | -- | -- | -- | No AP |
| 7/18/78 | 1924 | 2100 | -- | No Processing |
| 7/25/78 | -- | -- | -- | No AP |
| 7/29/78 | -- | -- | -- | No AP |
| 8/04/78 | 2000 | 2100 | -- | No Processing |
| 8/05/78 | 0915 | 0925 | 40 | |
| | 1850 | 1859 | 45 | |
| | 1900 | 2100 | 55 | |
| 8/10/78 | -- | -- | -- | No AP |
| 8/11/78 | 1529 | 1834 | 40 | |
| | 1835 | 1930 | 50 | |
| | 1931 | 2100 | -- | No Processing |
| 8/12/78 | 1940 | 1959 | 40 | |
| 8/13/78 | -- | -- | -- | No AP |
| 8/14/78 | -- | -- | -- | No AP |
| 8/16/78 | -- | -- | -- | No AP |
| 8/17/78 | -- | -- | -- | No AP |
| 8/18/78 | -- | -- | -- | No AP |
| 8/29/78 | 1925 | 1939 | 60 | |
| | 1940 | 2100 | -- | No Processing |

*Table 7. Minimum ranges used to eliminate AP contamination. (Continued)*

| Date | AP Time Start | AP Time Stop | Range (nmi) | Comments |
|---|---|---|---|---|
| 7/06/79 | -- | -- | -- | Missing Azimuths |
| 7/08/79 | 1810 | 2100 | -- | No Processing |
| 7/09/79 | 1759 | 2100 | -- | No Processing |
| 7/14/79 | 1430 | 1545 | 50 | |
| | 1930 | 2100 | -- | No Processing |
| 7/28/79 | 1910 | 2100 | -- | No Processing |
| 7/30/79 | 1349 | 2100 | 40 | |
| 7/31/79 | -- | -- | -- | No AP |
| 8/03/79 | -- | -- | -- | No AP |
| 8/09/79 | -- | -- | -- | No AP |
| 8/13/79 | 2055 | 2100 | -- | No Processing |
| 8/14/79 | -- | -- | -- | No AP |
| 8/16/79 | 2014 | 2100 | -- | No Processing |
| 8/18/79 | 1450 | 1500 | 45 | |
| | 1501 | 1549 | 30 | |
| | 1550 | 1700 | 45 | |
| | 1800 | 1835 | 40 | |
| | 1836 | 1919 | 50 | |
| | 1920 | 1930 | 55 | |
| | 1931 | 2100 | -- | No Processing |
| 8/20/79 | 1925 | 1939 | 50 | |
| | 1940 | 2010 | 60 | |
| | 2011 | 2100 | -- | No Processing |
| 8/25/79 | -- | -- | -- | No AP |
| 8/28/79 | -- | -- | -- | No AP |
| 8/29/79 | 1500 | 1549 | 40 | |
| | 1730 | 2100 | 40 | |

*Table 7. Minimum ranges used to eliminate AP contamination. (Continued)*

| Date | AP Time Start | AP Time Stop | Range (nmi) | Comments |
|---|---|---|---|---|
| 6/23/80 | 0900 | 1858 | 45 | |
| | 1859 | 1948 | 50 | |
| | 1949 | 2100 | -- | No Processing |
| 6/24/80 | 0900 | 1128 | 45 | |
| | 1129 | 1625 | 50 | |
| | 1626 | 1930 | 55 | |
| | 1931 | 2100 | -- | No Processing |
| 6/25/80 | 0950 | 1529 | 45 | |
| | 1530 | 1704 | 35 | |
| | 1705 | 1729 | 50 | |
| | 1730 | 1739 | 60 | |
| | 1740 | 1829 | 70 | |
| | 1830 | 2100 | -- | No Processing |
| 6/28/80 | -- | -- | -- | No WSR Tape |
| 7/04/80 | 2014 | 2100 | 40 | |
| 7/07/80 | 1019 | 1359 | 40 | |
| | 1539 | 1724 | 50 | |
| | 1725 | 1734 | 60 | |
| | 1735 | 2100 | -- | No Processing |
| 7/08/80 | 0900 | 1213 | 35 | |
| | 1759 | 1838 | 40 | |
| | 1839 | 1849 | 45 | |
| | 1850 | 1859 | 70 | |
| | 1900 | 2100 | -- | No Processing |
| 7/09/80 | 1924 | 2100 | 40 | |
| 7/10/80 | 1709 | 1753 | 50 | |
| | 1754 | 1818 | 70 | |
| | 1819 | 2100 | -- | No Processing |
| 7/12/80 | 0900 | 1743 | 40 | |
| | 1744 | 1758 | 45 | |
| | 1759 | 1948 | 50 | |
| | 1949 | 2100 | -- | No Processing |
| 7/14/80 | 2019 | 2038 | 40 | |
| | 2039 | 2100 | 50 | |
| 7/16/80 | 1614 | 1903 | 45 | |
| | 1904 | 1938 | 55 | |
| | 1939 | 1953 | 60 | |
| | 1954 | 2100 | -- | No Processing |
| 7/25/80 | -- | -- | -- | Bad WSR Tape |
| 7/29/80 | 1354 | 1638 | 40 | |
| | 1719 | 1758 | 40 | |
| | 1909 | 1948 | 35 | |
| | 1949 | 1958 | 40 | |
| | 1959 | 2100 | -- | No Processing |
| 7/31/80 | -- | -- | -- | Bad WSR Tape |

*Table 7. Minimum ranges used to eliminate AP contamination. (Continued)*

1980 Continued

| Date | AP Time Start | AP Time Stop | Range (nmi) | Comments |
|---|---|---|---|---|
| 8/02/80 | 1539 | 1643 | 35 | |
| | 1644 | 1908 | 40 | |
| | 1909 | 2100 | -- | No Processing |
| 8/03/80 | 1734 | 1903 | 40 | |
| | 1904 | 2100 | -- | No Processing |
| 8/04/80 | 0909 | 1523 | 40 | |
| | 1919 | 1933 | 40 | |
| | 1934 | 2018 | 50 | |
| | 2019 | 2100 | 55 | |
| 8/18/80 | 1234 | 1813 | 35 | |
| | 1814 | 1848 | 70 | |
| | 1849 | 2100 | -- | No Processing |
| 8/22/80 | 1939 | 2003 | 35 | |
| | 2004 | 2043 | 50 | |
| | 1849 | 2100 | -- | No Processing |
| 8/26/80 | 1939 | 1948 | 35 | |
| | 1949 | 2003 | 40 | |
| | 2004 | 2018 | 60 | |
| | 2019 | 2100 | 70 | |
| 8/29/80 | 1849 | 1903 | 40 | |
| | 1904 | 2100 | 50 | |

data for these days were recorded in analog form on magnetic tapes at 15 min intervals. To date, these analog tapes have not been processed, and there are no plans at this time to process them in the future. The major reason for this is the fact that the azimuths were recorded incorrectly, or not at all, on this system. No method has yet been developed to overcome this problem.

From 25 July until the end of the field program, digitized tapes of the radar data were recorded for each GO day. Later analysis of these data indicated a lack of sensitivity in the radar receiver components. As a result, weak echoes were neither detected nor recorded. The data that were recorded consisted of moderate to strong echoes only, resulting in a statistical bias towards stronger echoes and smaller echo areas.

Aside from the receiver problems, the remainder of the digitizer system worked fairly well with one exception. A defect in the tape recorder caused the parity count of each physical record to be in error. All other information including video and housekeeping information was written correctly.

Before the 1979 field season, the MPS-4 radar system was overhauled considerably so that the quality of the data was much superior to that of 1978. The receiver system was improved with a new Log IF and other components so that the sensitivity for low-level signals was considerably increased. The minimum detectable signal was about -108 dBm most often, compared with about -98 dBm in 1978. The automatic antenna position director system was also improved in reliability and accuracy at low elevation angles.

The tape deck, however, continued to have problems. Principally, it would go forward without recording data, leaving gaps in the tape and producing records of irregular length. While efforts were concentrated on solving that problem, and before the tapes could be routinely checked, a difficulty appeared in the buffer system just before the data were written on tape. When the tapes could be finally checked and the error detected, several days worth of data were lost.

For the 1980 experiment the MPS-4 radar had several important changes in the receiver section which improved the detection of the lower signal levels. The minimum detectable signal was about -107 to -108 dBm most often. Other changes were made in the method of beginning CAPPI sequence angles and automatic calibrations. These changes improved overall the reliability and accuracy of the measurements.

The Kennedy tape recorder that was the source of so many problems during the last 2 years was sent back to the factory for 2 months before the experiment. It was run for several hundred hours in simulated data collection modes, during which time failed parts were finally ferretted out and replaced. It worked extremely well during 1980.

A program was developed to run on NHRL's IGS computer to check the data daily. This program used the original tapes of data and produced a B-scan-type dump of the digitized data. The binary data (on a scale of 0 to 255) were coded so that a single character was assigned to each information bin. In addition, the housekeeping information was unpacked, decoded, and printed. This

program proved extremely useful in monitoring the quality of the data from both the MPS-4 and the WSR-57 radar systems.

Once the tapes were test dumped, they were duplicated and the copy sent to the Boulder Computer Center. The data quality program used in 1979 was then employed to check the data further and to determine the noise level and the appropriate calibration curves to use.

These preliminary analyses indicated that the data that were recorded were good and useful in the vast majority of cases. The only major difficulties originated when lightning struck nearby on two occasions. The resulting power surges affected the programable memory chips that send the elevation angle of the antenna to be recorded. On those days the elevation angle information has one bit fixed at the same value all the time. This problem, however, has been corrected with some additional software development.

WSR-57. In general, the quality of data collected in 1978 was very good.

One tape was made on each of the 78 FACE 1978 days. These tapes were mounted before 0900 EDT and were removed between 2100 EDT and 2200 EDT, with the following exceptions: on each of two days, two tapes were required; on another day the tape was mounted late, and on three evenings the tape was removed early. Time lost to radar maintenance during daytime hours totaled 25 hr for FACE 1978. A failed power supply resulted in an 11 1/2-hr outage of the WSR-57 on 25 June. There was a 6-hr loss on 26 August. Both were non-GO days. Time lost from daytime electrical power failure

totaled 15 min, the result of two close lightning strikes 25 min apart on 19 August. Data lost from digital processor "chip" failure was about three days, but none were GO days. Some tapes have subnormal footages as a result of unexplained nonfunctioning of selected "Start" and "Stop" azimuths.

The amount and quality of the taped S-band radar data in 1979 were adversely impacted during the first third of the FACE program because of two factors. First, FACE Control and the NHC were moved to new locations on 26 and 27 June. Second, malfunctioning hardware in the form of a new dual-density tape recording device was used in place of the hardware that had been newly installed in 1978. However, the dual-density equipment arrived only 5 days before FACE 1979 was to start; it arrived with damage to the buffer/formatter that, electronically, was more severe than casual appearance suggested; and it arrived while the location for FACE Control was being moved to space that the NHC still was in the process of vacating. Thus, FACE 1979 began with a radar digitizer/recorder system that had been installed in a time frame so small as to preclude checking and testing of all its features and its failings.

A calibration tape was made on Sunday, 1 July. The printouts from the computer dump were available for study only after aircraft had been launched on 2 July. The printouts showed that no intelligible data were being recorded. The buffer/formatter was repaired on 5 July and again on 7, 19, and 22 July. On 19 July, excessive heat in the buffer was deduced to be the cause of the malfunctioning of solid-state circuit "chips". The heat,

which came from a power supply unit that was required by the 1600 bpi feature, was reduced by disabling the power supply of the 1600 bpi feature. Following this repair, the radar data were gathered daily until the end of FACE 1979.

In FACE 1979 during daytime hours (0900-2100 EDT), some S-band radar data were tape-recorded on all but one day. However, the quality of the data was much more variable than in past years. A large percentage of the data gathered in the first third of the program suffers from having been recorded with circuitry that was improperly functioning. For example, tapes made on 2, 3, and 4 July contain no recoverable data. From 5 through 22 July, the tapes have been found to contain housekeeping (azimuth and time) information that is badly flawed at frequent intervals; however, the range bin (rainfall) data appear to be good. Dumps of the 19 July tape indicated that data on alternate pairs of azimuths were not recorded at all. Because of the scrambled values of time and azimuth, the computer code cannot perform correctly.

The tape deck occasionally began uncontrolled spooling ("runaway") of magnetic tape, during which no data were recorded. Recovery from this situation usually was accomplished within a few minutes. Runaways occurred at least once in the course of each of 14 days.

The radar was sometimes out of service because of maintenance during the crucial 12 hr starting at 0900 EDT. Time lost during this half of the day to radar maintenance exceeded an hour on each of 12 days during FACE 1979, including the GO days of 7, 9, and

31 July and 9, 13, and 16 August. The radar had always been returned to operation before seeding began.

The frequency of good digitizer performance in 1980 was not as high as in past years of FACE. Out of 23 GO days, 3 had unacceptable digital data. Out of the 77 days of the FACE 1980 season on which tapes were checked, 21 were categorized as having failed to produce satisfactory data; 6 were in the marginally acceptable category, and 50 were found to be of good quality. It is noteworthy that a much higher proportion of GO-days than non-GO-days had good tape data. None of the 6 days having marginally acceptable tape data were GO-days.

Most of the tape data problems were due to sporadic mechanical/electrical failures within the digitizer. The most common severe problem had as its major symptom a scrambling of the housekeeping (including times and azimuths) information, precluding processing by the existing FACE software. Marginally acceptable tape data typically had 1 to 2 percent of the azimuths detrimentally affected; these were scattered throughout the tape in a fairly uniform density.

## TAPE COPYING

Most of the radar tapes from both the MPS-4 and WSR-57 have been archived and copied. The copies have been sent to the NOAA Boulder Computing Center. Copying the tapes permitted a number of corrections to be made:

1) Removal of extra EOF's imbedded in the data.

2) Eliminating sections of blank tape caused by tape runaways.

3) Rewriting data records with correct parity.

4) Combining of partially filled tapes and short tapes from the same day onto a single tape.

All processing was then performed on the "cleaned-up" copies.

## V. Preliminary Data-Analysis Products

### TYPES OF PRODUCTS

The present chapter contains those results of the analysis procedures that are considered important in the determination of seeding effects on the cloud field or that provide a background description of the echo population present on GO days. Three major products are presented: The first set (Figs. 4 to 6) consists of time series of the area covered with echoes, and of average values of reflectivity and height over the FACE target area. The second group (Figs. 7 to 9) contains series of cell and echo characteristics such as number of entities, and average values of reflectivity, area, and height. The last set (Table 8) lists the parameters of the distributions of the characteristics of directly treated and nontreated cells.

### TIME SERIES

Before each data set was plotted, both upper and lower bounds were imposed. Any values less than the least value of the y-axis were set to the value of the y-axis origin. The upper bound was set at one division of the y-axis larger than the uppermost value of the y-axis scale. No adjustments were imposed on the range of the x-axis.

The WSR-57 data normally contained data in 5-min intervals, while the MPS-4 had intervals that varied from 6 to 9 minutes. This necessitated the use of two different methods of plotting the time on the x-axis.

The WSR-57 data was plotted using discrete 5-min intervals. In the event of missing data, a six-point interpolation scheme was used, namely

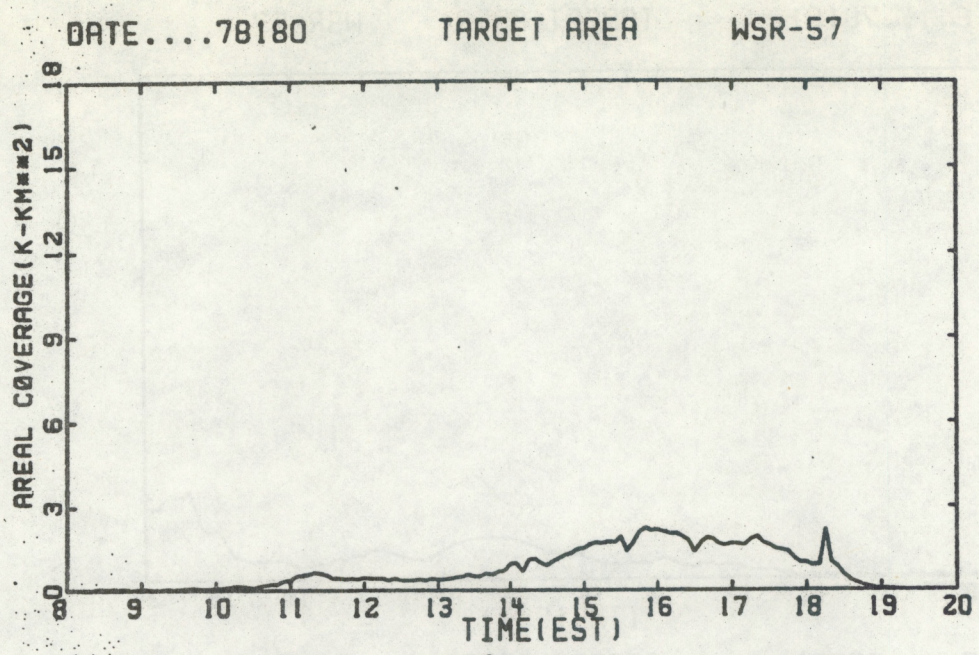
$$Y_i = \frac{\sum_{\substack{i-3 \\ j\neq i}}^{i+3} Y_j/|X_j-X_i|}{\sum_{\substack{j=i-3 \\ j\neq i}}^{i+3} 1/|X_j-X_i|}$$

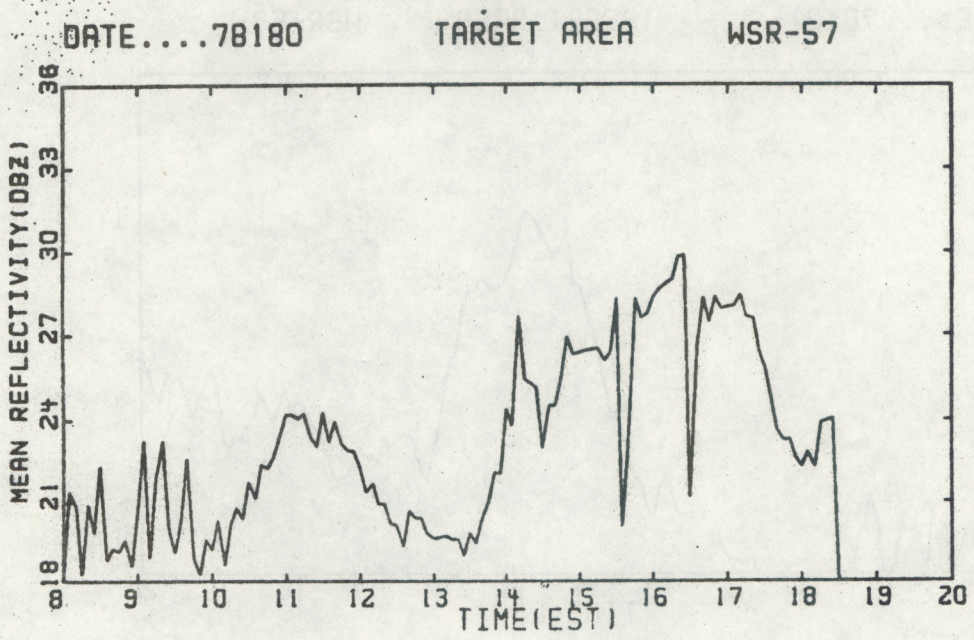
This scheme worked very well, except in those cases when three or more adjacent data points were missing, or when the missing point was a relative maximum or minimum.

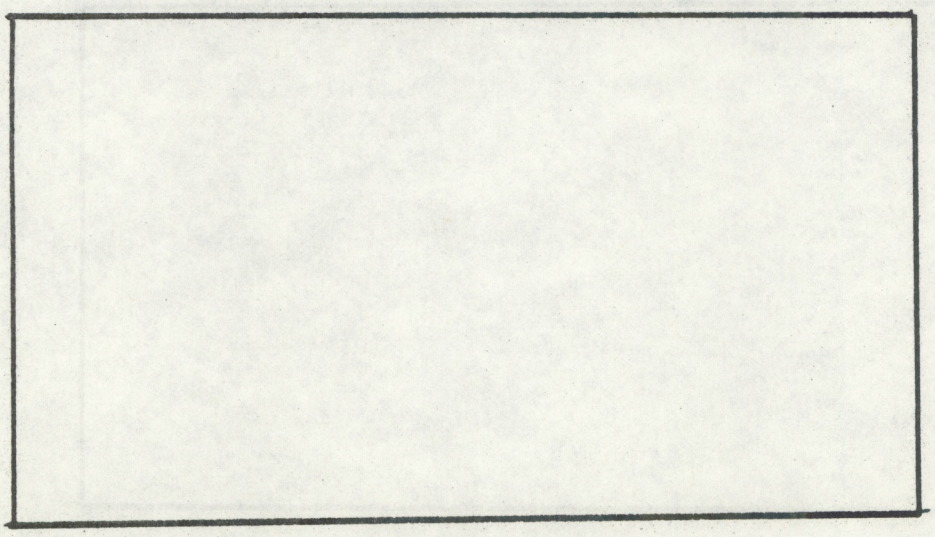
The MPS-4 data were plotted using a continuous time function; therefore no interpolation for missing values was used.

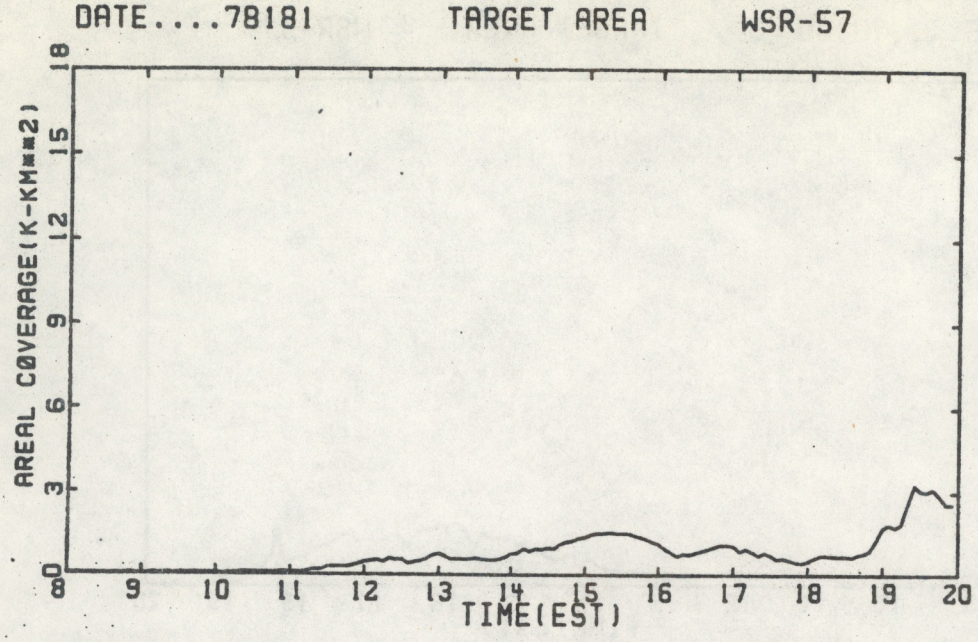
A problem that was peculiar to the MPS-4 radar was encountered on a number of occasions. Because of certain problems mentioned earlier, some of the height data was incorrect. In some instances, sudden increases in mean height or sudden drops to heights of zero km occur. These are fictitious height values. They were kept simply because the base tilt PPI data in that particular volume scan was of good quality and the decision was made to keep the data, including the bogus height, rather than discard the entire scan. This problem was most common in 1978, but also occurred in 1979 and 1980.

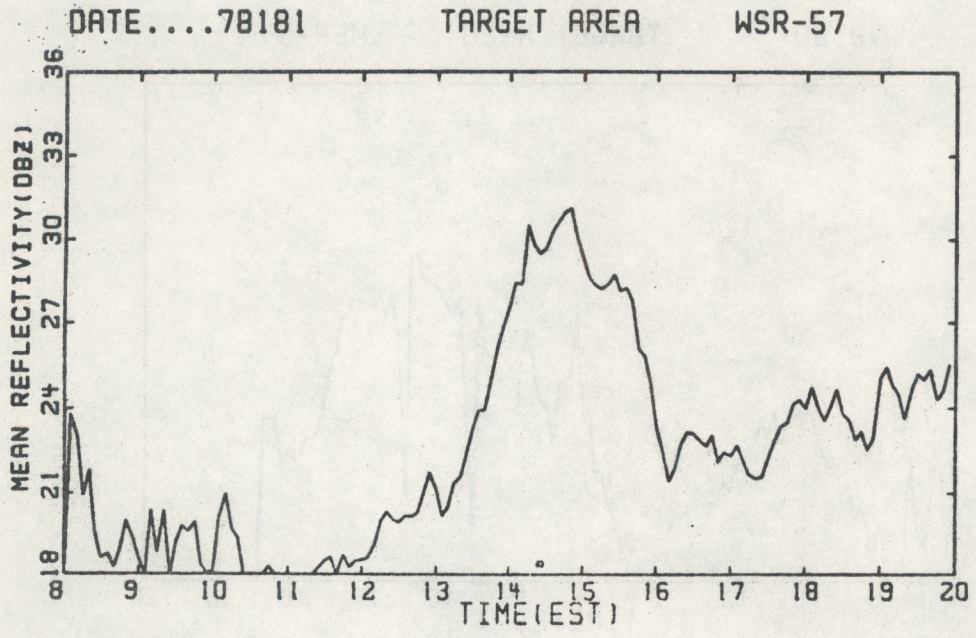
*Fig. 4. Time series of average echo properties for GO days in 1978. Blank frames indicate missing data.*

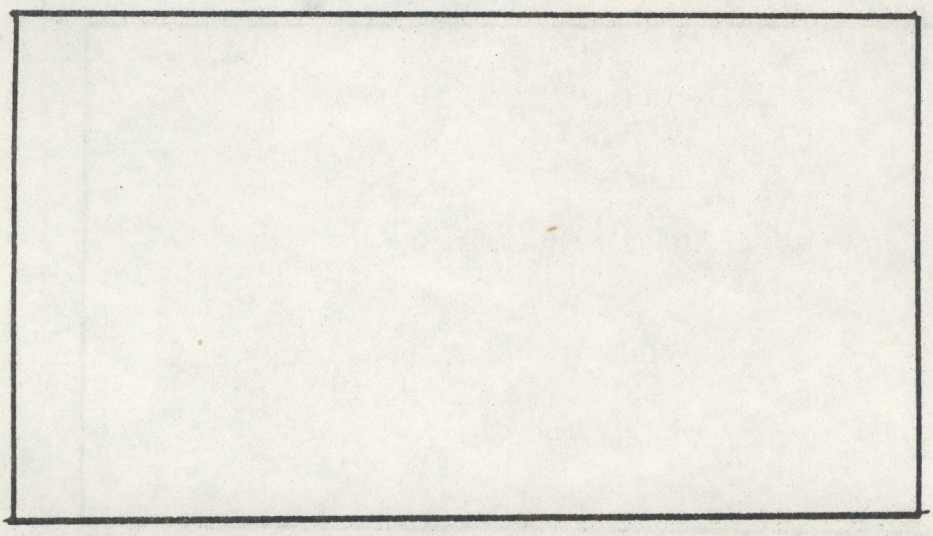

DATE....78180 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

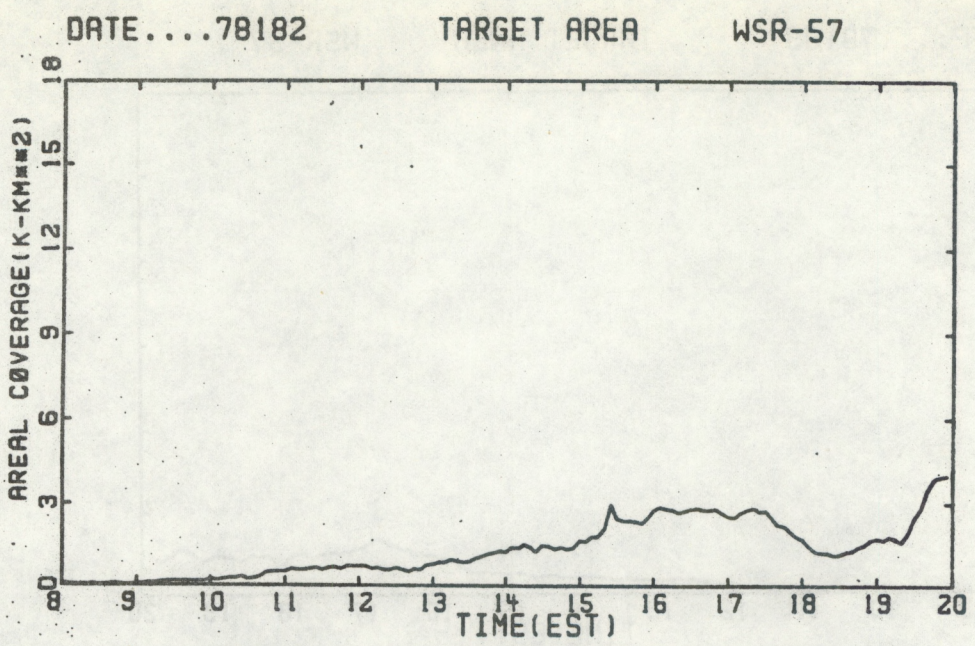

DATE....78180 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

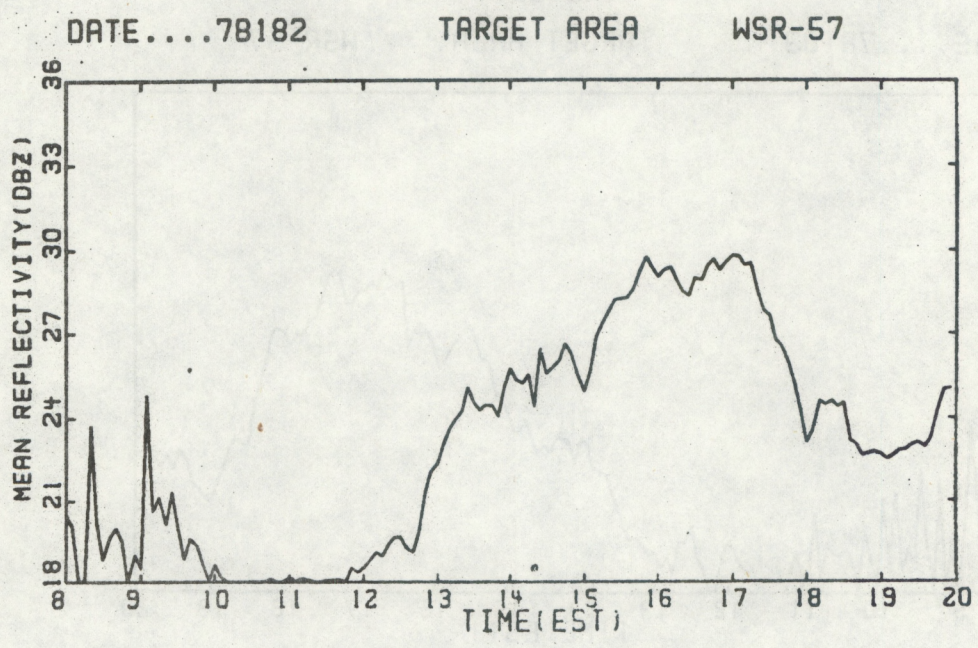


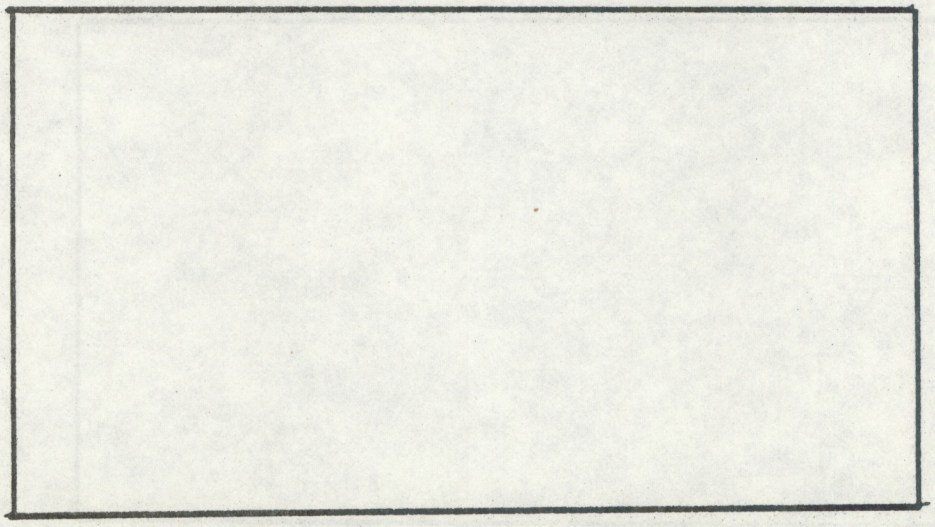

DATE....78181 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

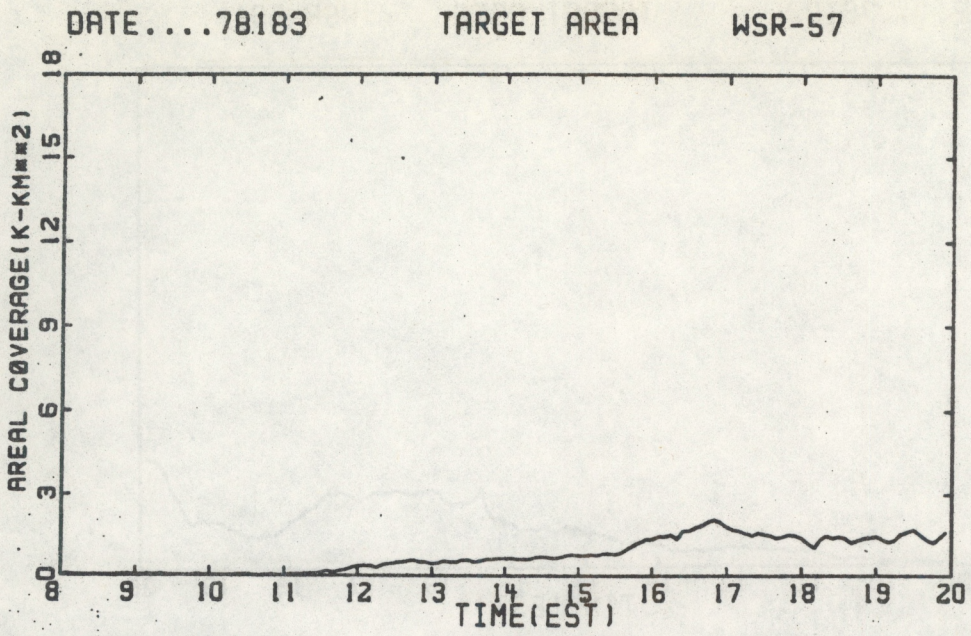

DATE....78181 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

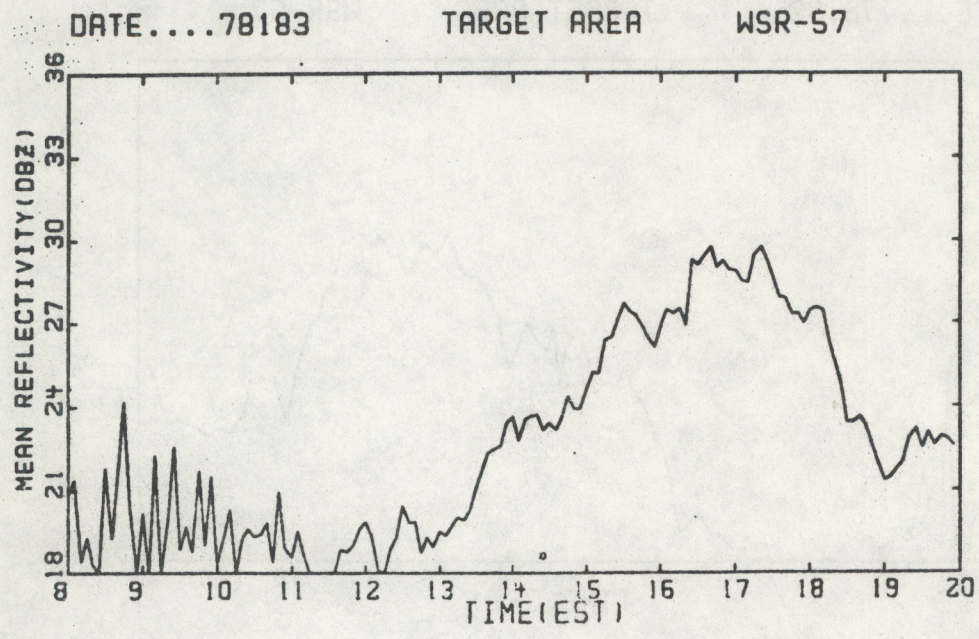


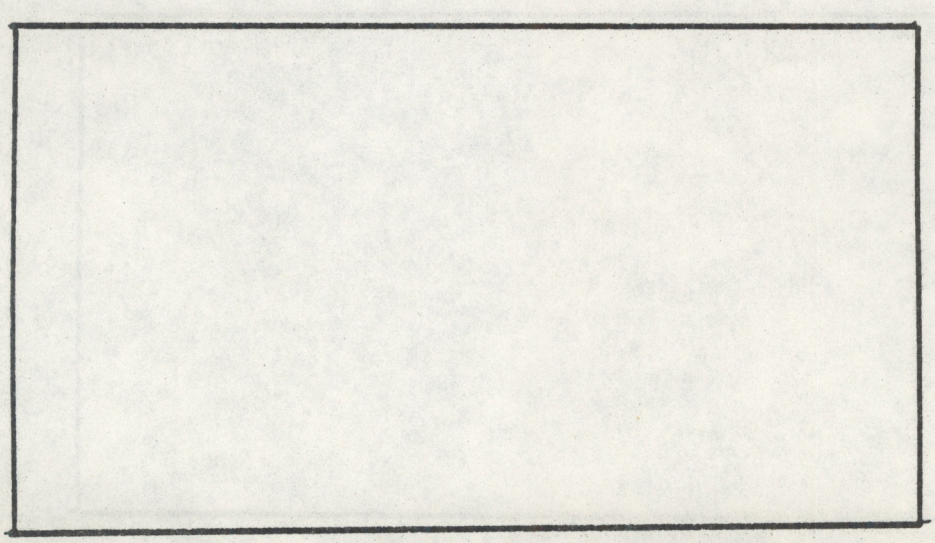

DATE....78182 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

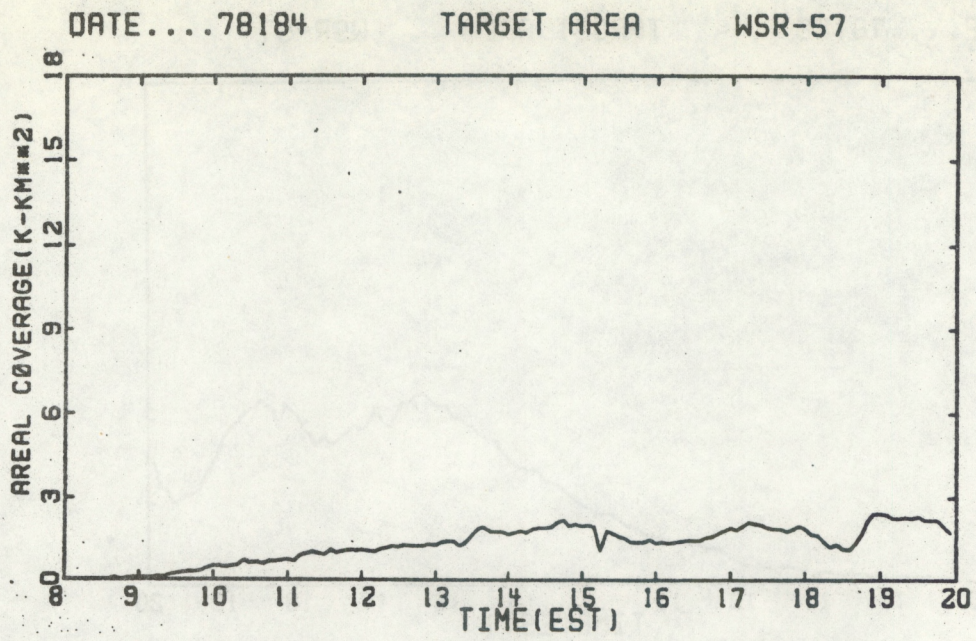

DATE....78182 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

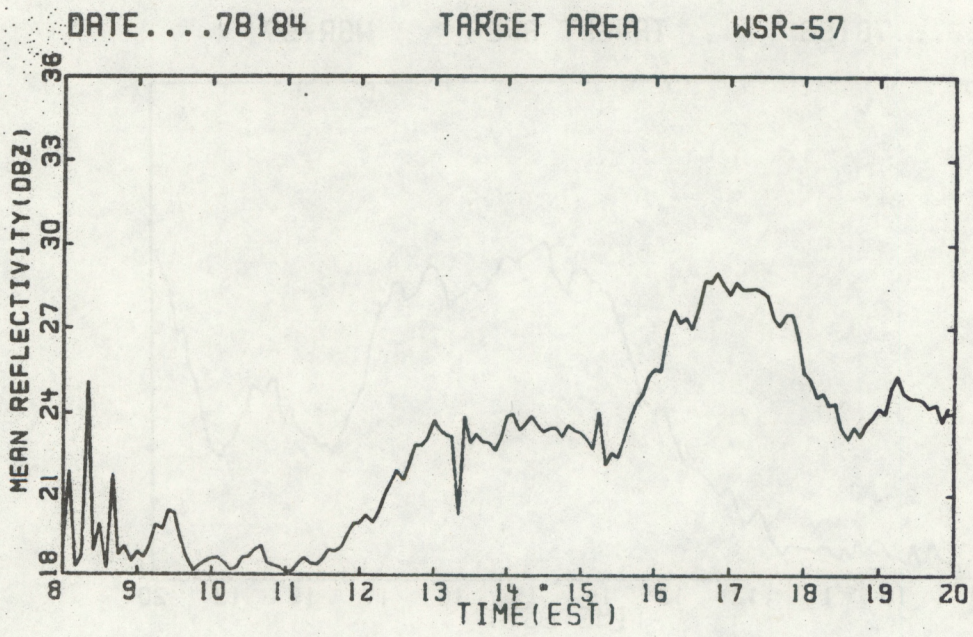


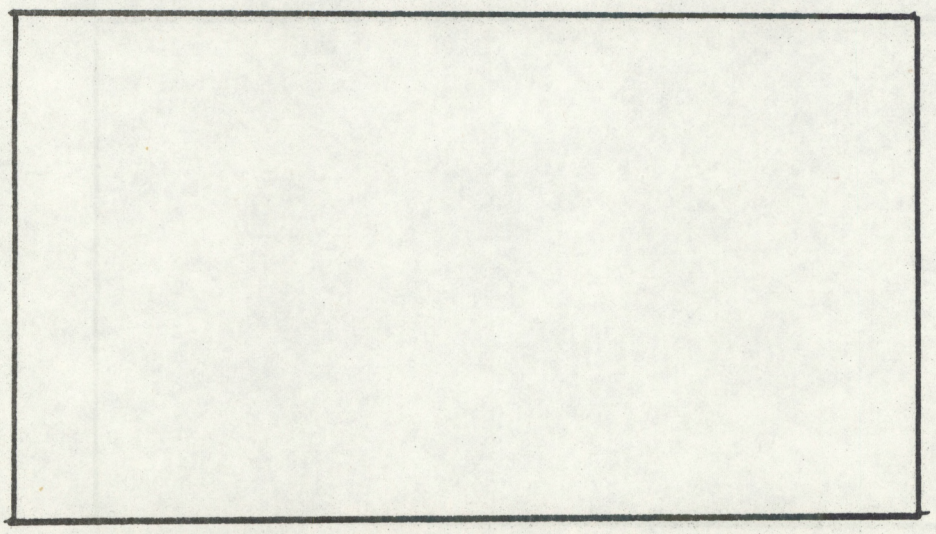

DATE....78183
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
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18
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18
19
20
TIME(EST)

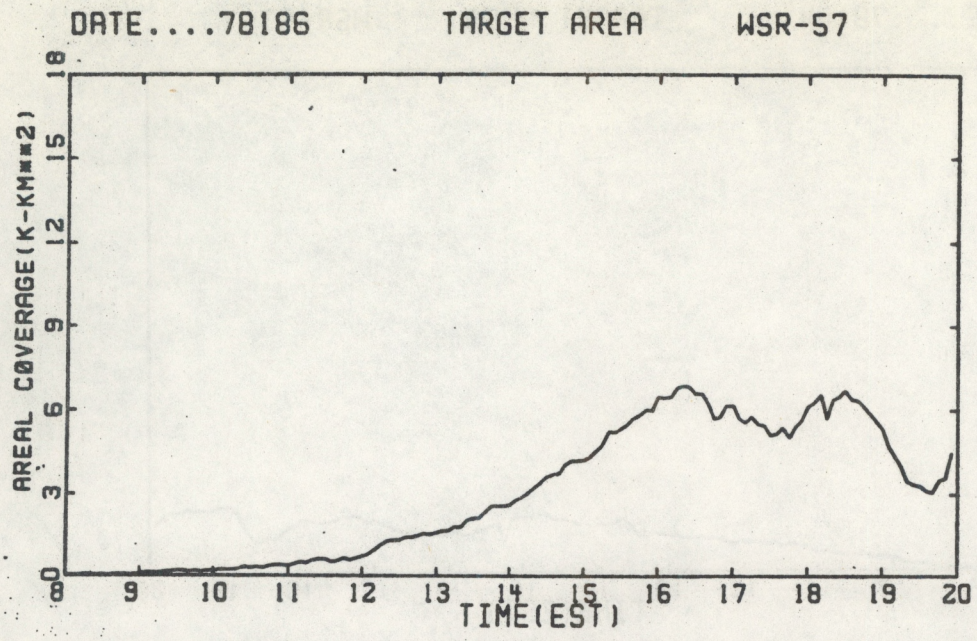

DATE....78183
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
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18
19
20
TIME(EST)

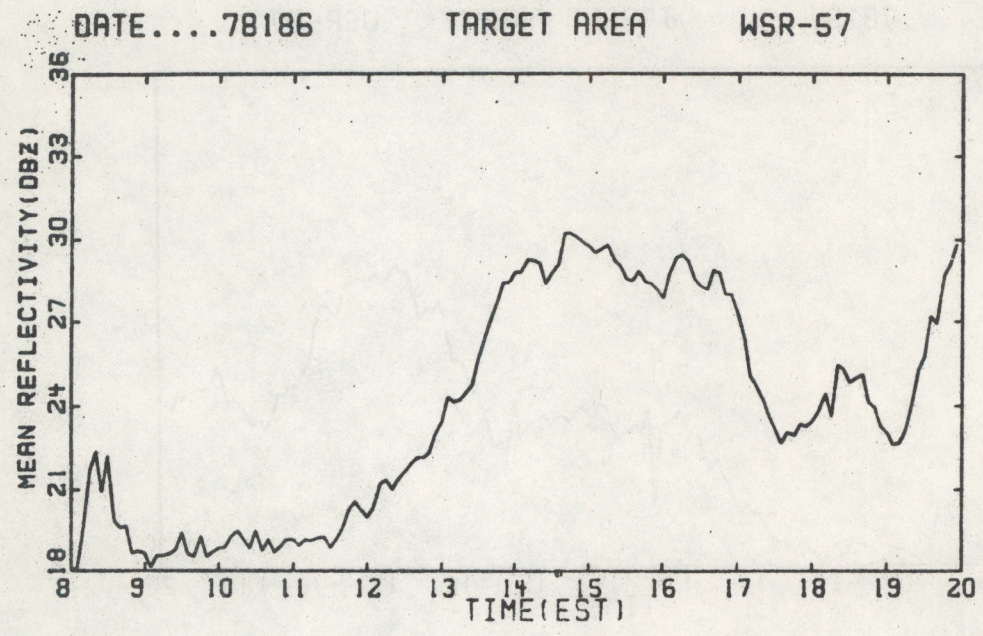


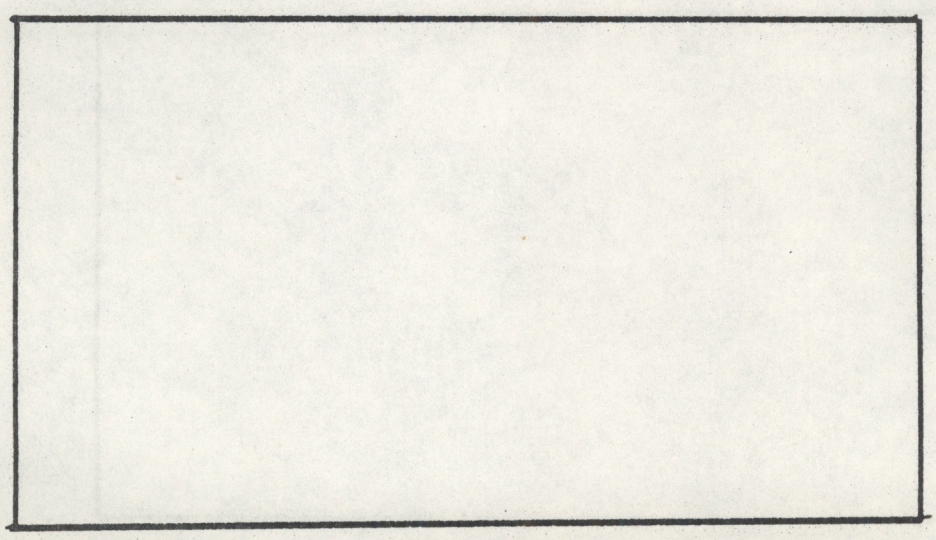

DATE....78184 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
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18
19
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TIME(EST)

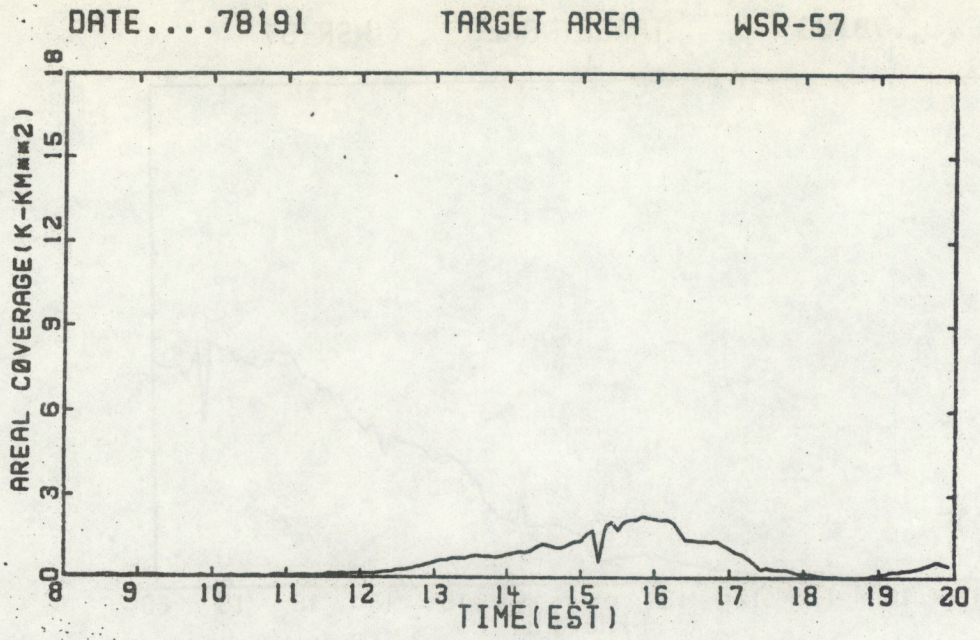

DATE....78184 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18
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16
17
18
19
20
TIME(EST)

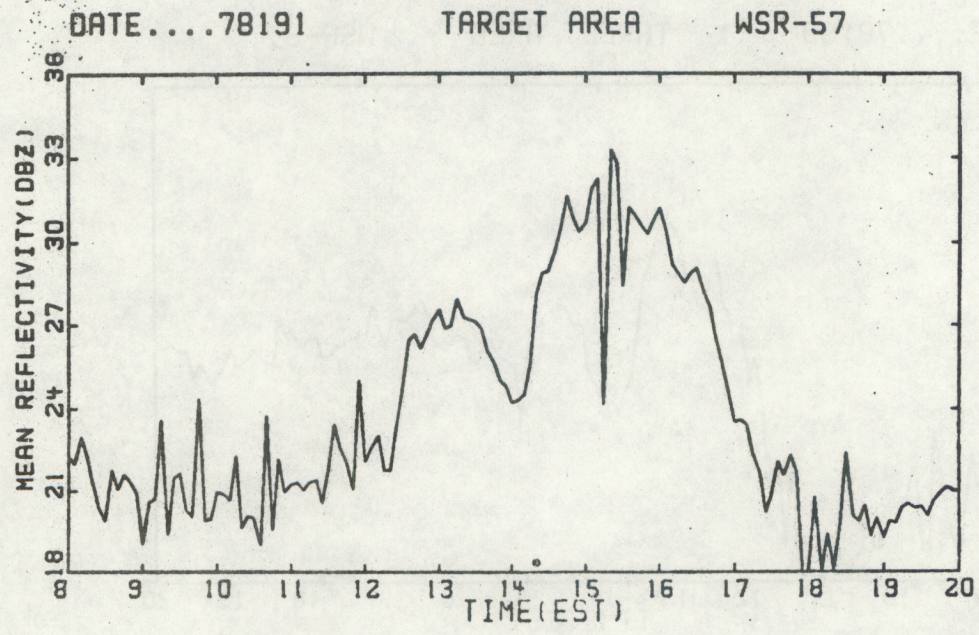


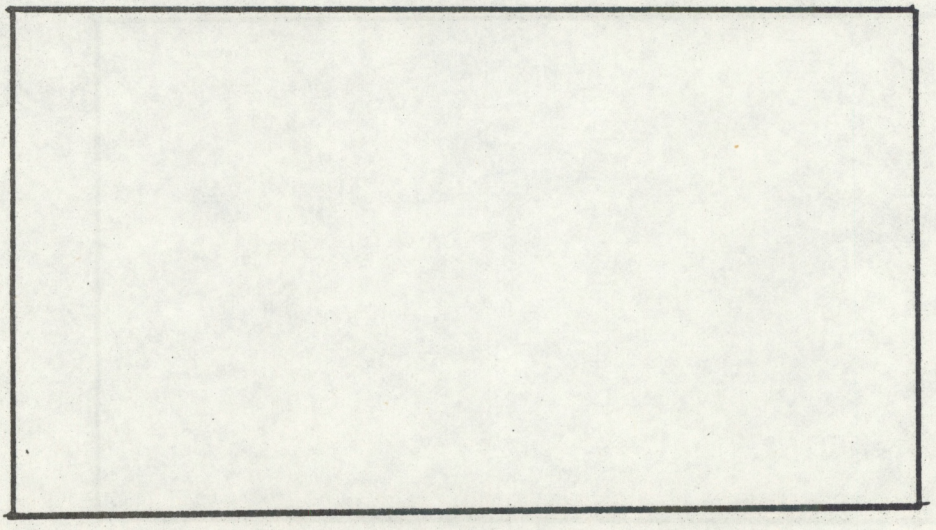

DATE....78186 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
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11
12
13
14
15
16
17
18
19
20
TIME(EST)

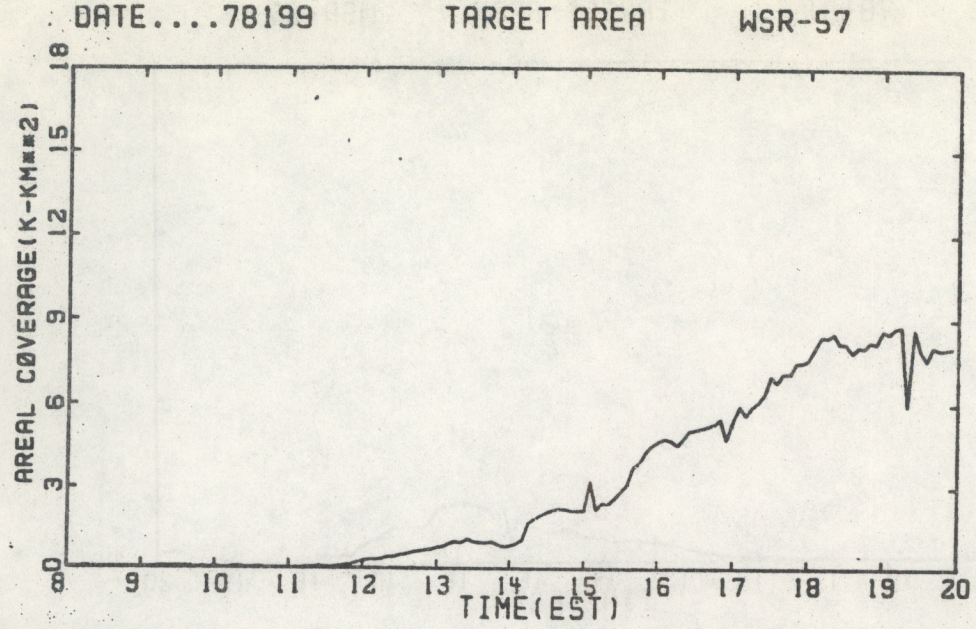

DATE....78186 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
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33
36
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11
12
13
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15
16
17
18
19
20
TIME(EST)

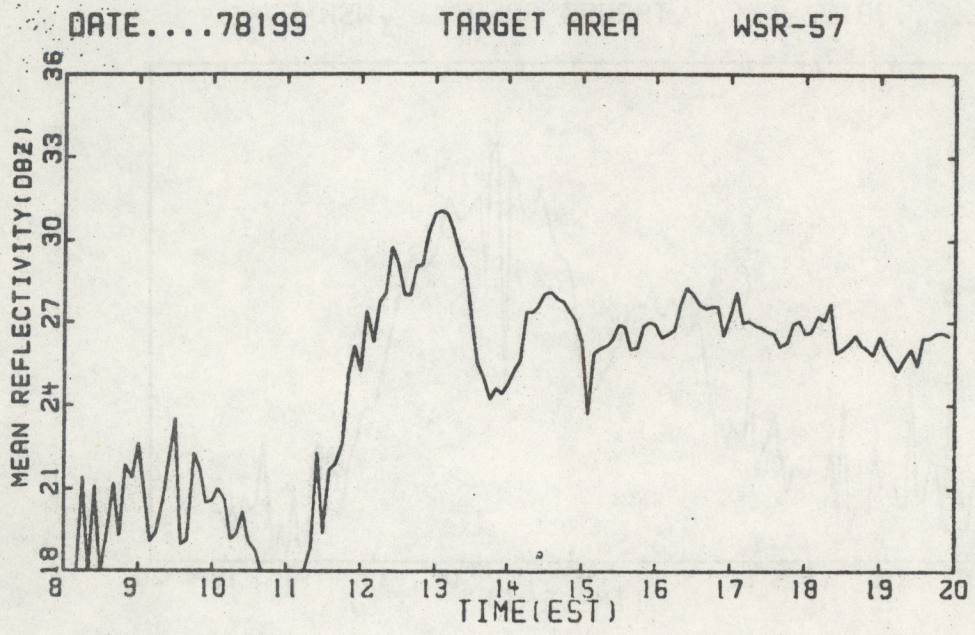


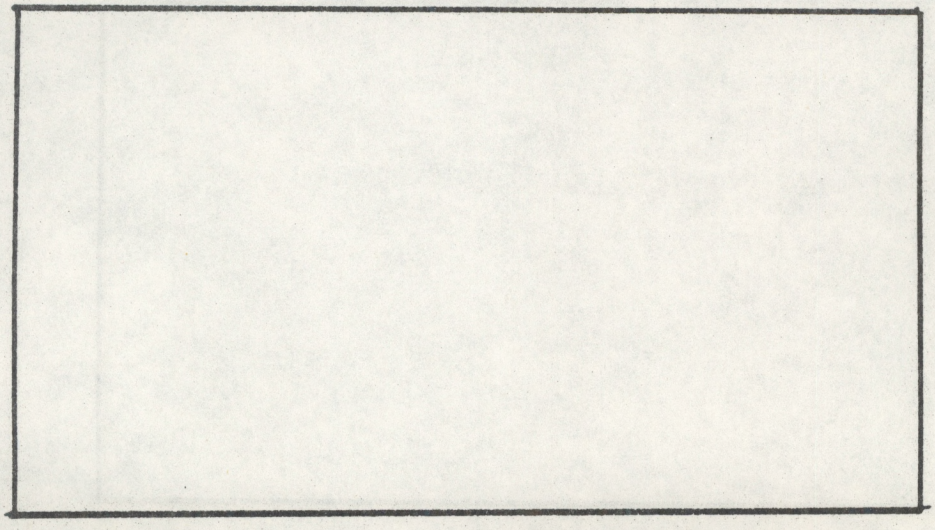

DATE....78191 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

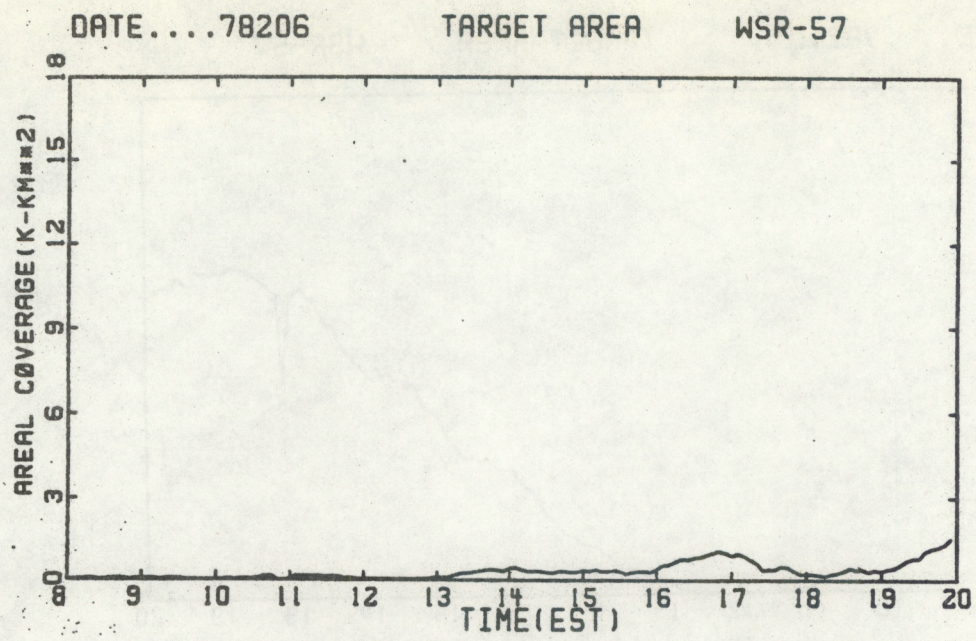

DATE....78191 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

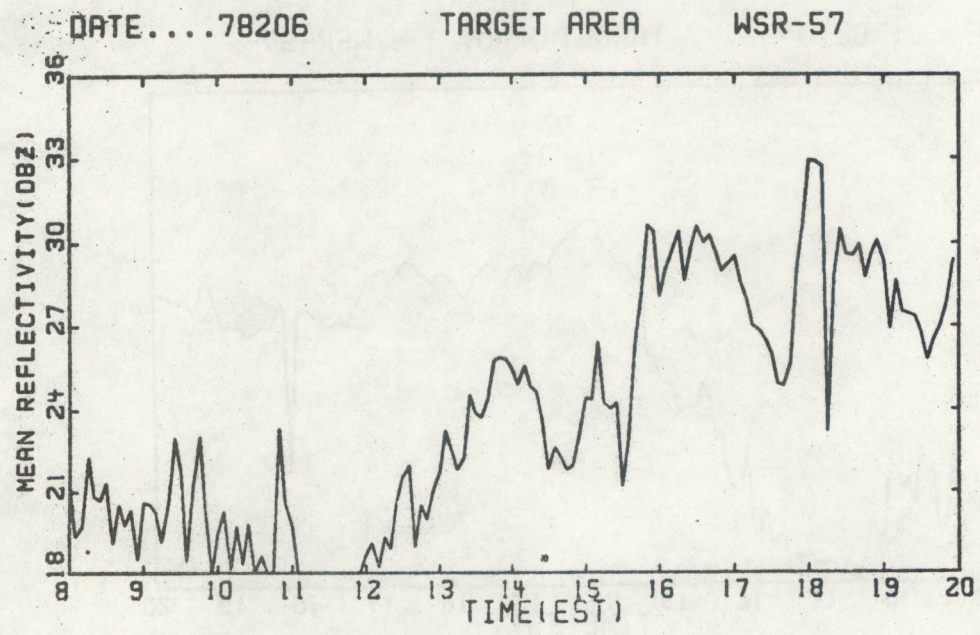


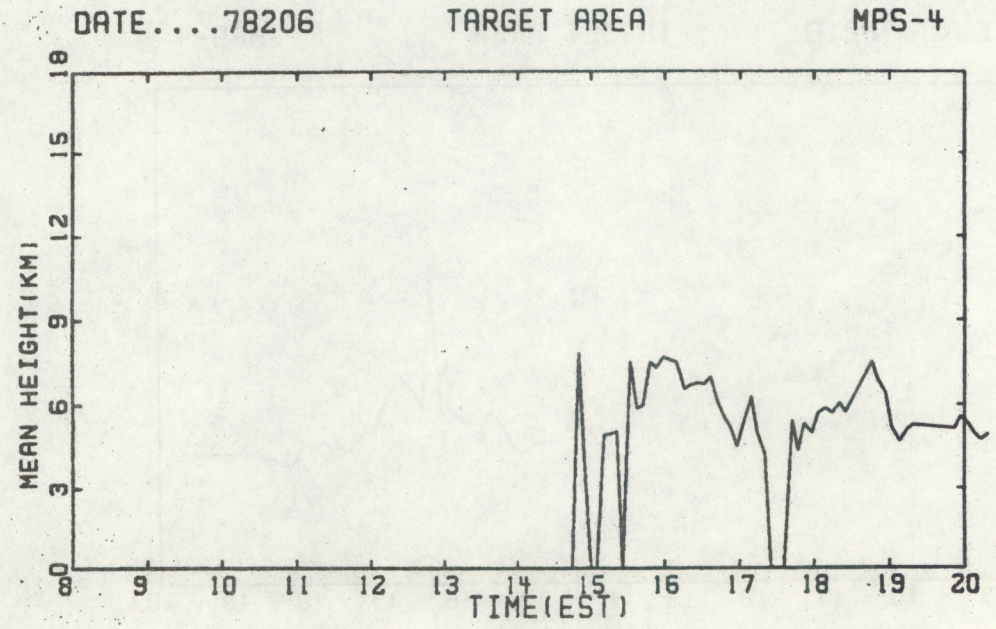

DATE....78199
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

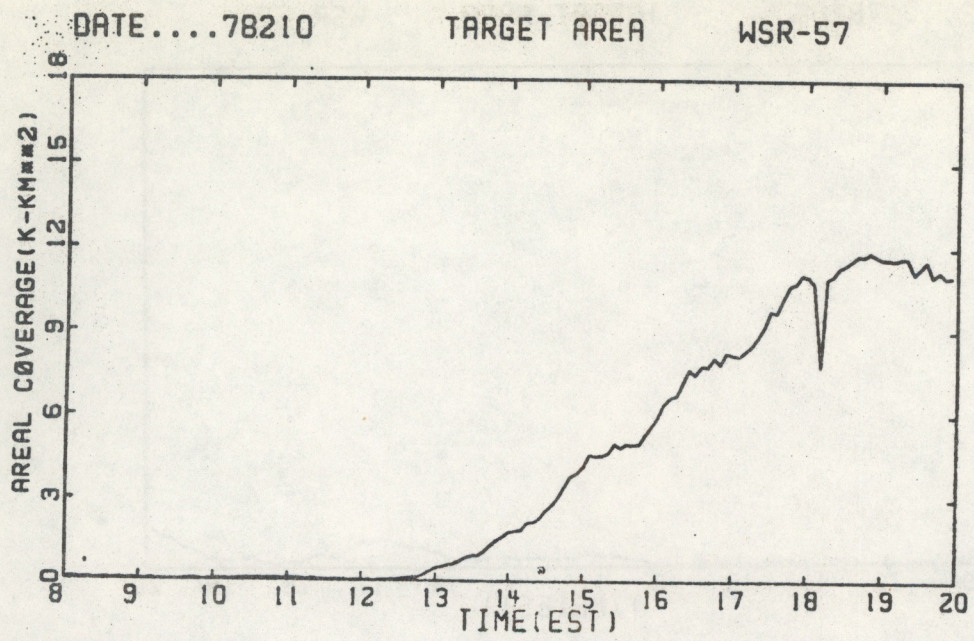

DATE....78199
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

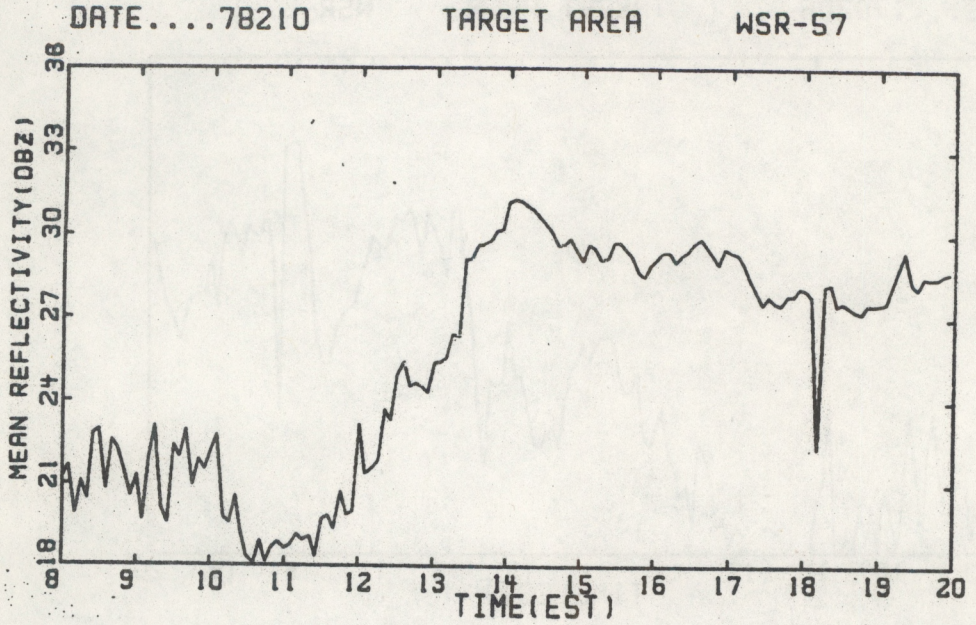


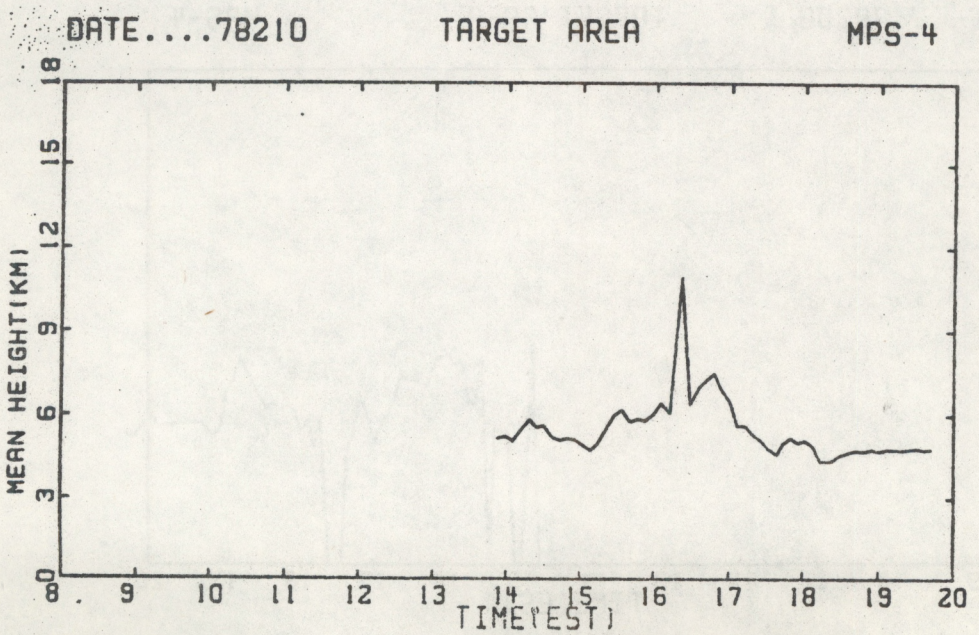

DATE....78206 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

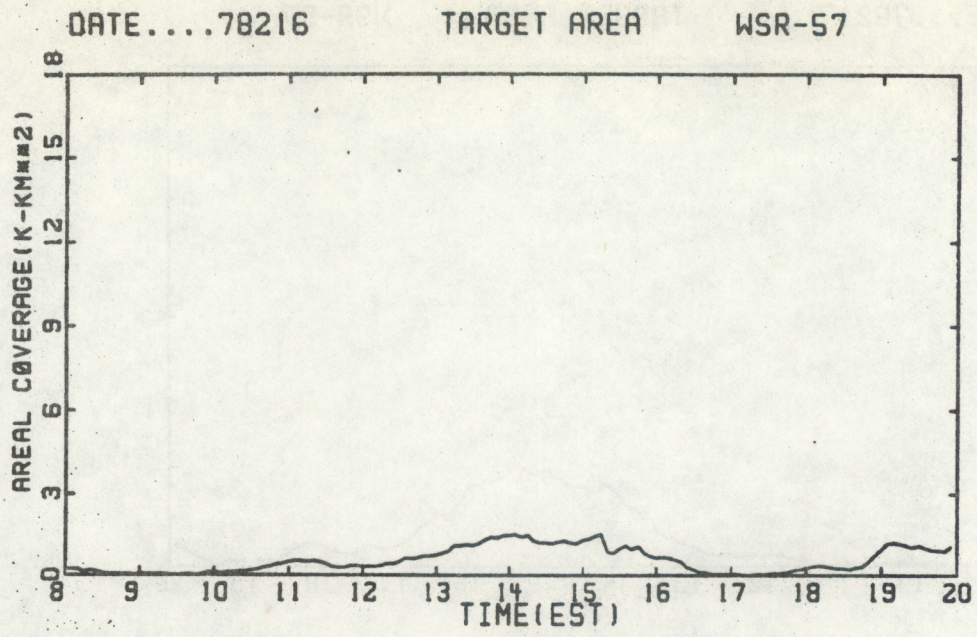

DATE....78206 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

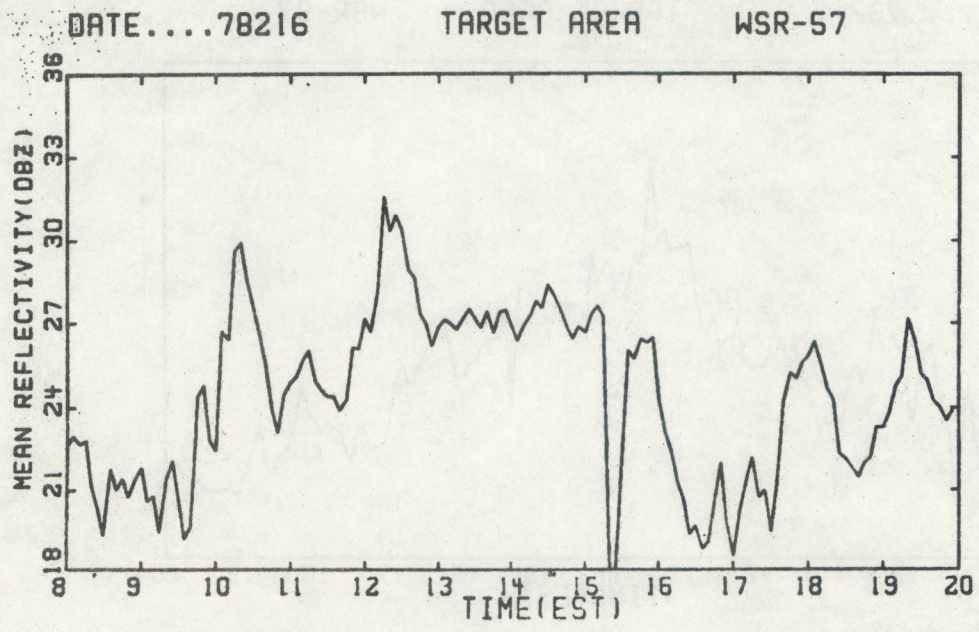

DATE....78206 TARGET AREA MPS-4
MEAN HEIGHT(KM)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

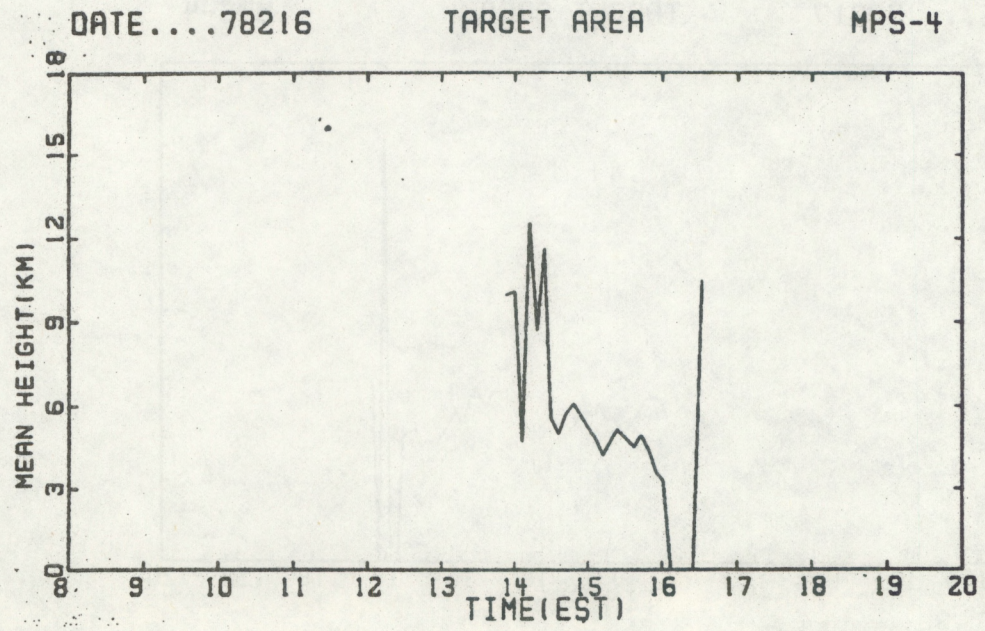

DATE....78210
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

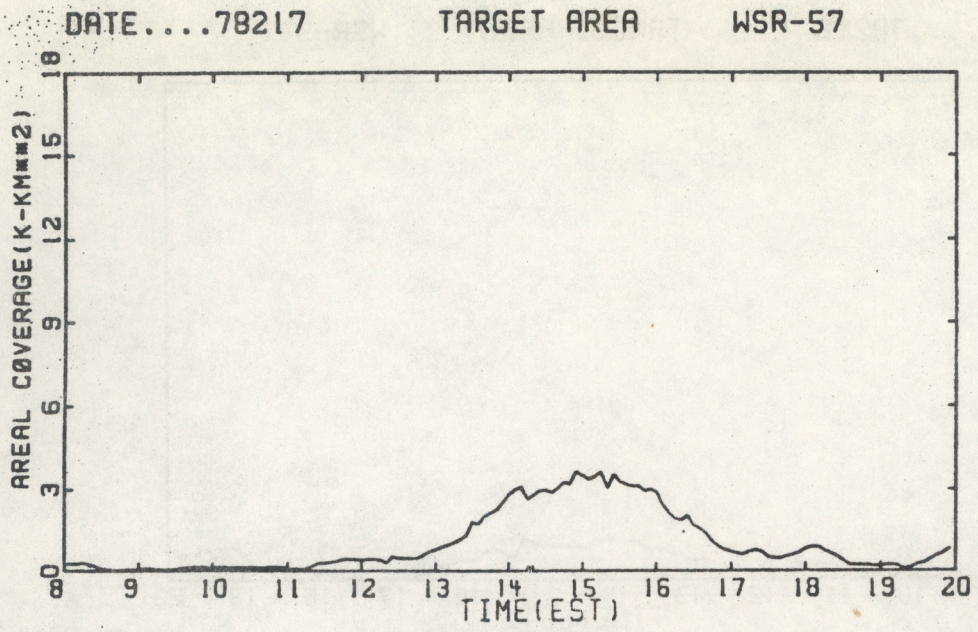

DATE....78210
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

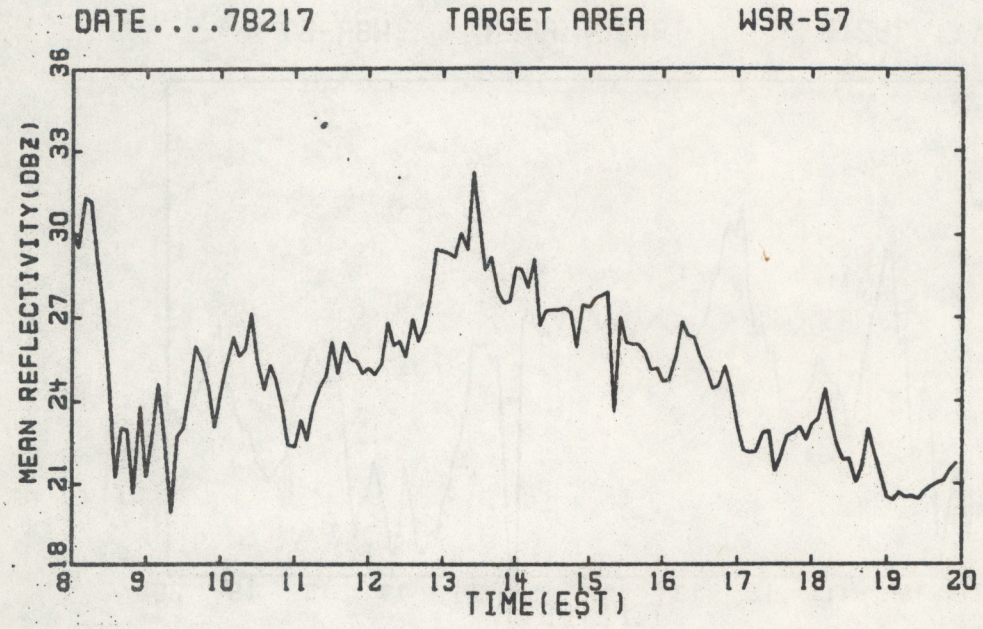

DATE....78210
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

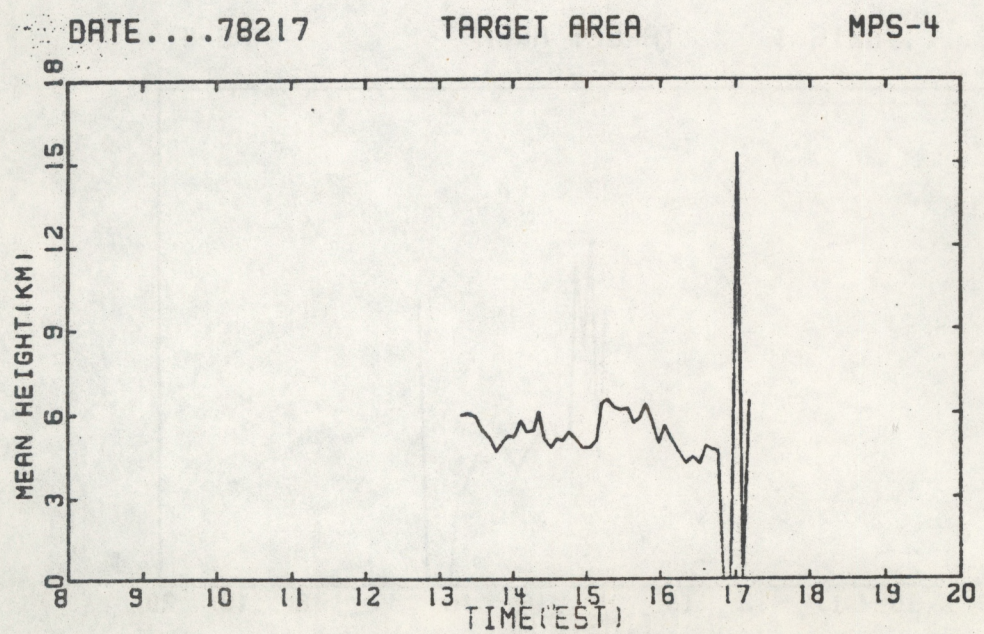

DATE....78216 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

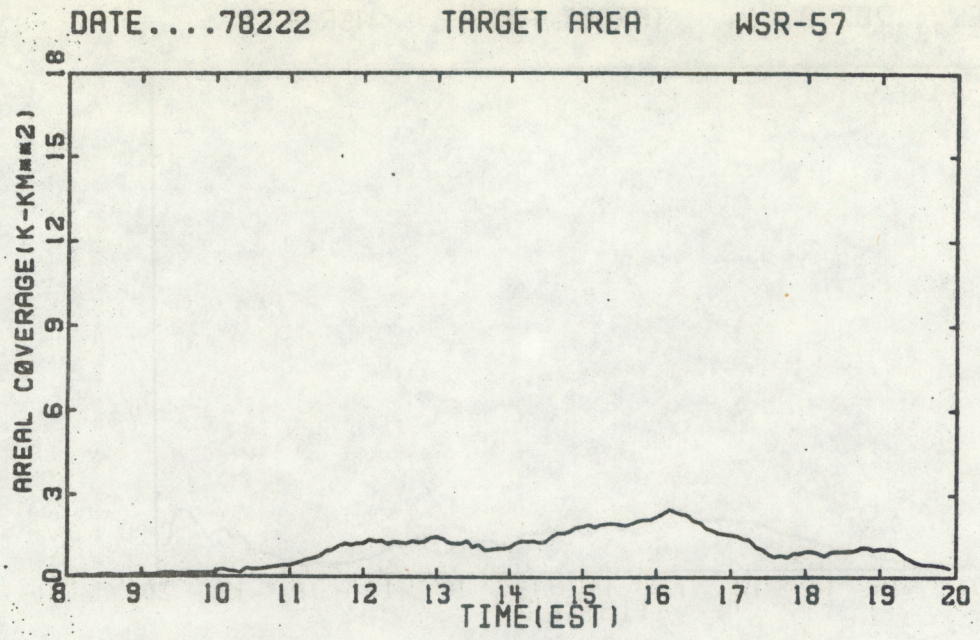

DATE....78216 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

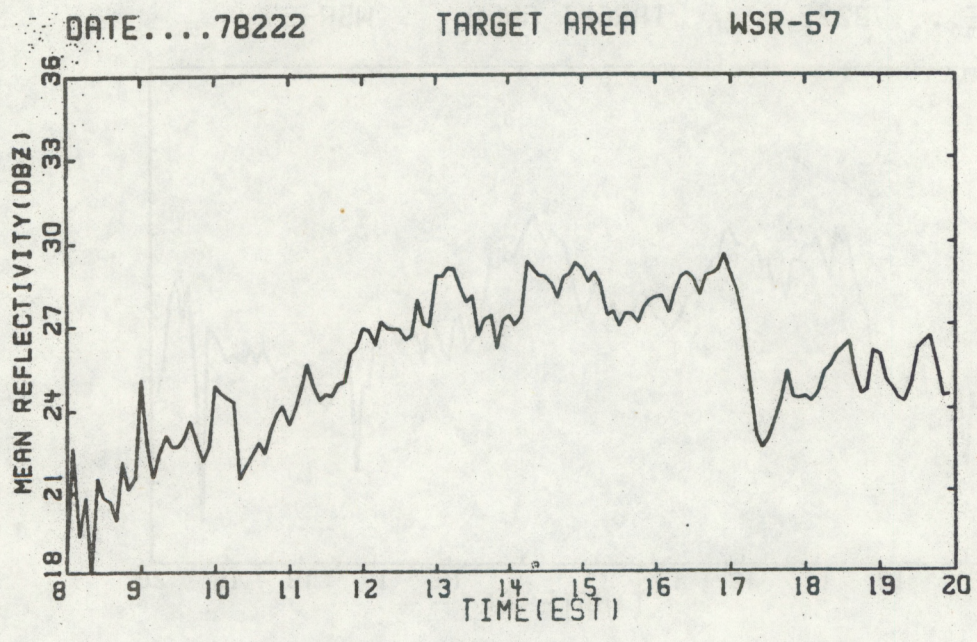

DATE....78216 TARGET AREA MPS-4
MEAN HEIGHT(KM)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

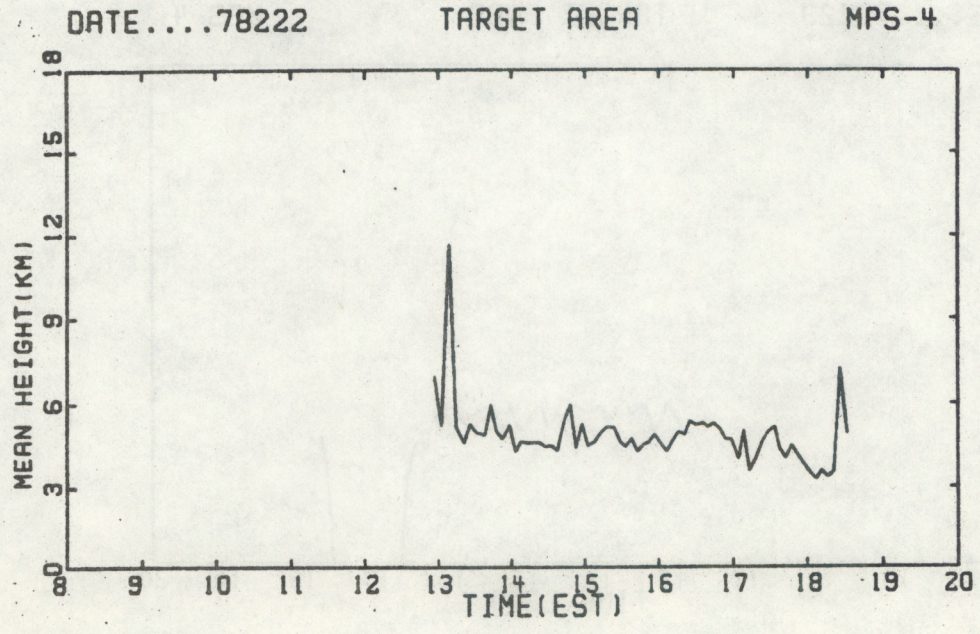

DATE....78217 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

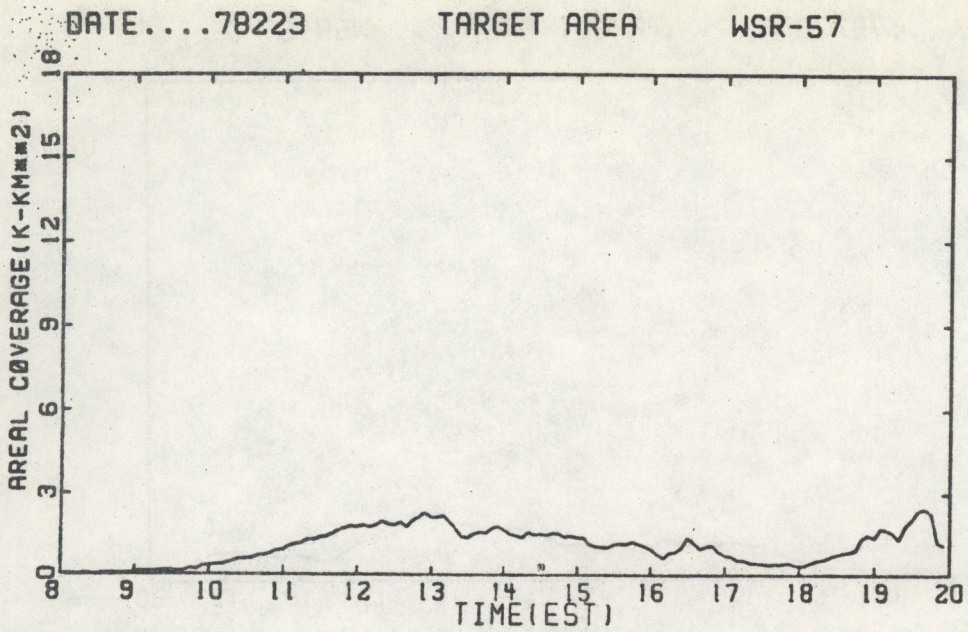

DATE....78217 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

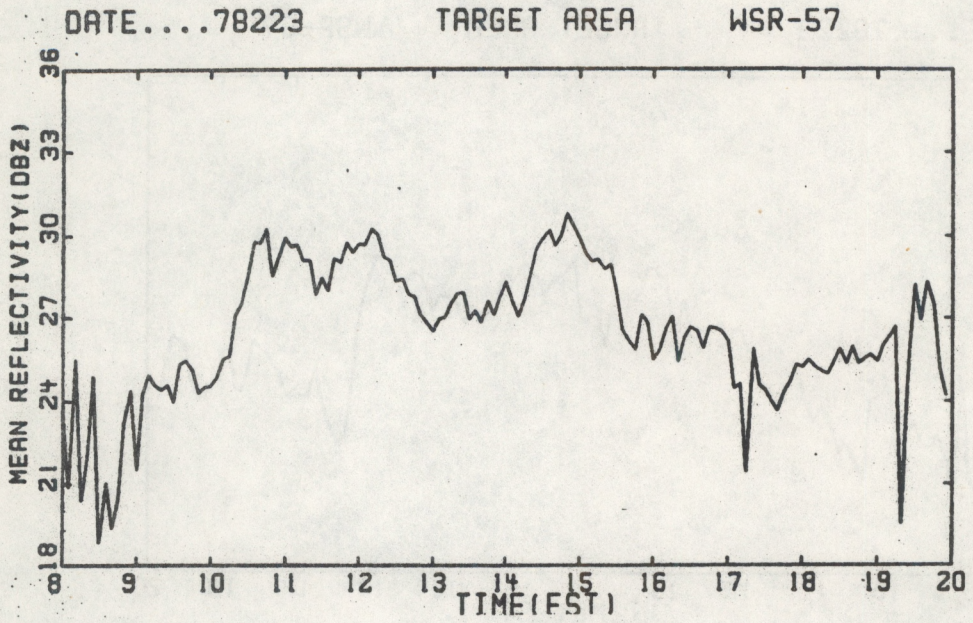

DATE....78217 TARGET AREA MPS-4
MEAN HEIGHT(KM)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

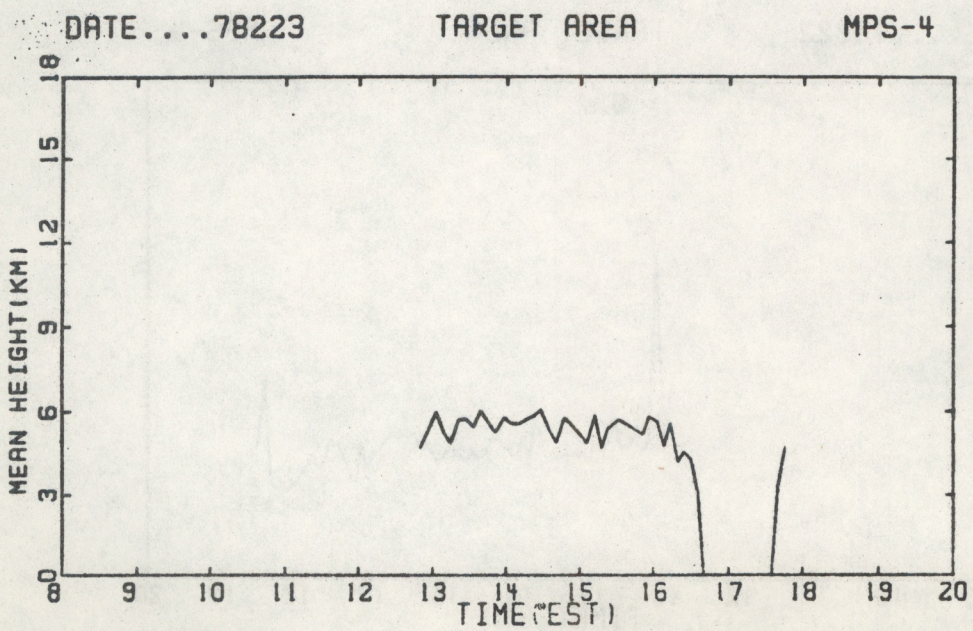

DATE....78222 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

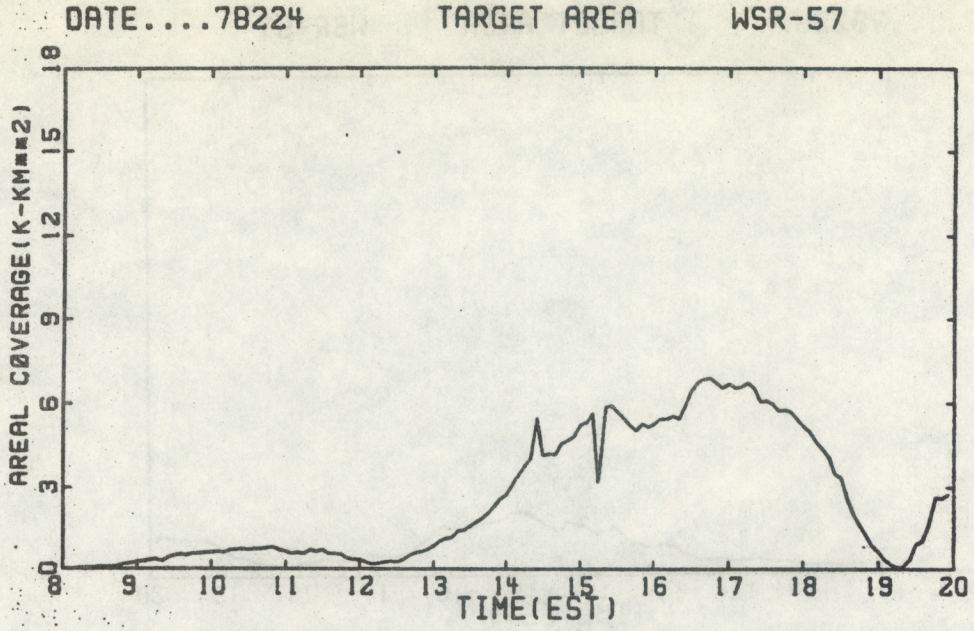

DATE....78222 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

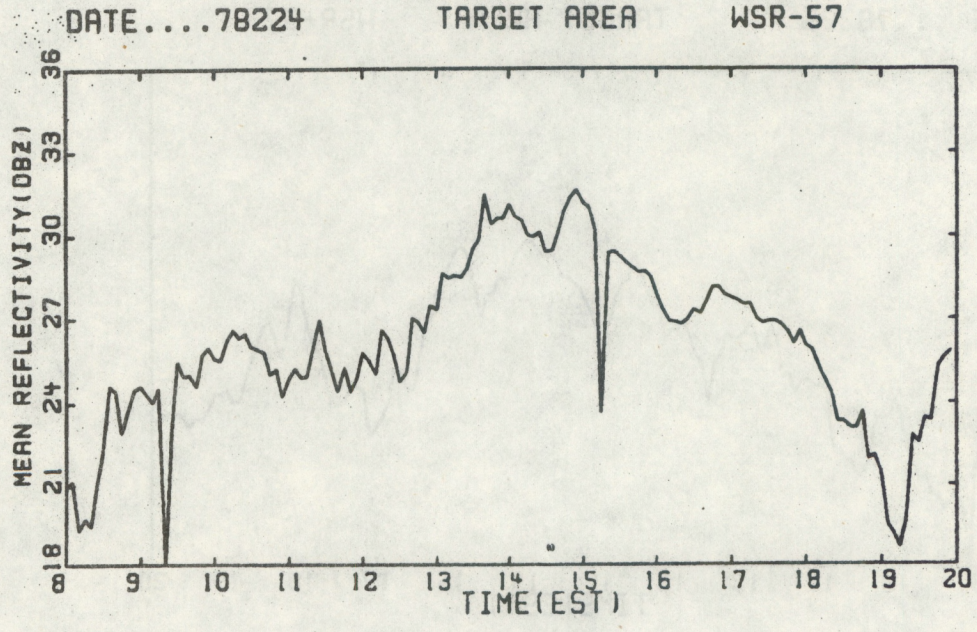

DATE....78222 TARGET AREA MPS-4
MEAN HEIGHT(KM)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

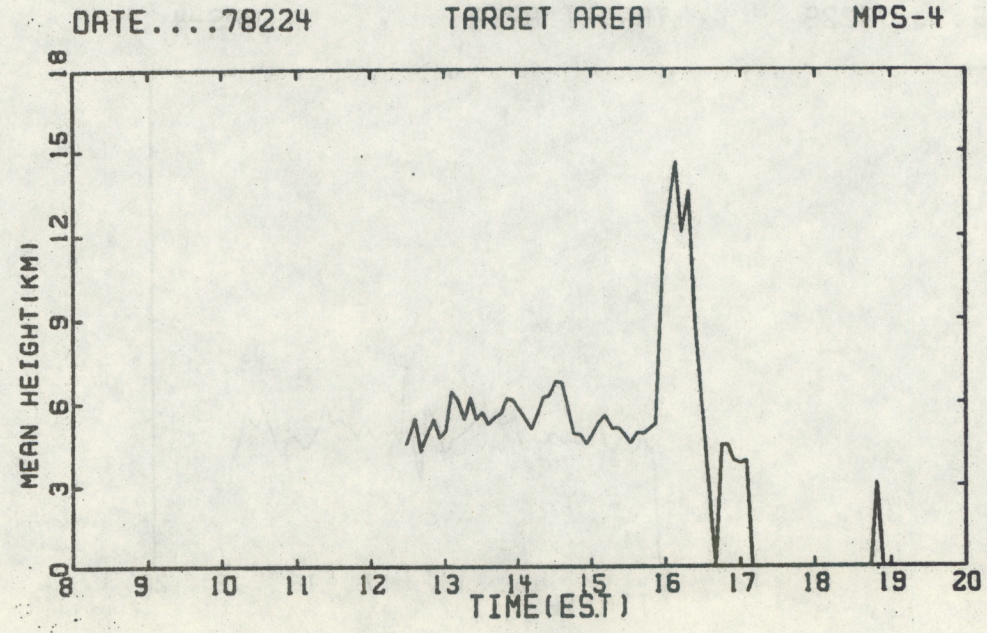

DATE....78223
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

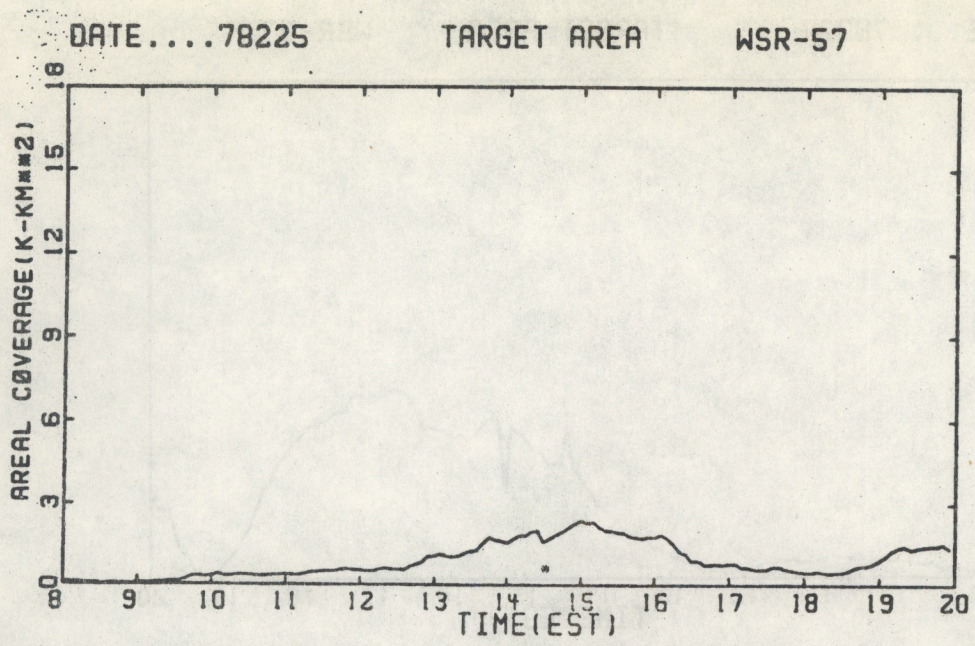

DATE....78223
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

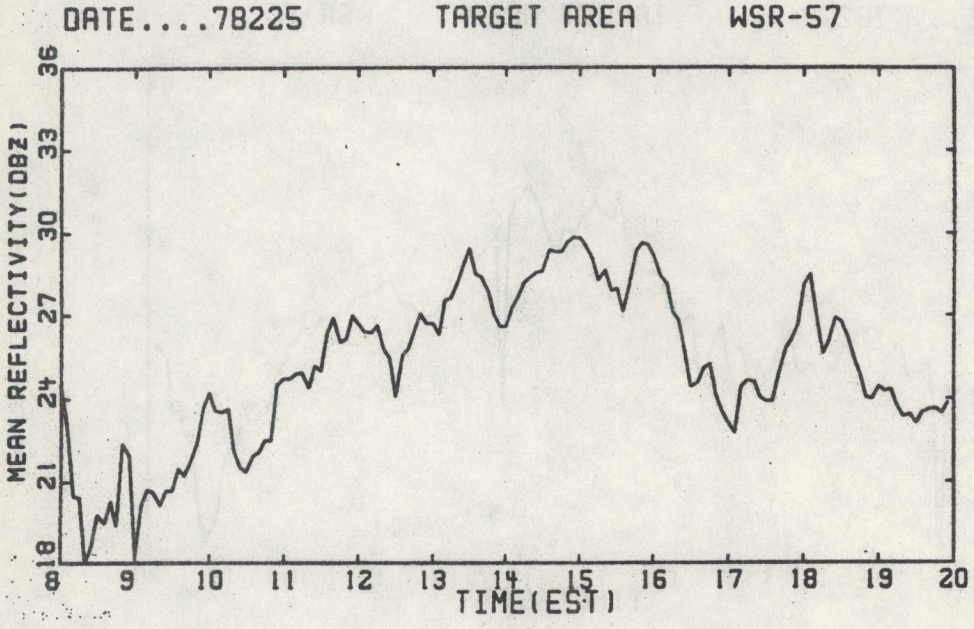

DATE....78223
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

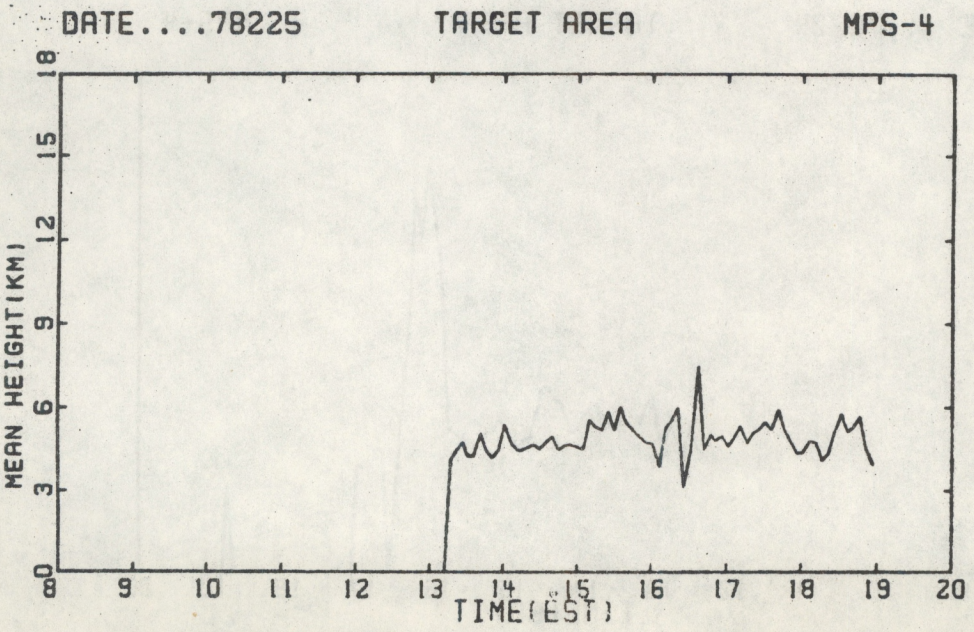

DATE....78224
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
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11
12
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14
15
16
17
18
19
20
TIME(EST)

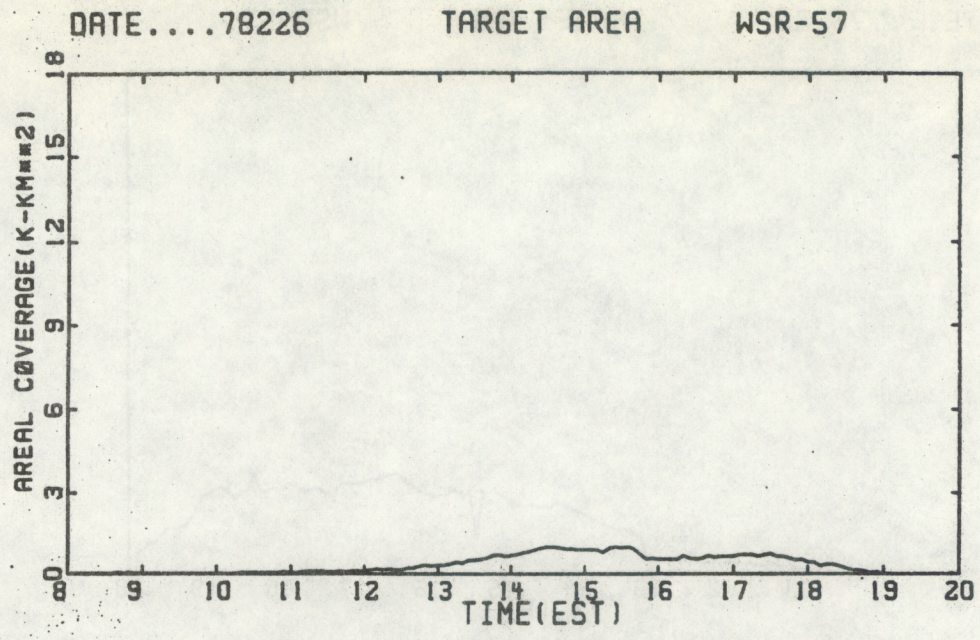

DATE....78224
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

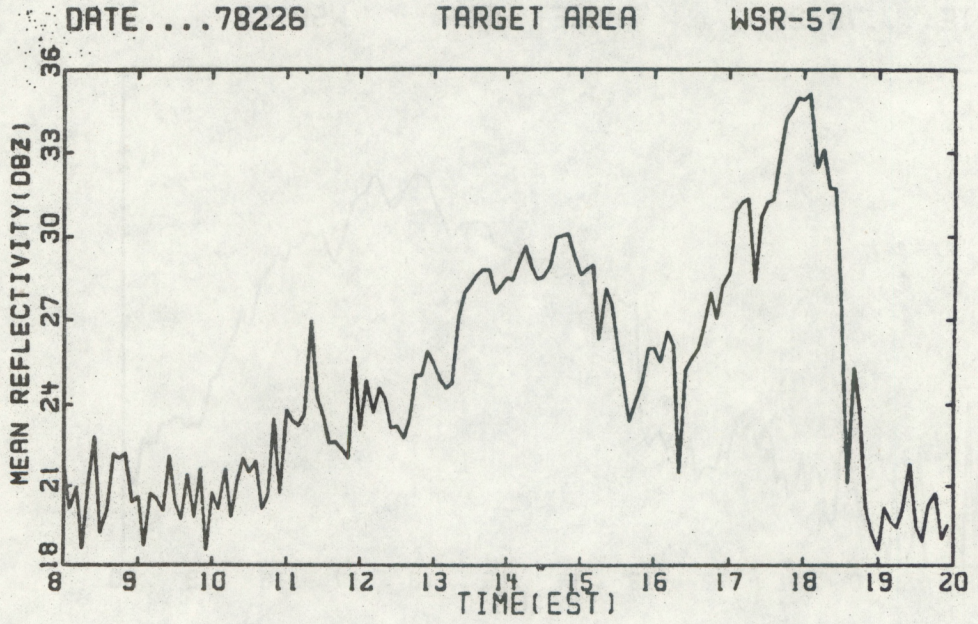

DATE....78224
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

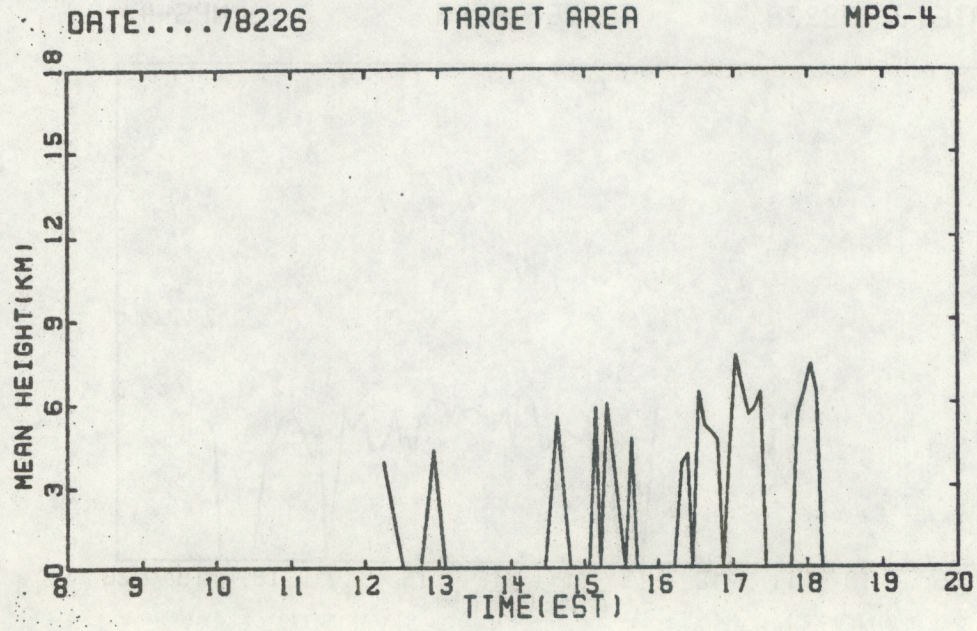

DATE....78225 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

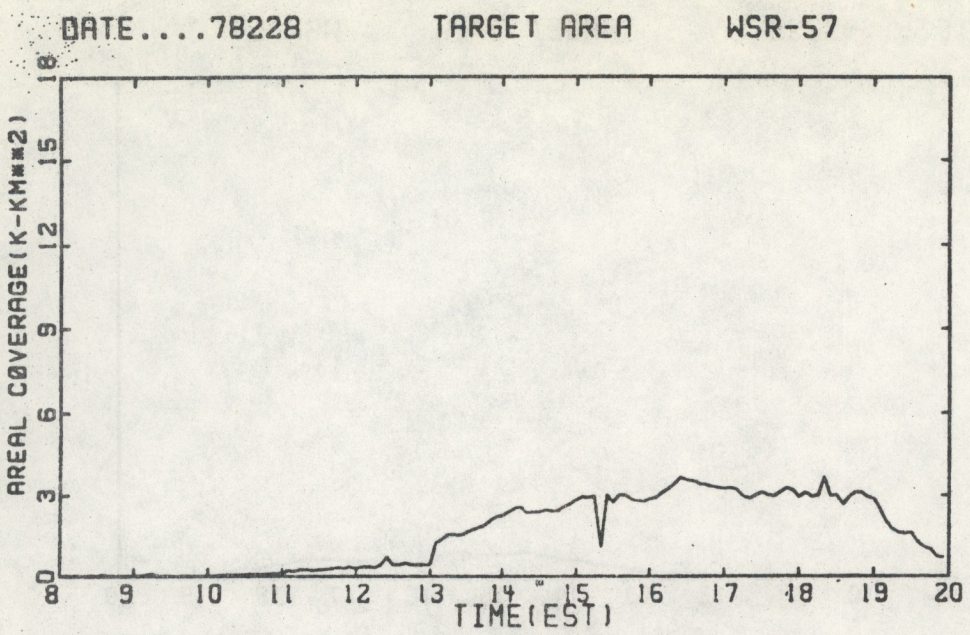

DATE....78225 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

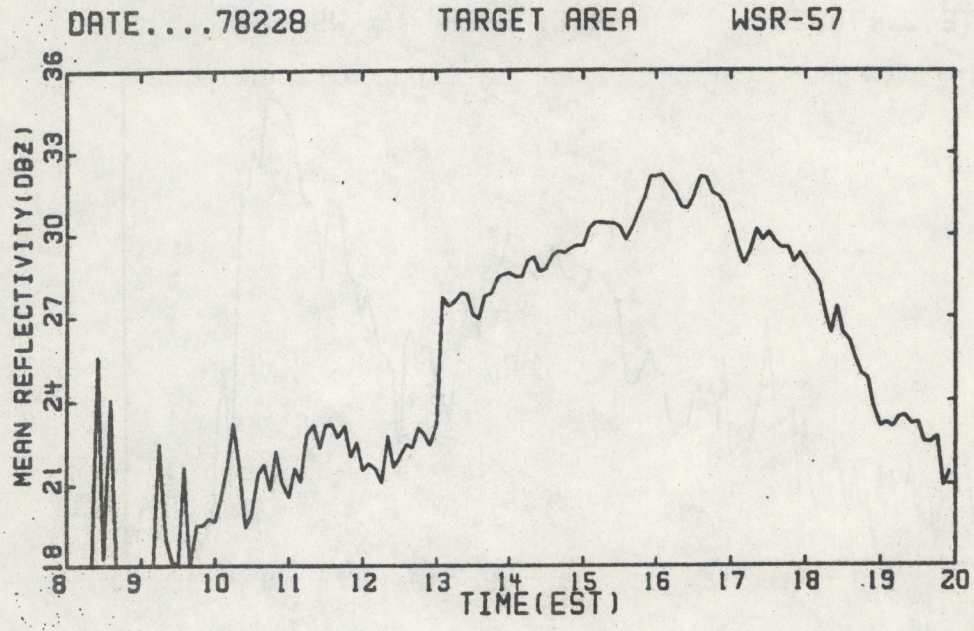

DATE....78225 TARGET AREA MPS-4
MEAN HEIGHT(KM)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

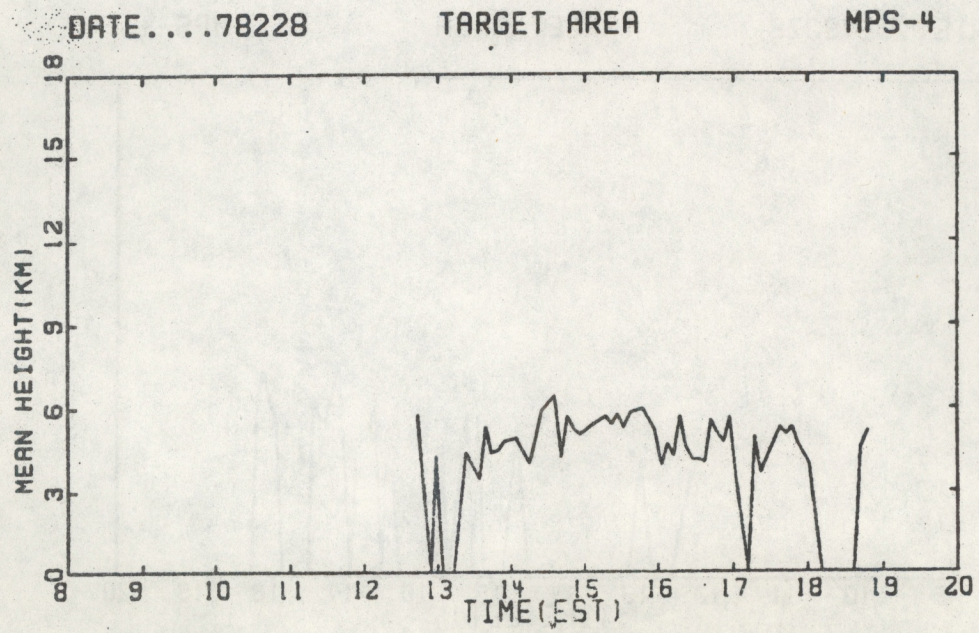

DATE....78226
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

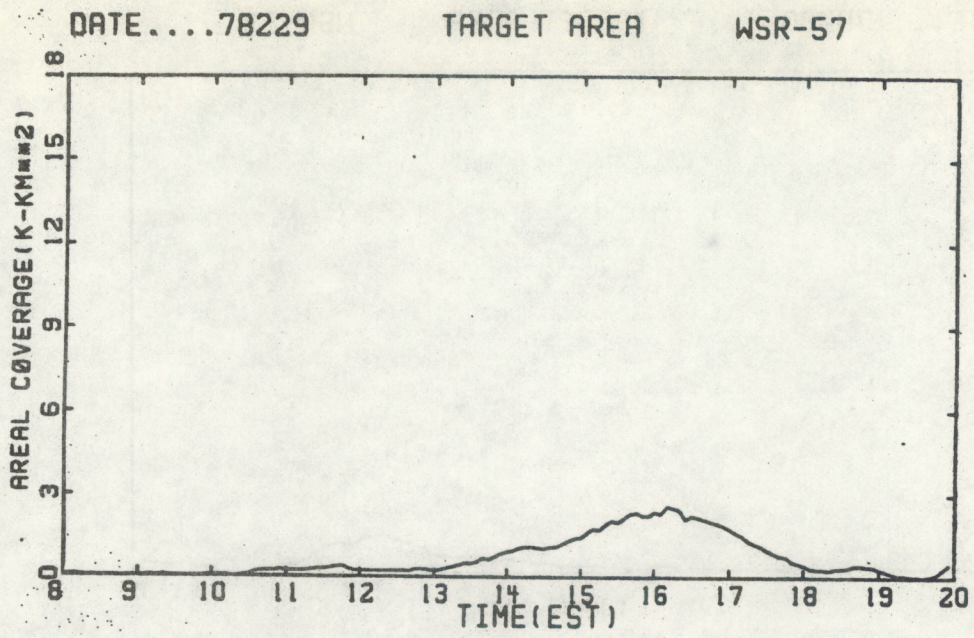

DATE....78226
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

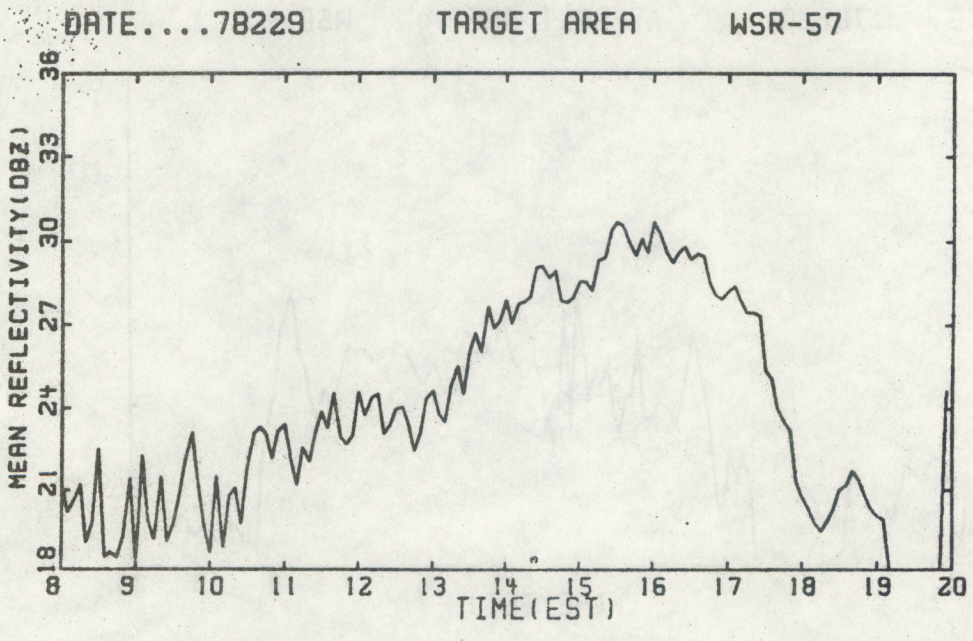

DATE....78226
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

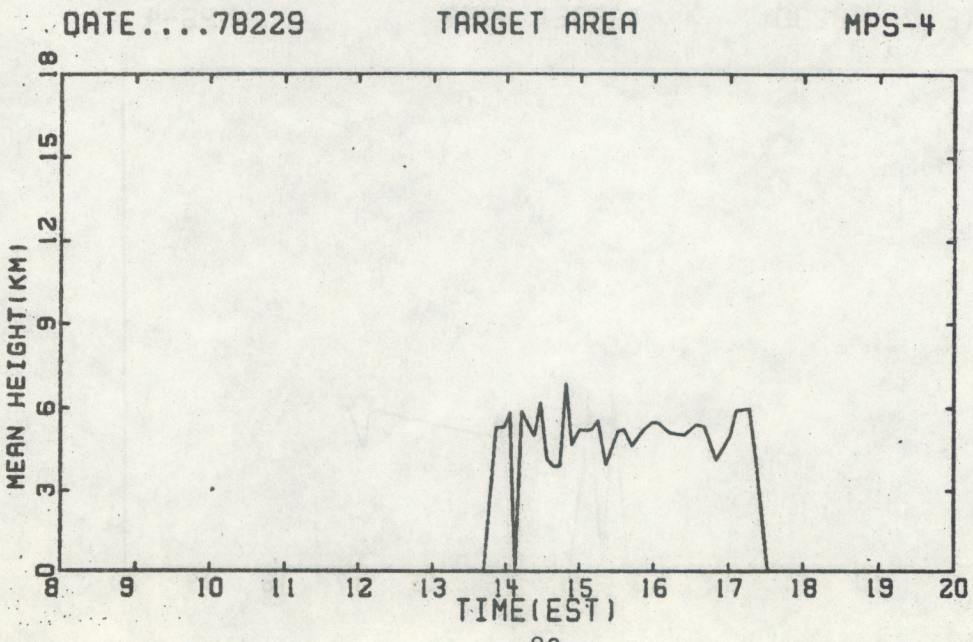

DATE....78228 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

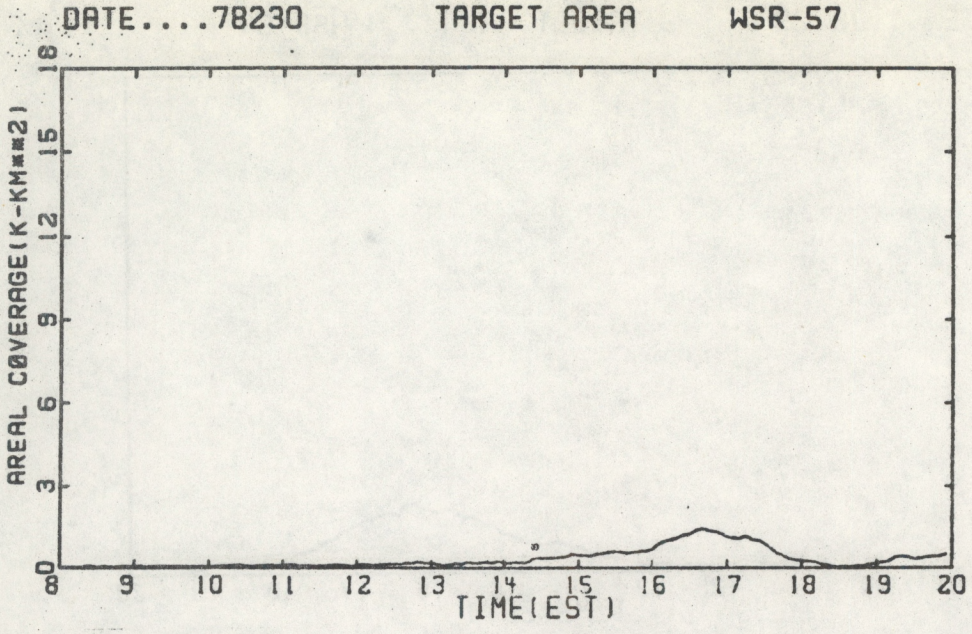

DATE....78228 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

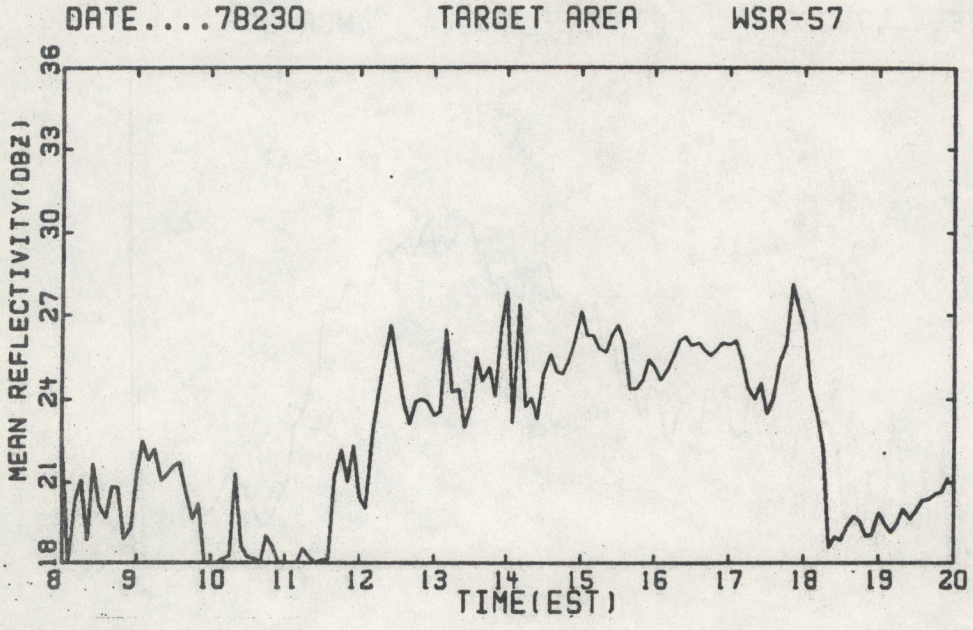

DATE....78228 TARGET AREA MPS-4
MEAN HEIGHT(KM)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

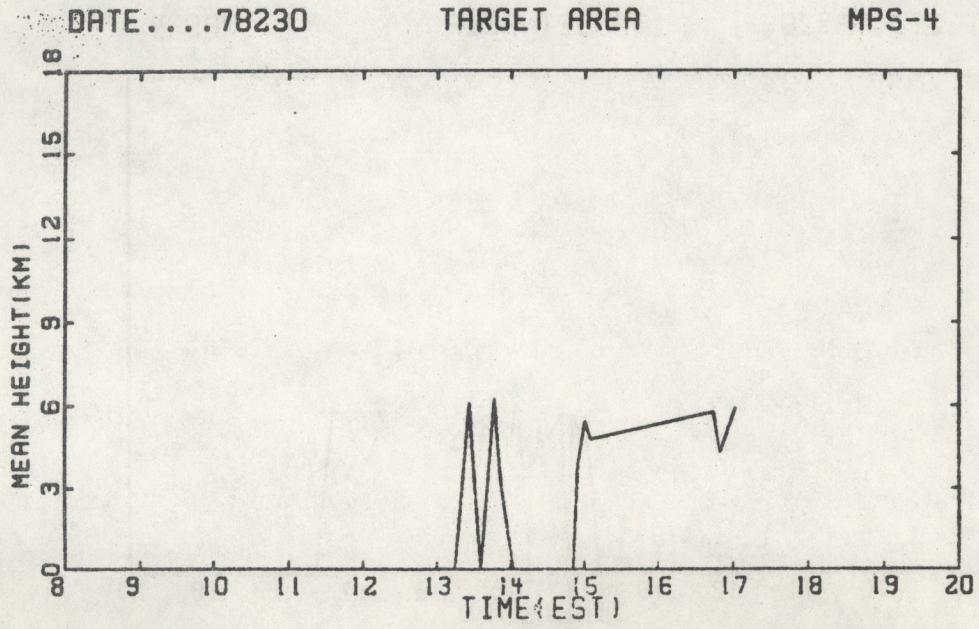

DATE....78229 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

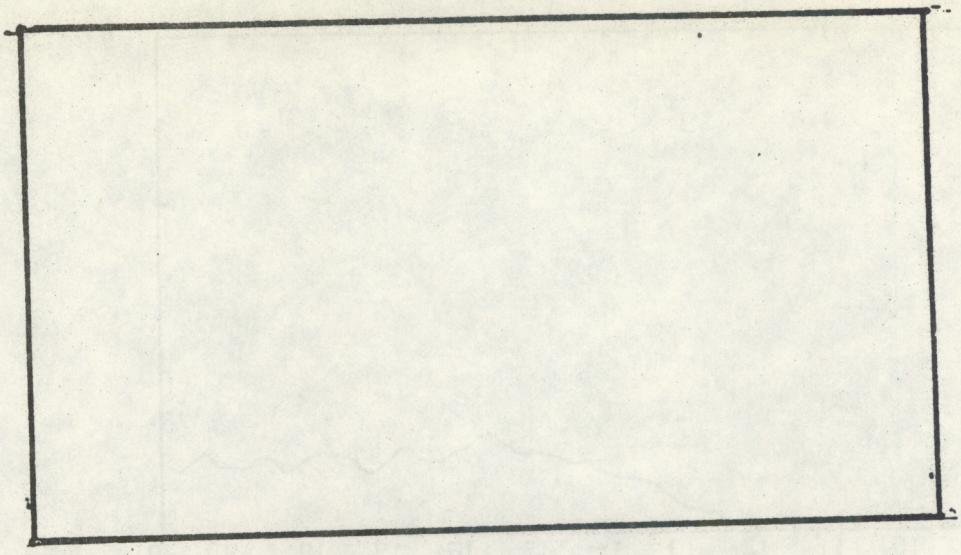

DATE....78229 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

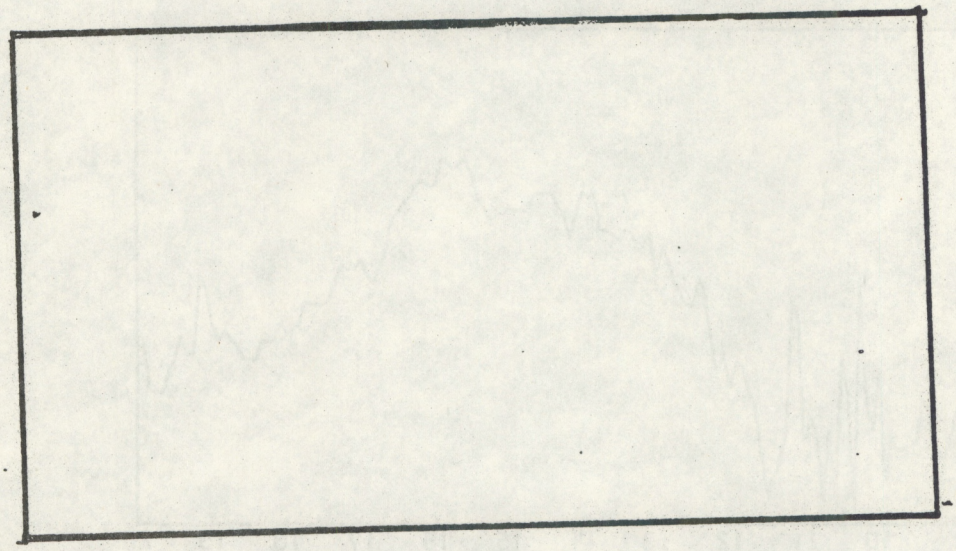

DATE....78229 TARGET AREA MPS-4
MEAN HEIGHT(KM)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

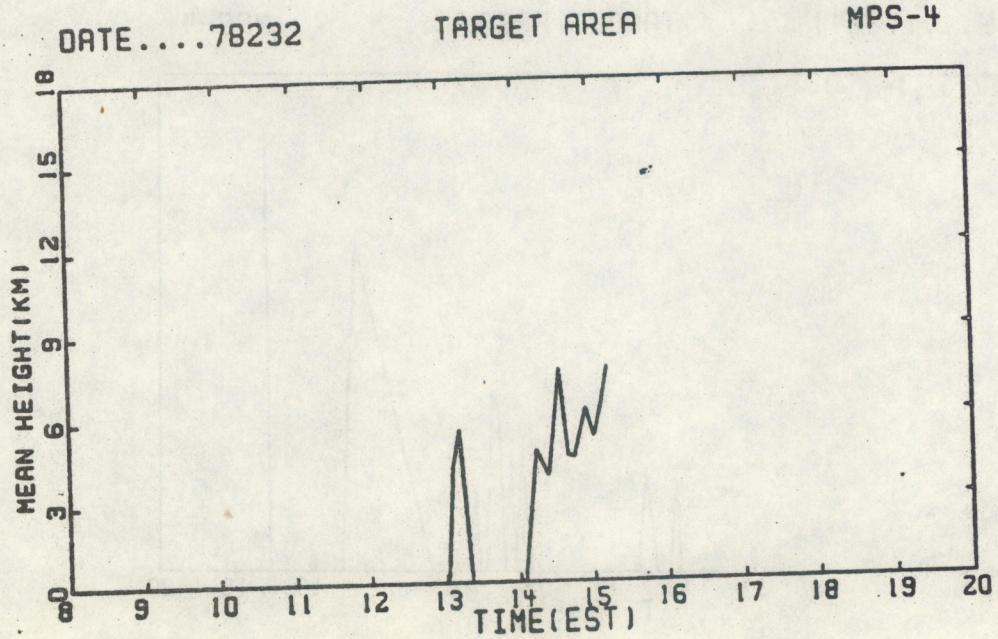

DATE....78230 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

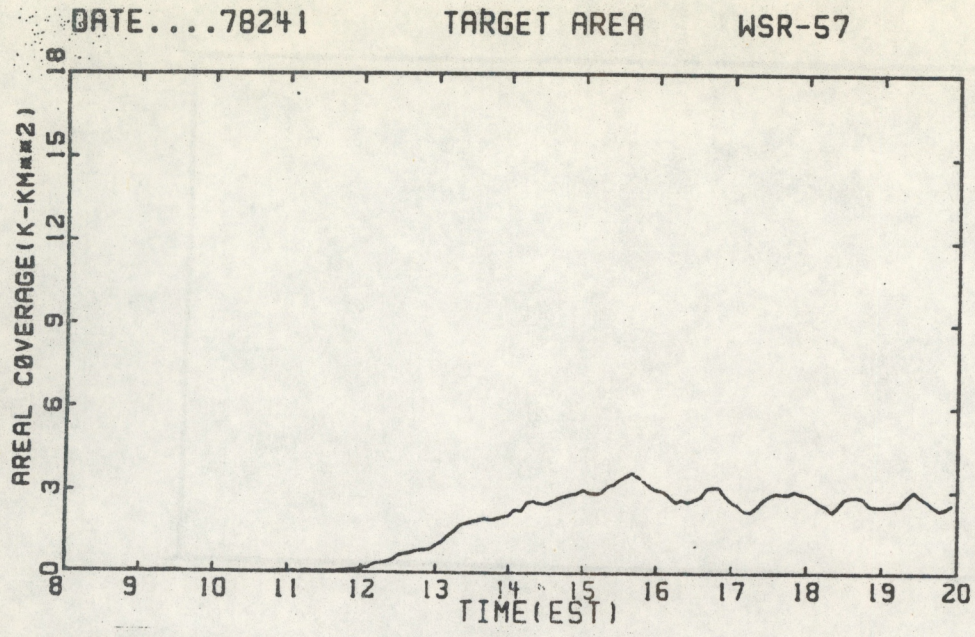

DATE....78230 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

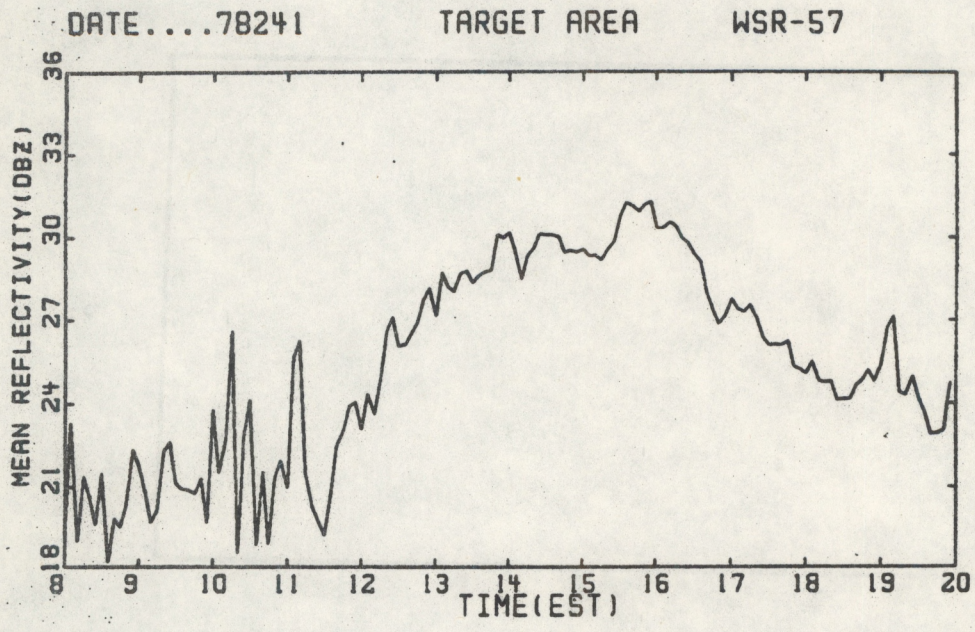

DATE....78230 TARGET AREA MPS-4
MEAN HEIGHT(KM)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)






DATE....78232
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE....78241
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE....78241
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
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11
12
13
14
15
16
17
18
19
20
TIME(EST)

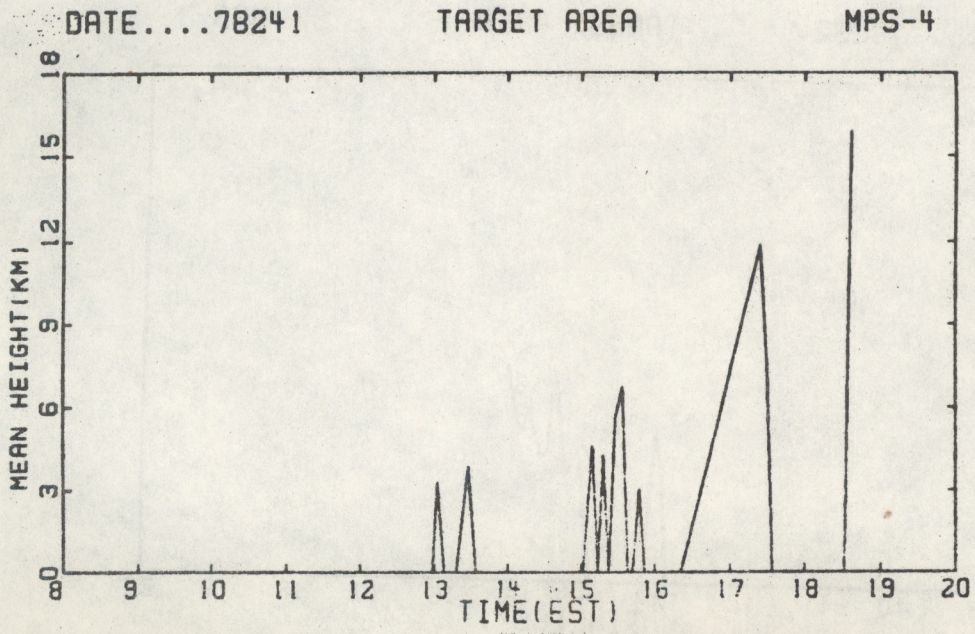
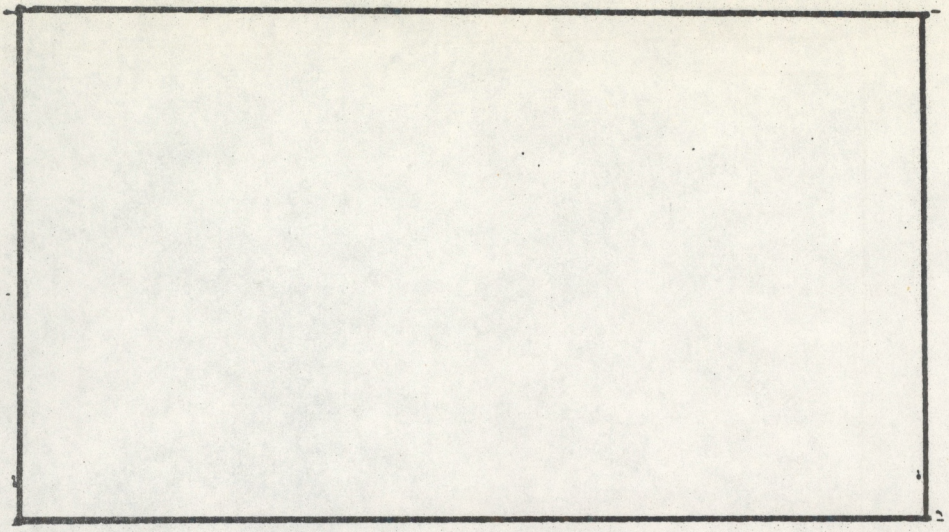
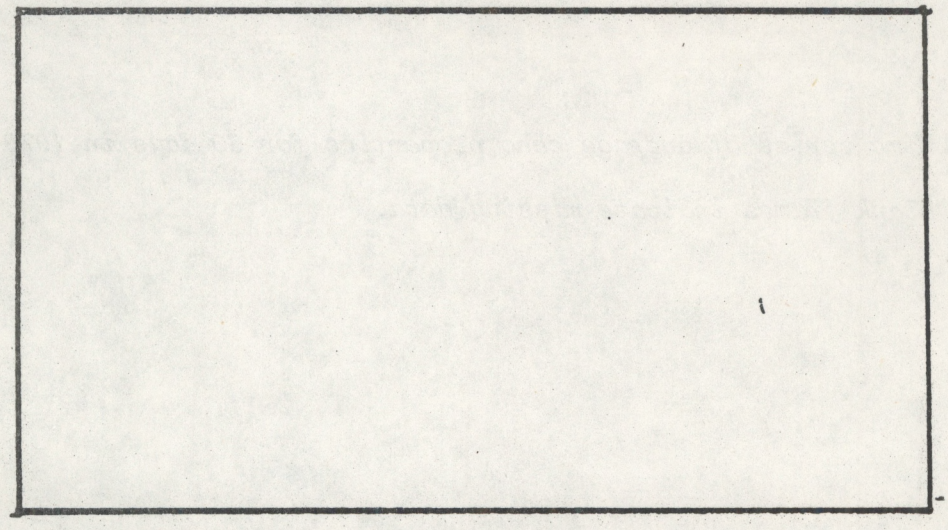
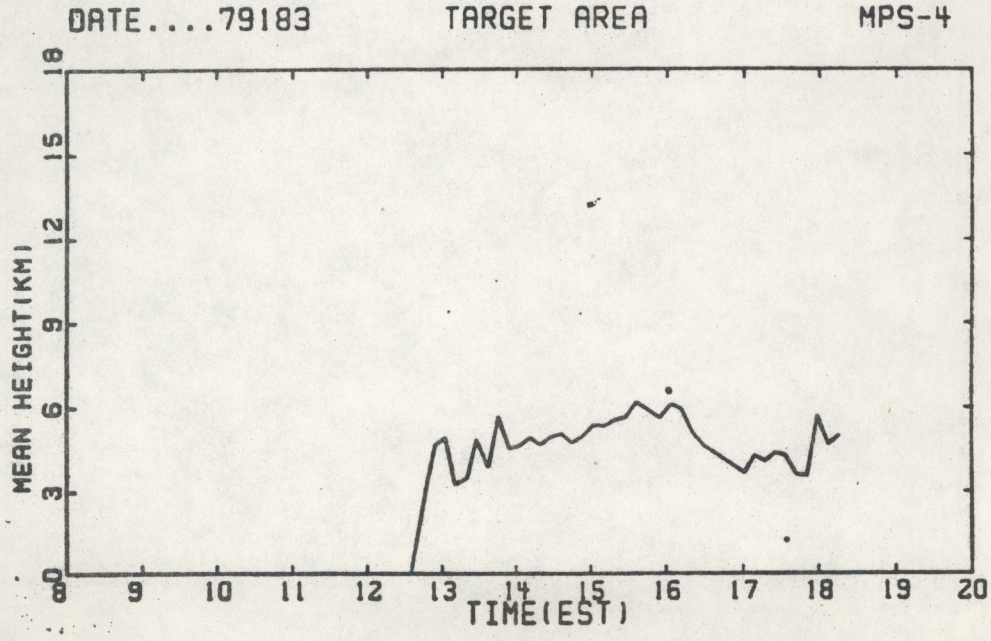
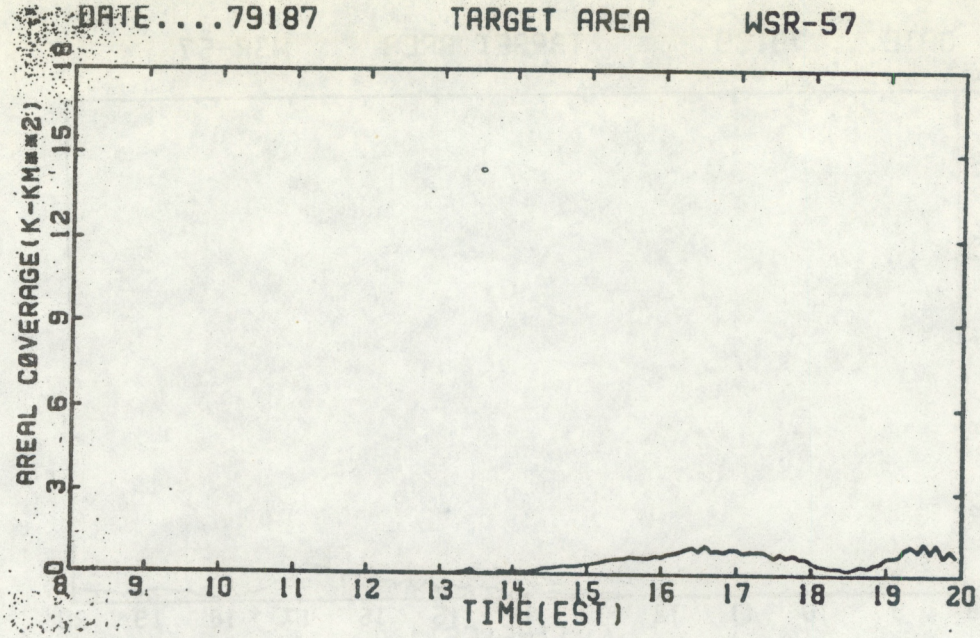

DATE....78241
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
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18
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11
12
13
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16
17
18
19
20
TIME(EST)

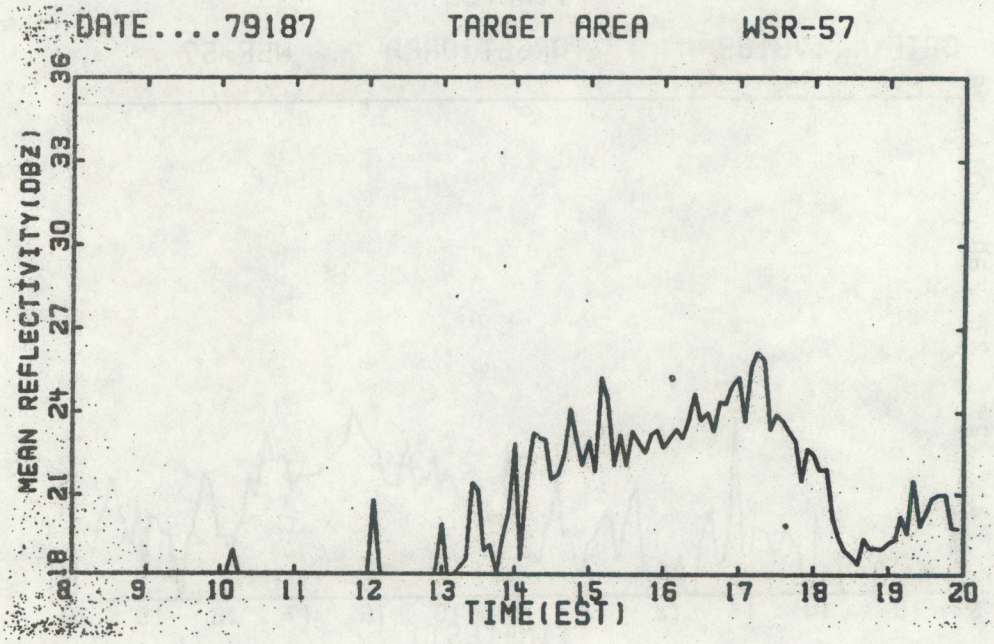
*Fig. 5. Time series of average echo properties for 60 days in 1979. Blank frames indicate missing data.*

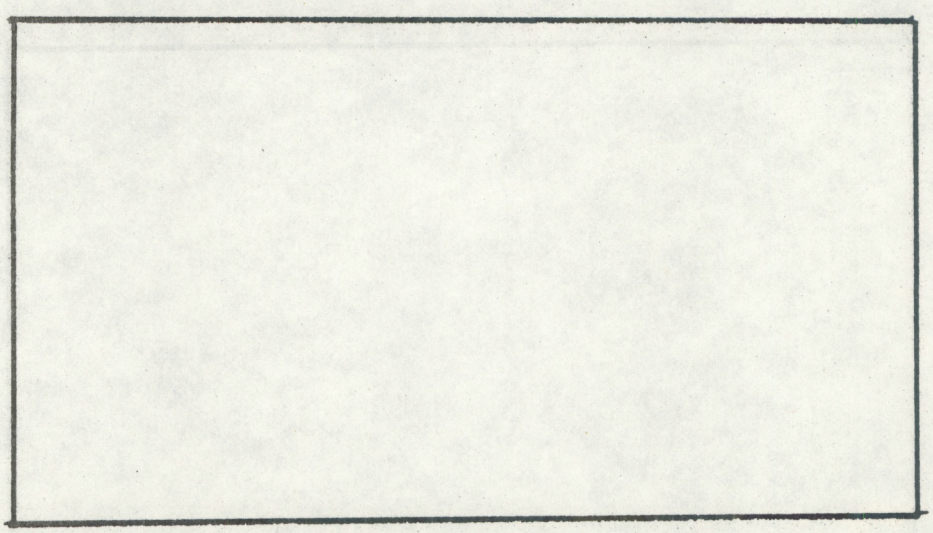


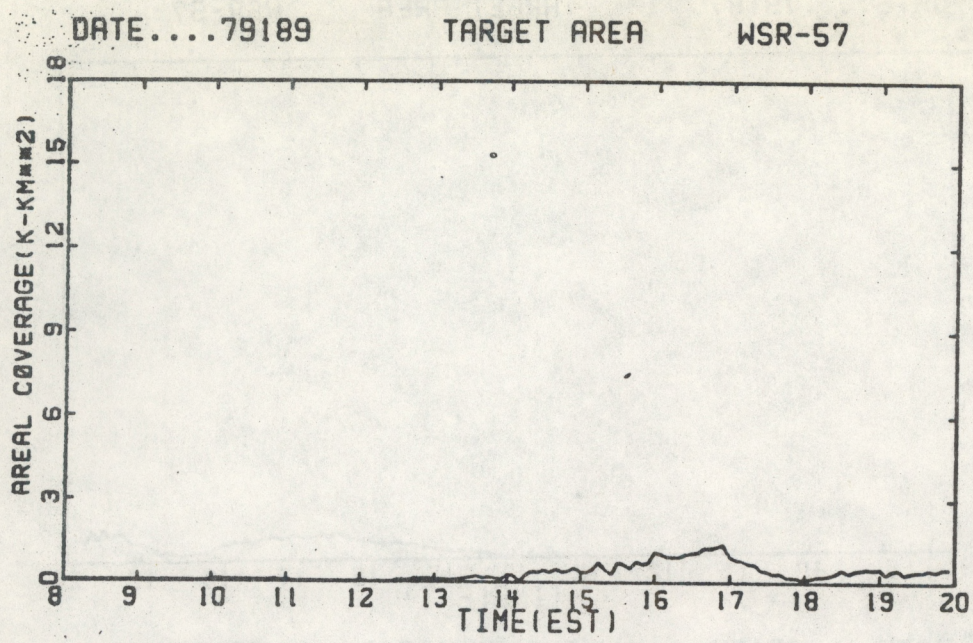


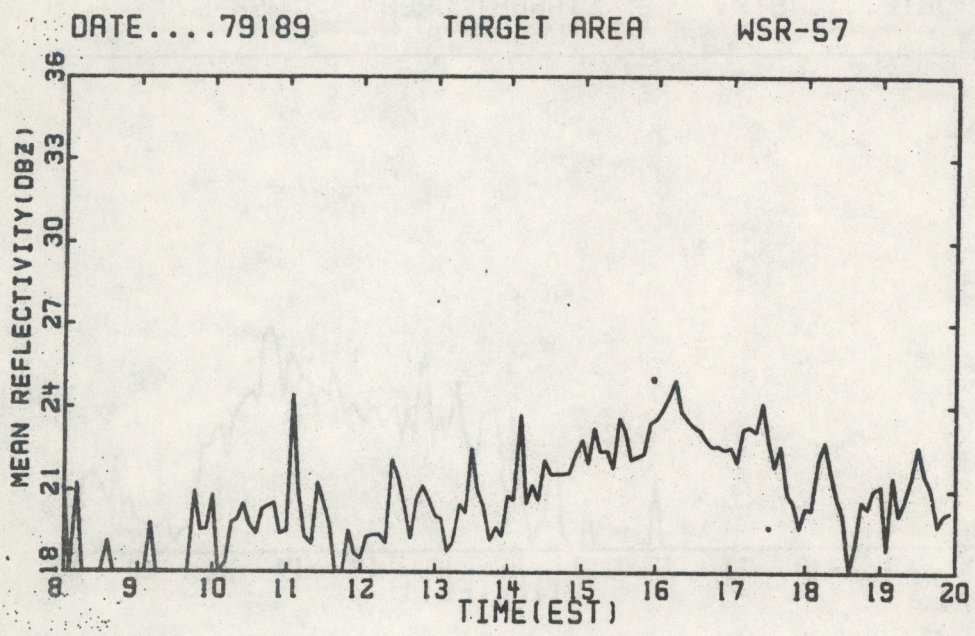

DATE....79183
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

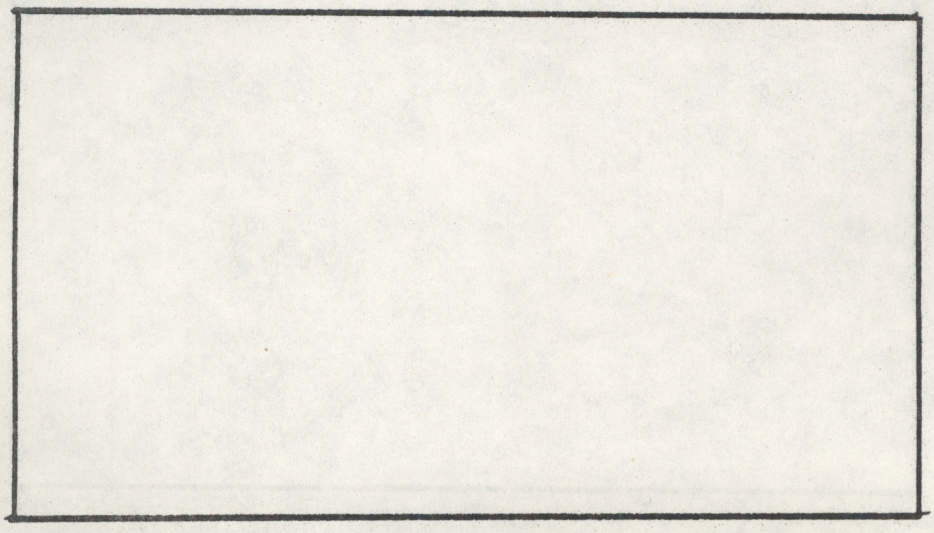

DATE....79187
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

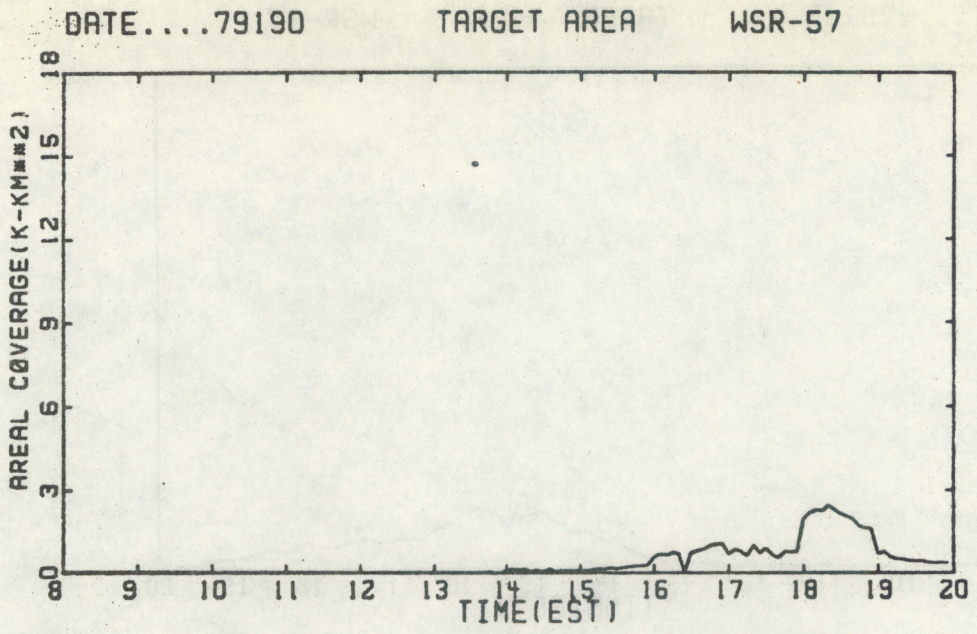

DATE....79187
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

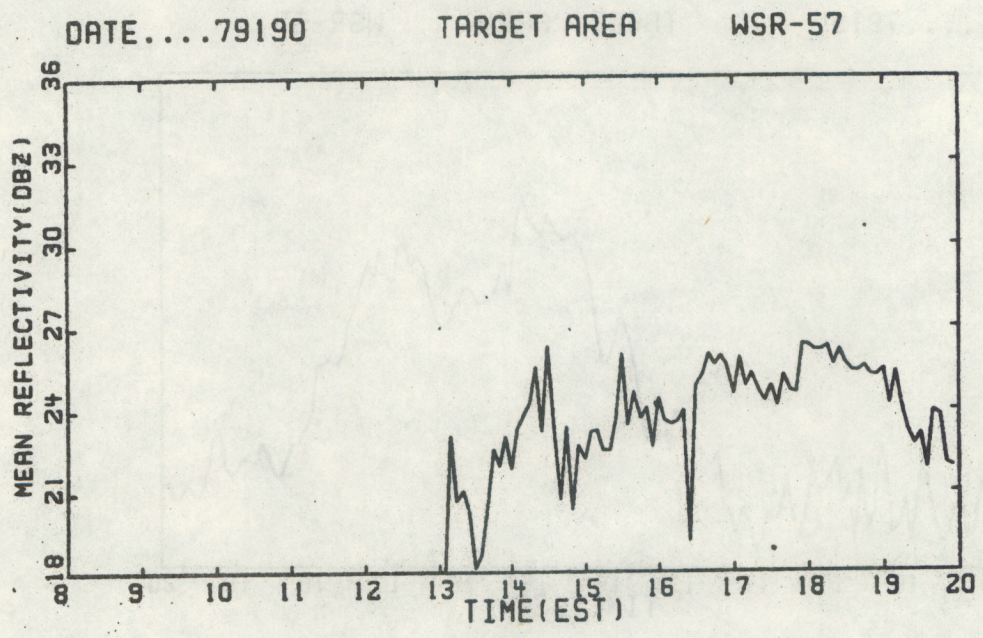


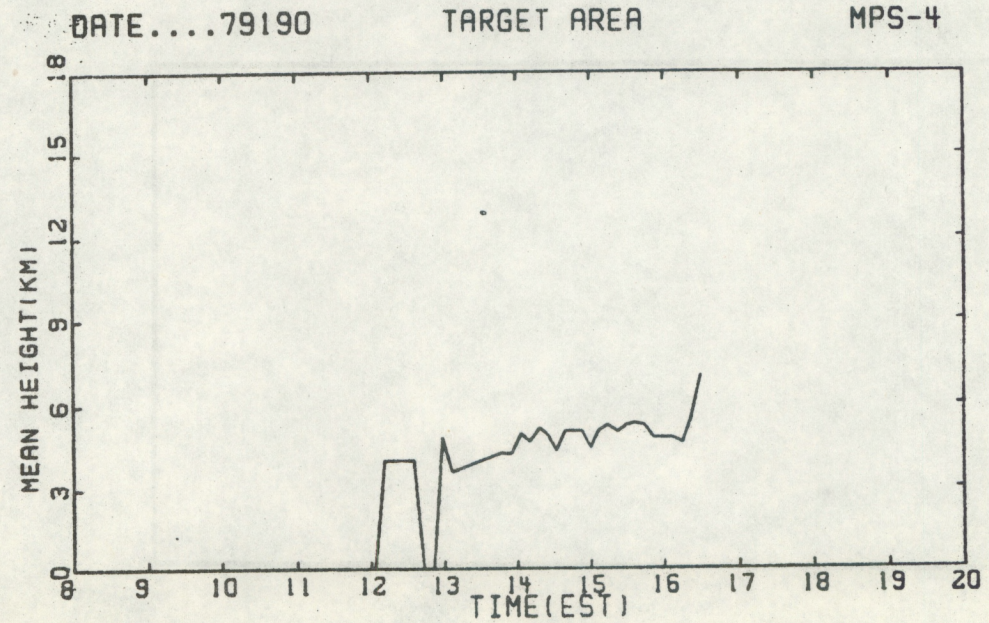

DATE....79189
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

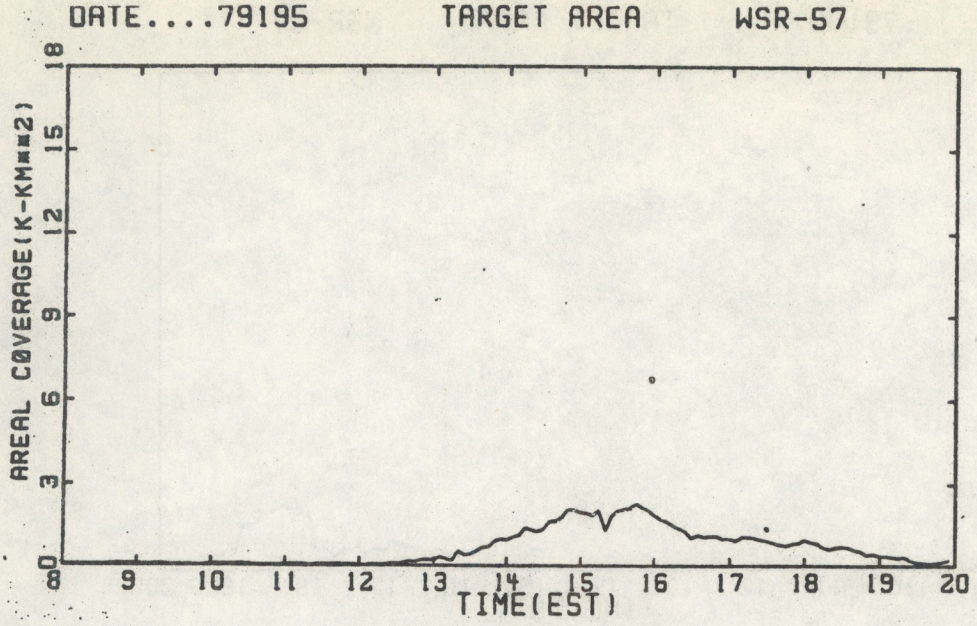

DATE....79189
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

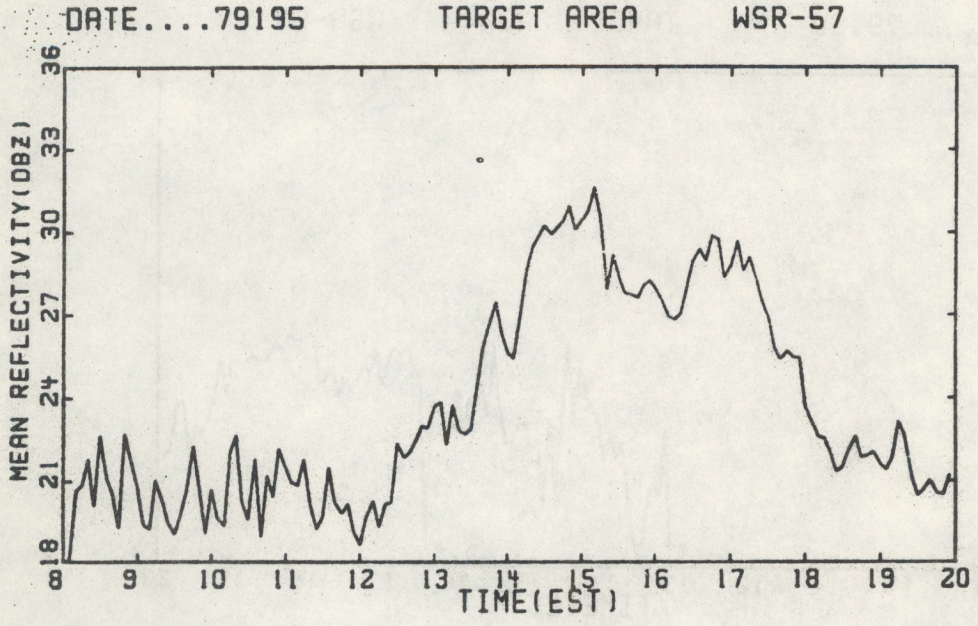


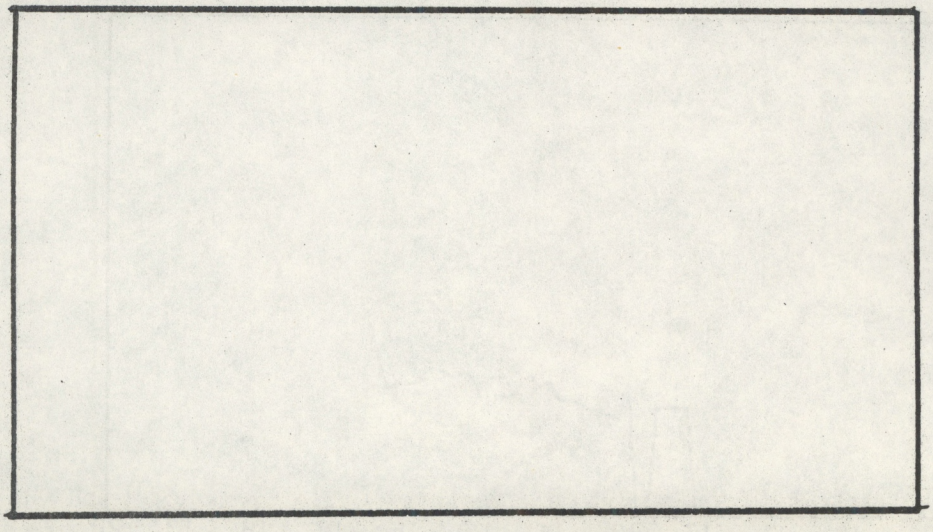

DATE....79190
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

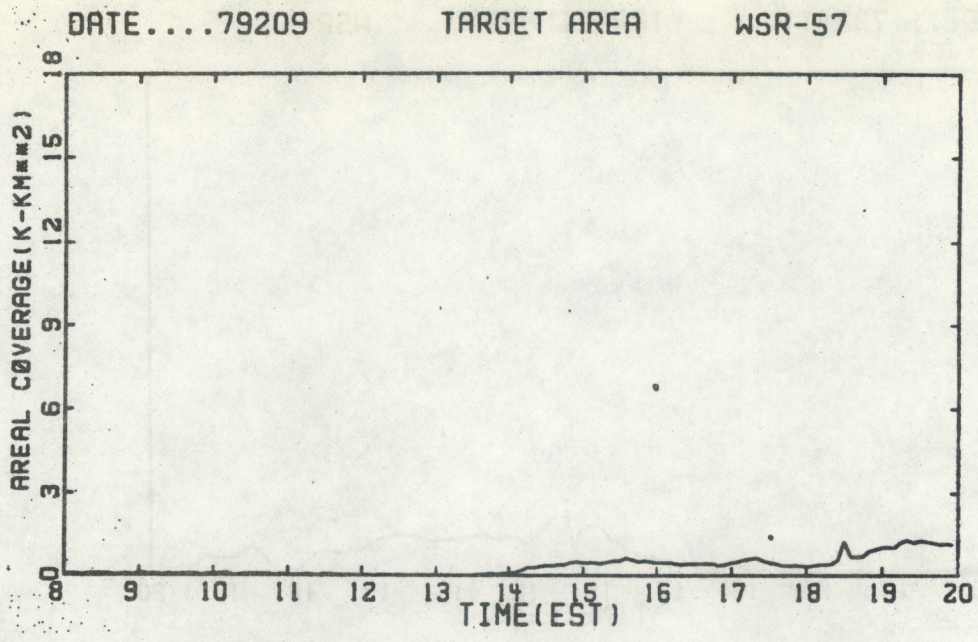

DATE....79190
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

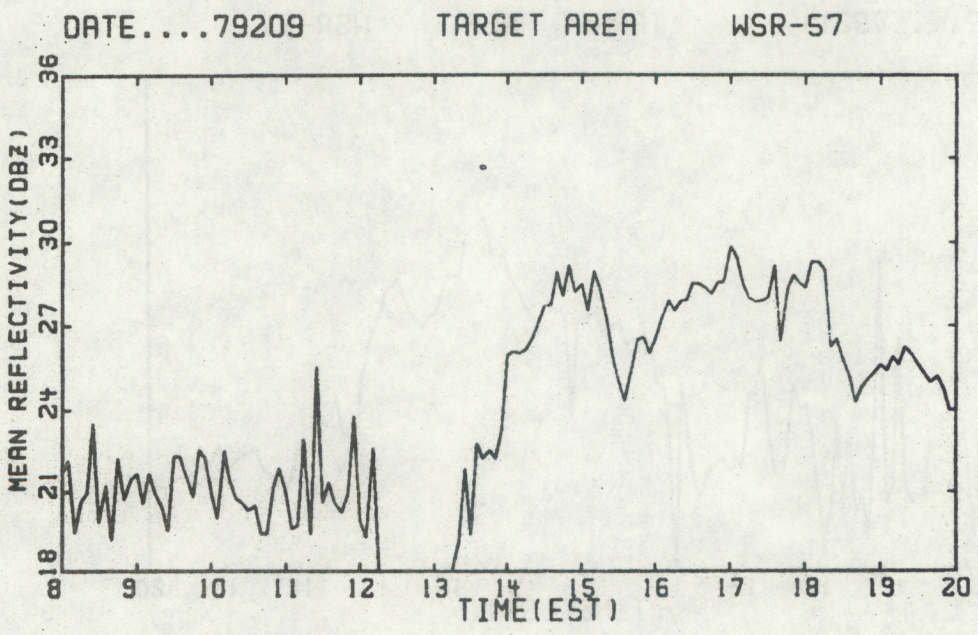

DATE....79190
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

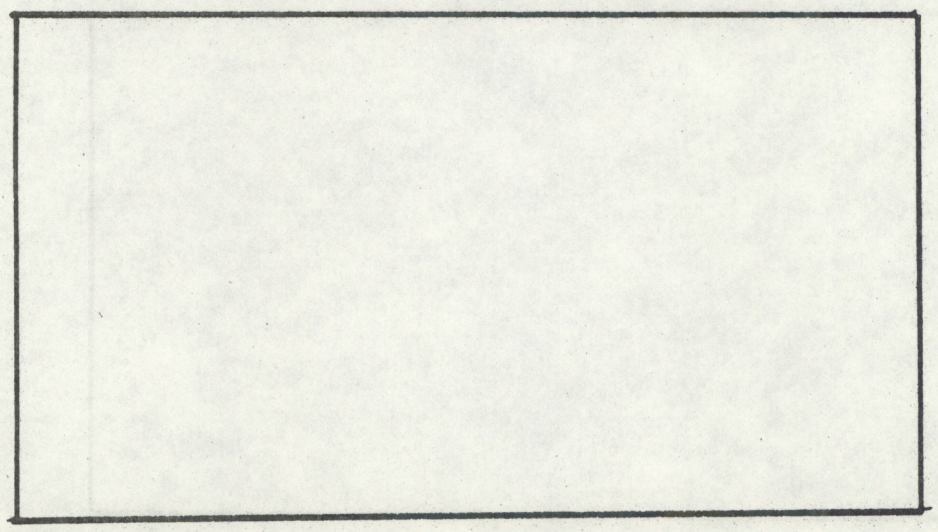

DATE....79195 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

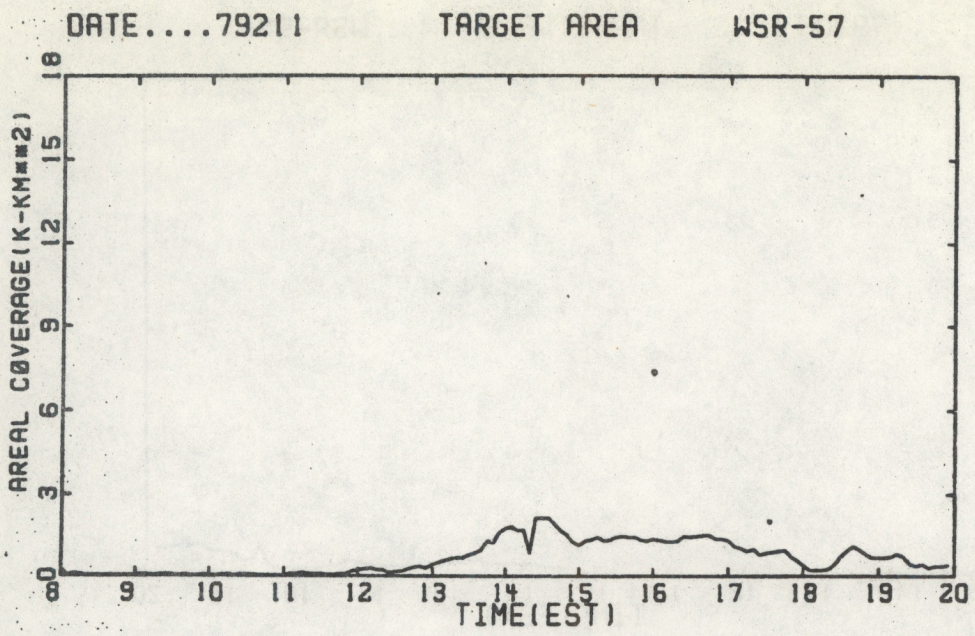

DATE....79195 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

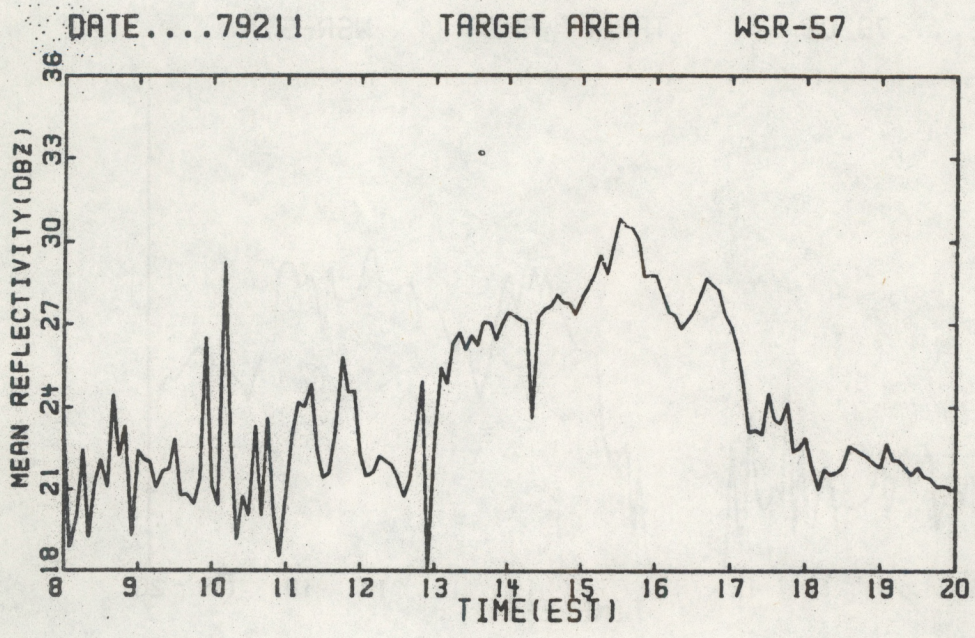


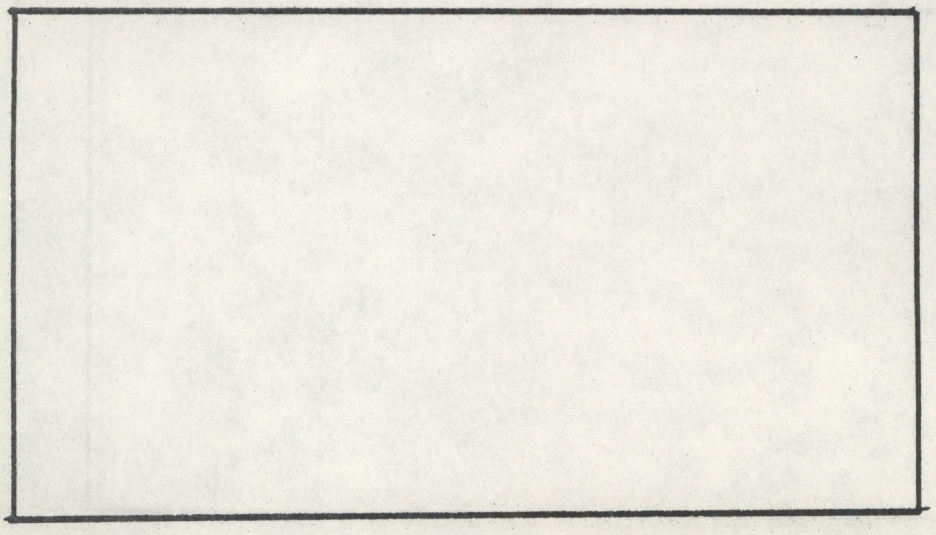

DATE....79209
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

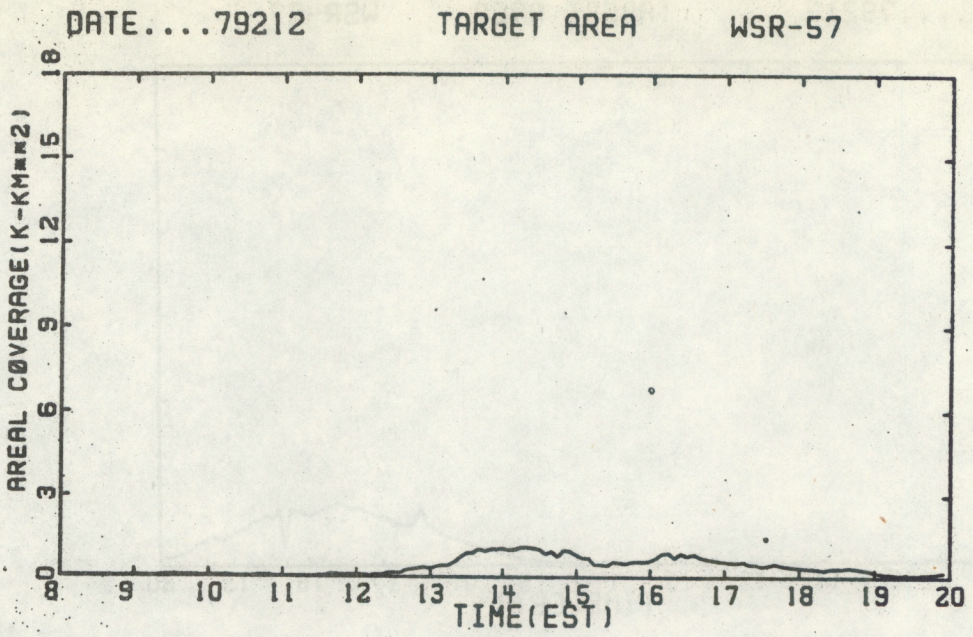

DATE....79209
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

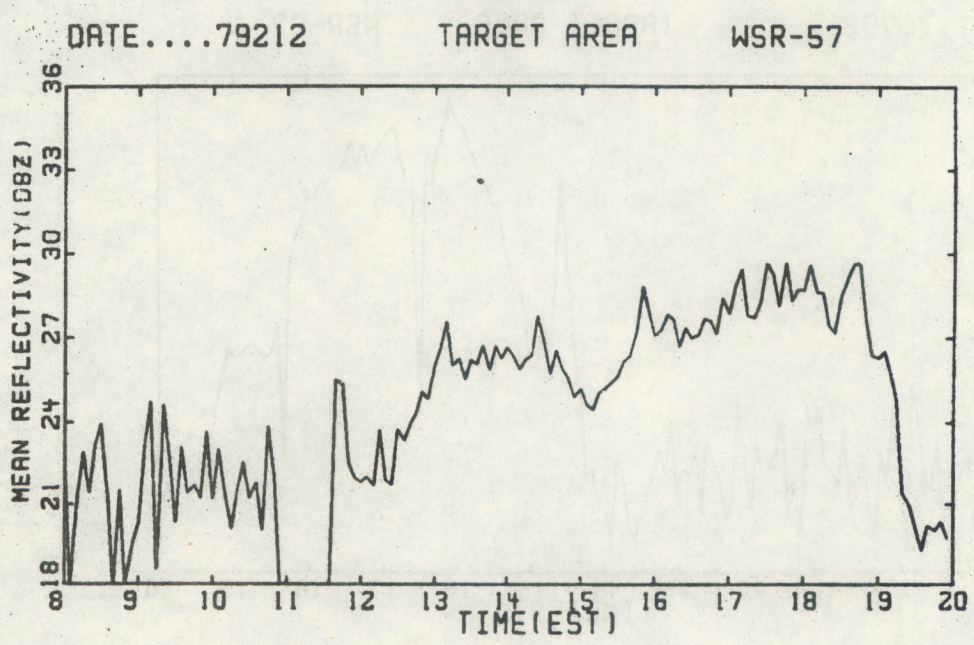


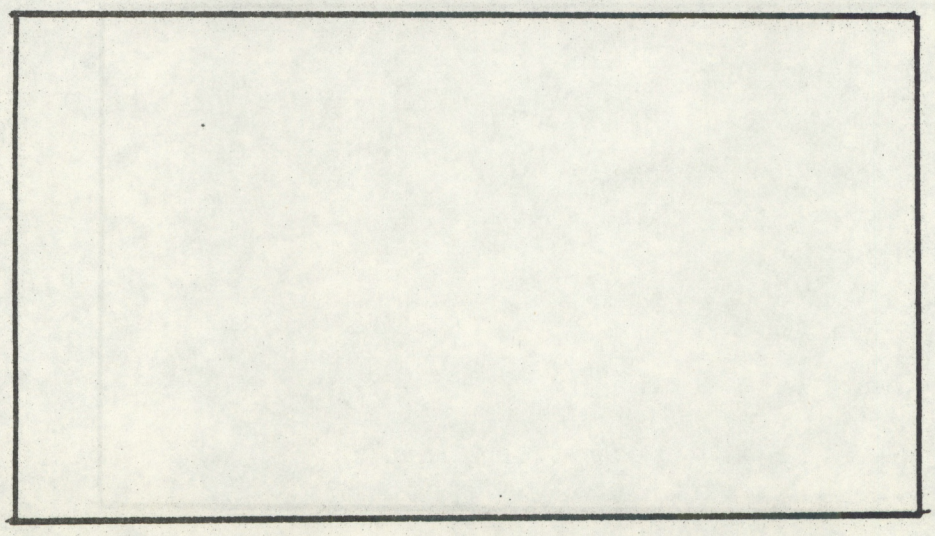

DATE....79211 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

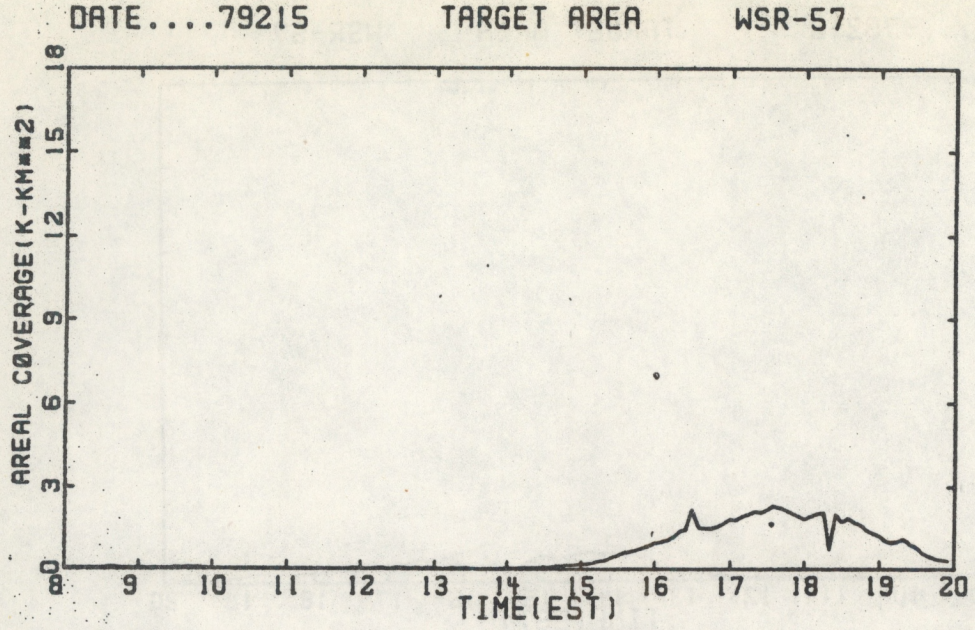

DATE....79211 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

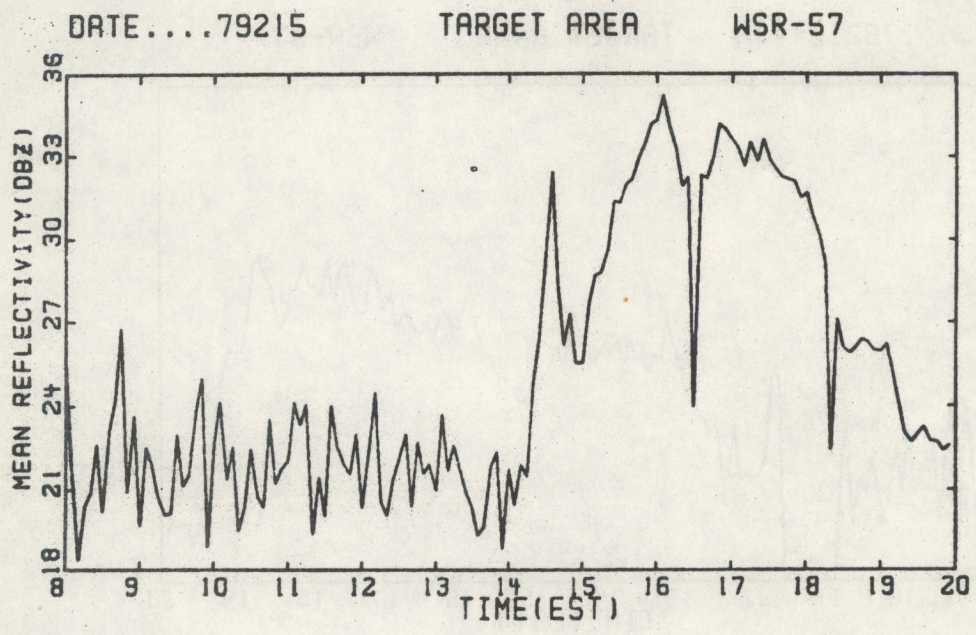


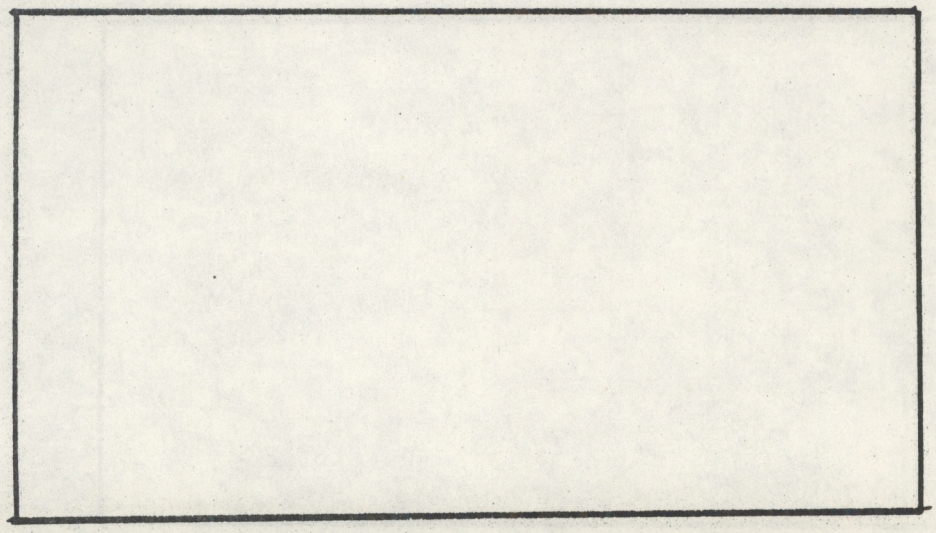

DATE....79212 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

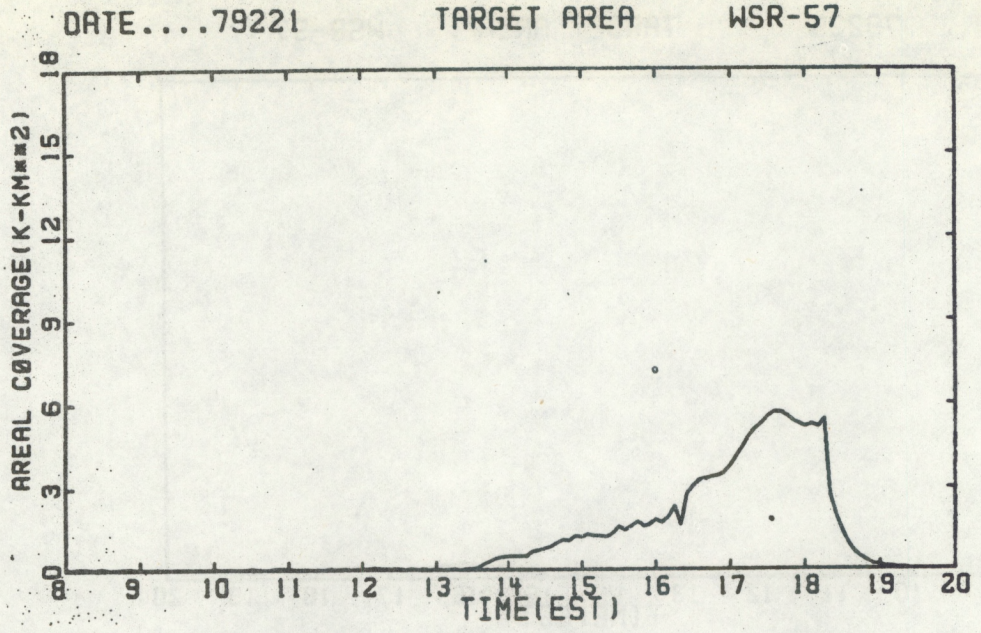

DATE....79212 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

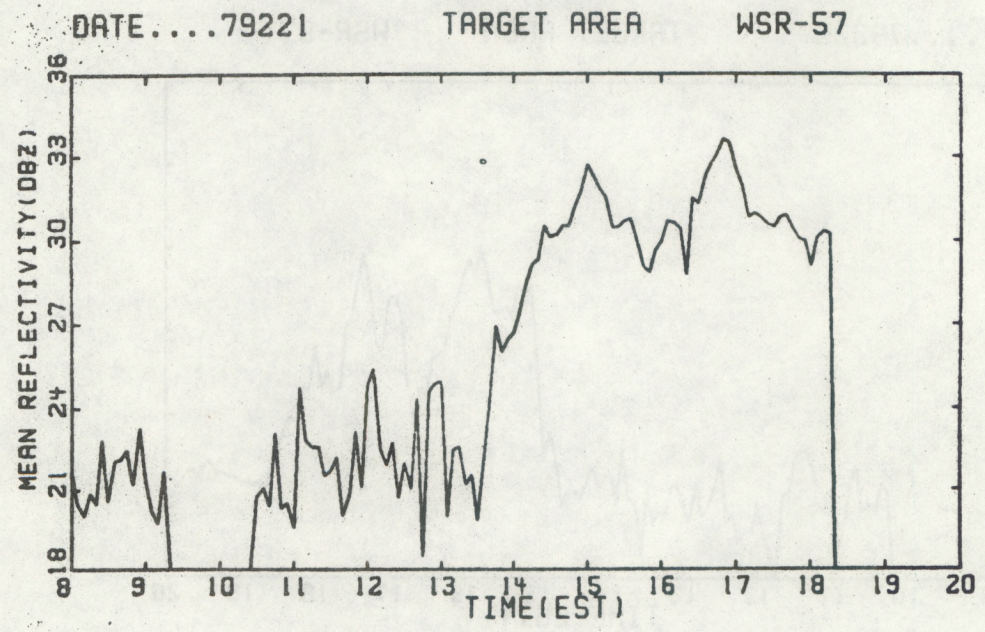


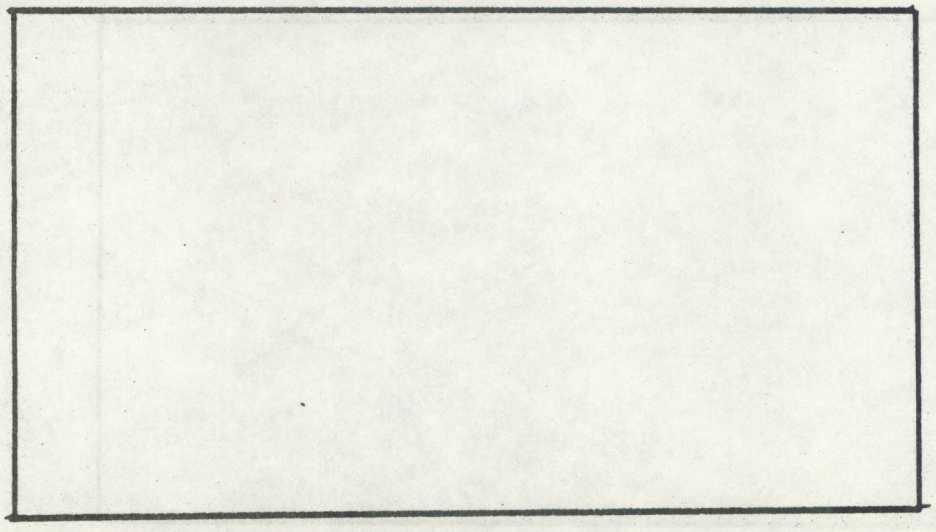

DATE....79215 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

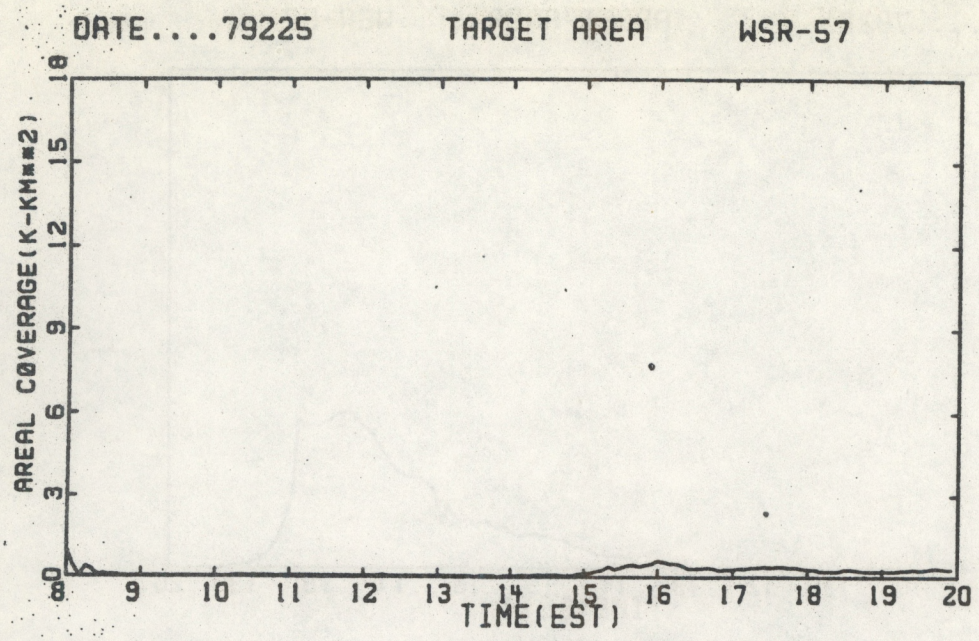

DATE....79215 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

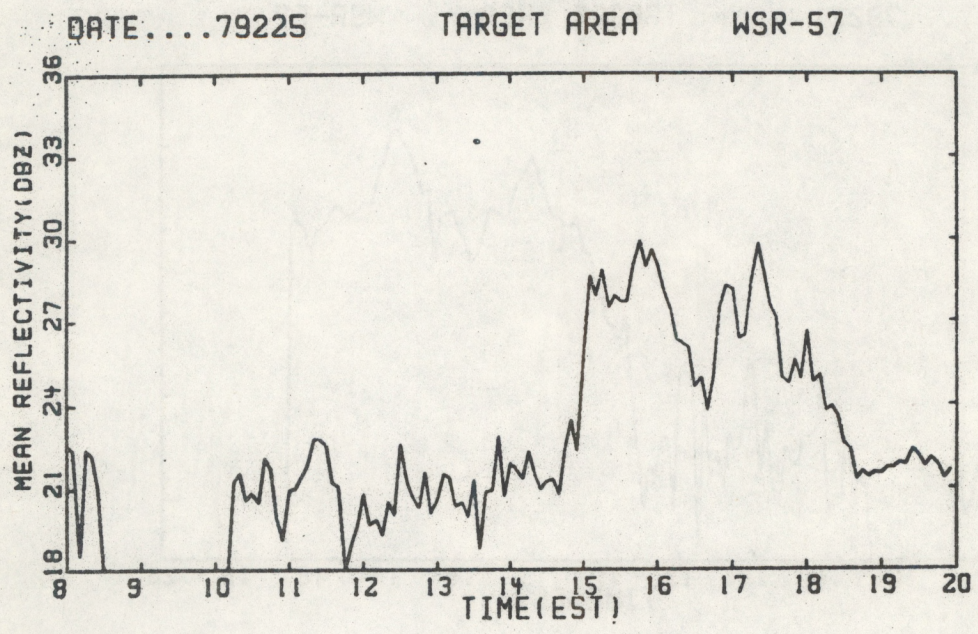


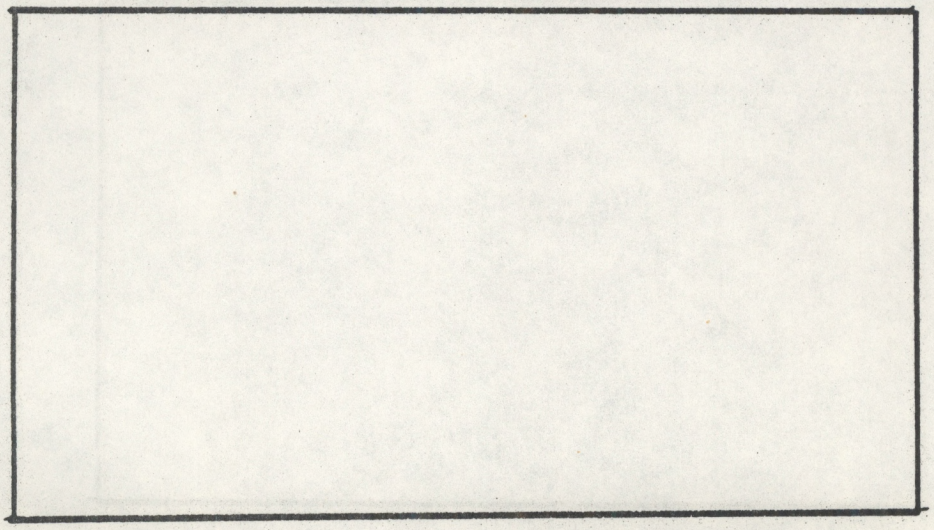

DATE....79221 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

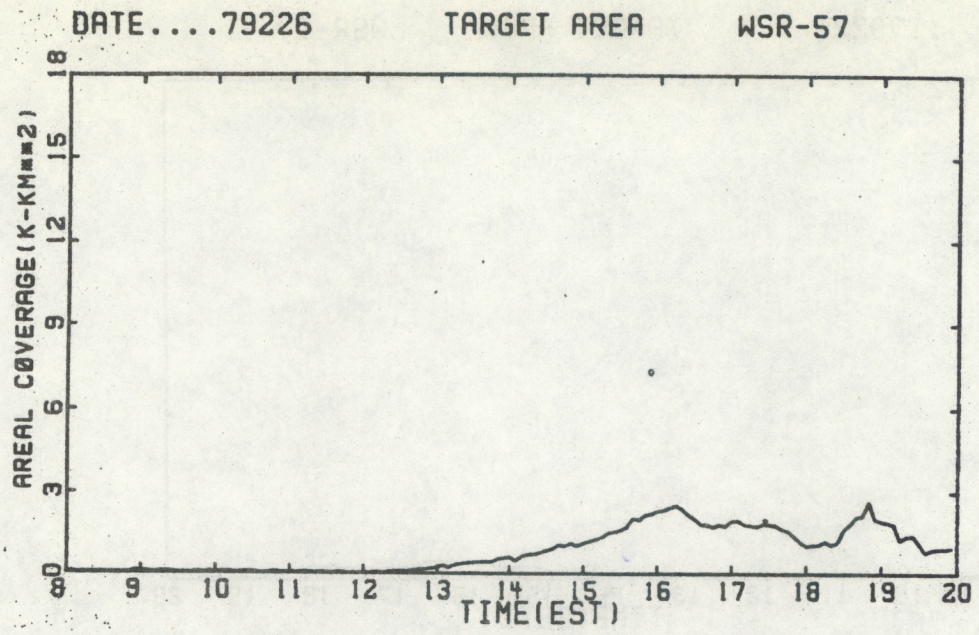

DATE....79221 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

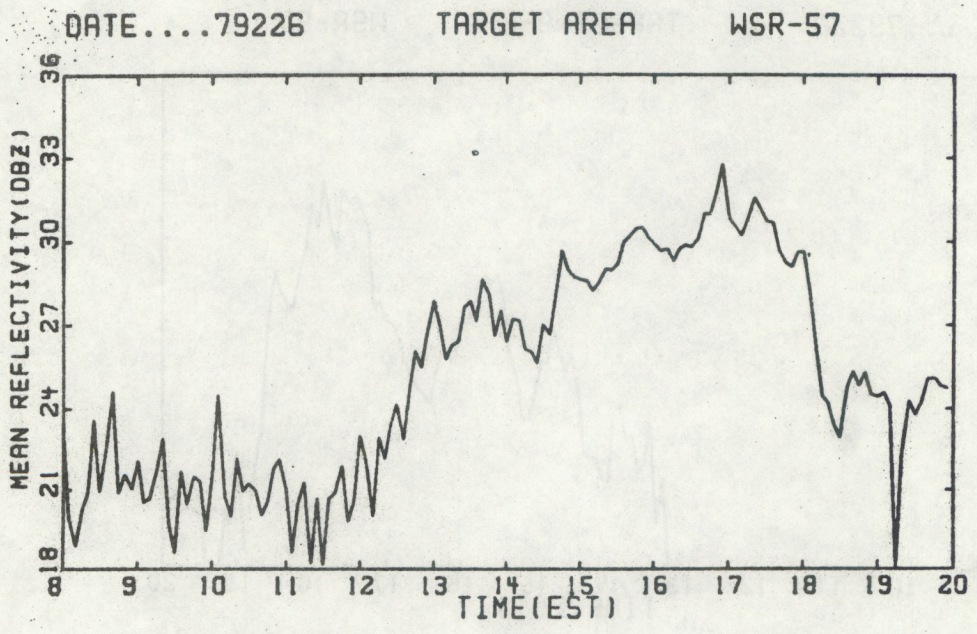


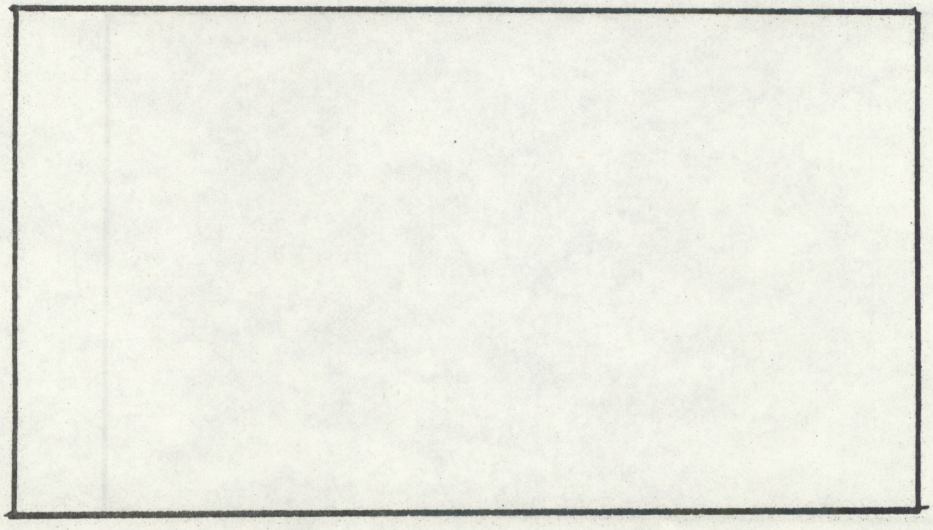

DATE....79225 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

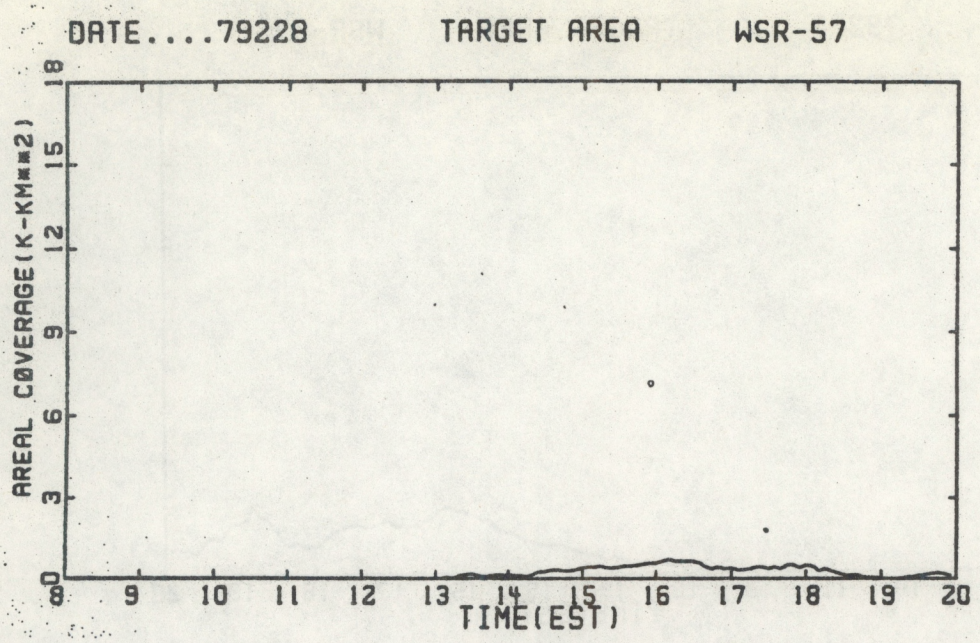

DATE....79225 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

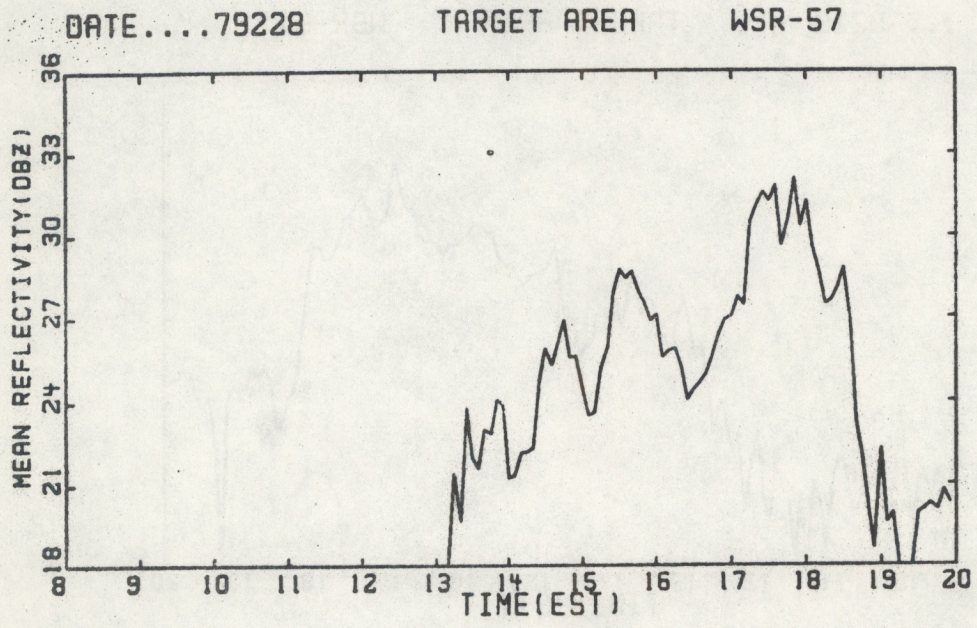


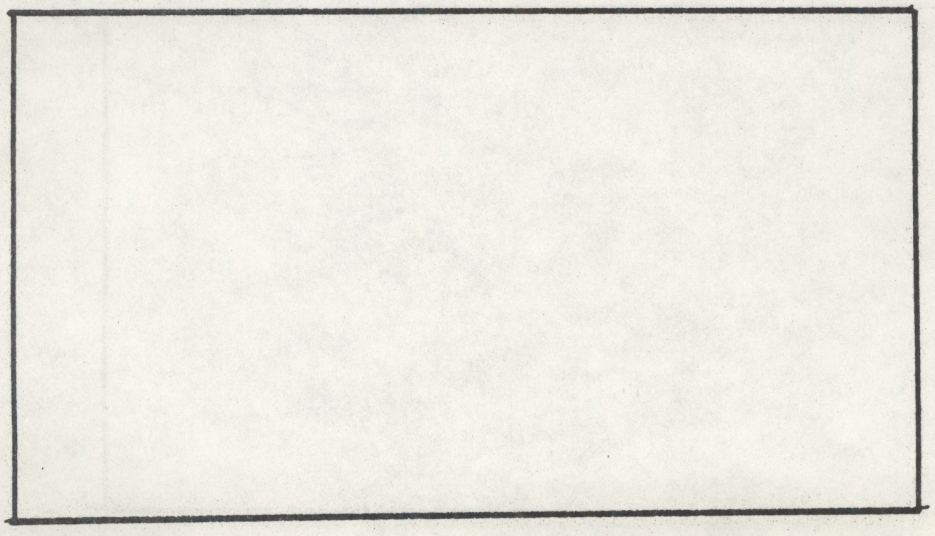

DATE....79226 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

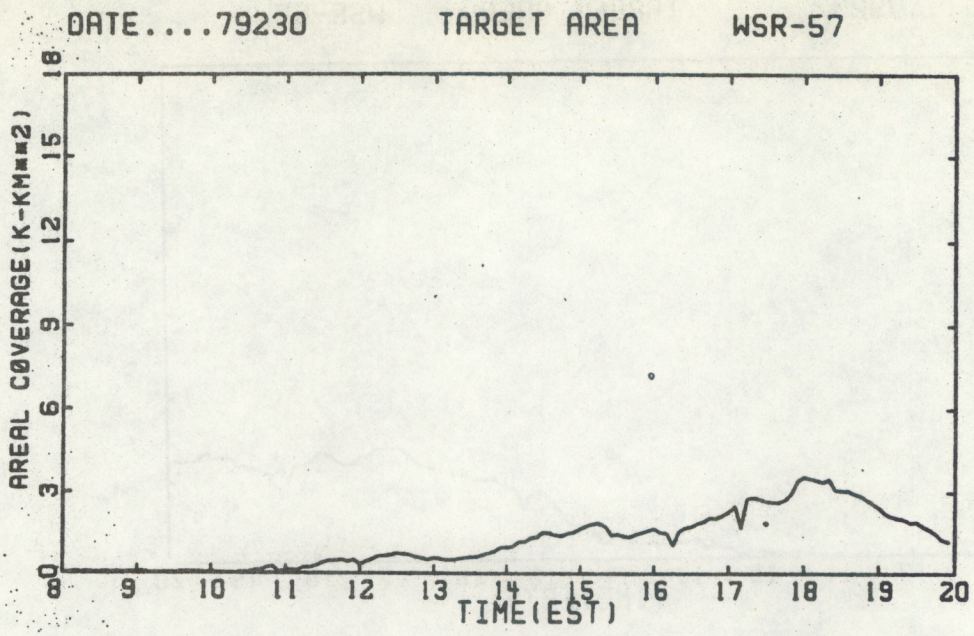

DATE....79226 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

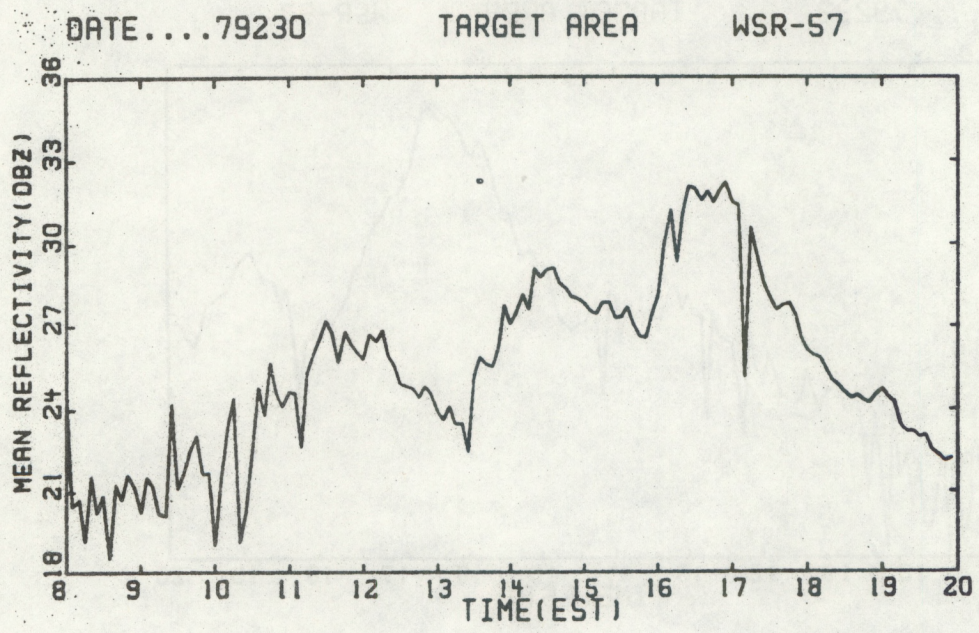


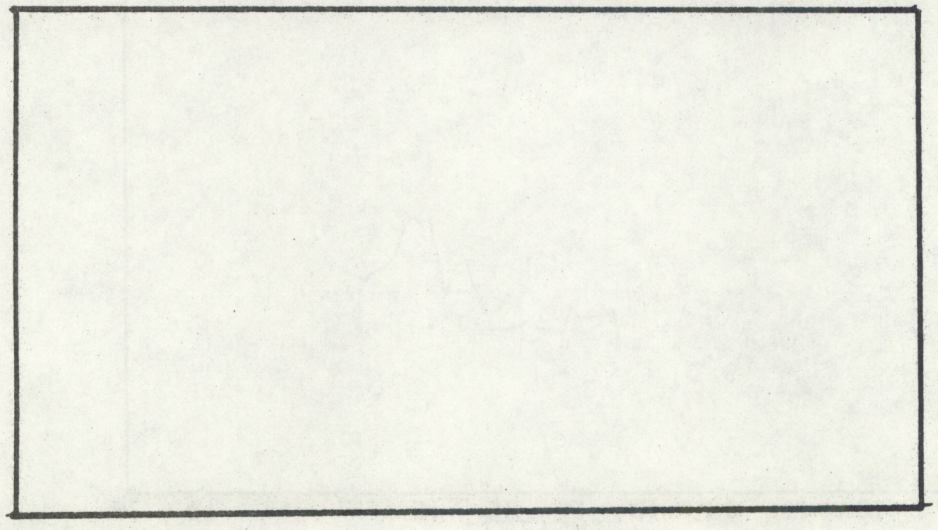

DATE....79228
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
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11
12
13
14
15
16
17
18
19
20
TIME(EST)

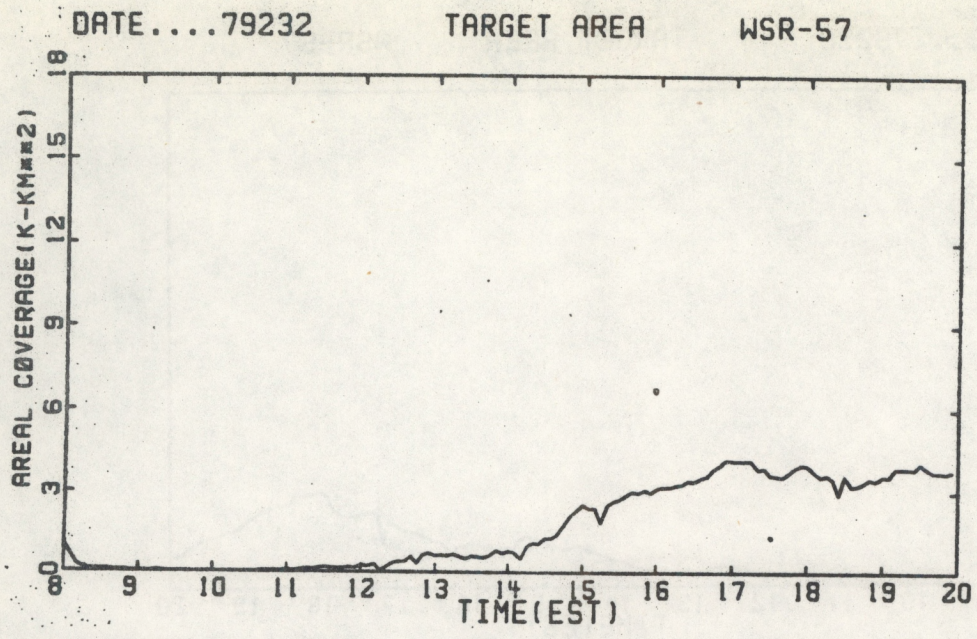

DATE....79228
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
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12
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15
16
17
18
19
20
TIME(EST)

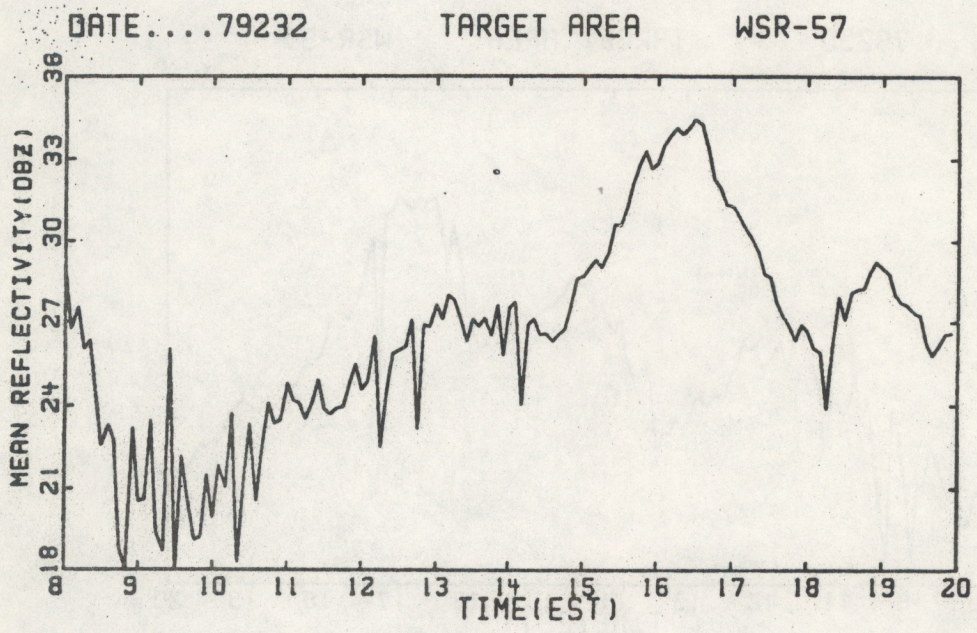


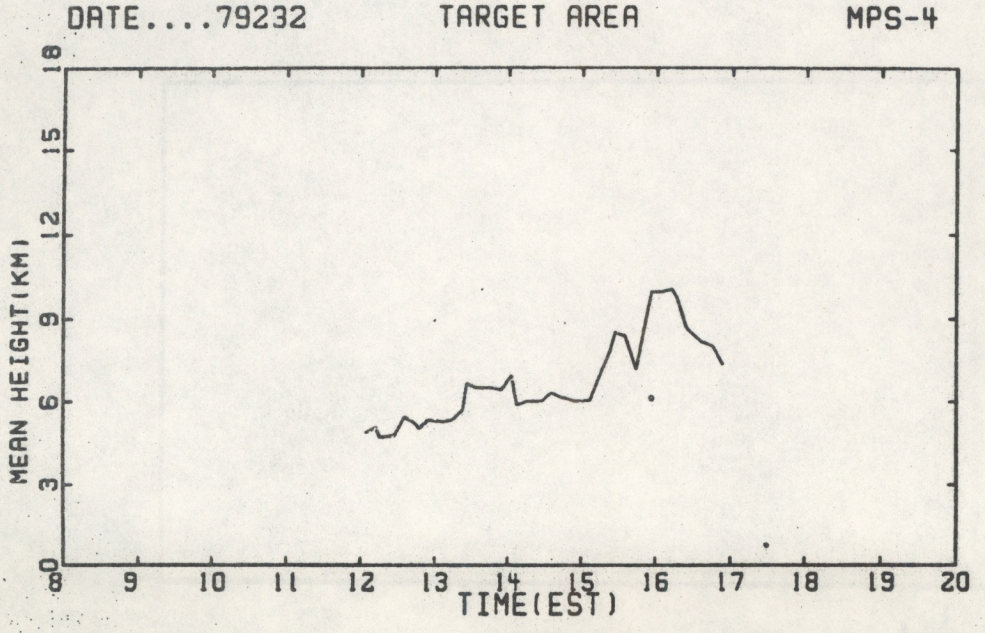

DATE....79230 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

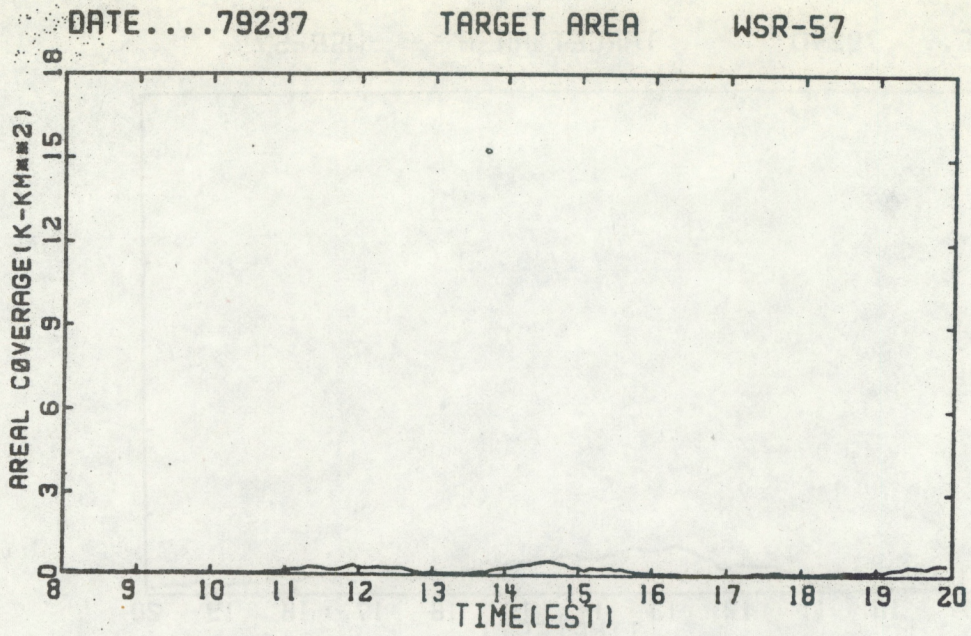

DATE....79230 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

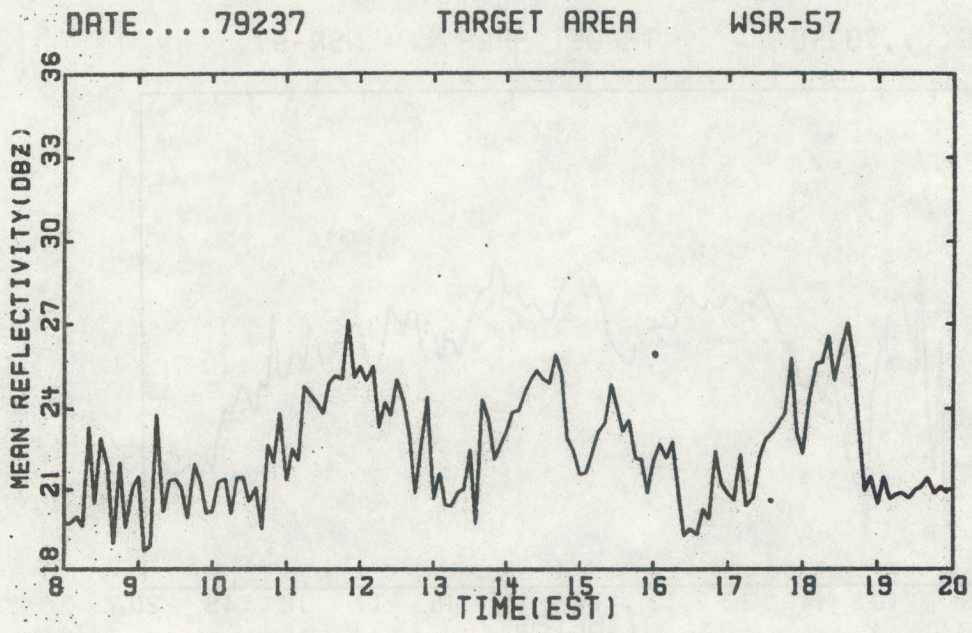


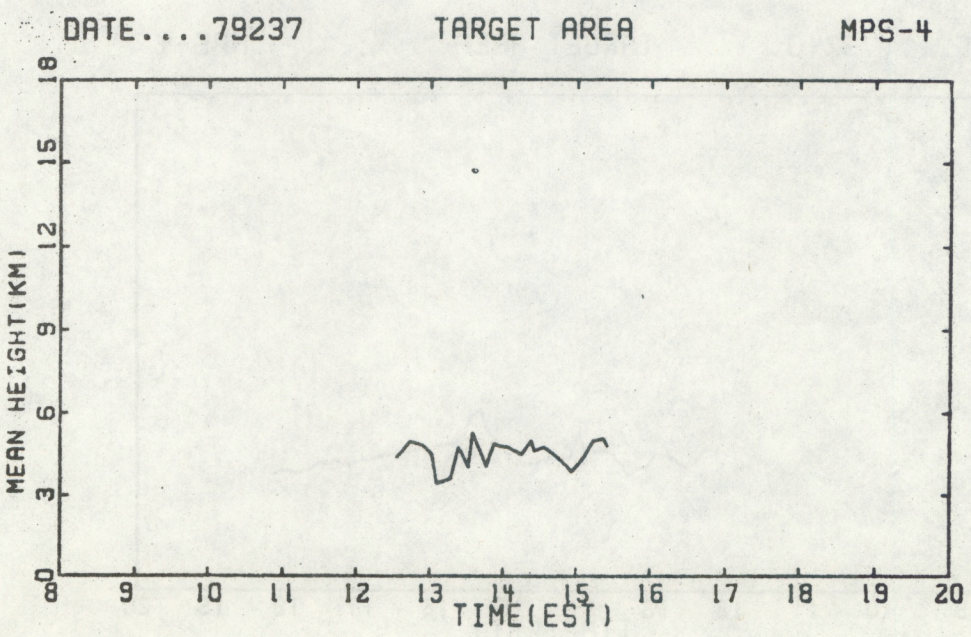

DATE....79232
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
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11
12
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17
18
19
20
TIME(EST)

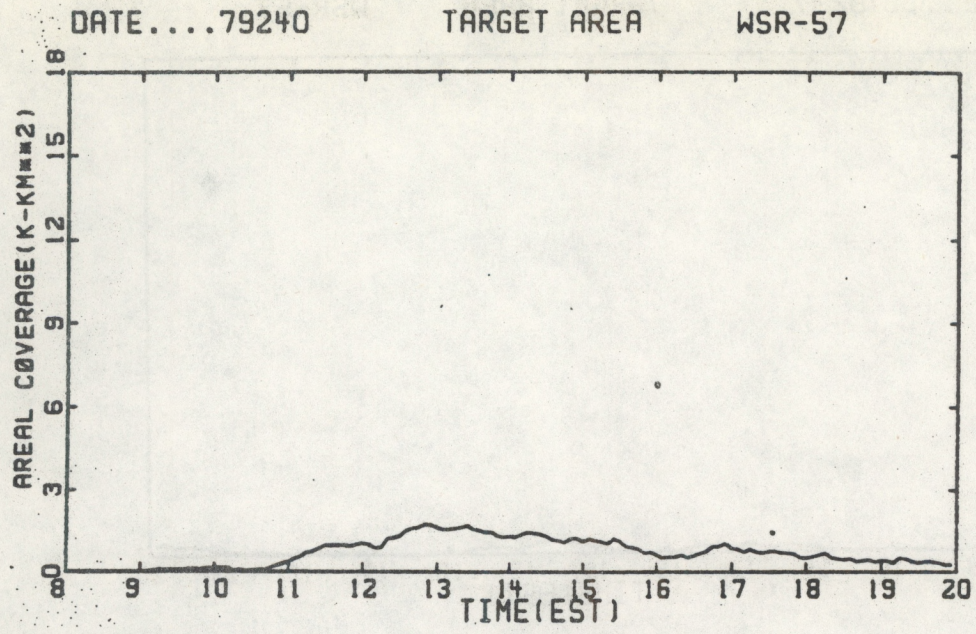

DATE....79232
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
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12
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18
19
20
TIME(EST)

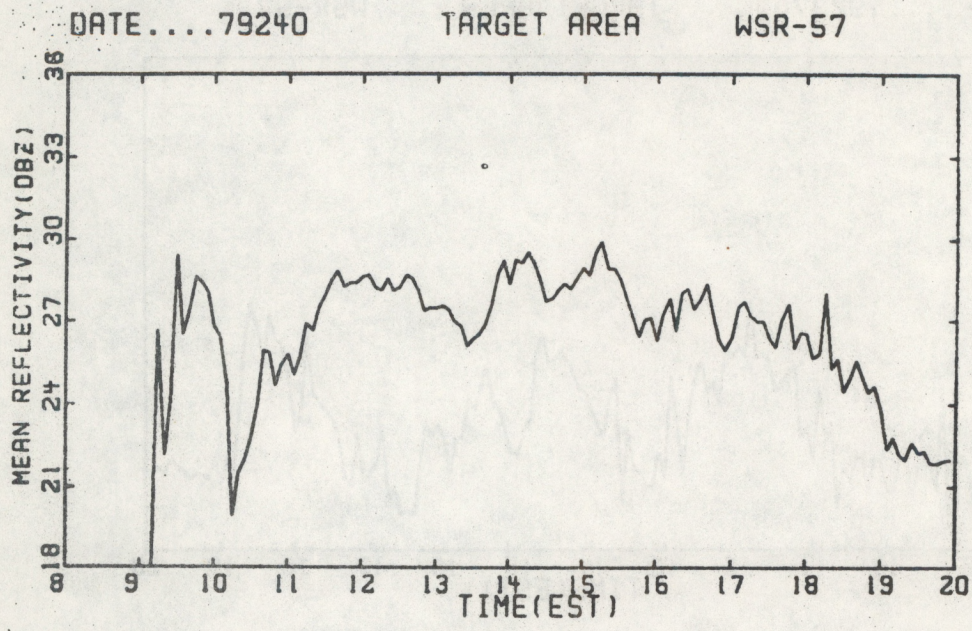

DATE....79232
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

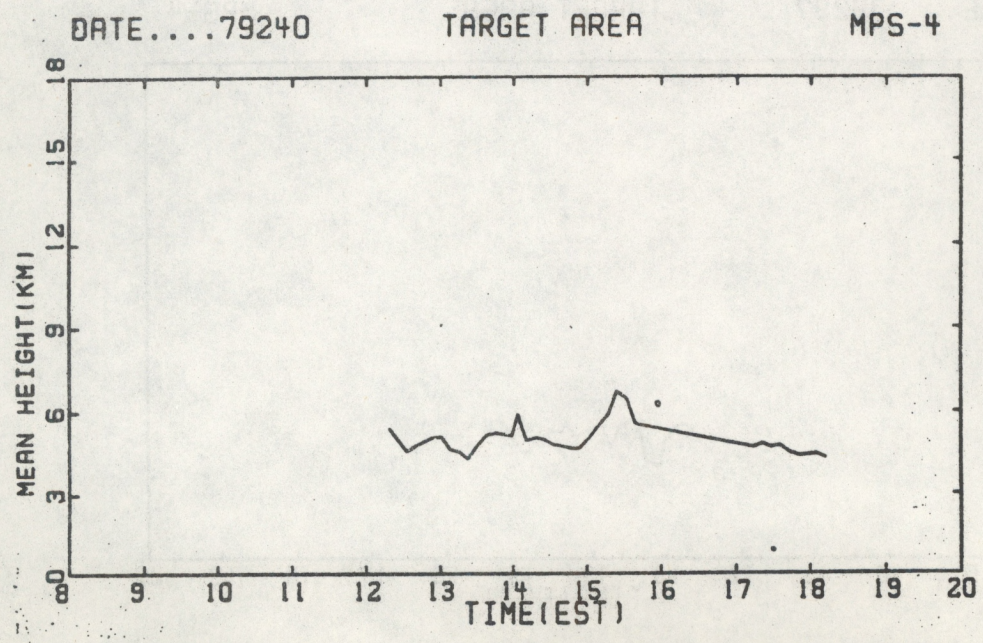

DATE....79237
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
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11
12
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14
15
16
17
18
19
20
TIME(EST)

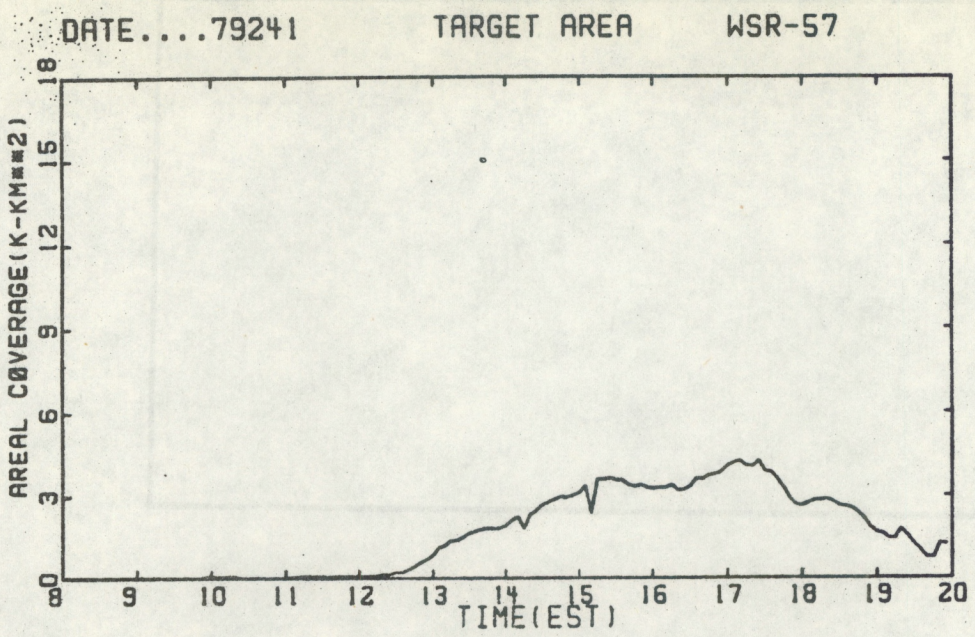

DATE....79237
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
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33
36
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14
15
16
17
18
19
20
TIME(EST)

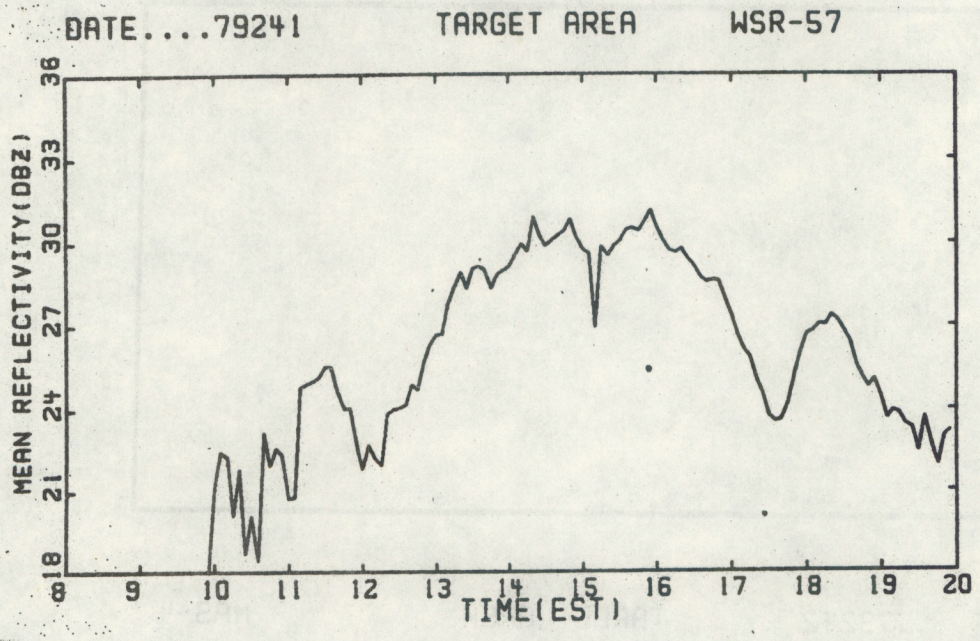

DATE....79237
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

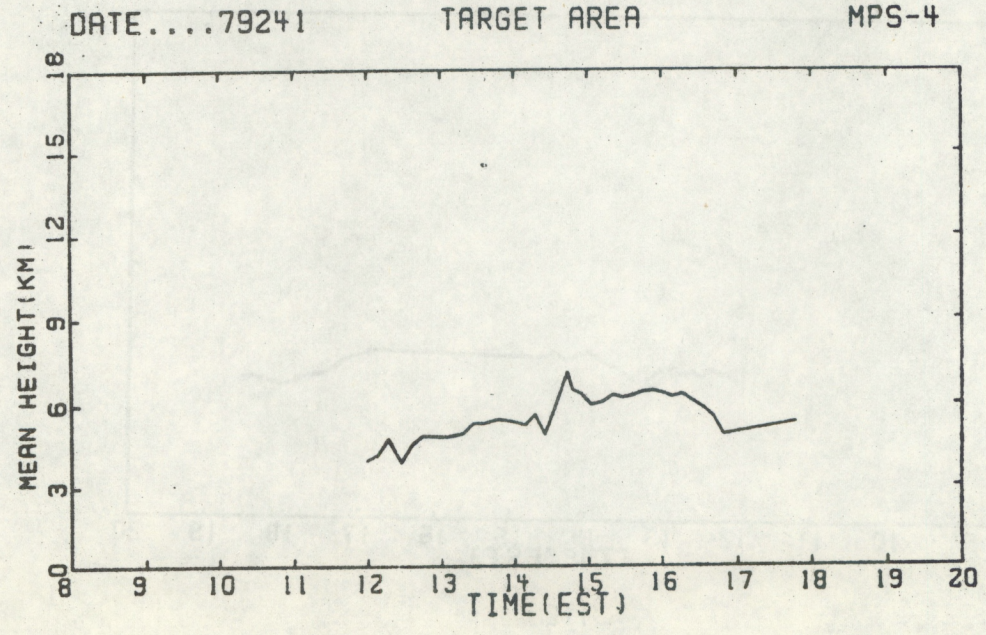

DATE....79240
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

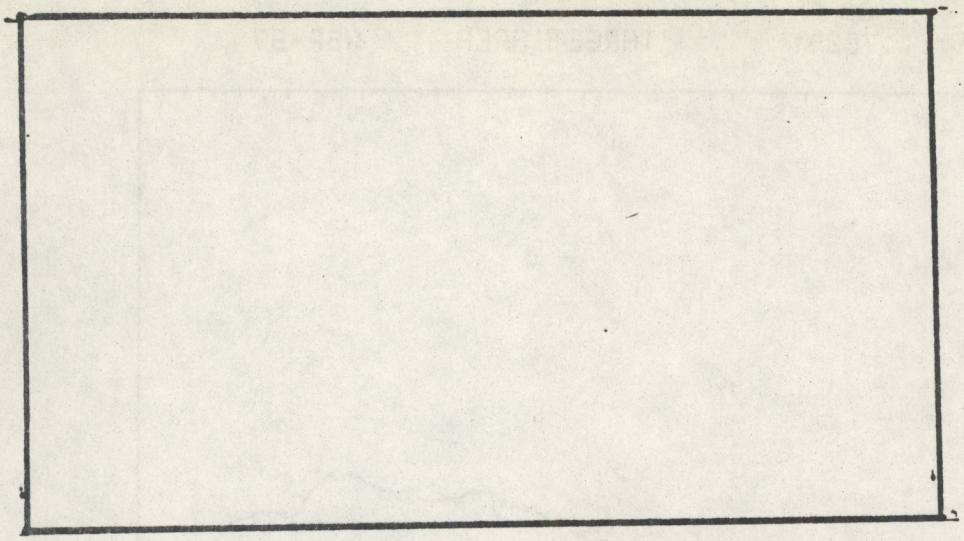

DATE....79240
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

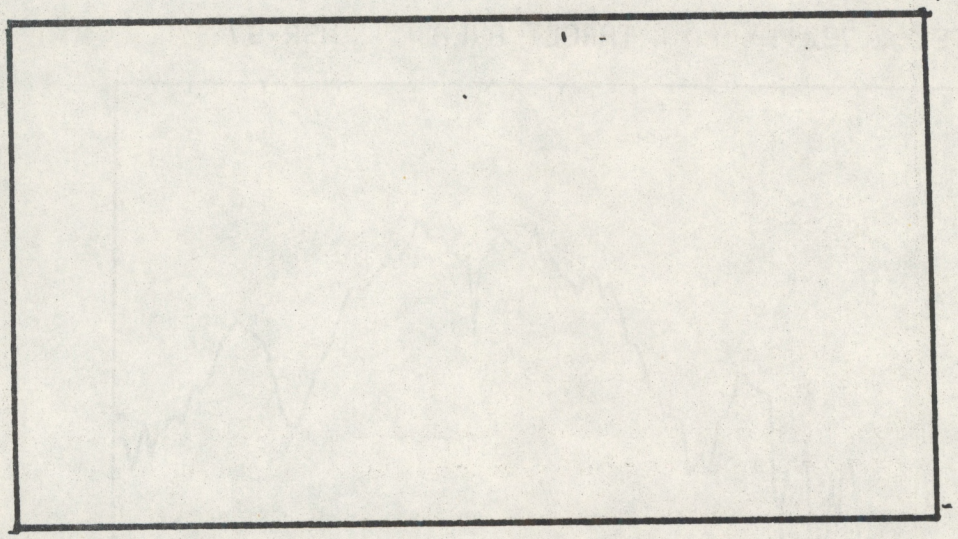

DATE....79240
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE....79241
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE....79241
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE....79241
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
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16
17
18
19
20
TIME(EST)





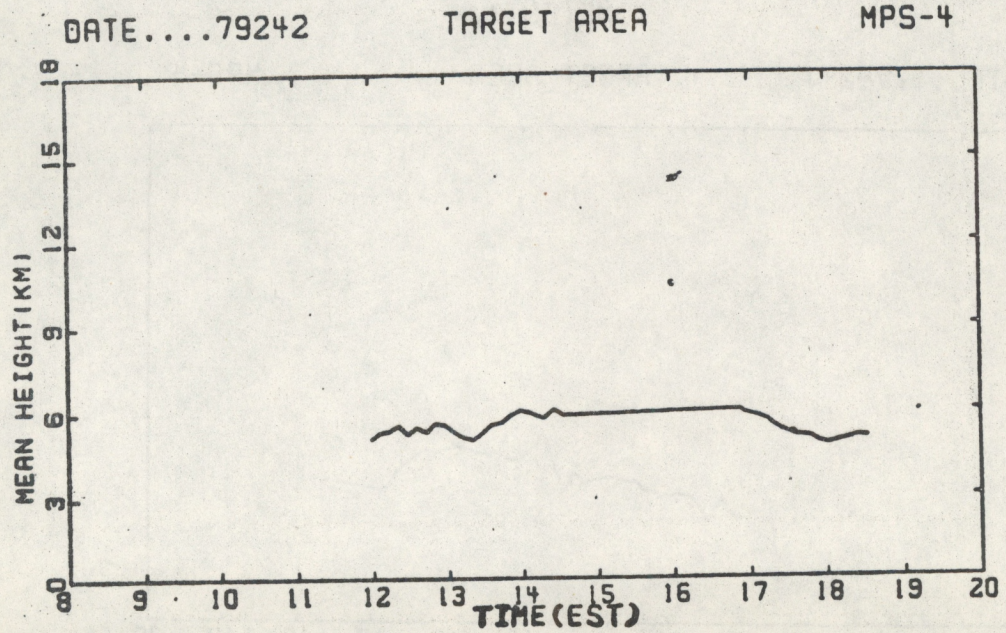
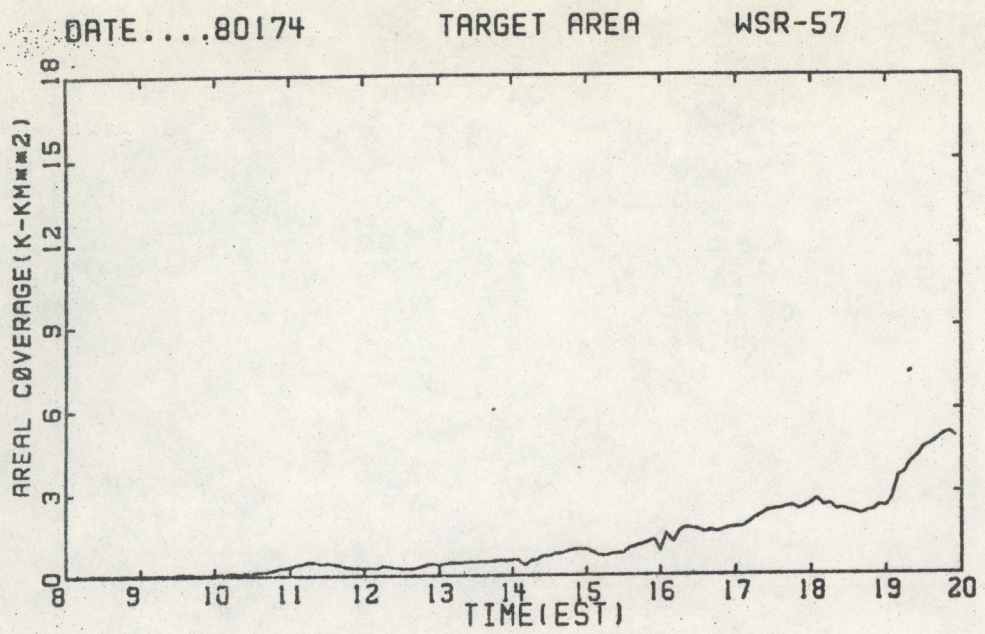
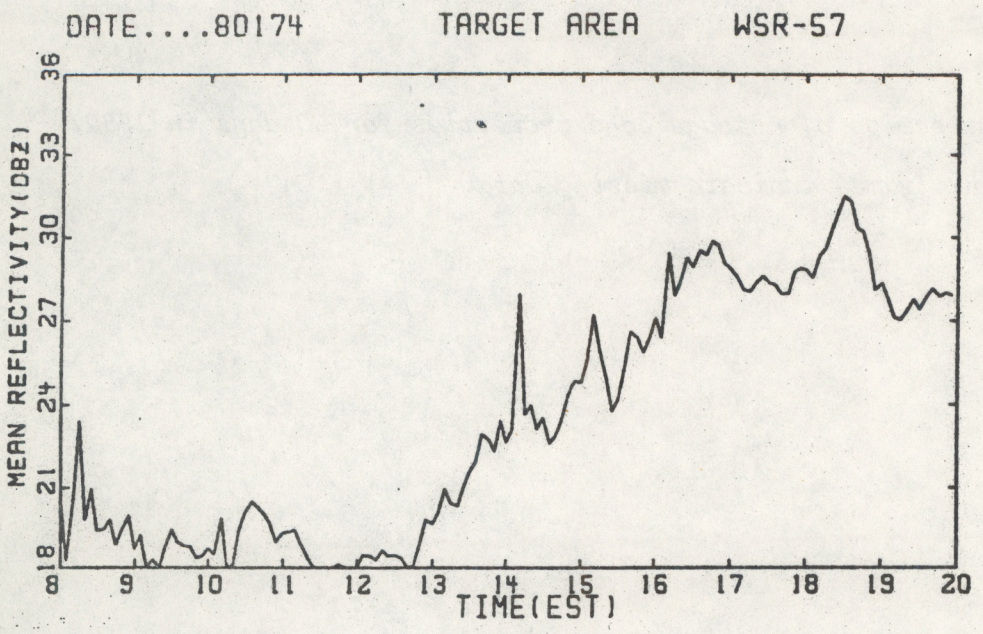
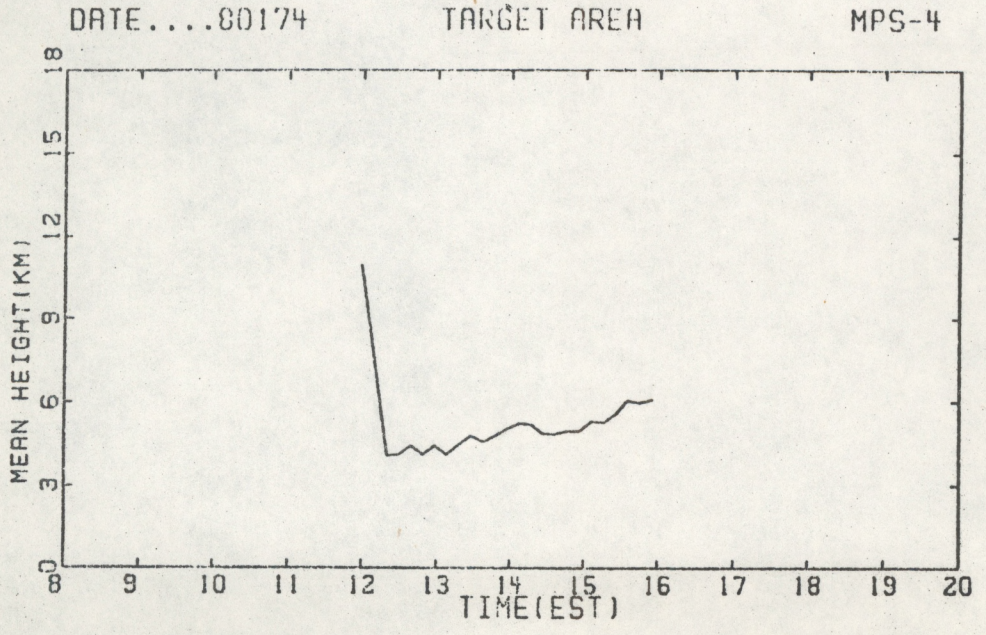
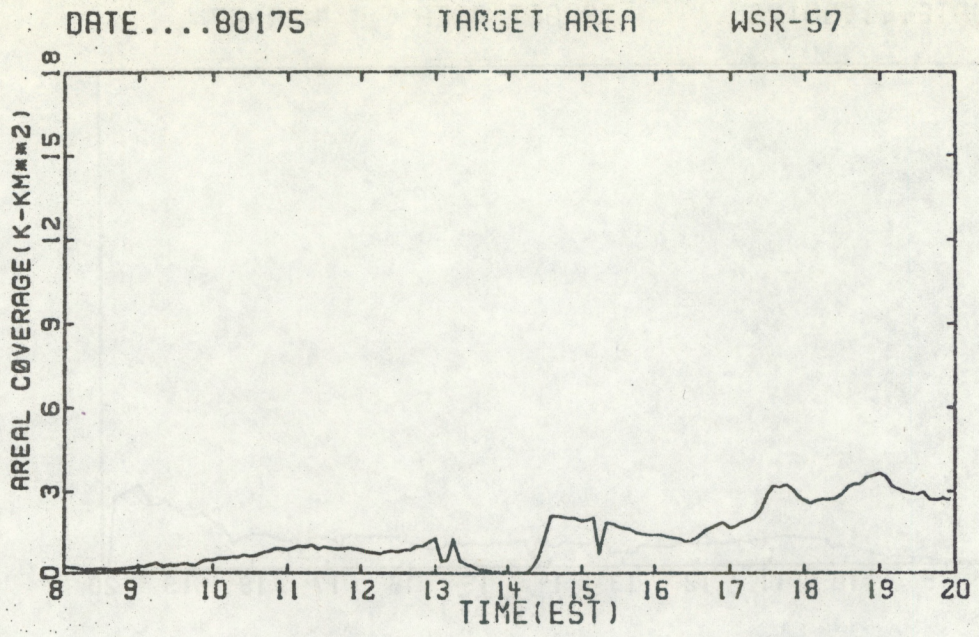

DATE....79242
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

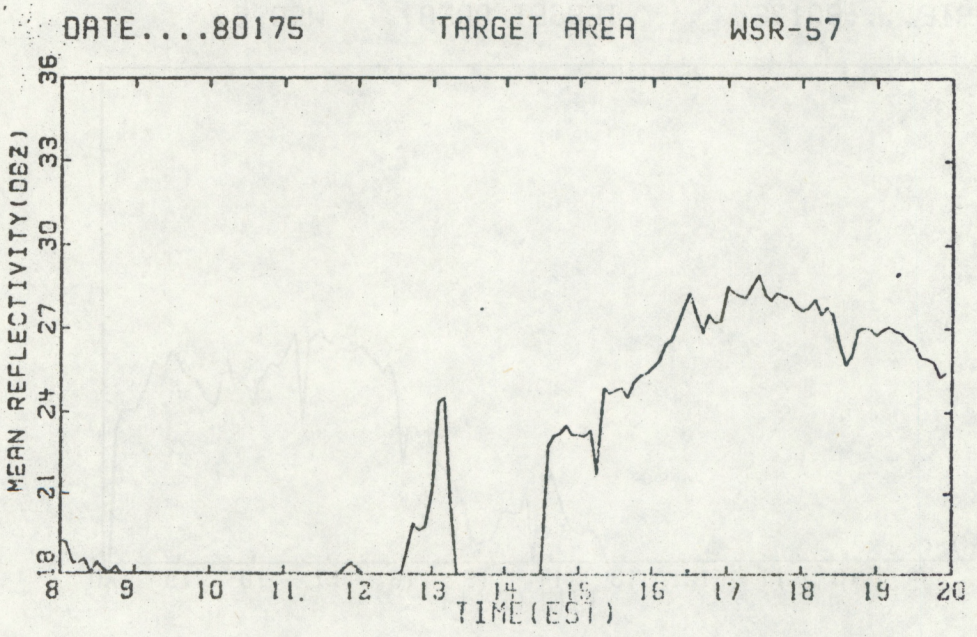
*Fig. 6. Time series of average echo properties for 60 days in 1980. Blank frames indicate missing data.*

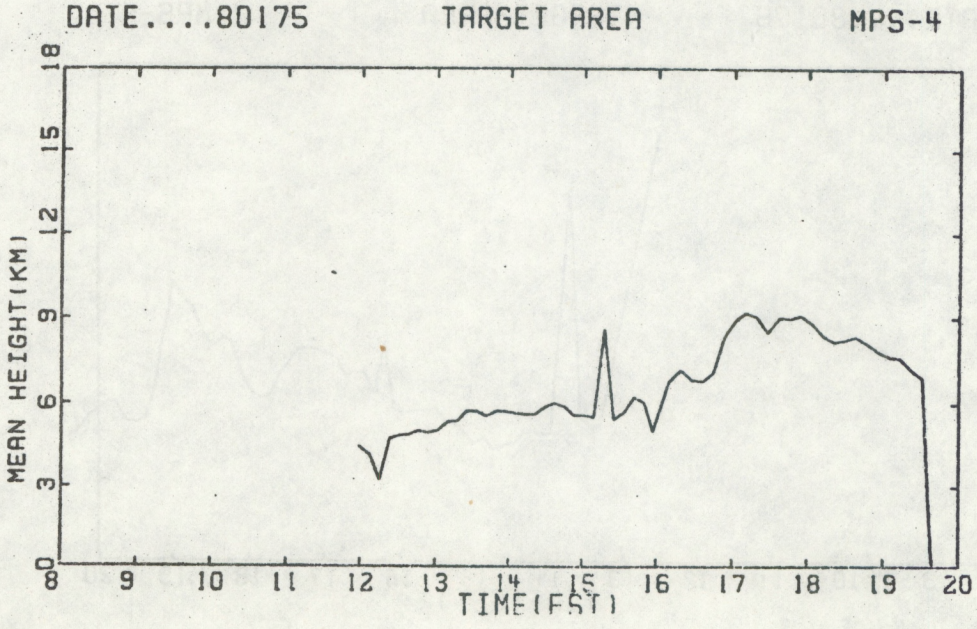

DATE....80174
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

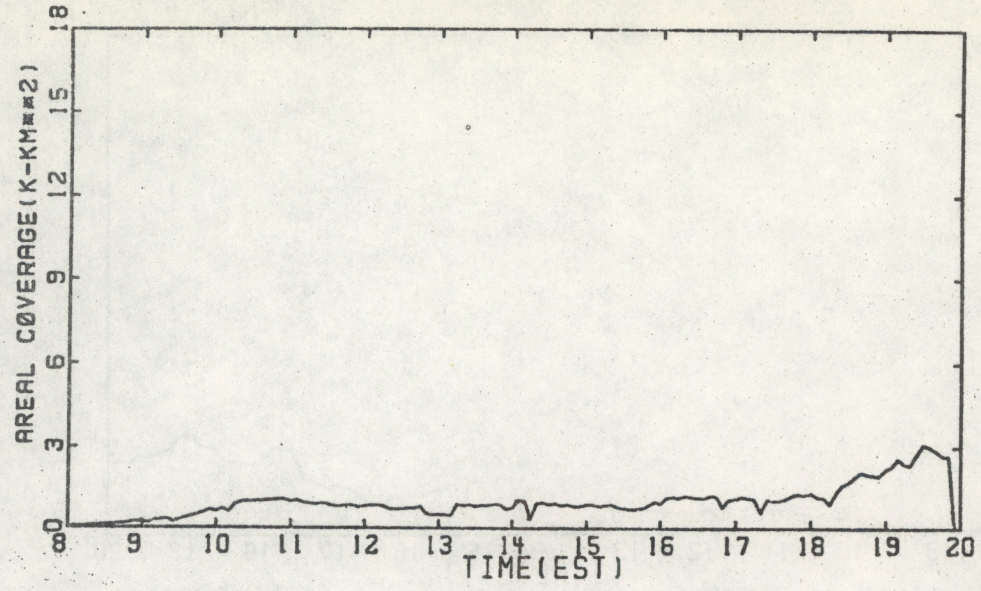

DATE....80174
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

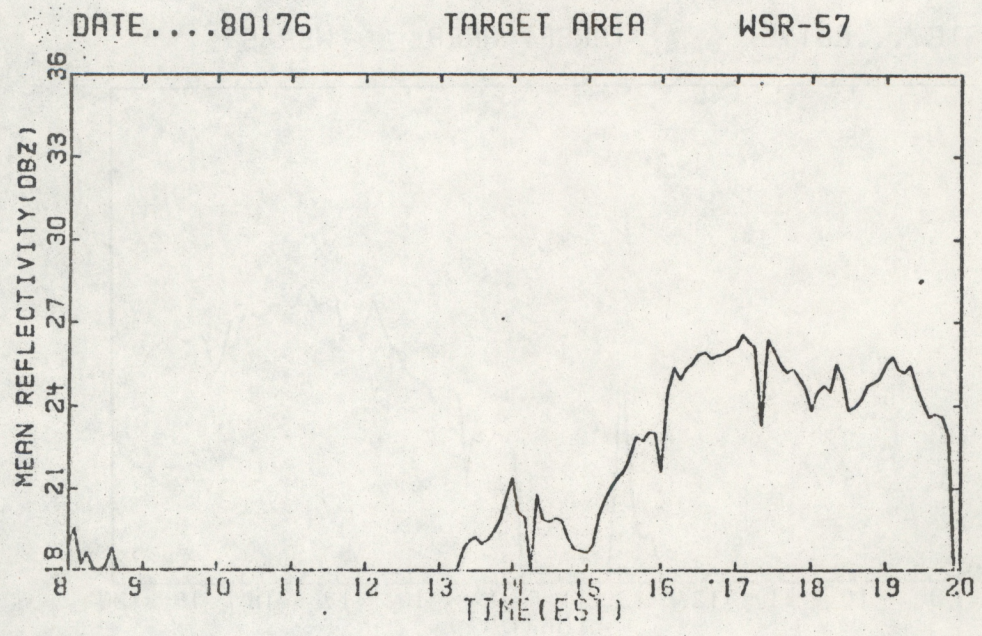

DATE....80174
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

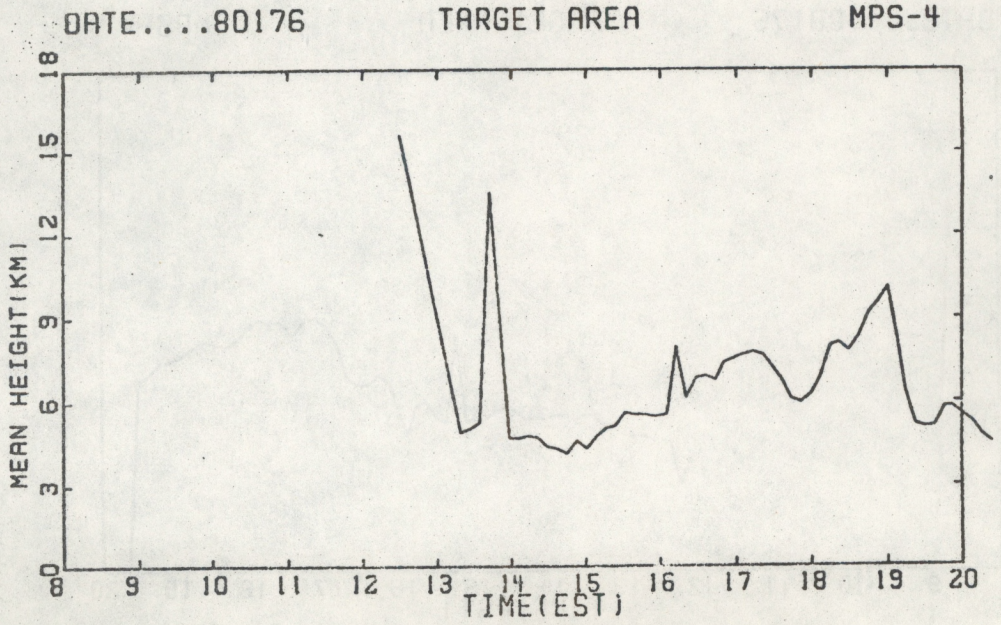

DATE....80175 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

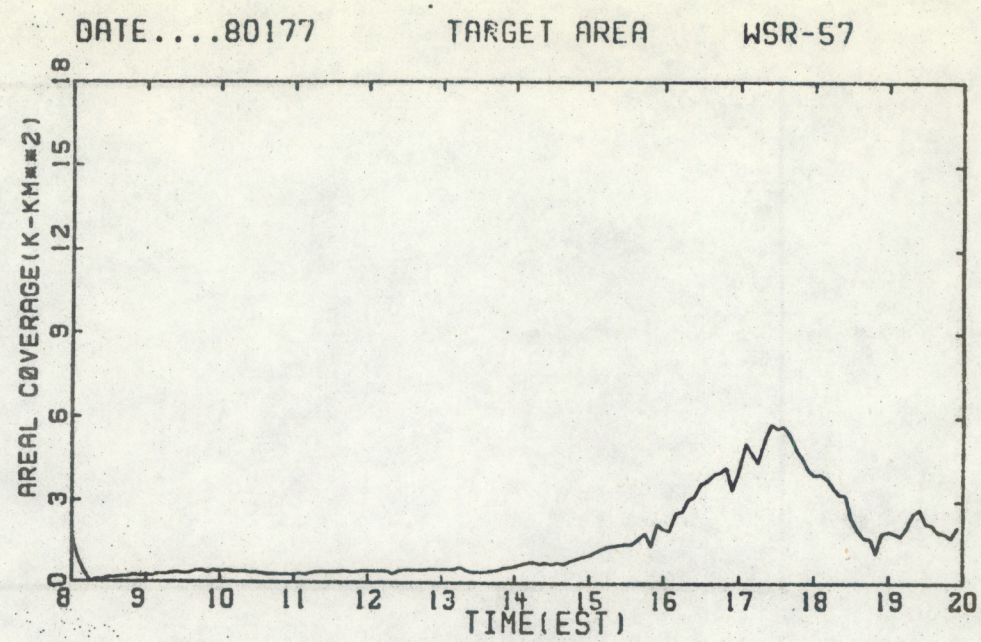

DATE....80175 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

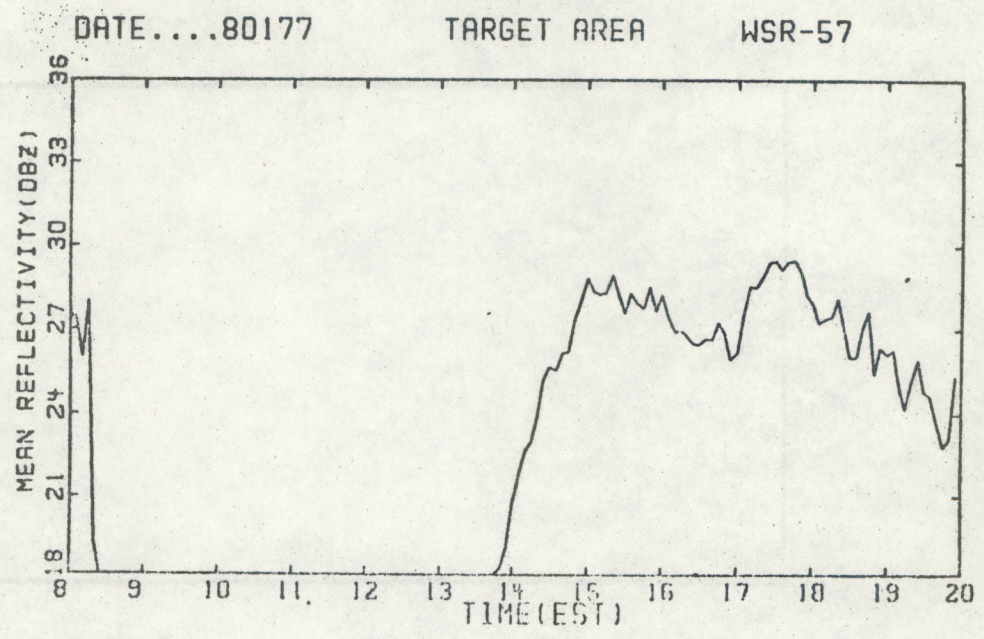

DATE....80175 TARGET AREA MPS-4
MEAN HEIGHT(KM)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

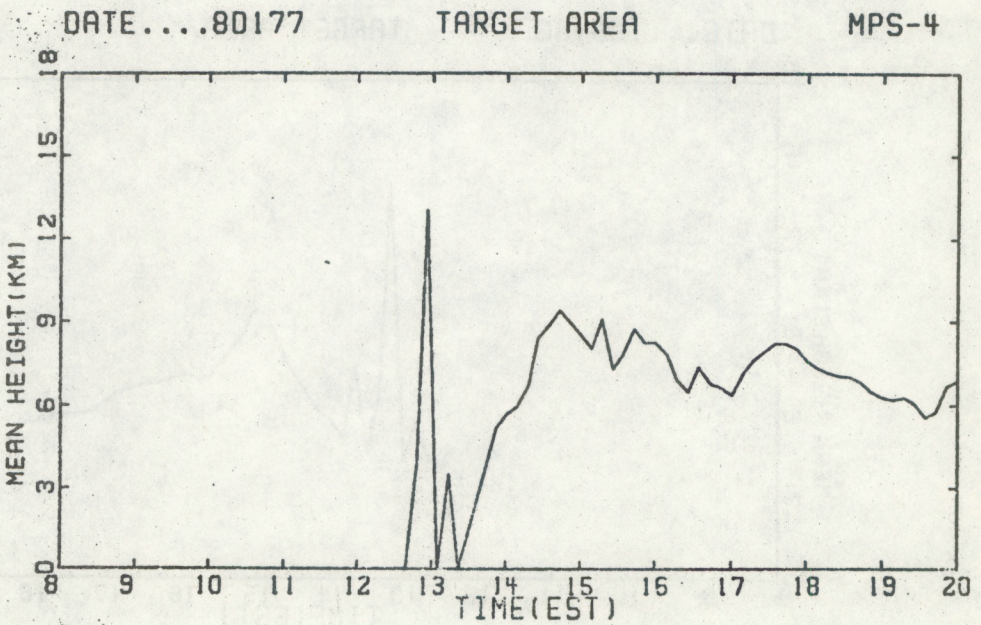

DATE....80176 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

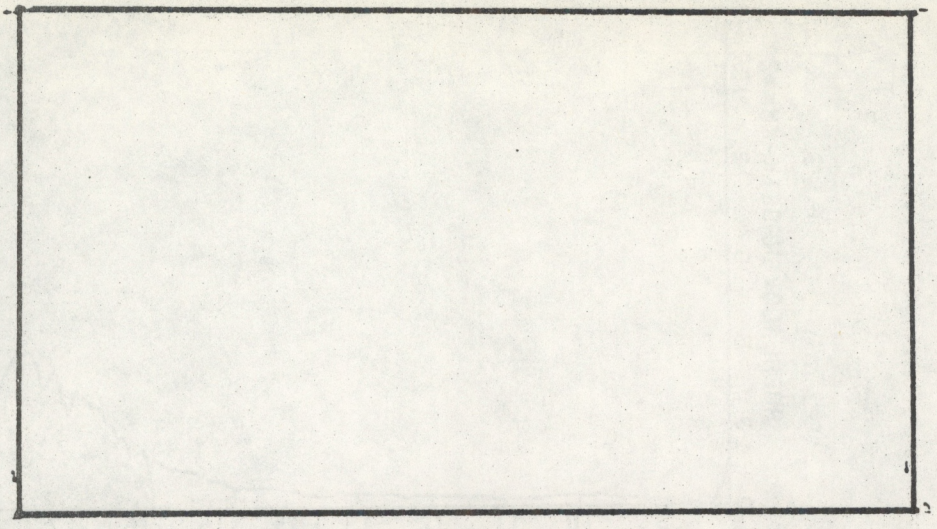

DATE....80176 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

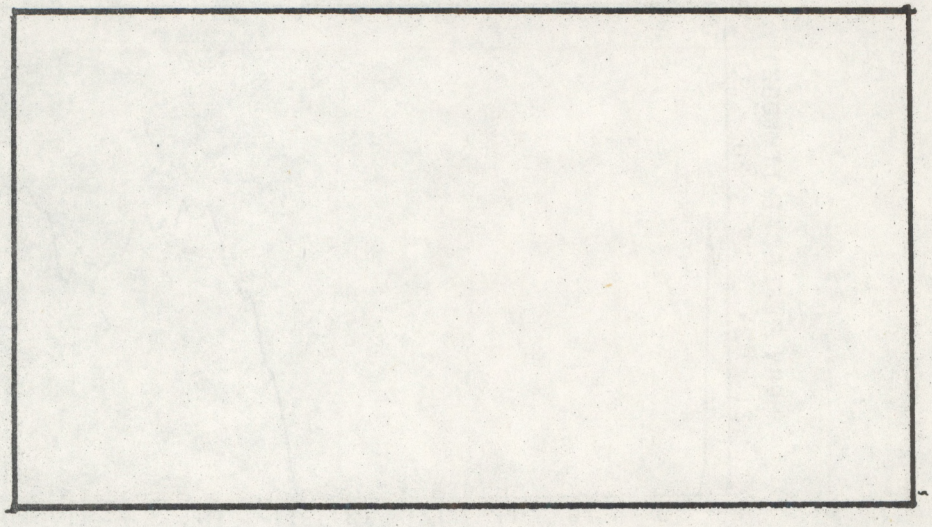

DATE....80176 TARGET AREA MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

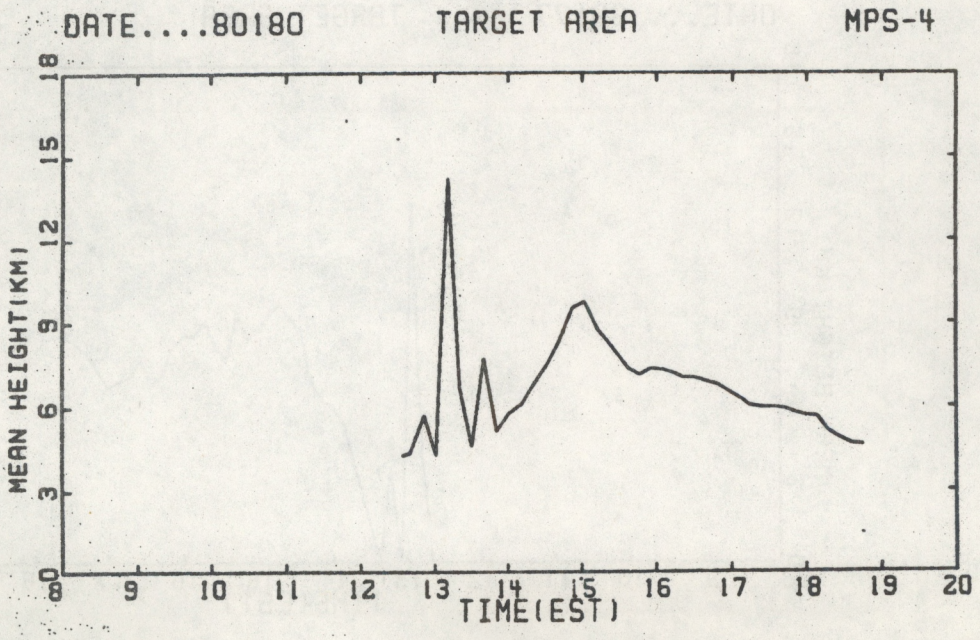

DATE....80177
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

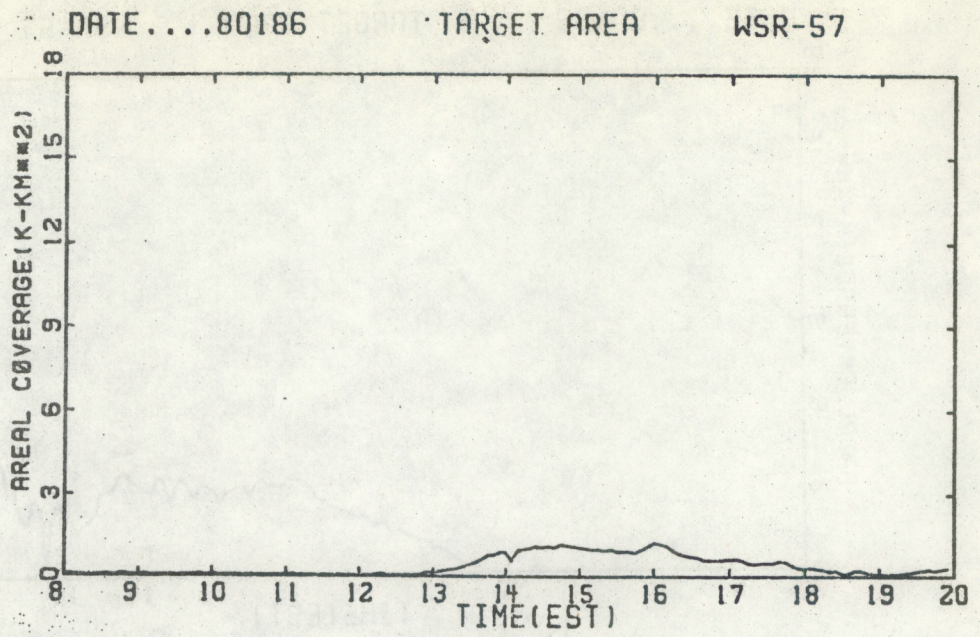

DATE....80177
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
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36
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10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

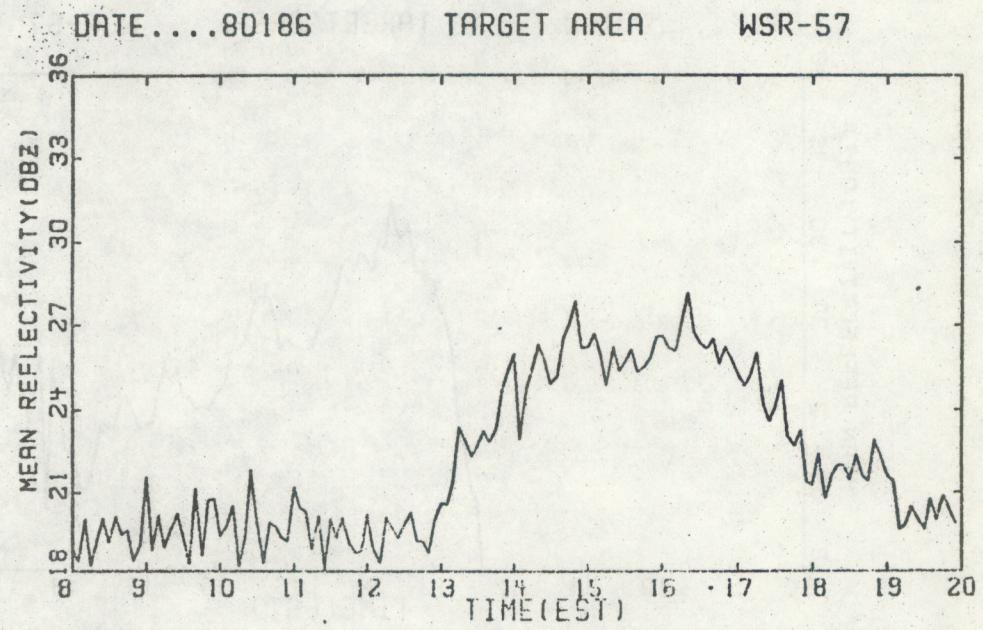

DATE....80177
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
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13
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16
17
18
19
20
TIME(EST)

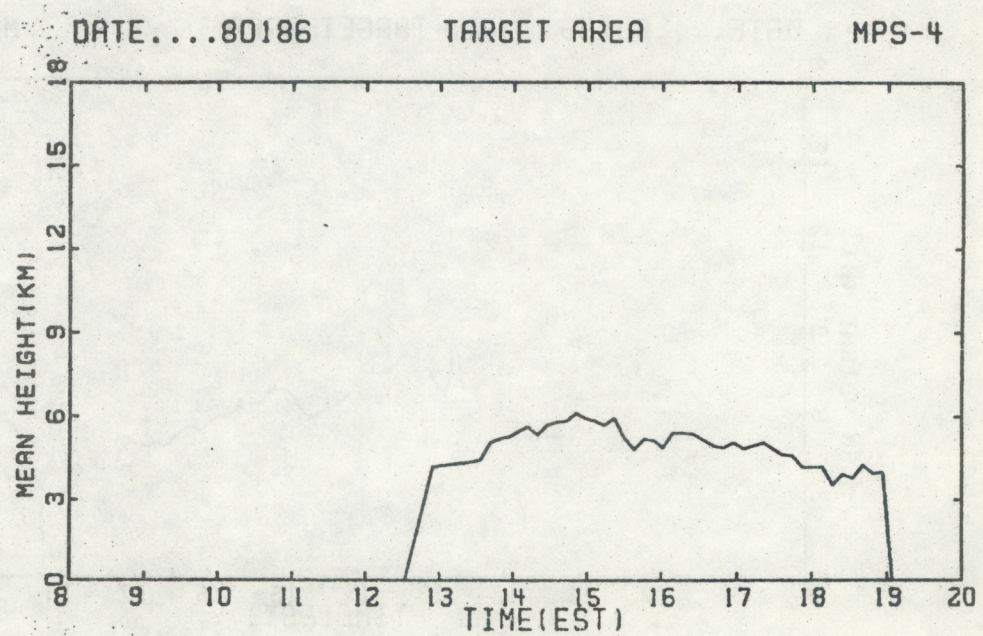


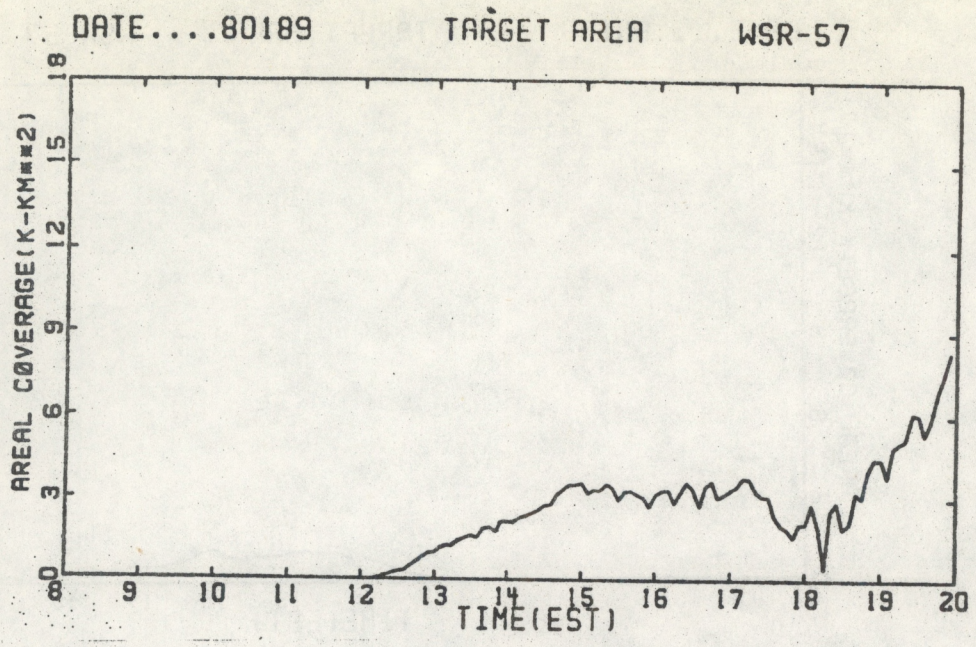


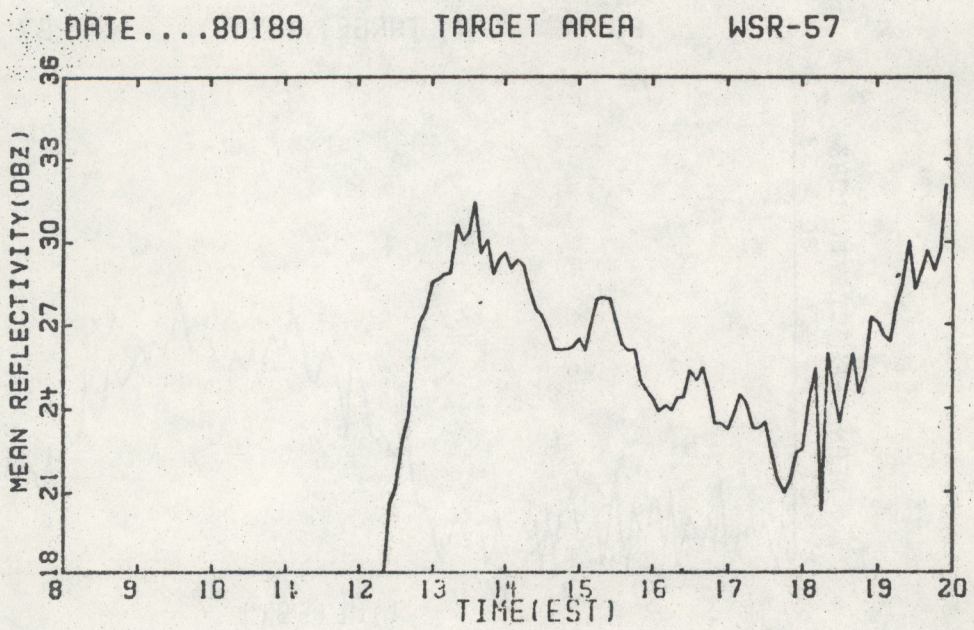

DATE....80180
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
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11
12
13
14
15
16
17
18
19
20
TIME(EST)

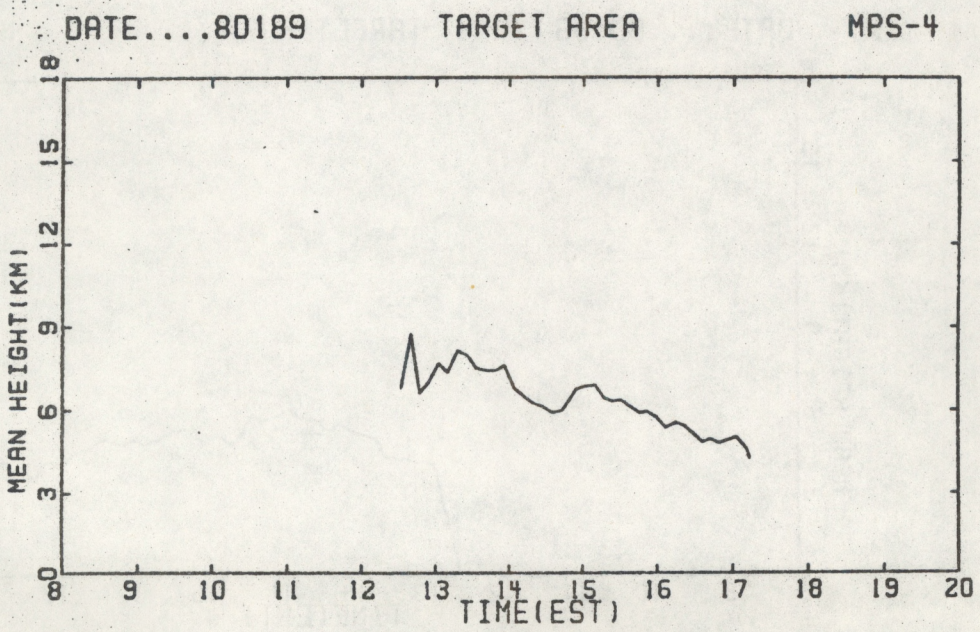

DATE....80186 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

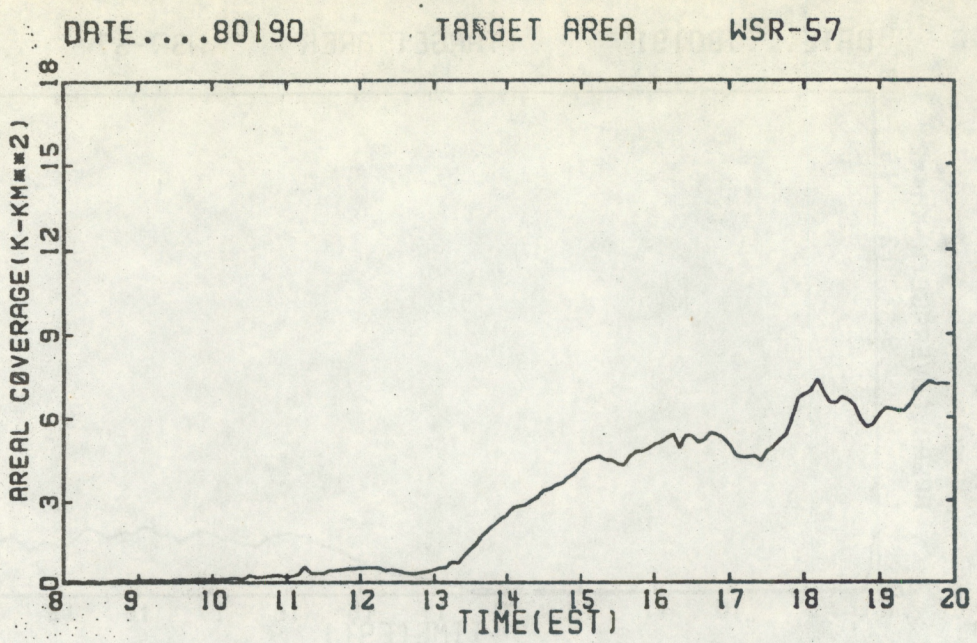

DATE....80186 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

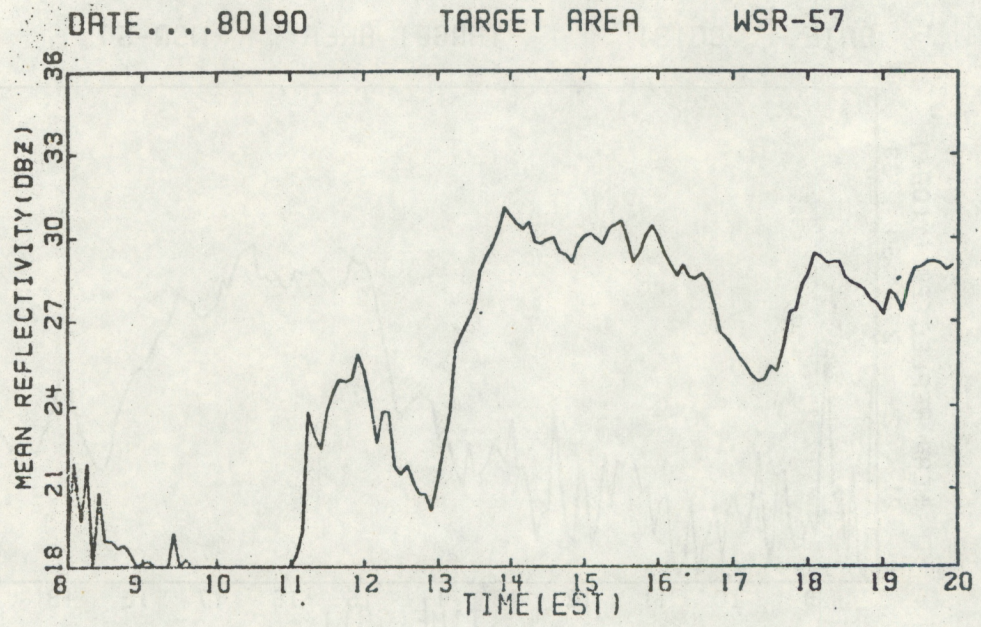

DATE....80186 TARGET AREA MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

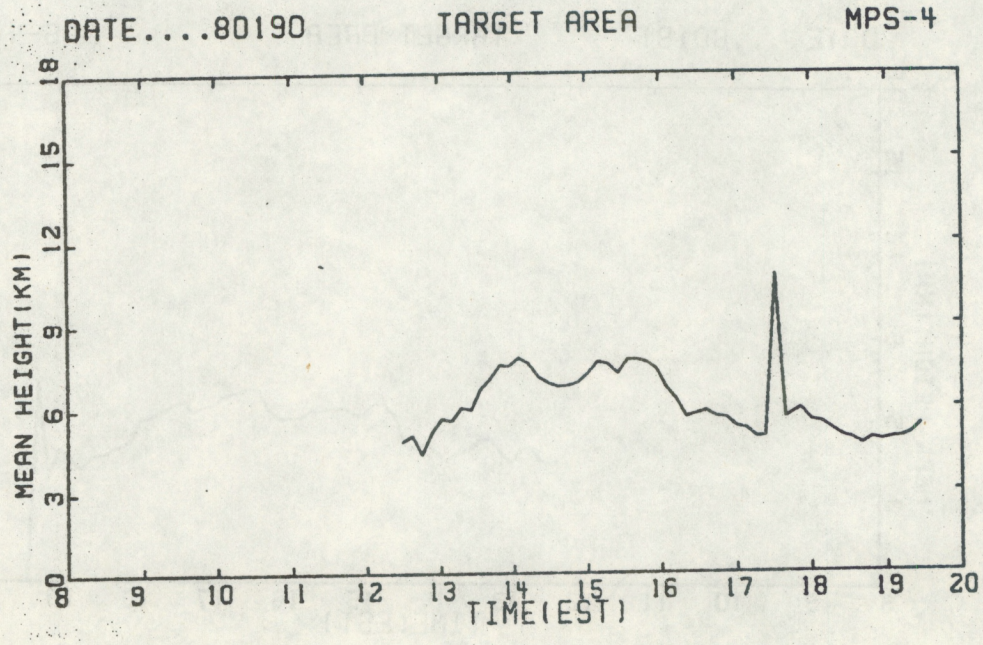

DATE....80189
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

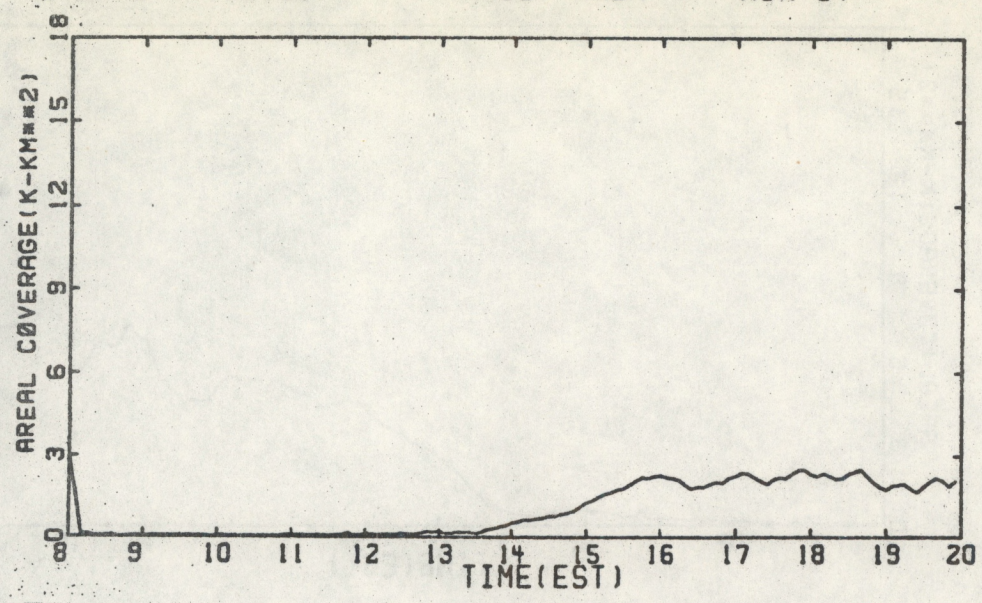

DATE....80189
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
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11
12
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15
16
17
18
19
20
TIME(EST)

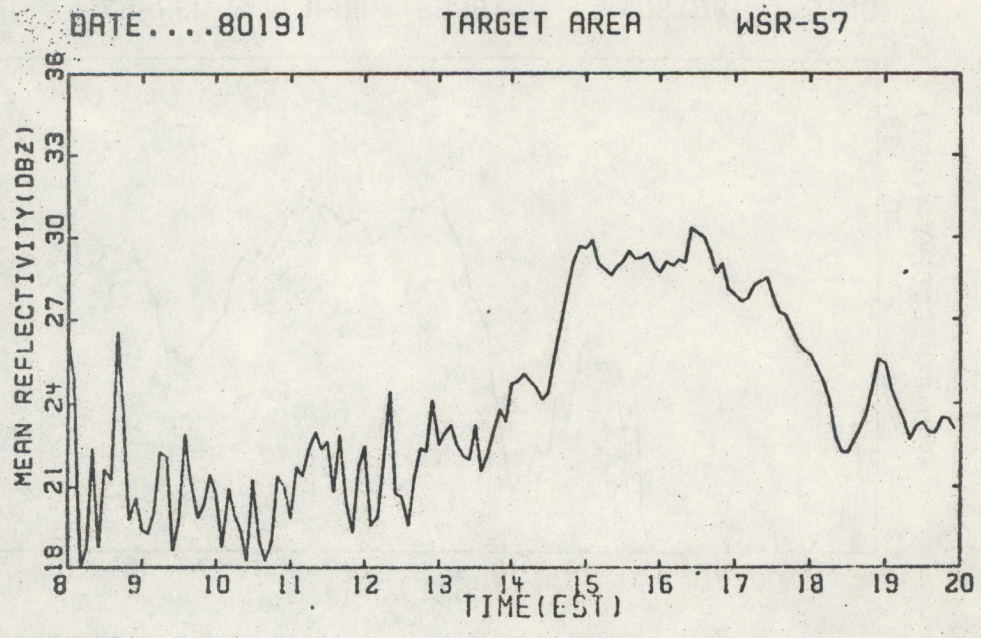

DATE....80189
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

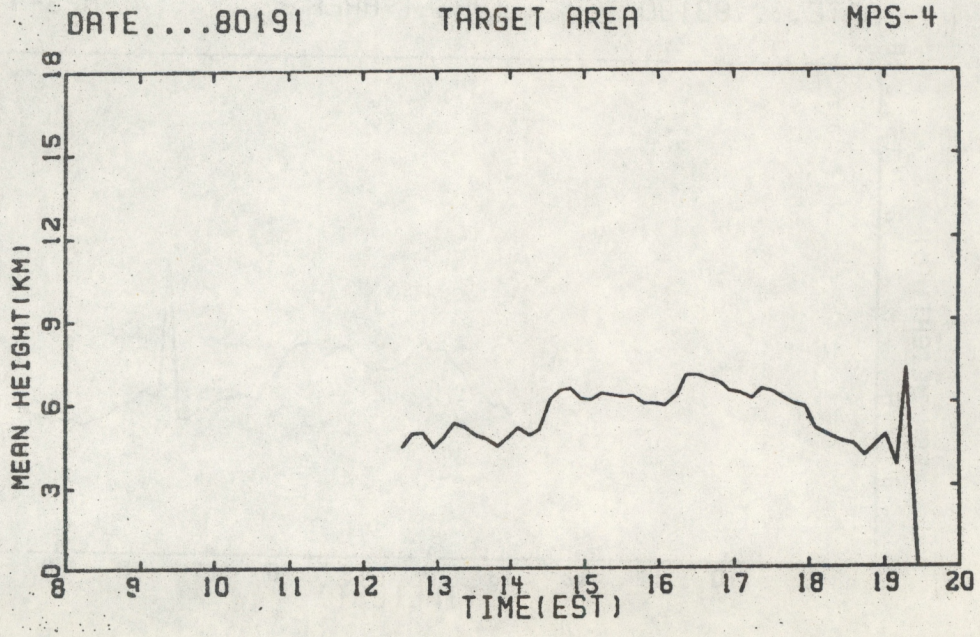

DATE....80190
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
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18
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18
19
20
TIME(EST)

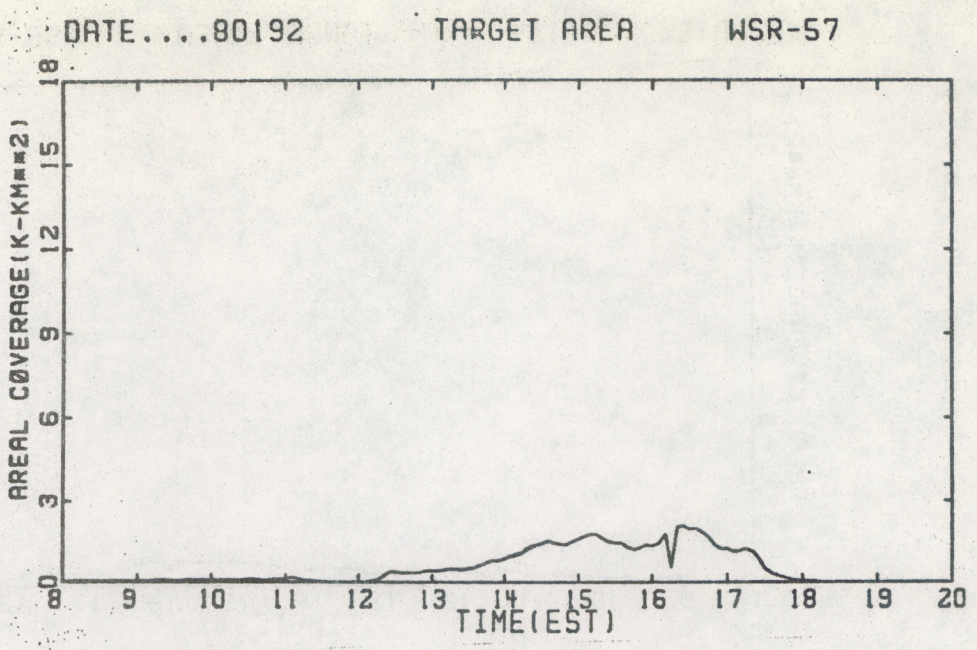

DATE....80190
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
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36
8
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18
19
20
TIME(EST)

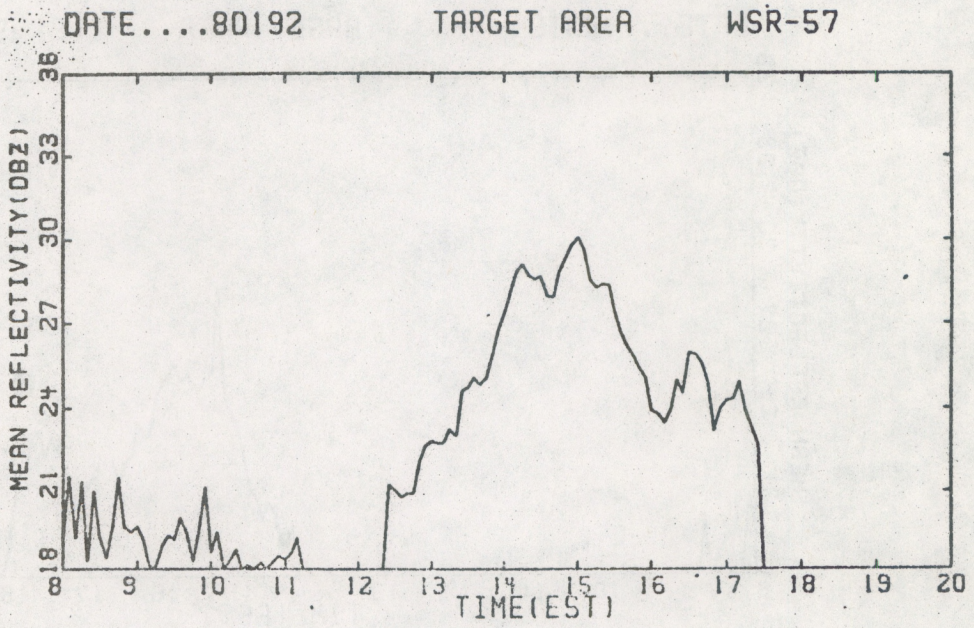

DATE....80190
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
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17
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19
20
TIME(EST)

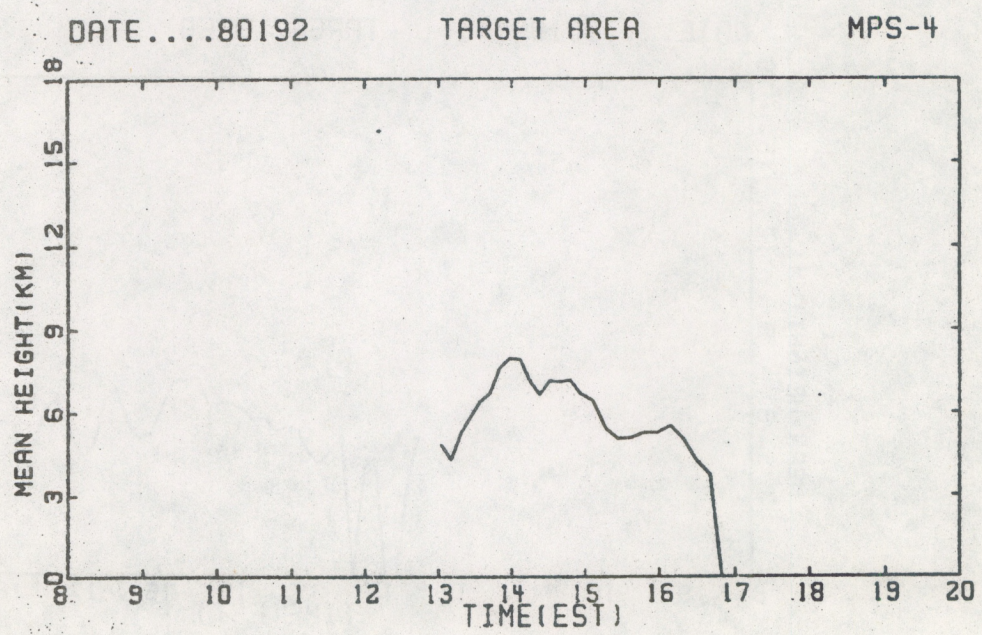

DATE....80191 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

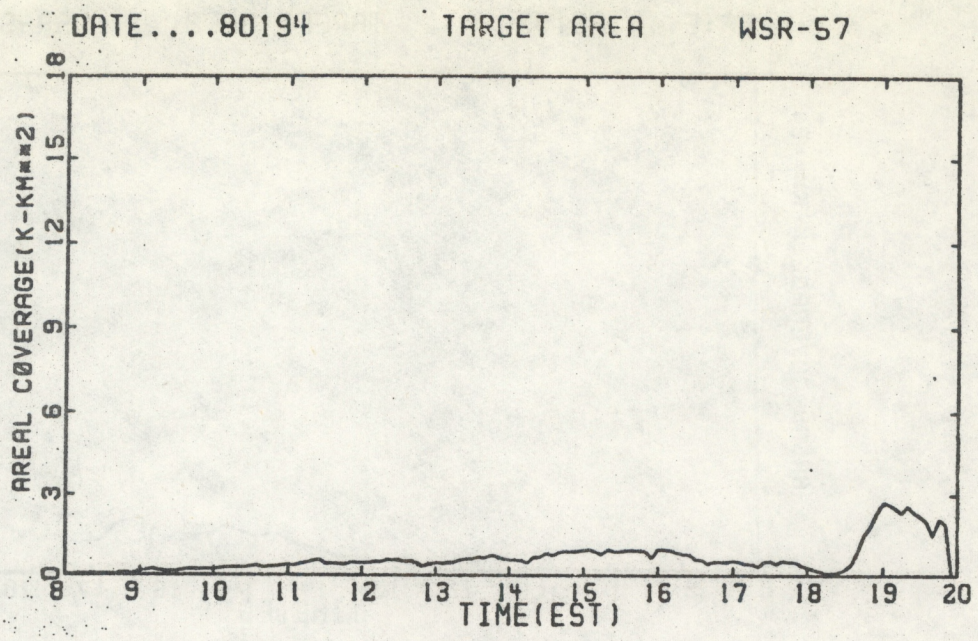

DATE....80191 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

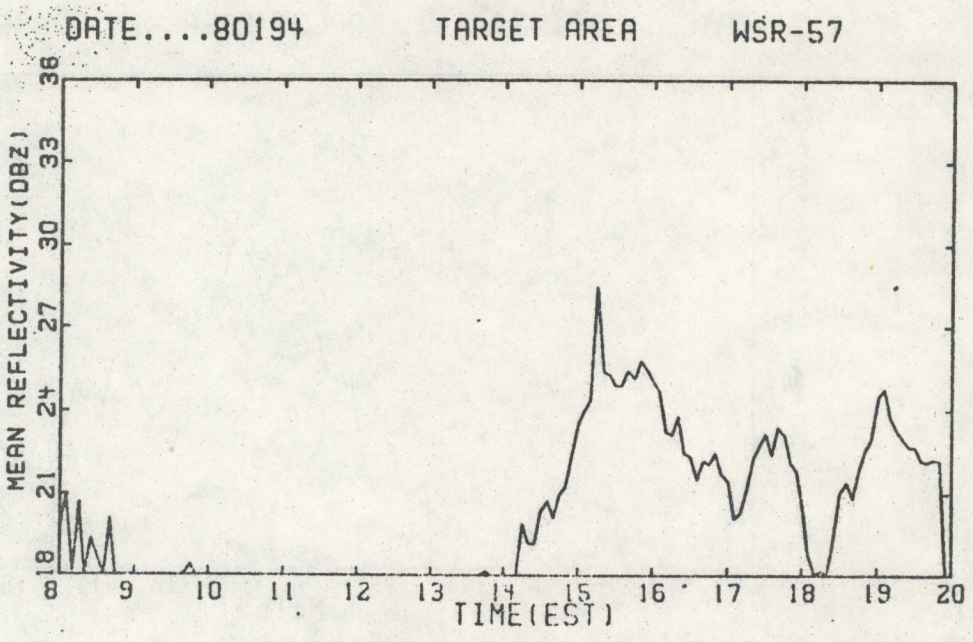

DATE....80191 TARGET AREA MPS-4
MEAN HEIGHT(KM)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

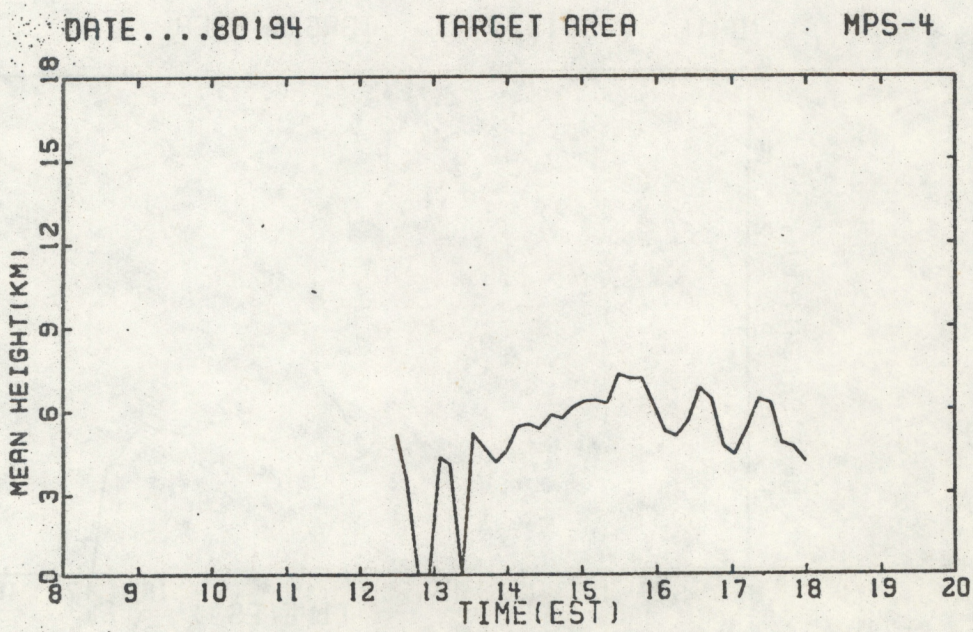

DATE....80192 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

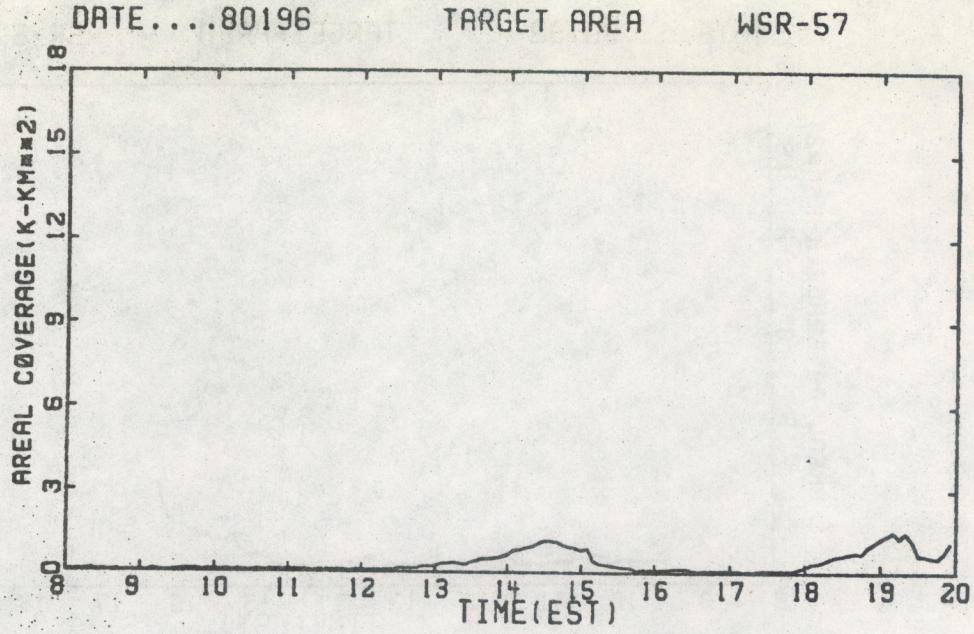

DATE....80192 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

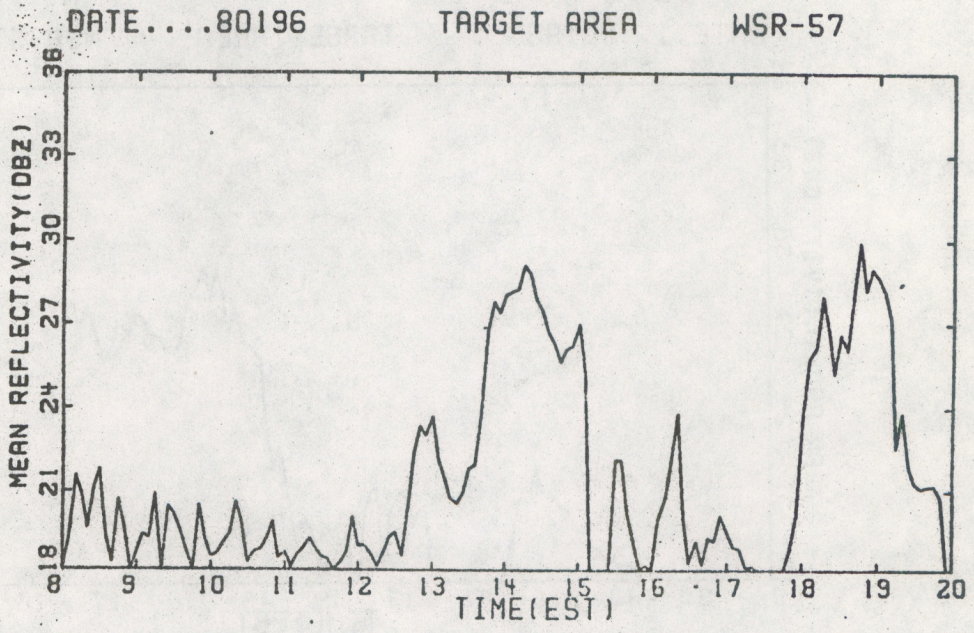

DATE....80192 TARGET AREA MPS-4
MEAN HEIGHT(KM)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

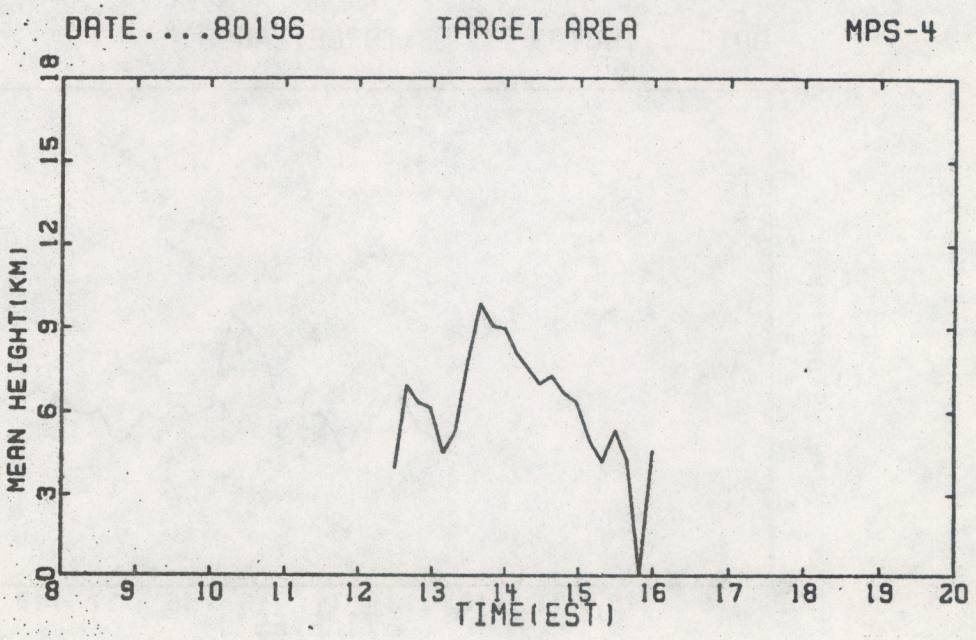

DATE....80194
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
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19
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TIME(EST)

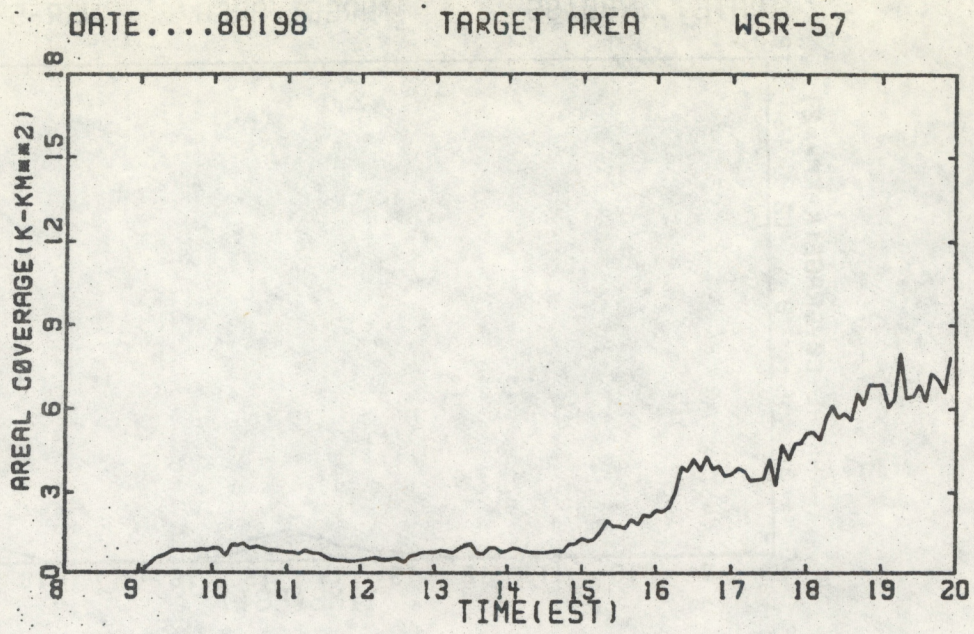

DATE....80194
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
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19
20
TIME(EST)

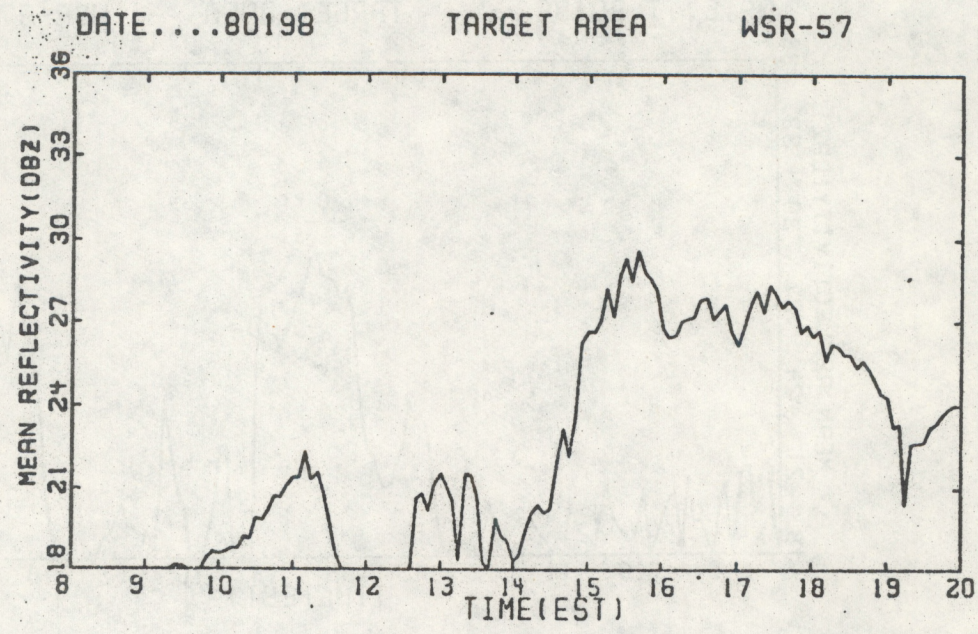

DATE....80194
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
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18
19
20
TIME(EST)

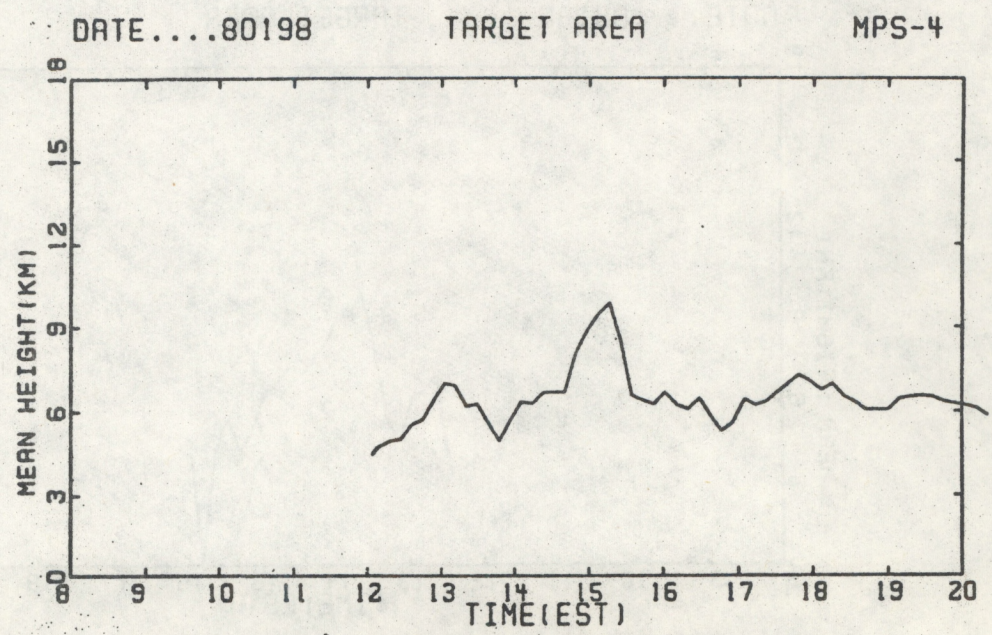

DATE....80196
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

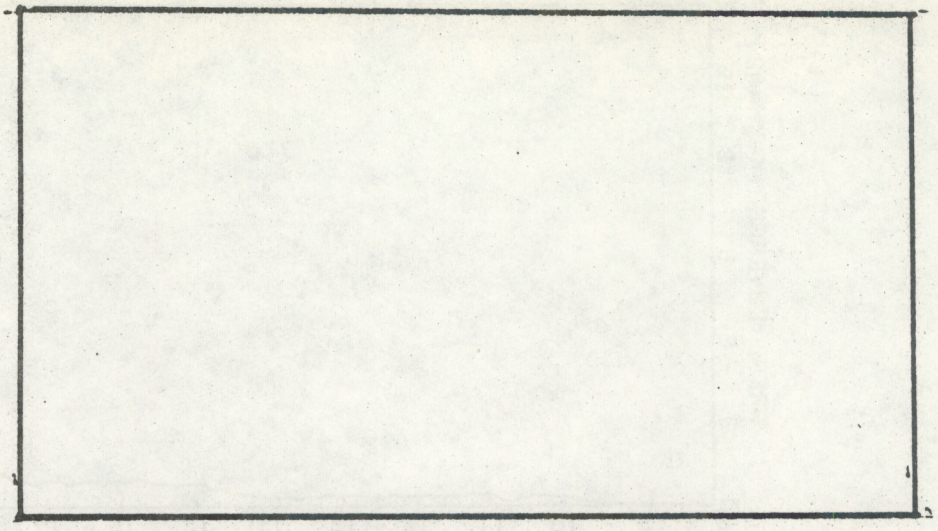

DATE....80196
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

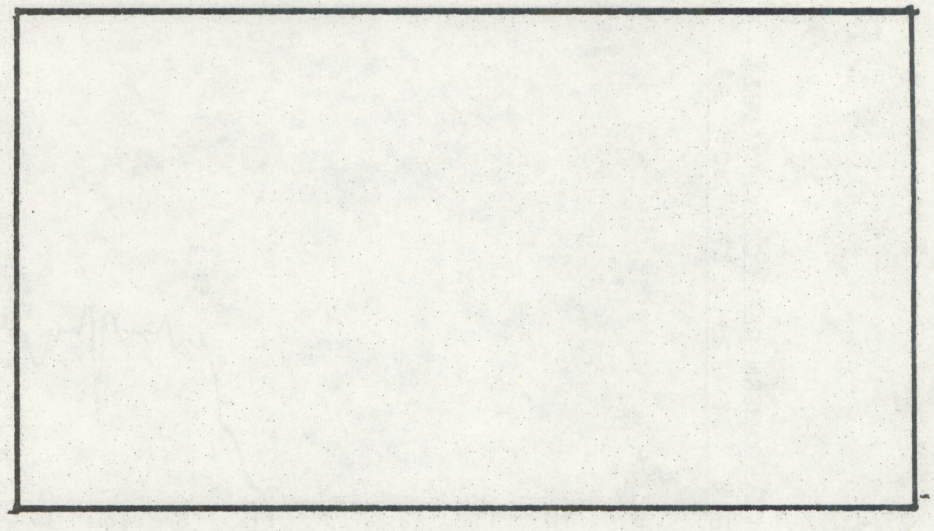

DATE....80196
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

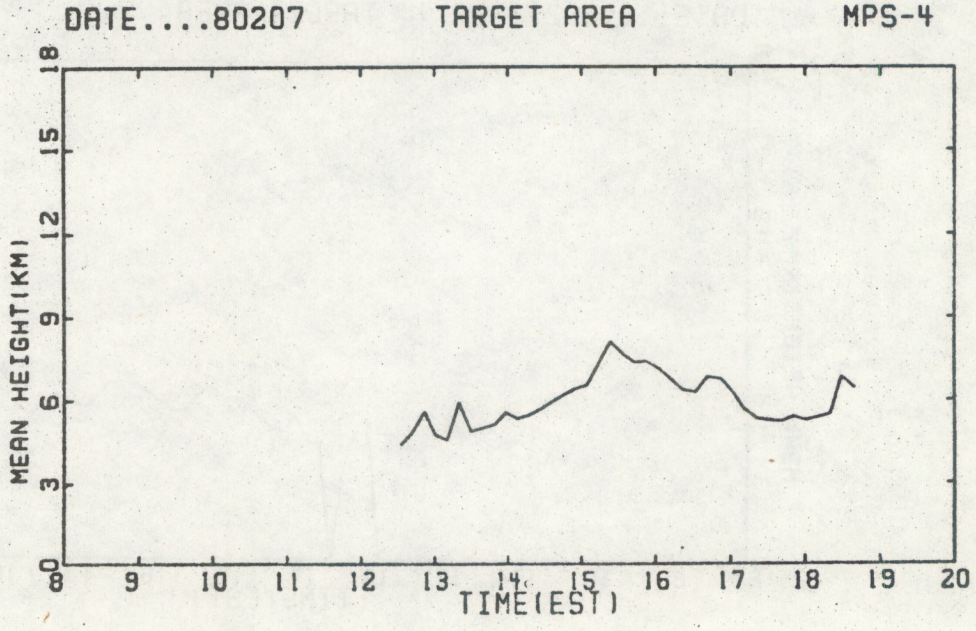

DATE....80198 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

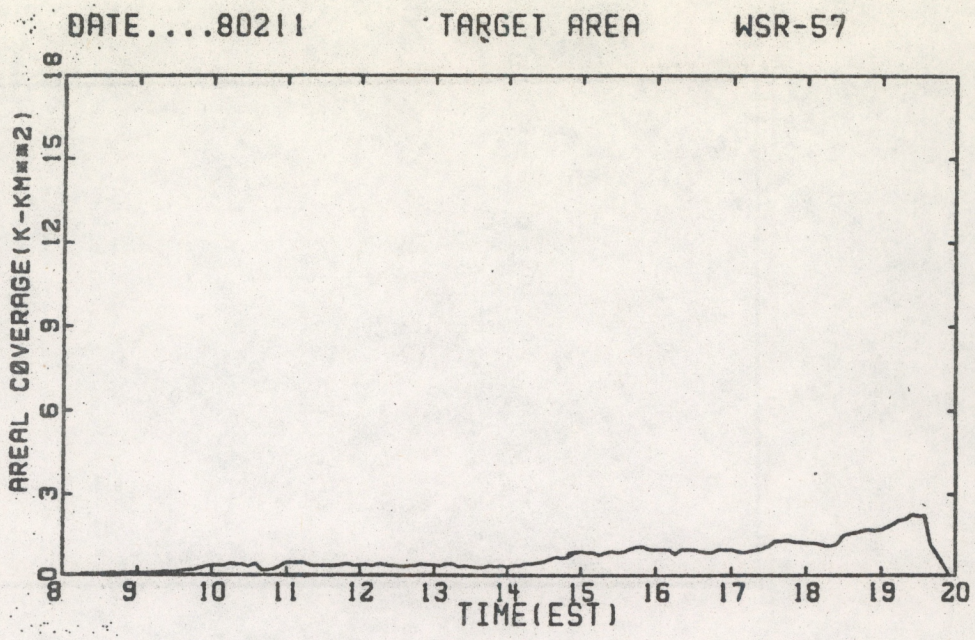

DATE....80198 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

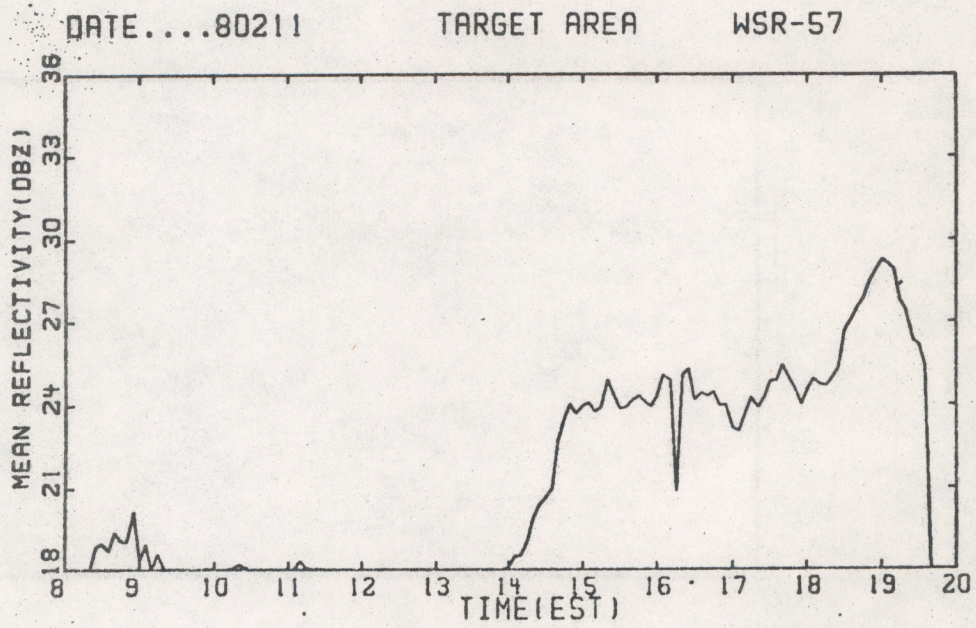

DATE....80198 TARGET AREA MPS-4
MEAN HEIGHT(KM)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

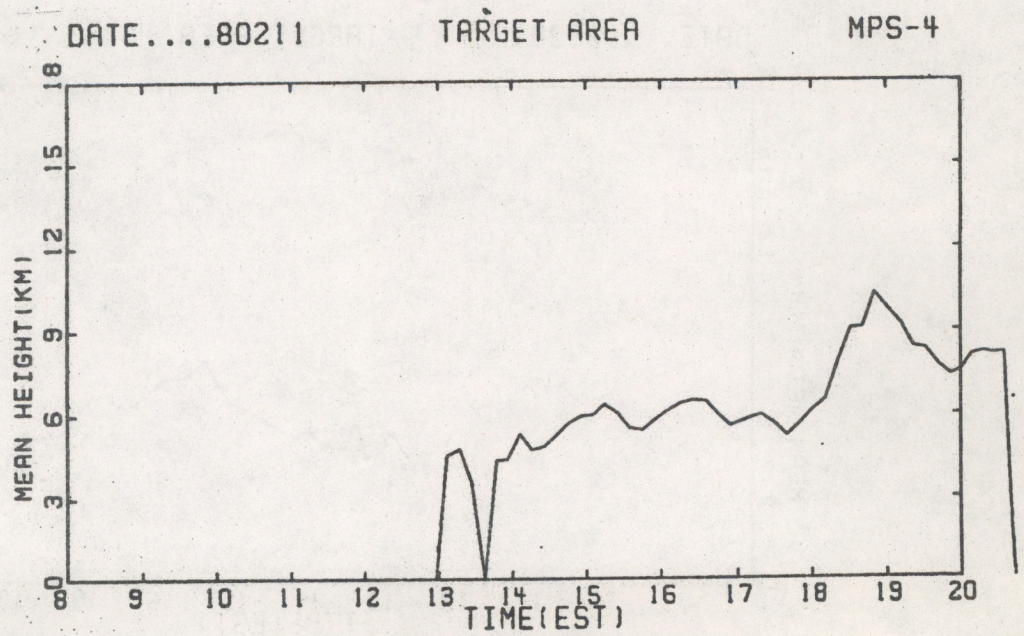


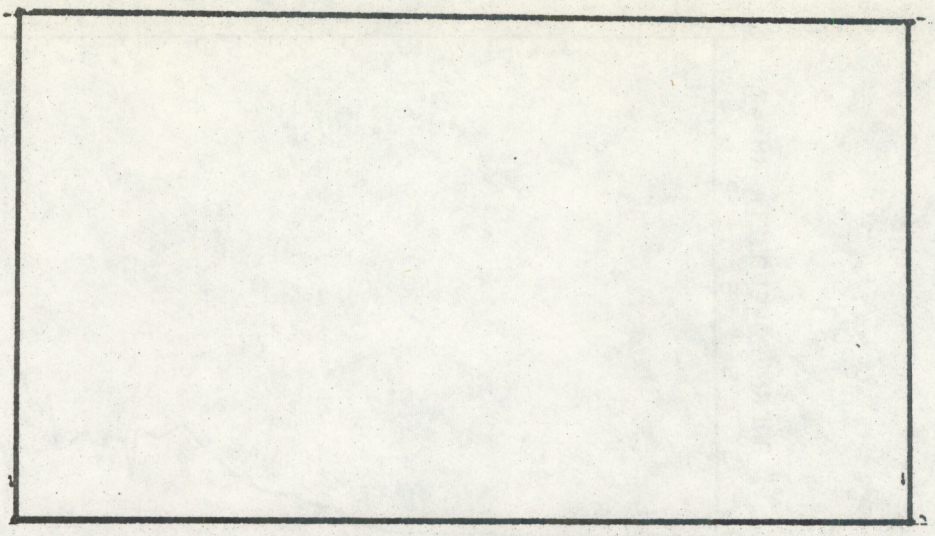


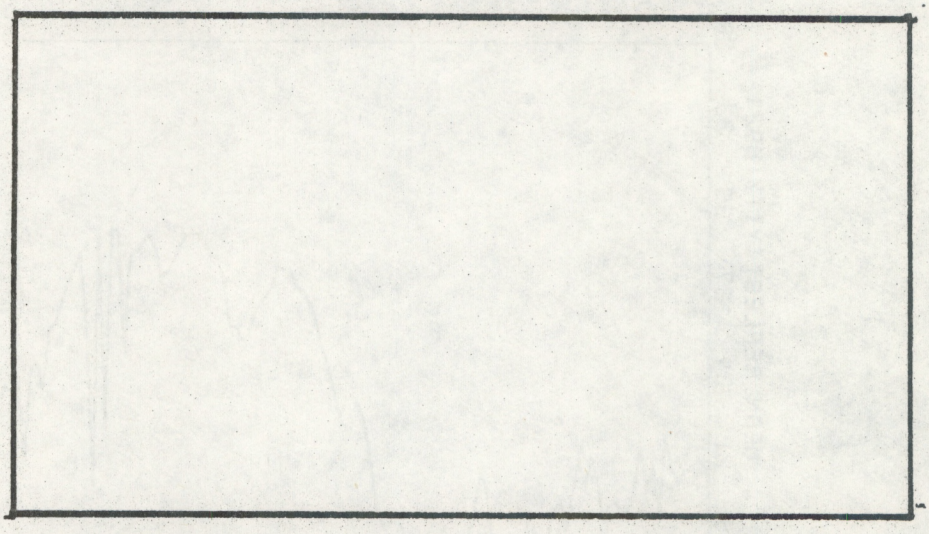

DATE....80207
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

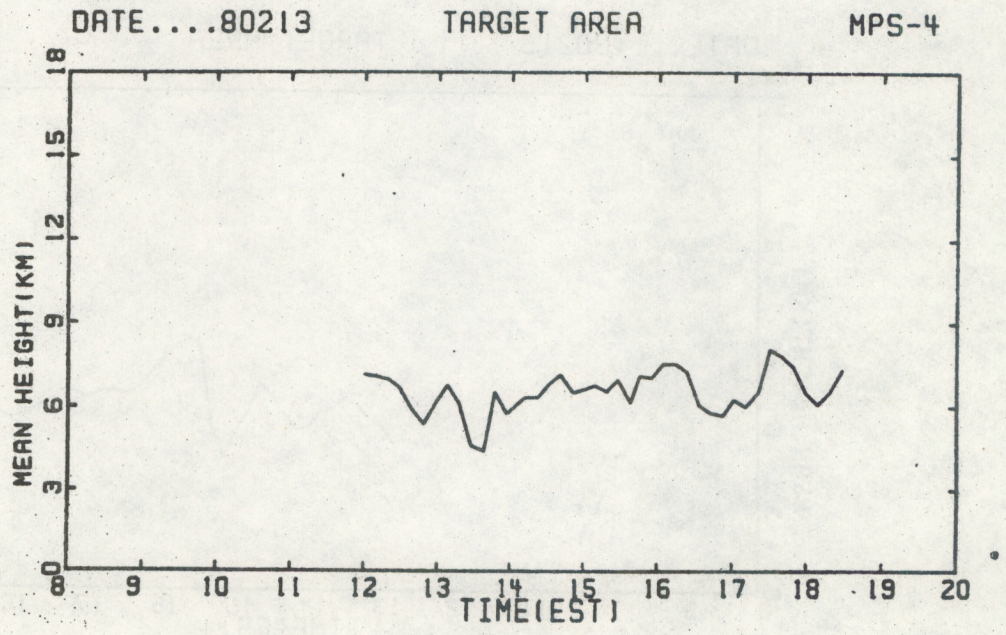

DATE....80211
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

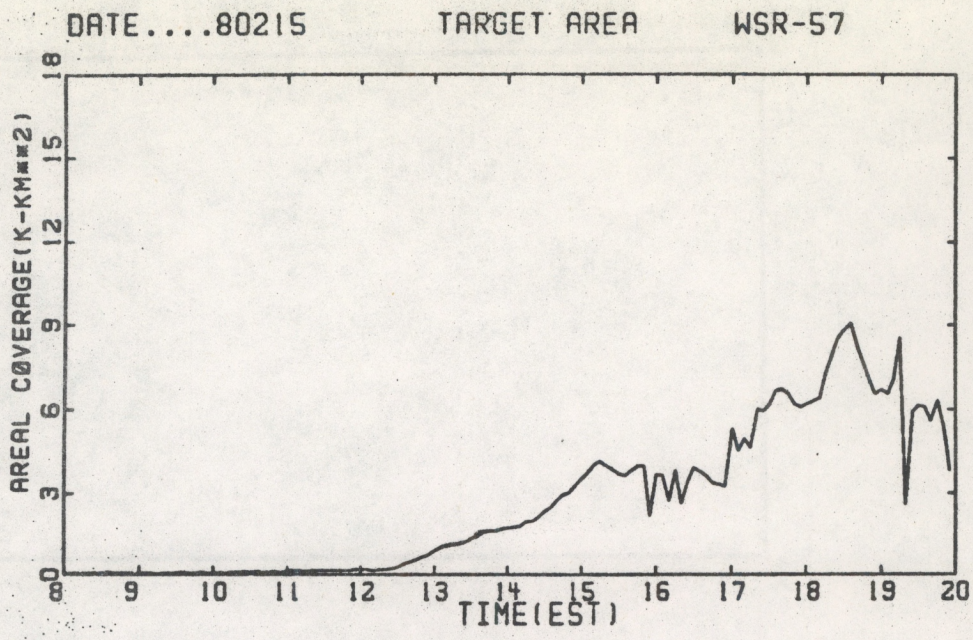

DATE....80211
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

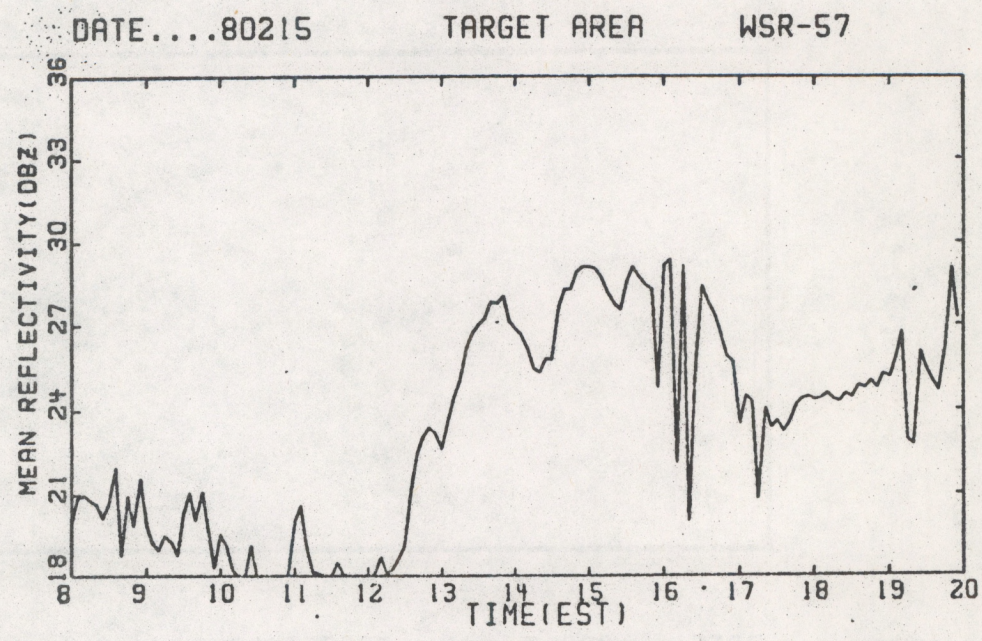

DATE....80211
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

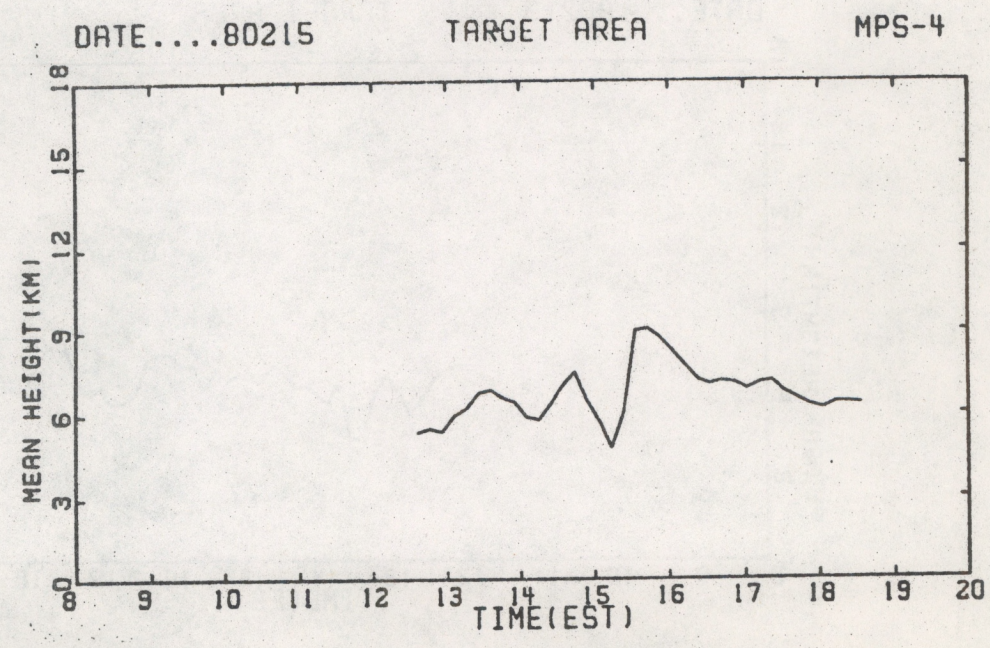


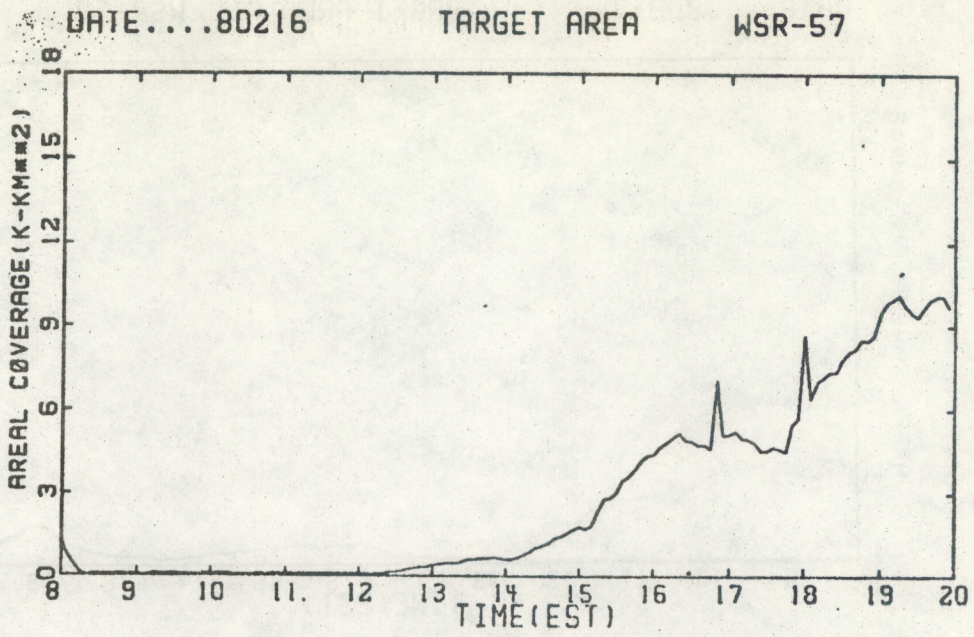


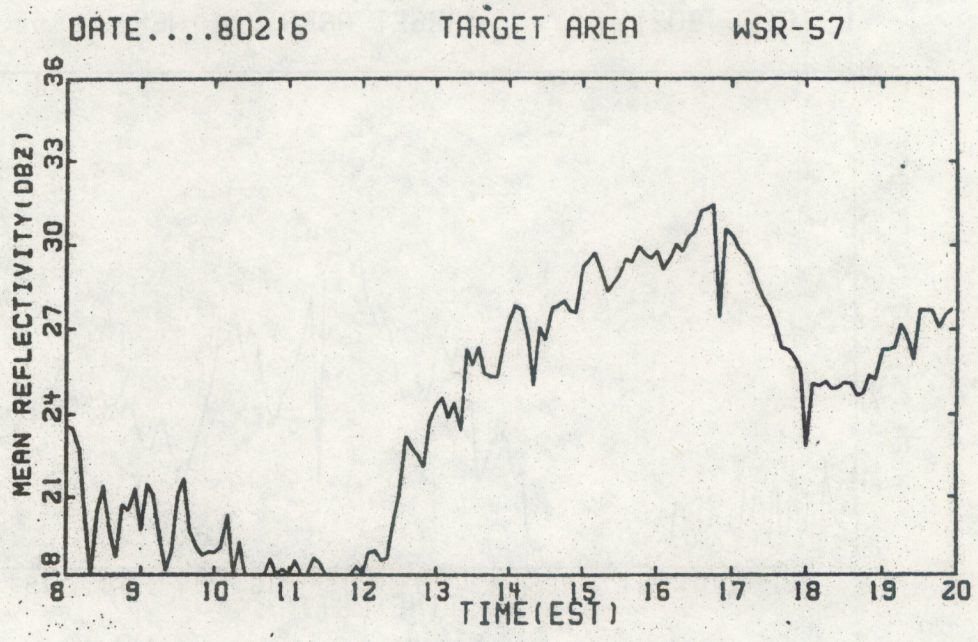

DATE....80213
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

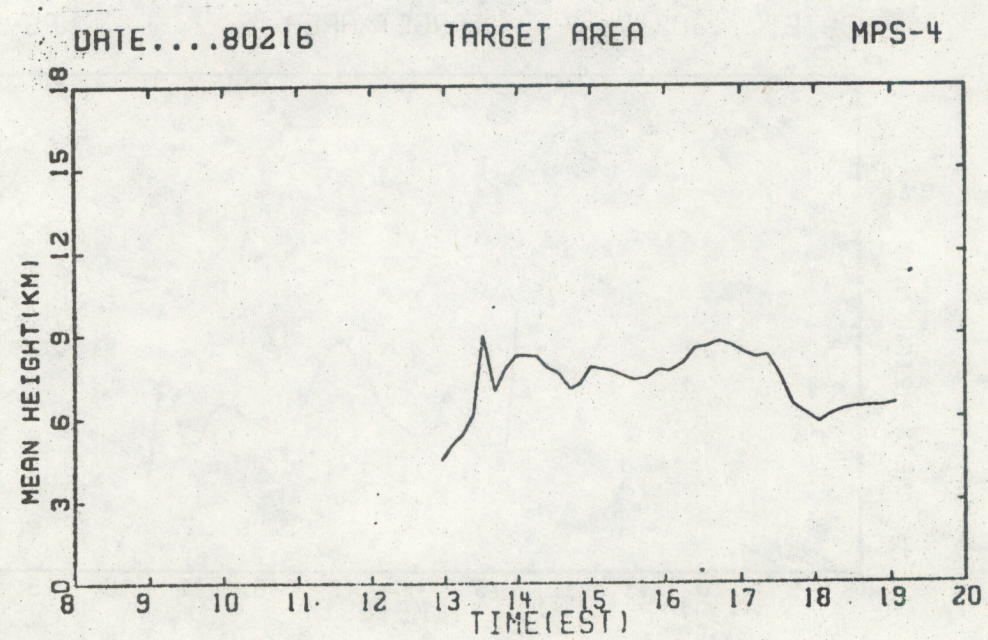

DATE....80215 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

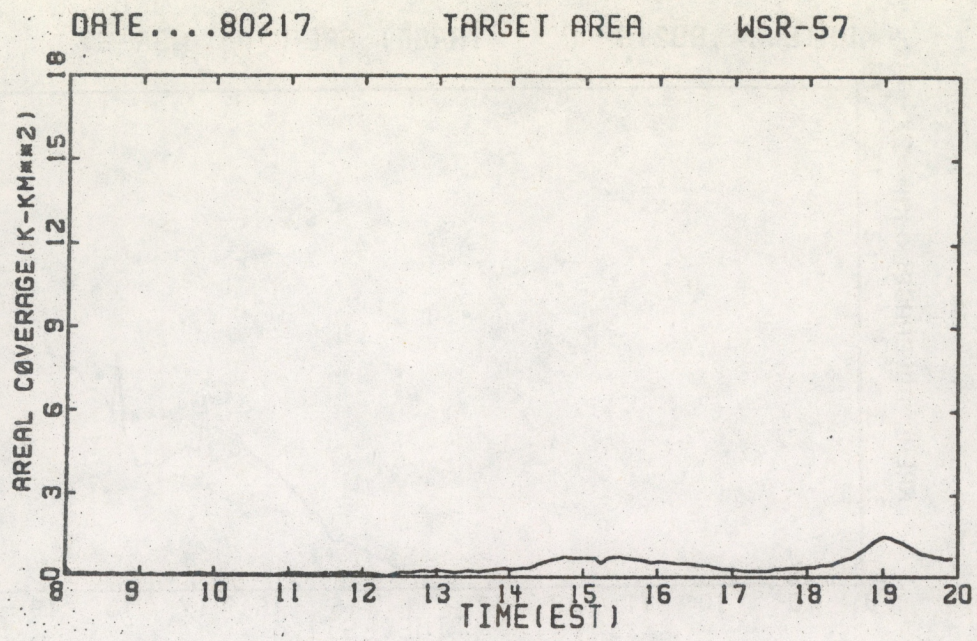

DATE....80215 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

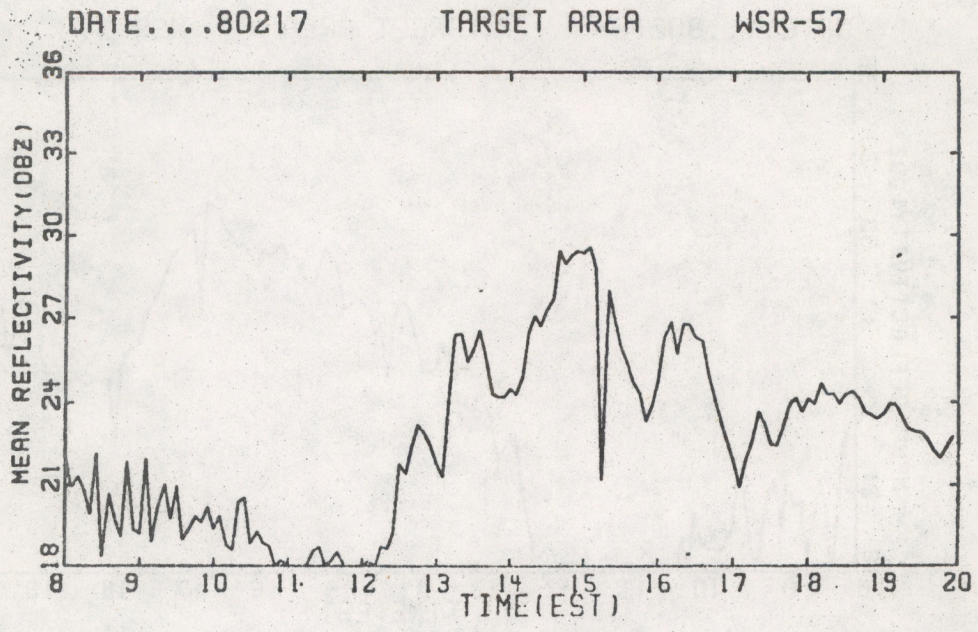

DATE....80215 TARGET AREA MPS-4
MEAN HEIGHT(KM)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

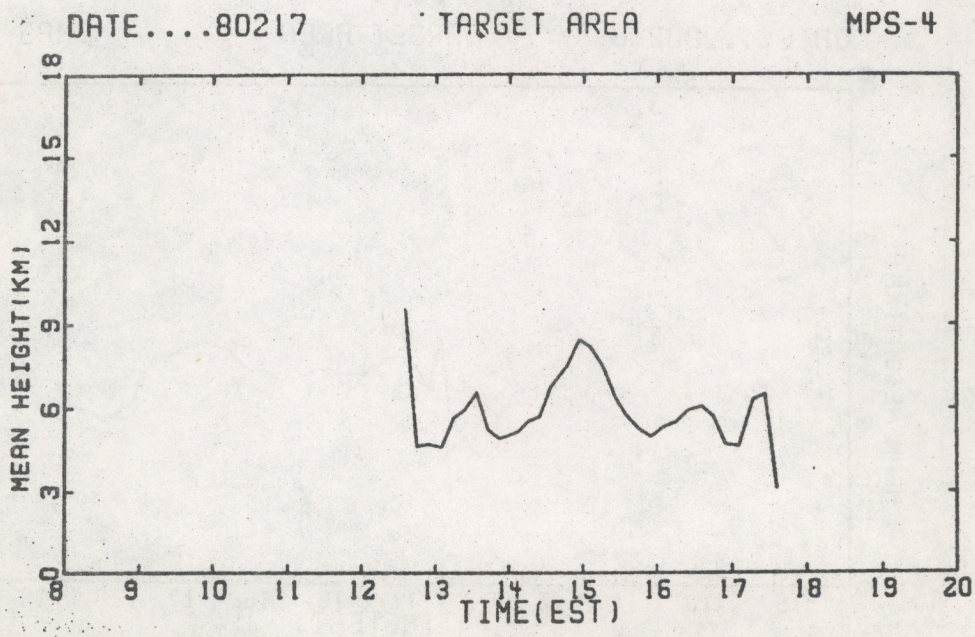

DATE....80216
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11.
12
13
14
15
16
17
18
19
20
TIME(EST)

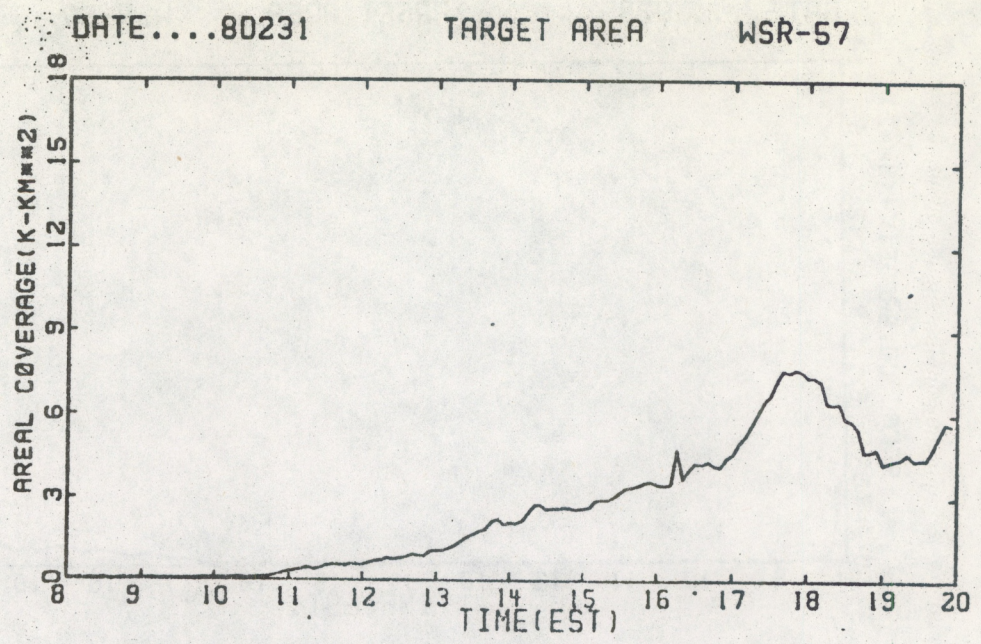

DATE....80216
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

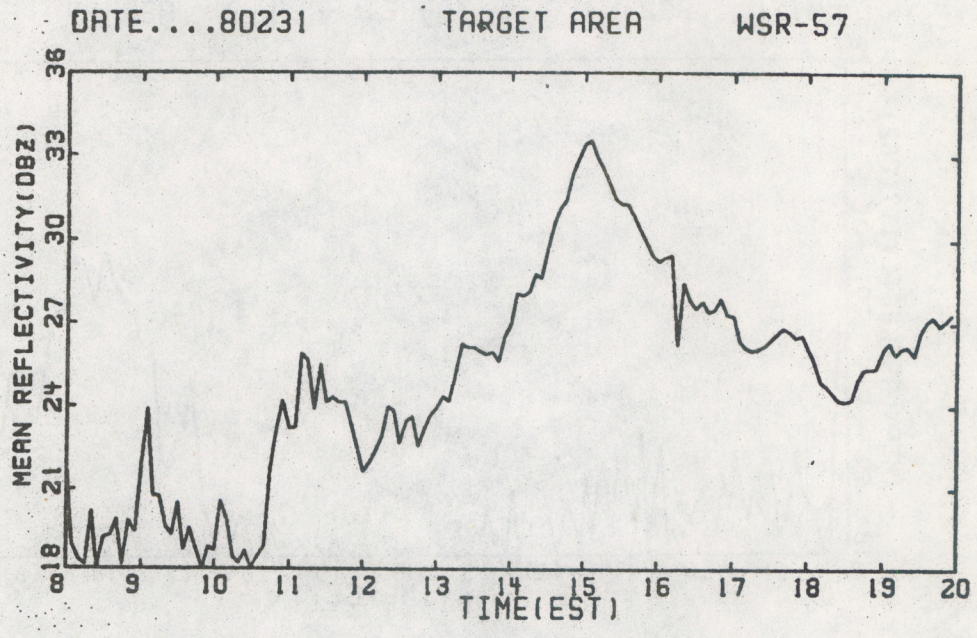

DATE....80216
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11.
12
13
14
15
16
17
18
19
20
TIME(EST)

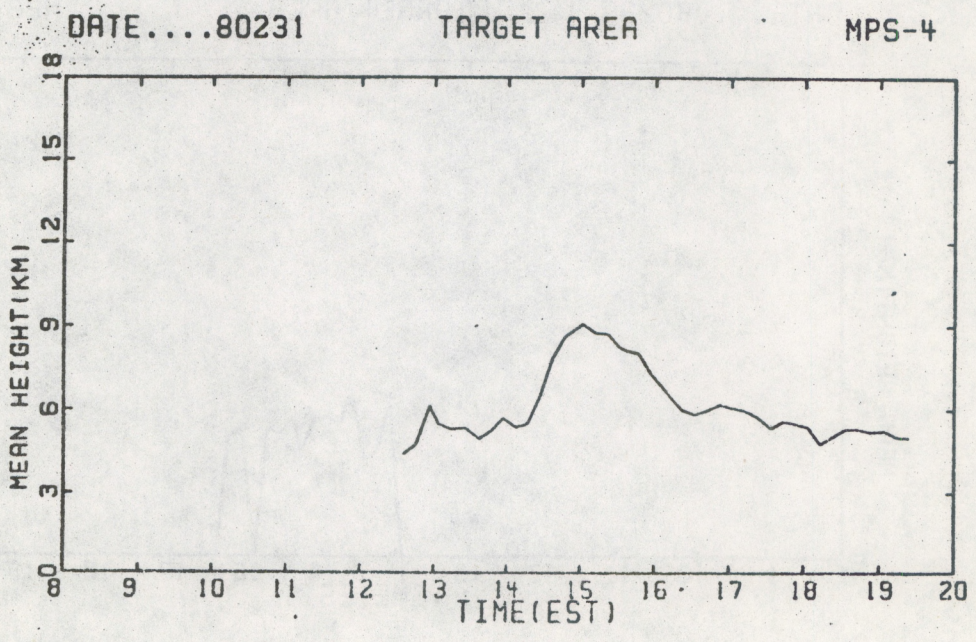

DATE....80217
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

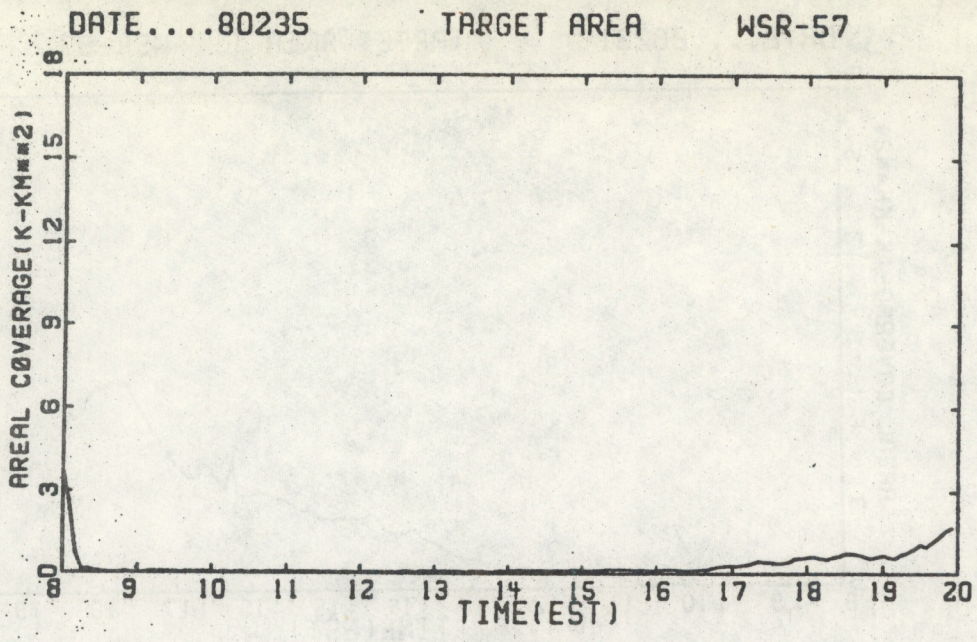

DATE....80217
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

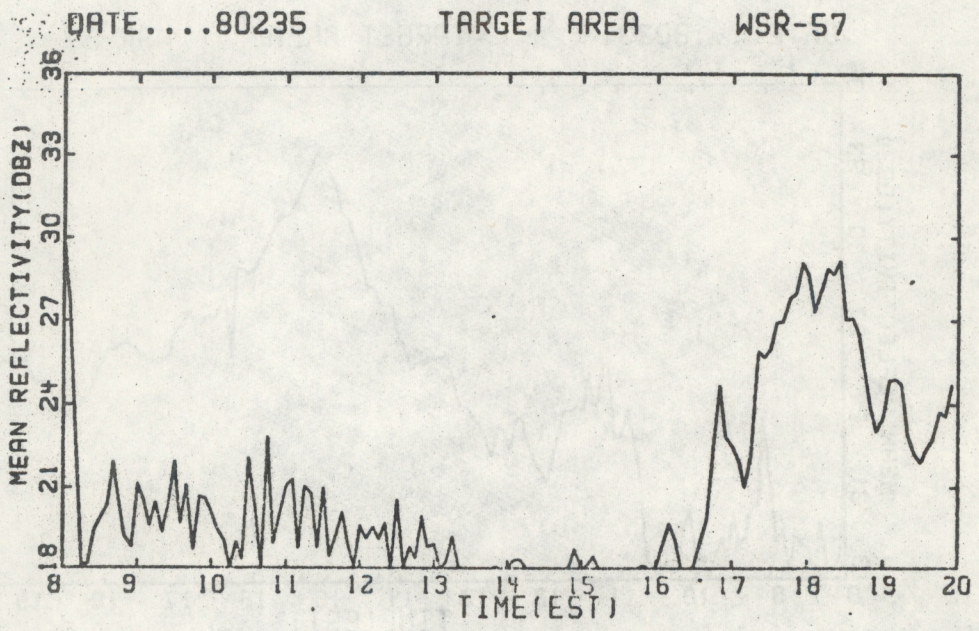

DATE....80217
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

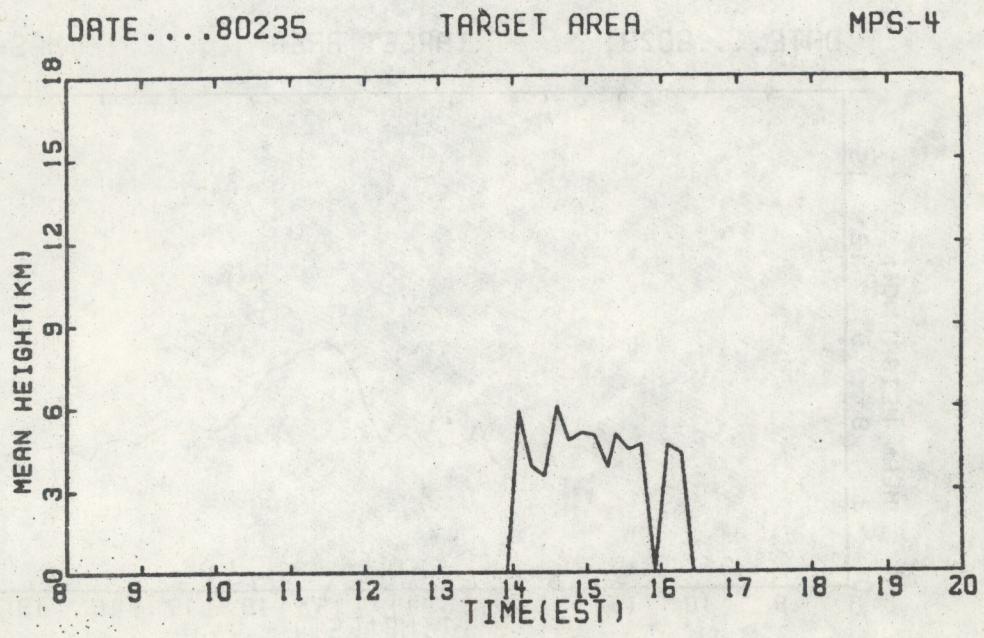

DATE....80231
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

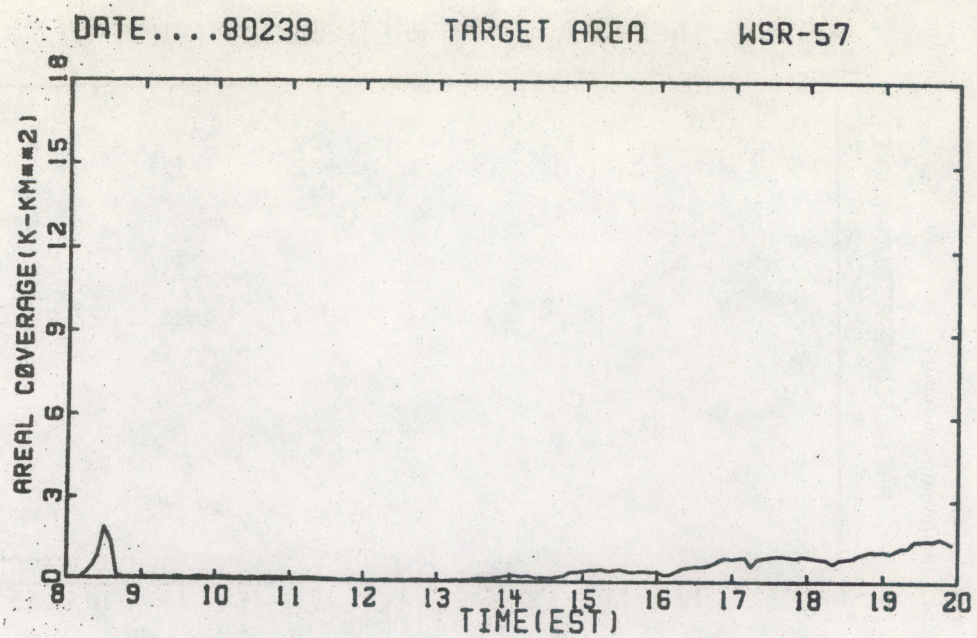

DATE....80231
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

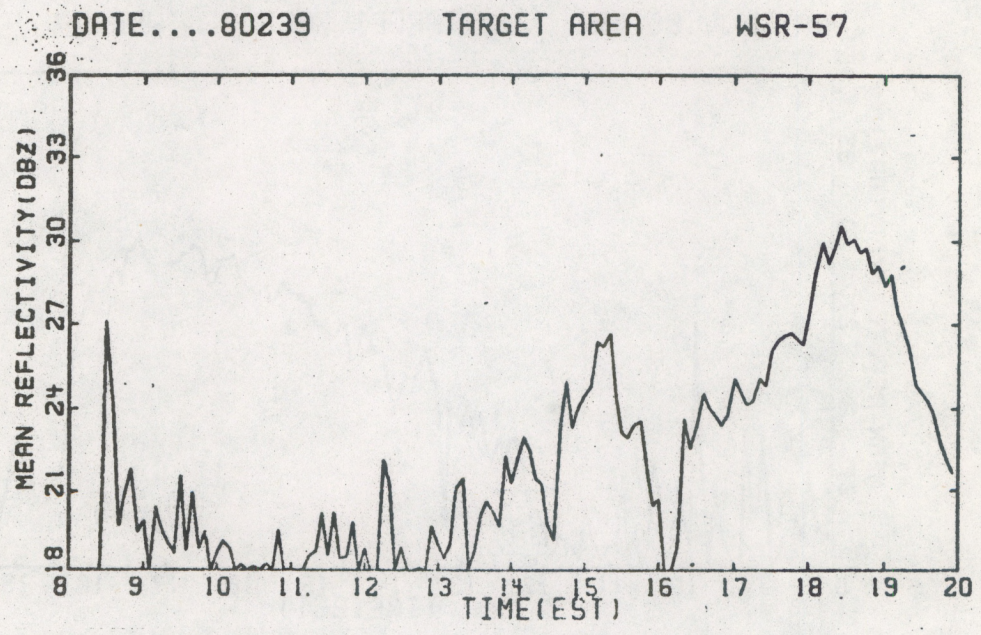

DATE....80231
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

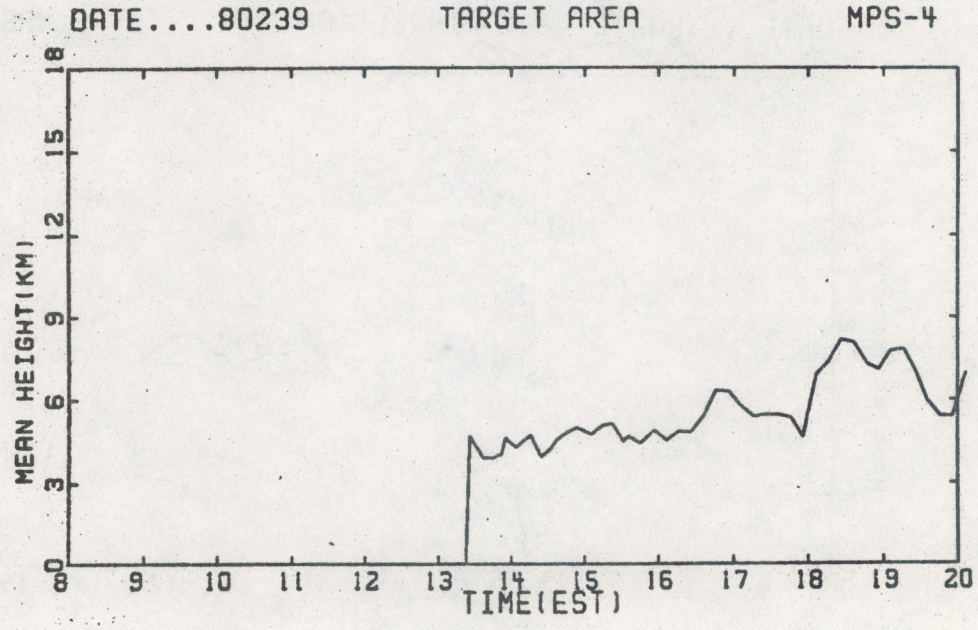

DATE....80235
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

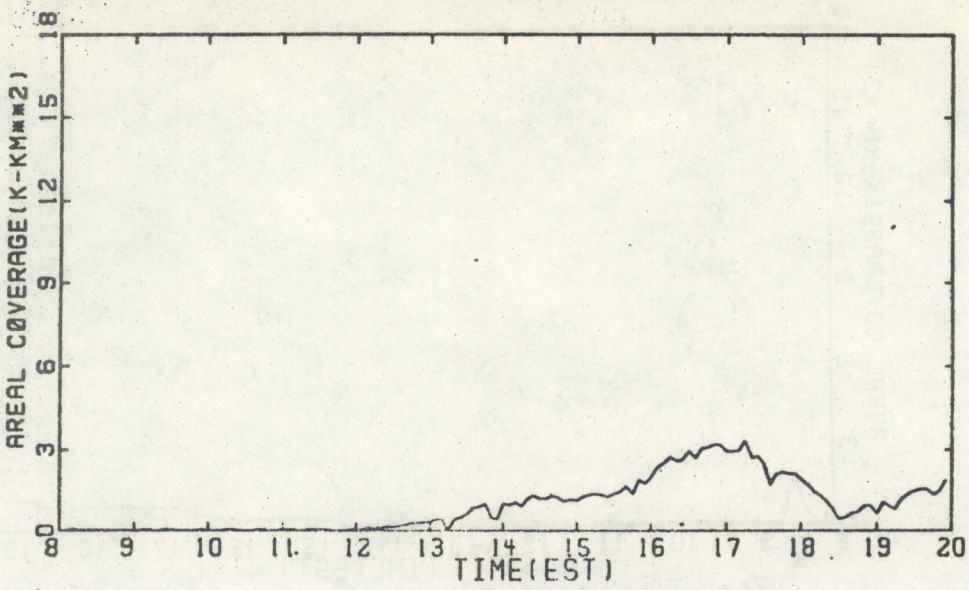

DATE....80235
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

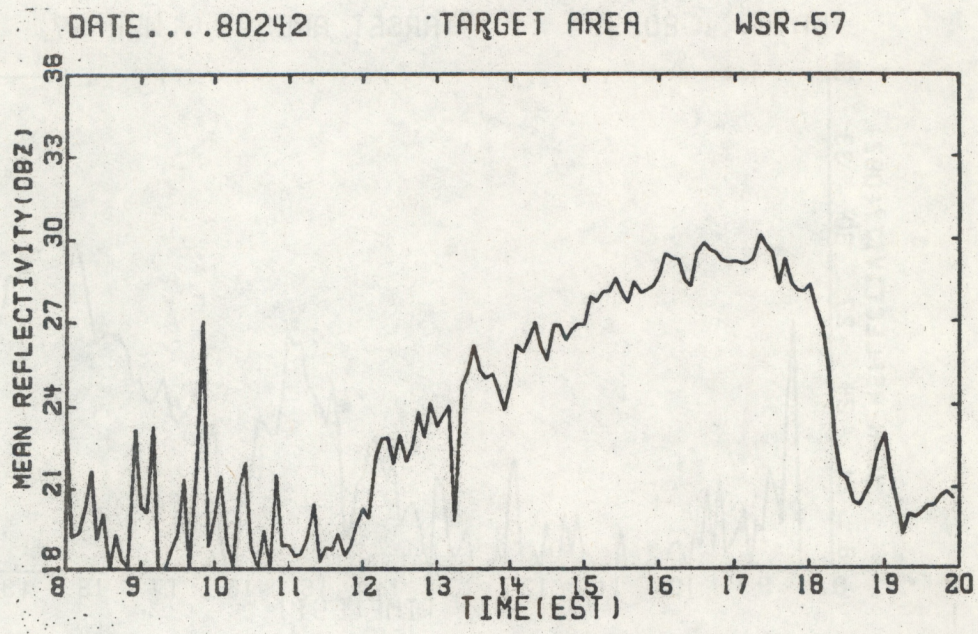

DATE....80235
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE....80239
TARGET AREA
WSR-57
AREAL COVERAGE(K-KM**2)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE....80239
TARGET AREA
WSR-57
MEAN REFLECTIVITY(DBZ)
18
21
24
27
30
33
36
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE....80239
TARGET AREA
MPS-4
MEAN HEIGHT(KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE....80242 TARGET AREA WSR-57
AREAL COVERAGE(K-KM**2)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)


DATE....80242 TARGET AREA WSR-57
MEAN REFLECTIVITY(DBZ)
18 21 24 27 30 33 36
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

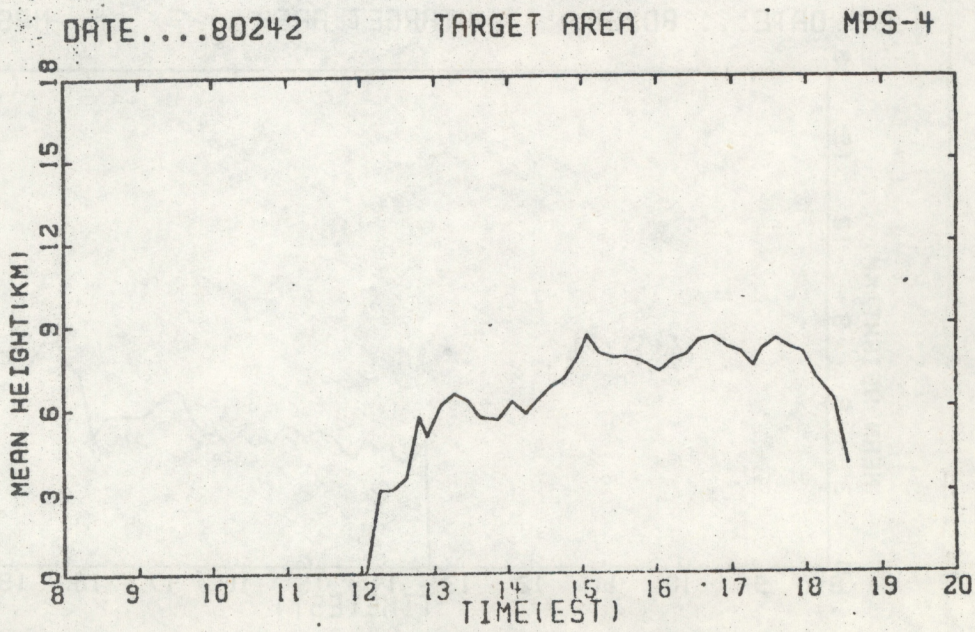
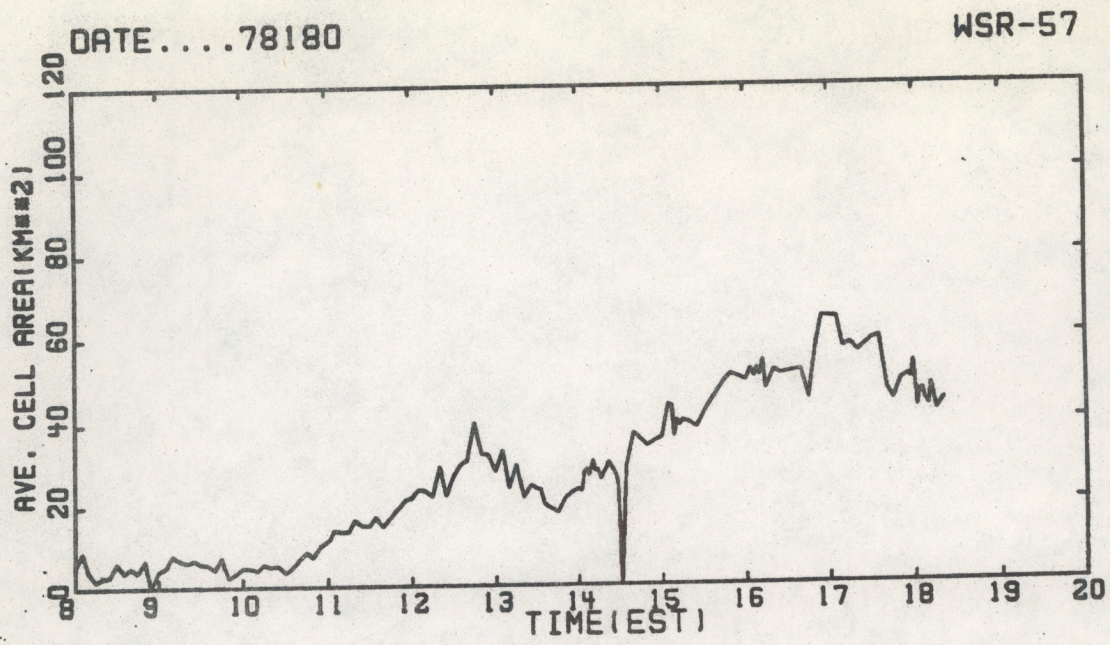
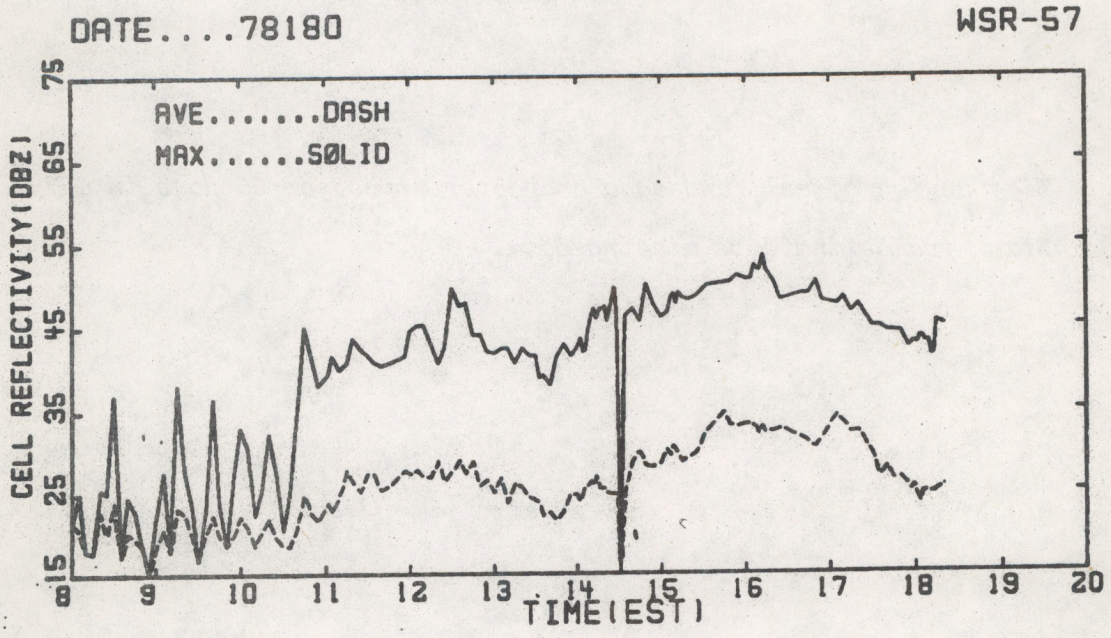
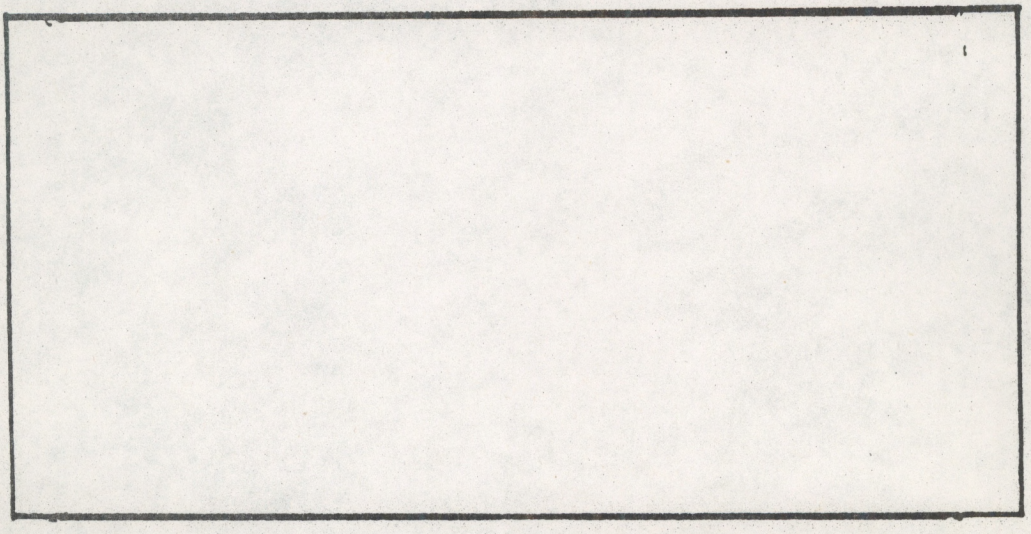
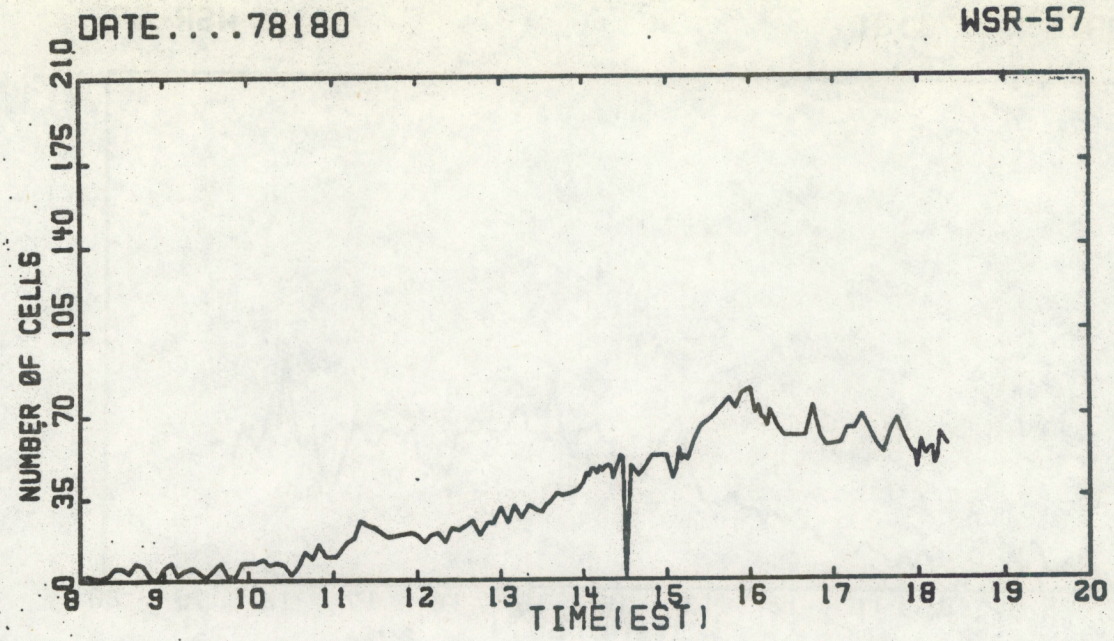

DATE....80242 TARGET AREA MPS-4
MEAN HEIGHT(KM)
0 3 6 9 12 15 18
8 9 10 11 12 13 14 15 16 17 18 19 20
TIME(EST)

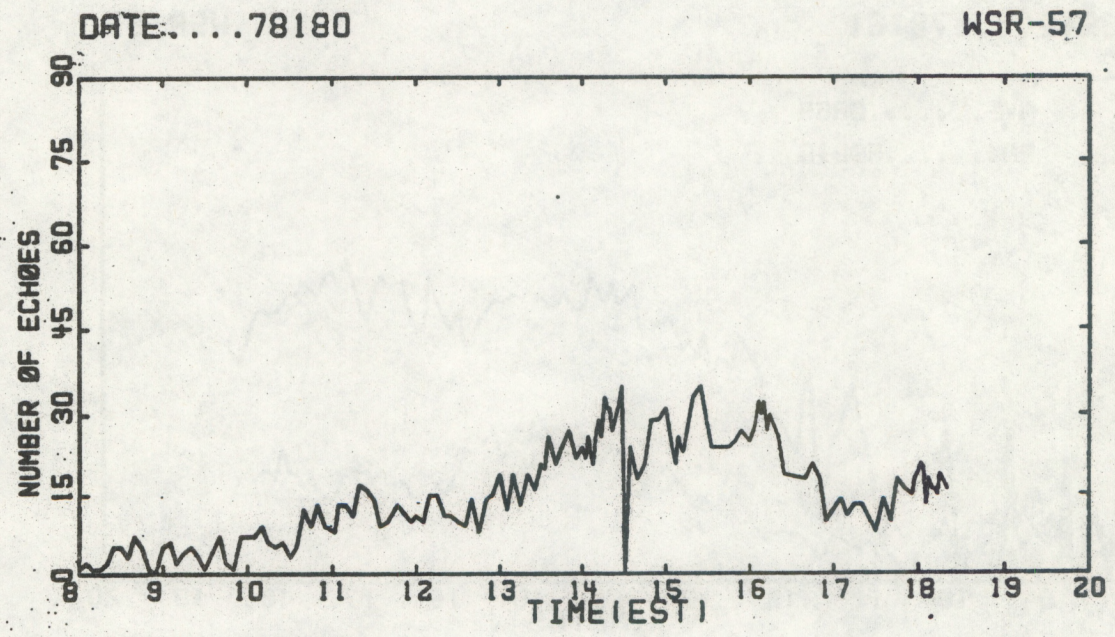
*Fig. 7. Time series of cell and echo characteristics for 60 days in 1978. Blank frames indicate missing data.*

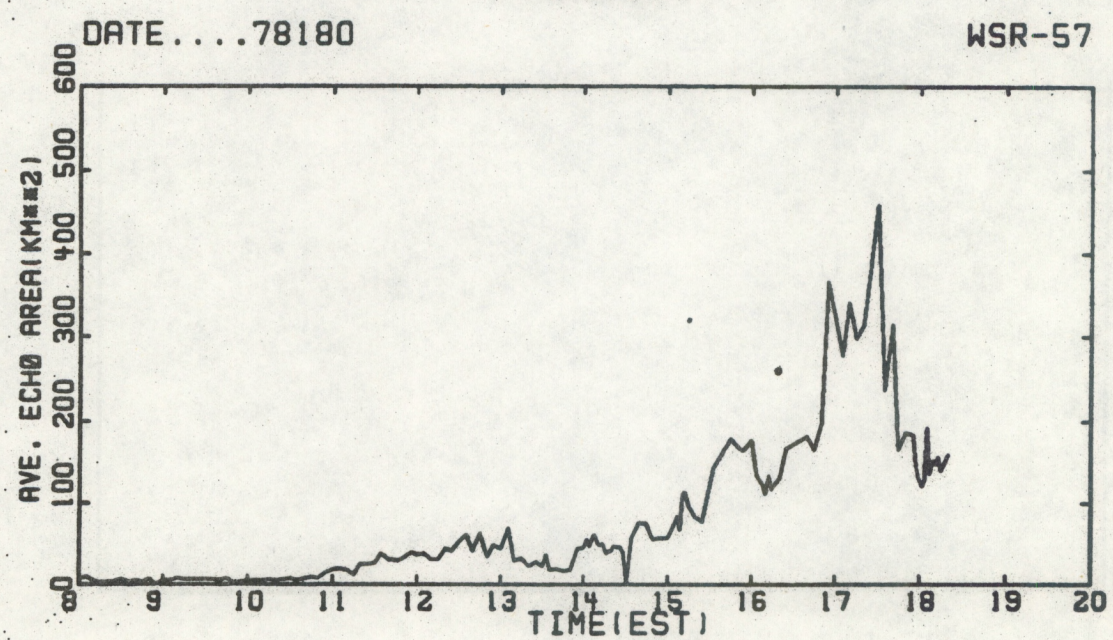

DATE....78180
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

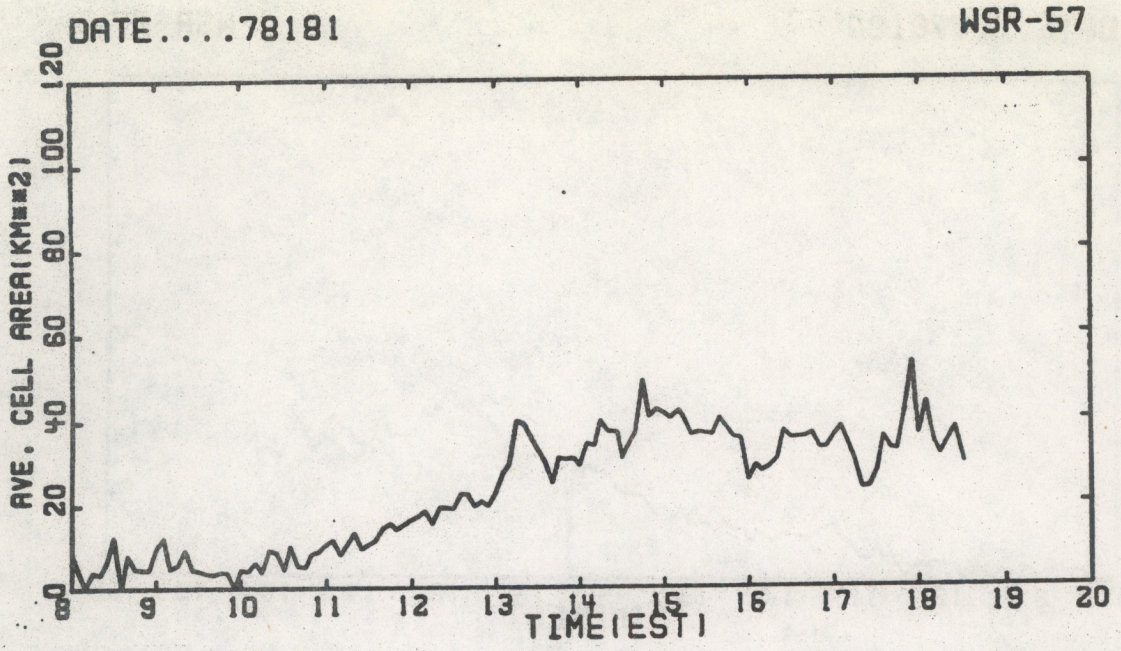

DATE....78180
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

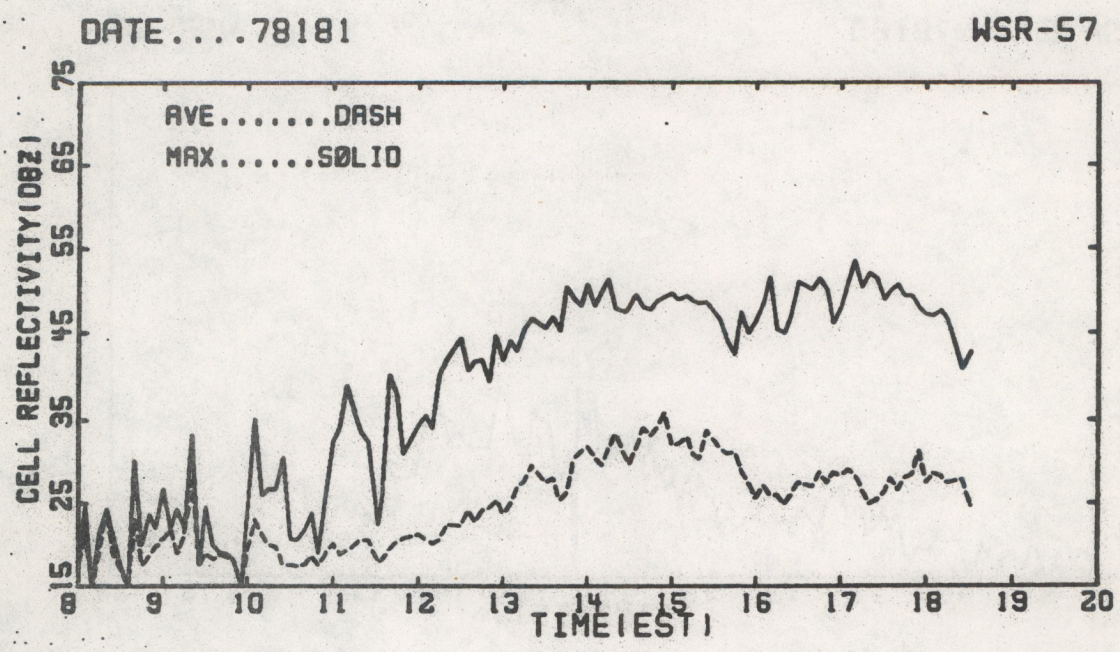


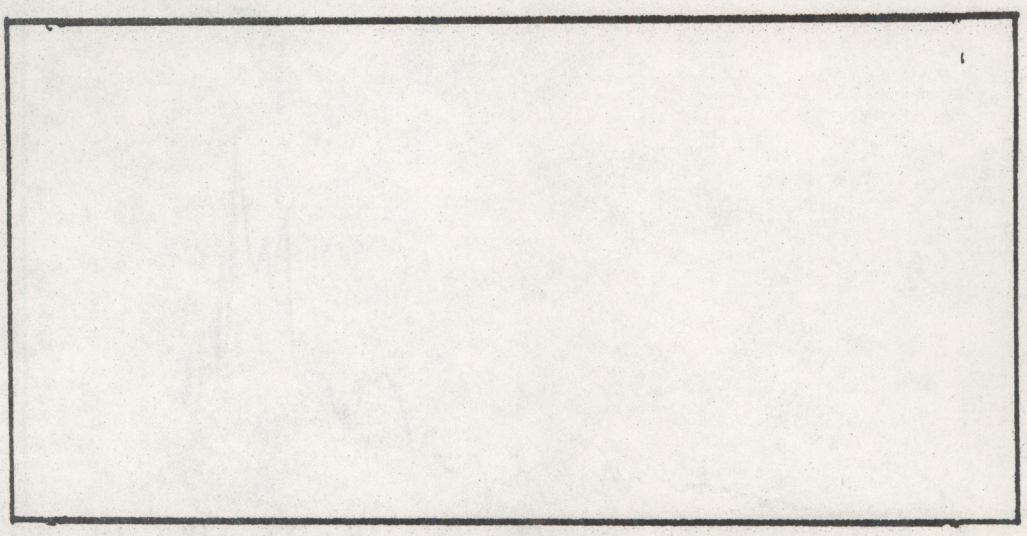

DATE....78180
WSR-57
NUMBER ØF CELLS
0
35
70
105
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175
210
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TIME(EST)

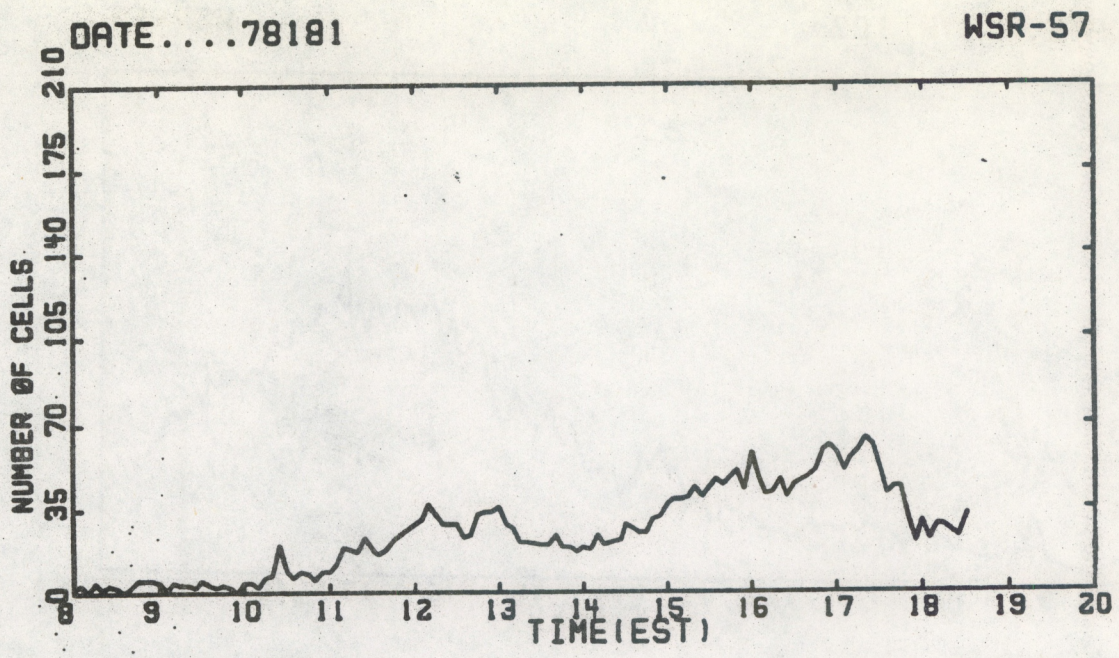

DATE....78180
WSR-57
NUMBER ØF ECHØES
0
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90
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TIME(EST)

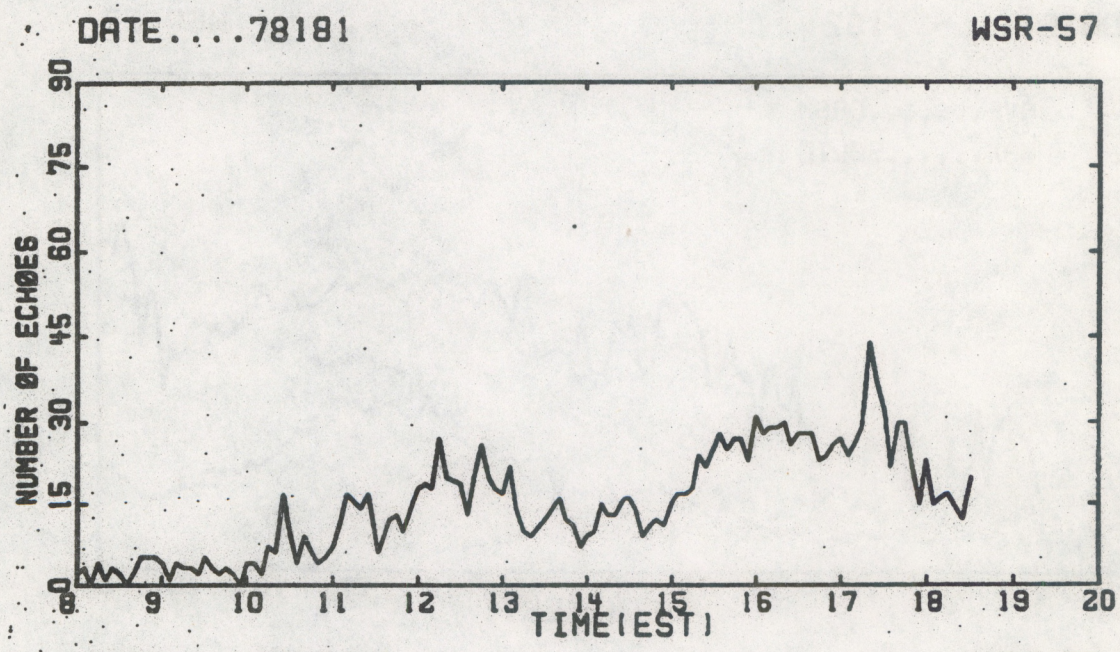

DATE....78180
WSR-57
AVE. ECHØ AREA(KM**2)
0
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600
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TIME(EST)

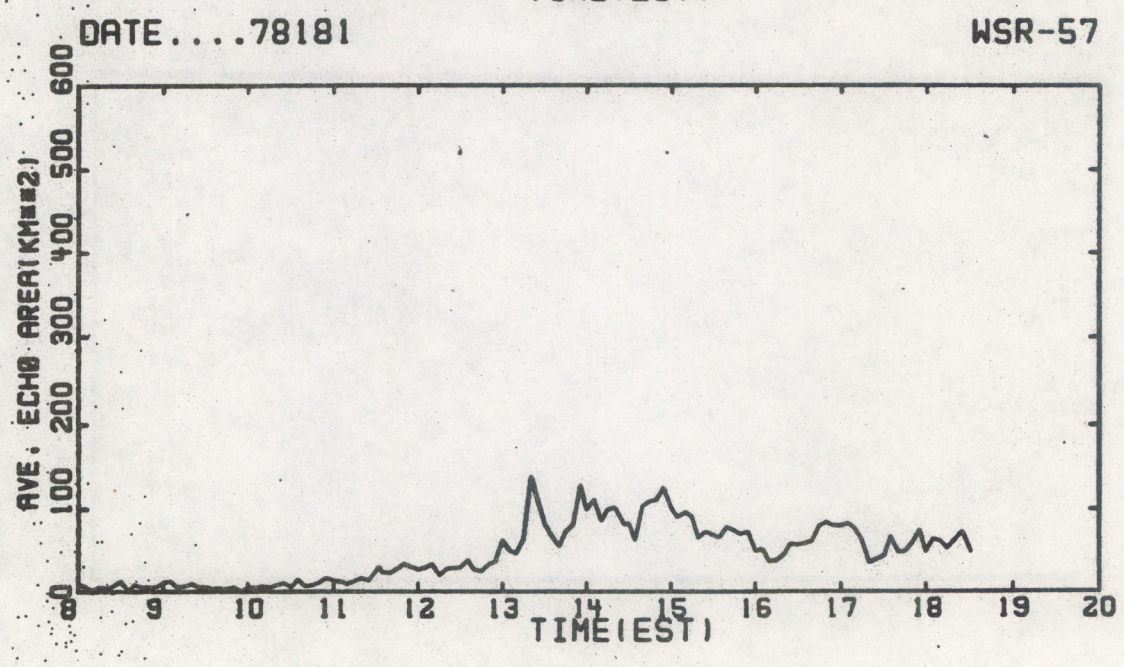

DATE....78181
WSR-57
AVE. CELL AREA(KM**2)
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TIME(EST)

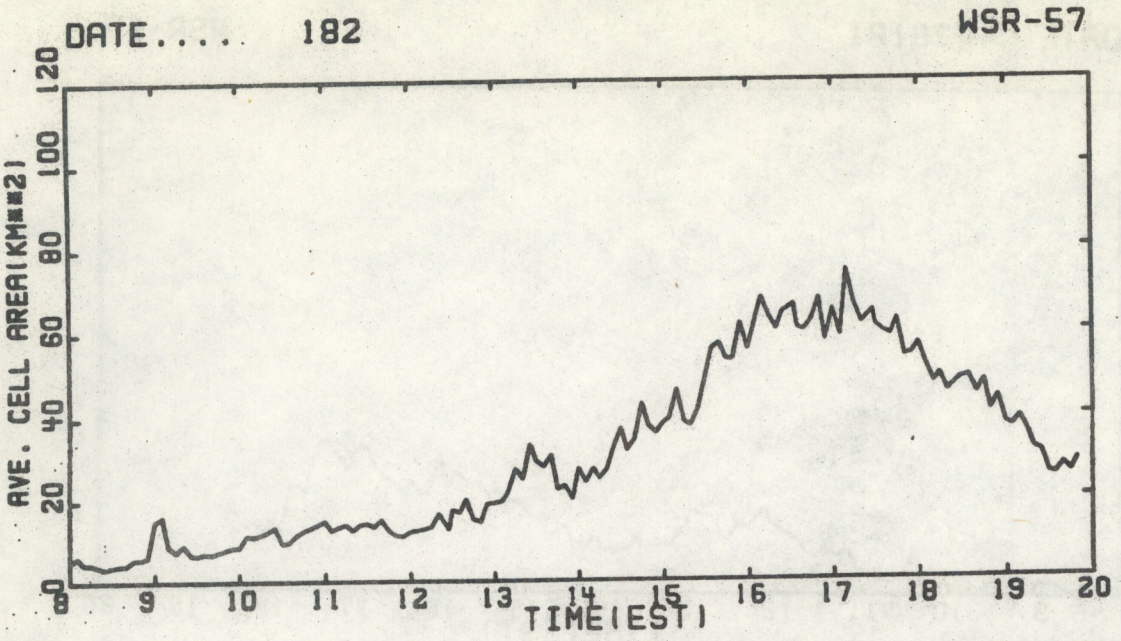

DATE....78181
WSR-57
AVE.....DASH
MAX.....SOLID
CELL REFLECTIVITY(DBZ)
15
25
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75
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20
TIME(EST)

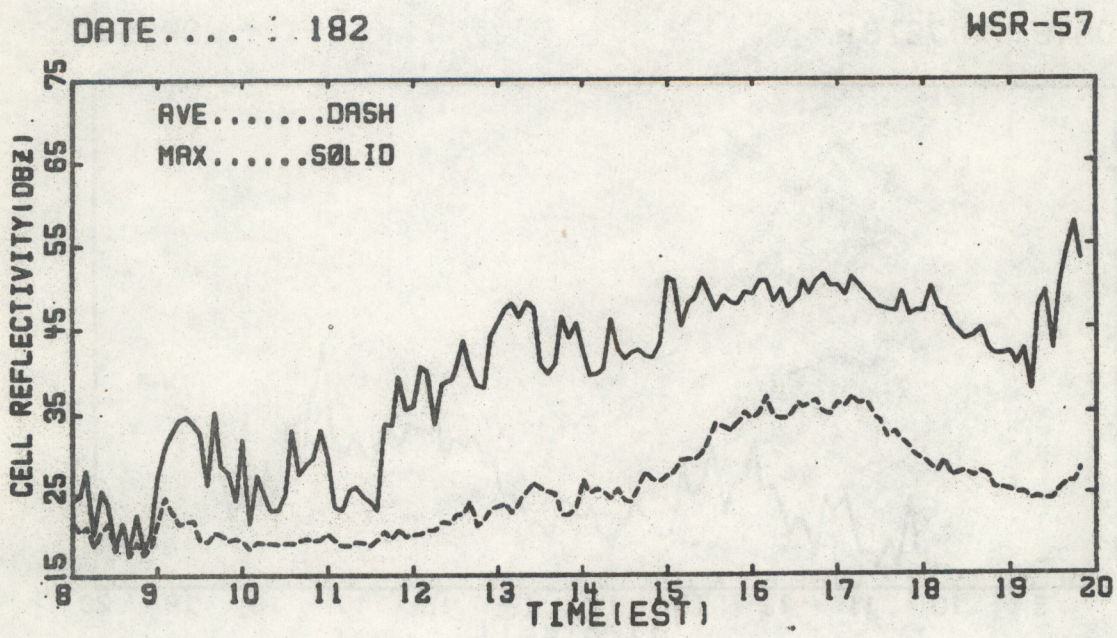


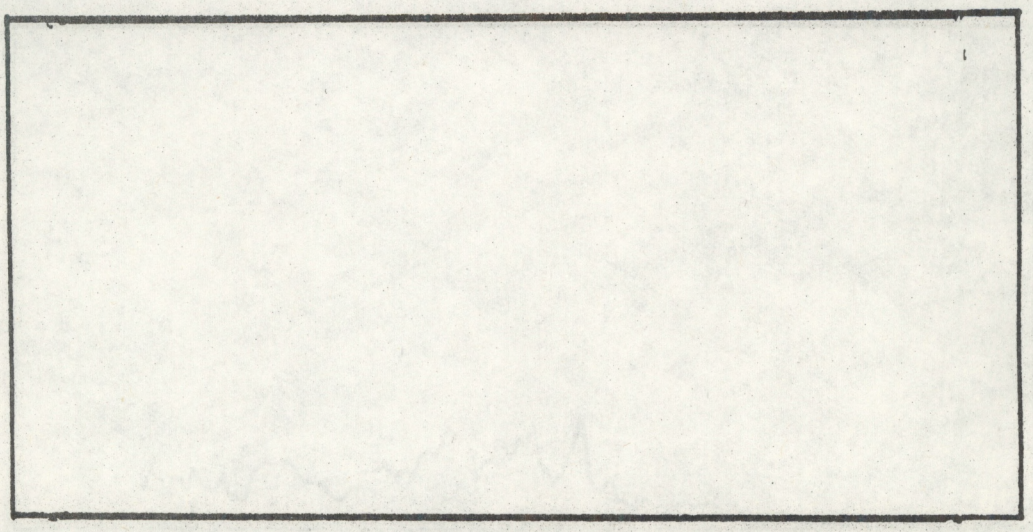

DATE....78181
WSR-57
NUMBER ØF CELLS
0
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105
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TIME(EST)

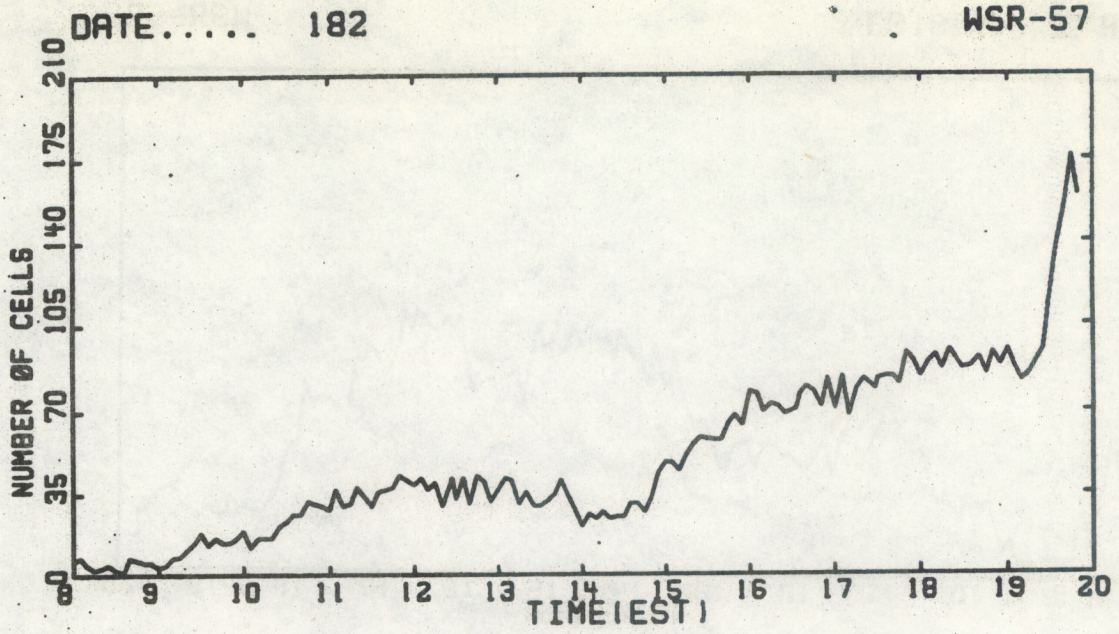

DATE....78181
WSR-57
NUMBER ØF ECHØES
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TIME(EST)

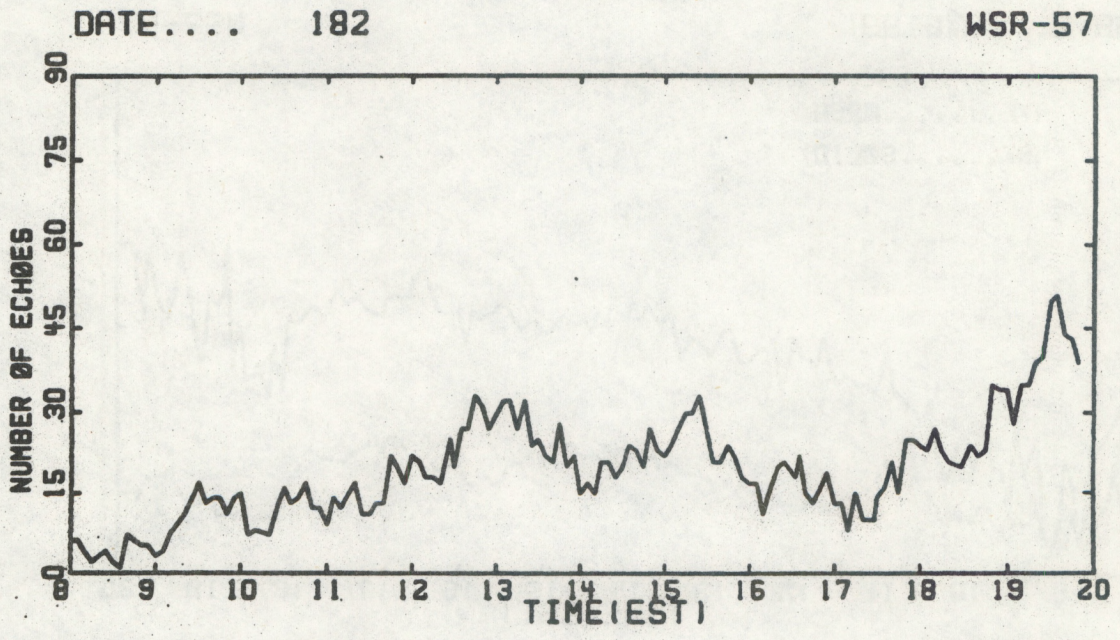

DATE....78181
WSR-57
AVE. ECHØ AREA(KM**2)
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TIME(EST)

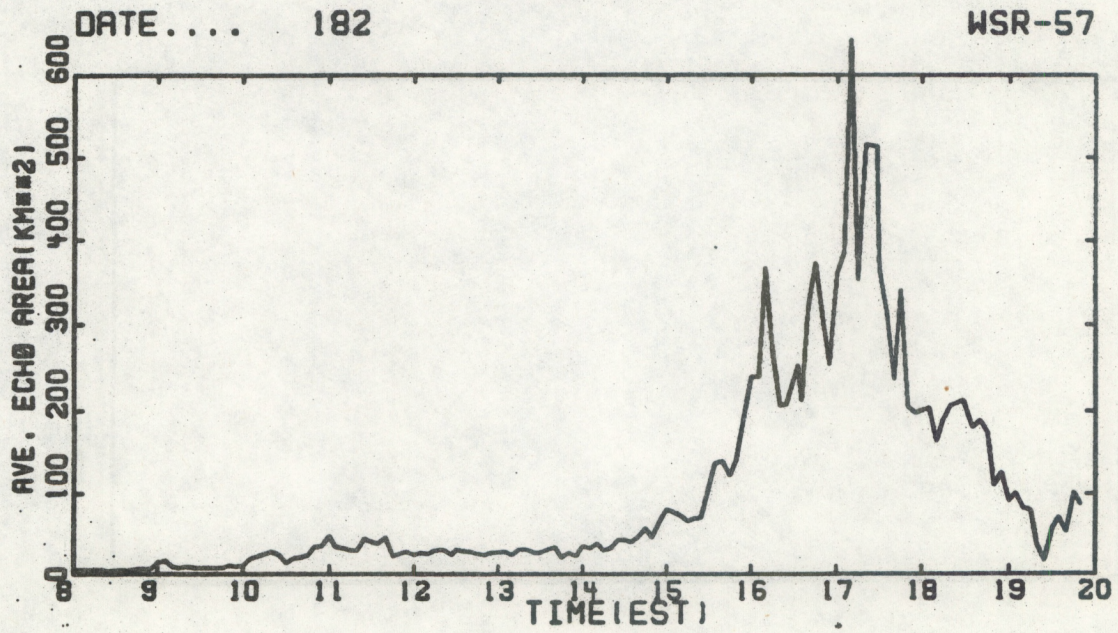

DATE..... 182
WSR-57
AVE. CELL AREA(KM**2)
0
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TIME(EST)

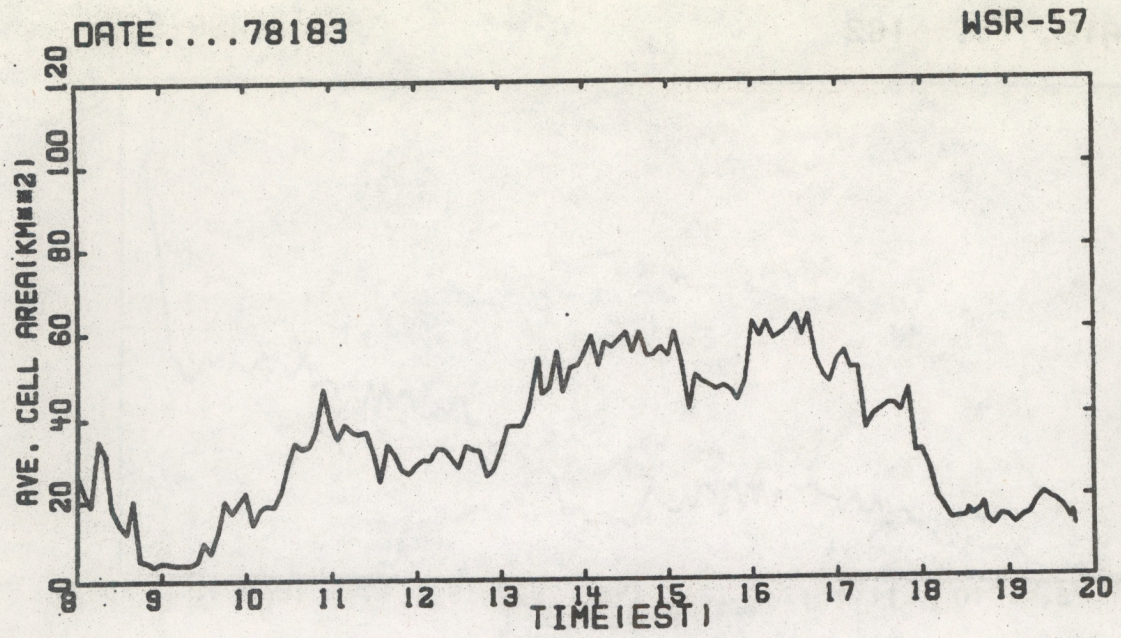

DATE..... 182
WSR-57
AVE.....DASH
MAX.....SOLID
CELL REFLECTIVITY(DBZ)
15
25
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75
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TIME(EST)

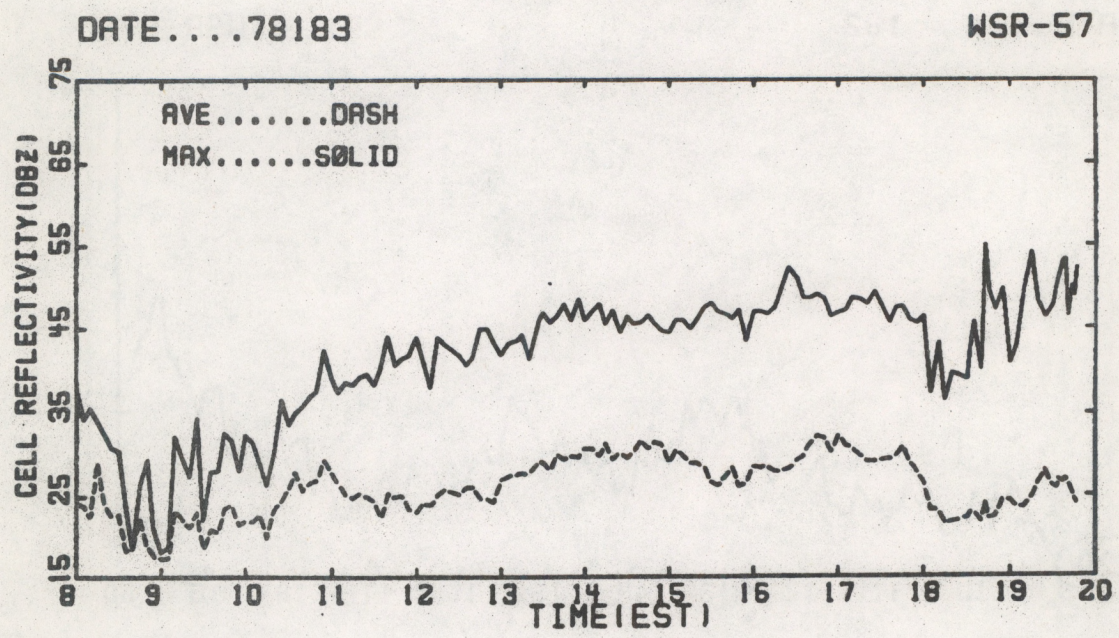


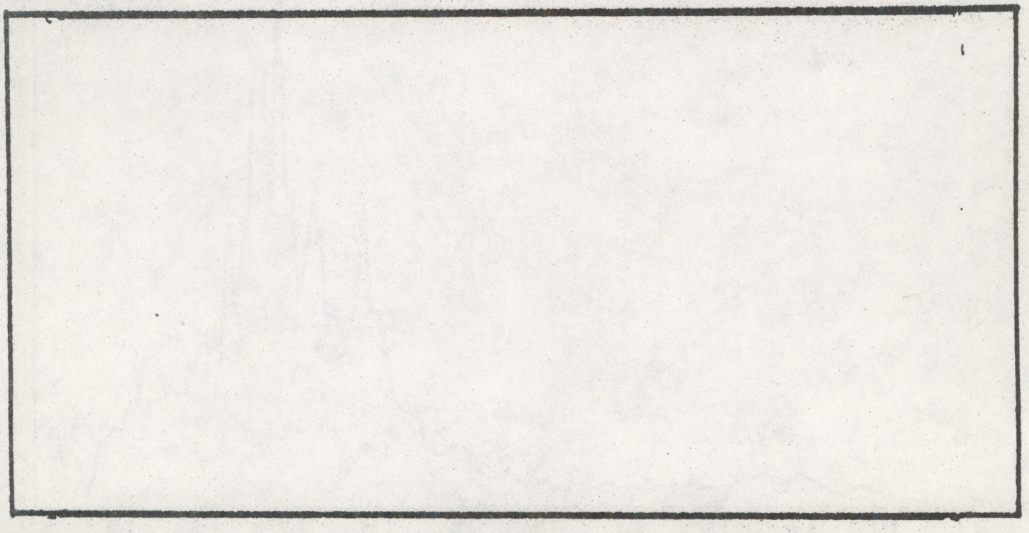

DATE..... 182
WSR-57
NUMBER OF CELLS
0
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140
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210
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TIME(EST)

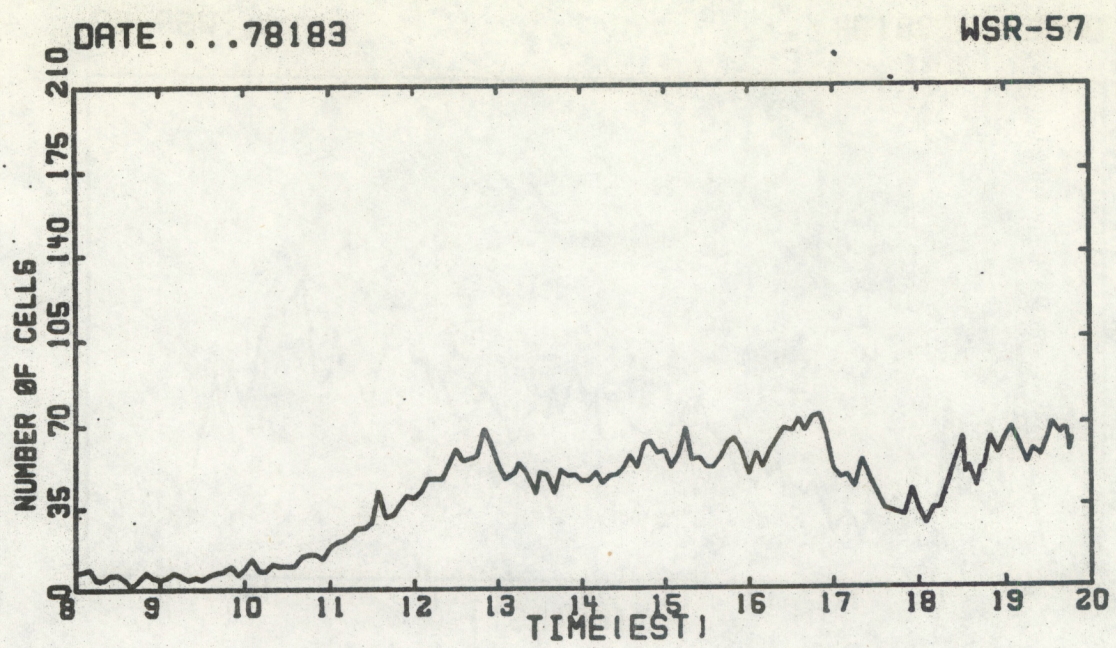

DATE.... 182
WSR-57
NUMBER OF ECHOES
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TIME(EST)

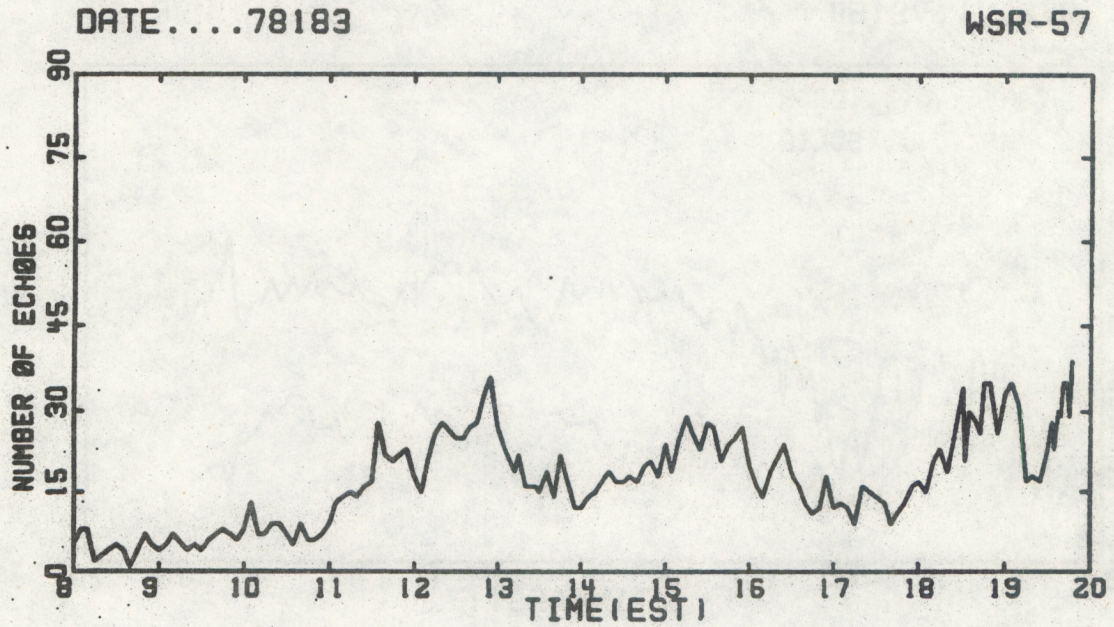

DATE.... 182
WSR-57
AVE. ECHO AREA(KM**2)
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TIME(EST)

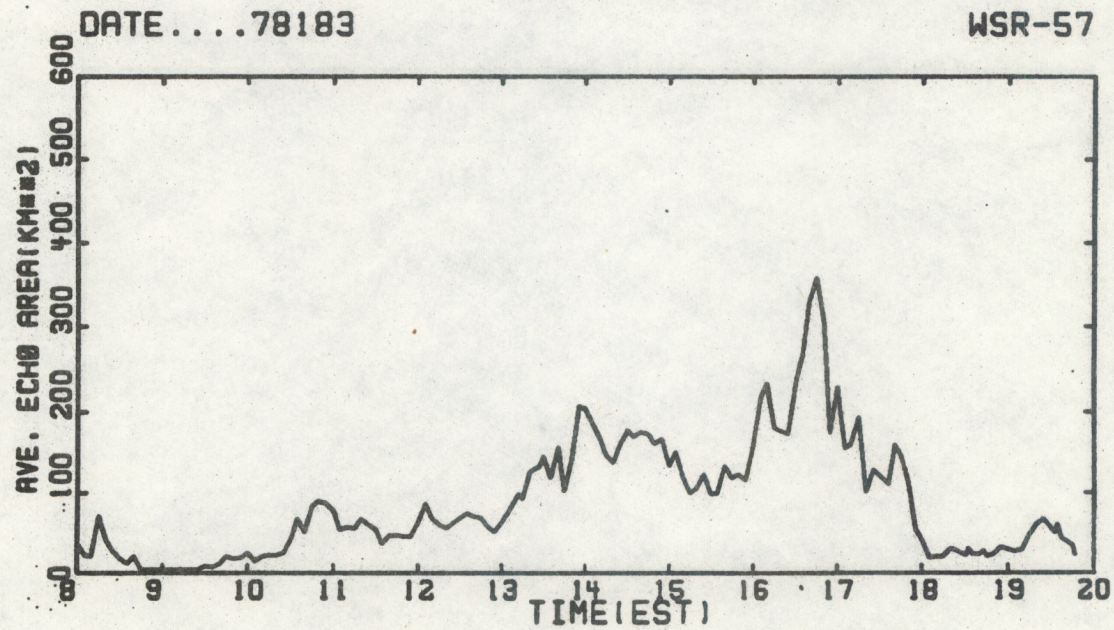

DATE....78183
WSR-57
AVE. CELL AREA(KM**2)
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TIME(EST)

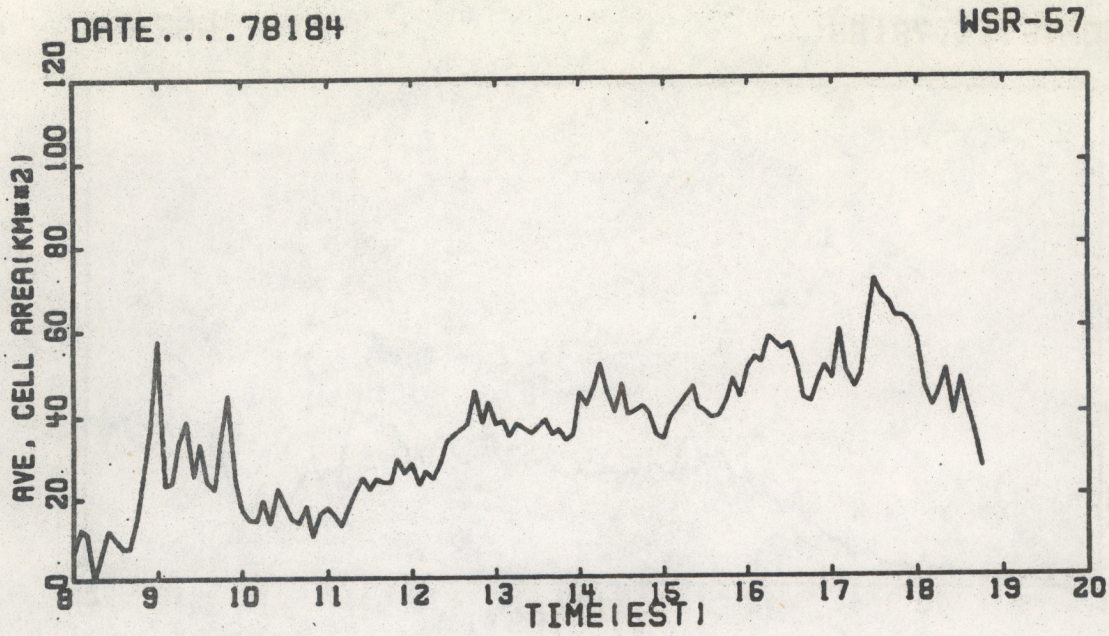

DATE....78183
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
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TIME(EST)

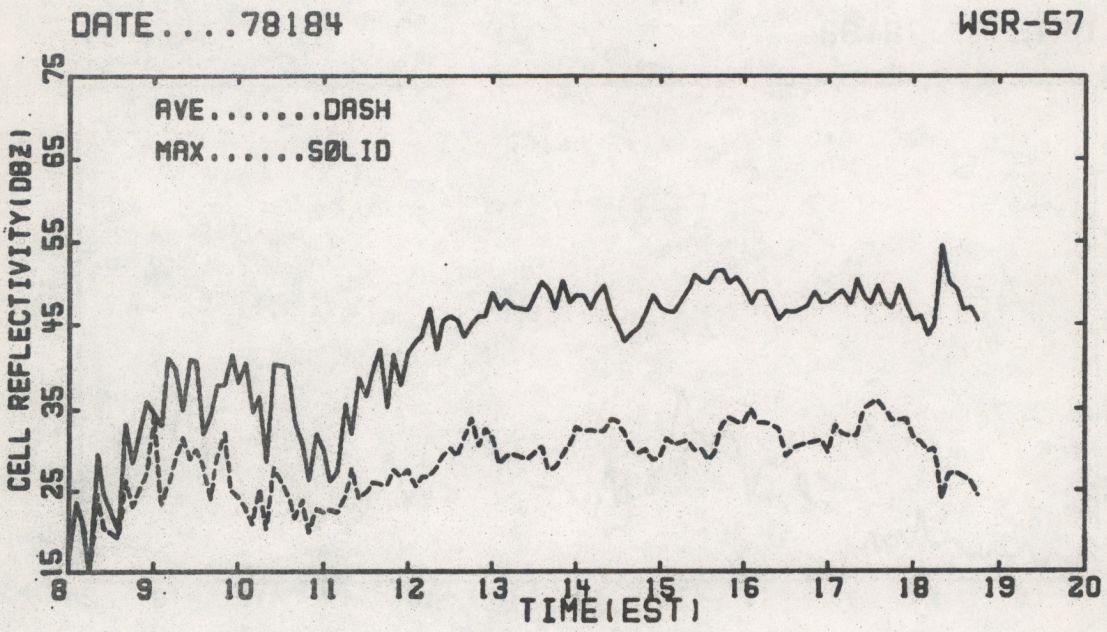


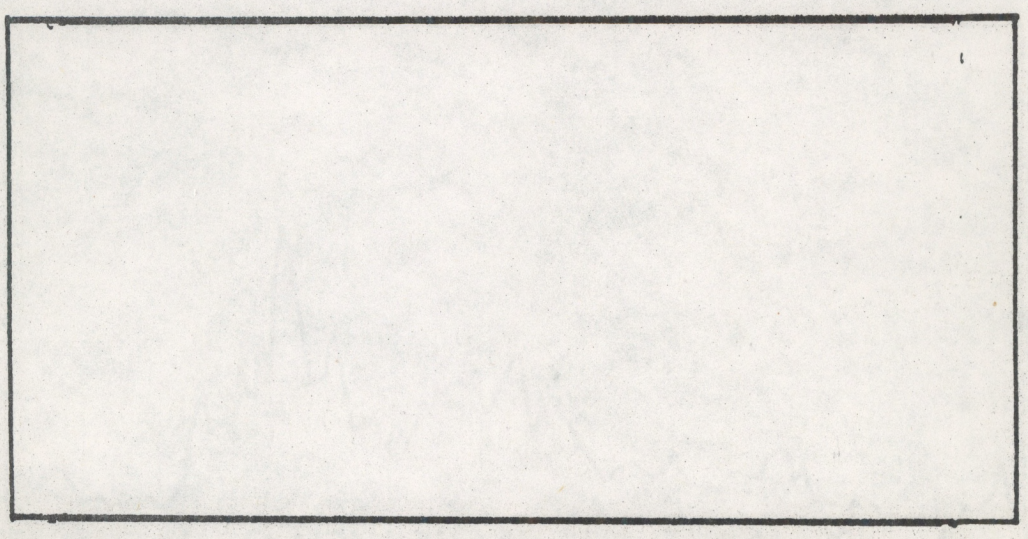

DATE....78183
WSR-57
NUMBER ØF CELLS
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TIME(EST)

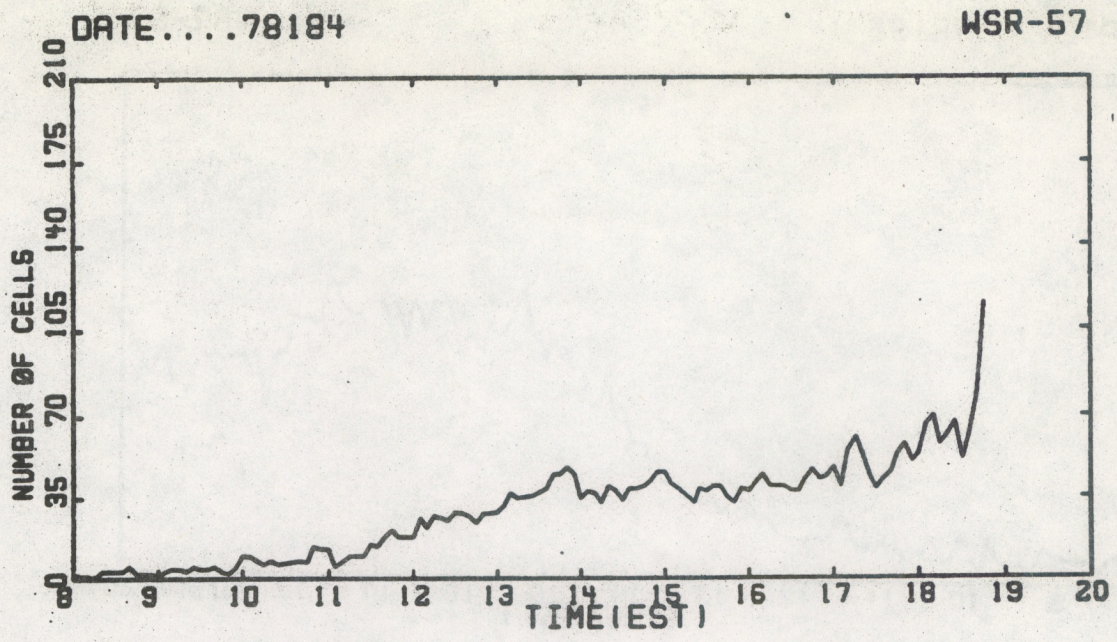

DATE....78183
WSR-57
NUMBER ØF ECHØES
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TIME(EST)

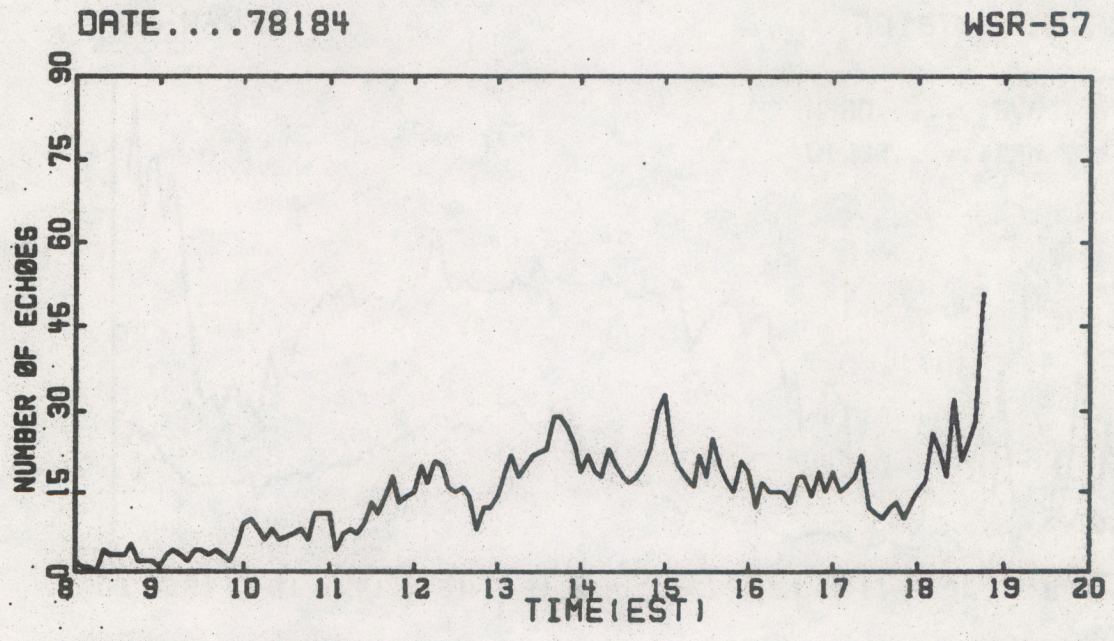

DATE....78183
WSR-57
AVE. ECHØ AREA(KM**2)
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TIME(EST)

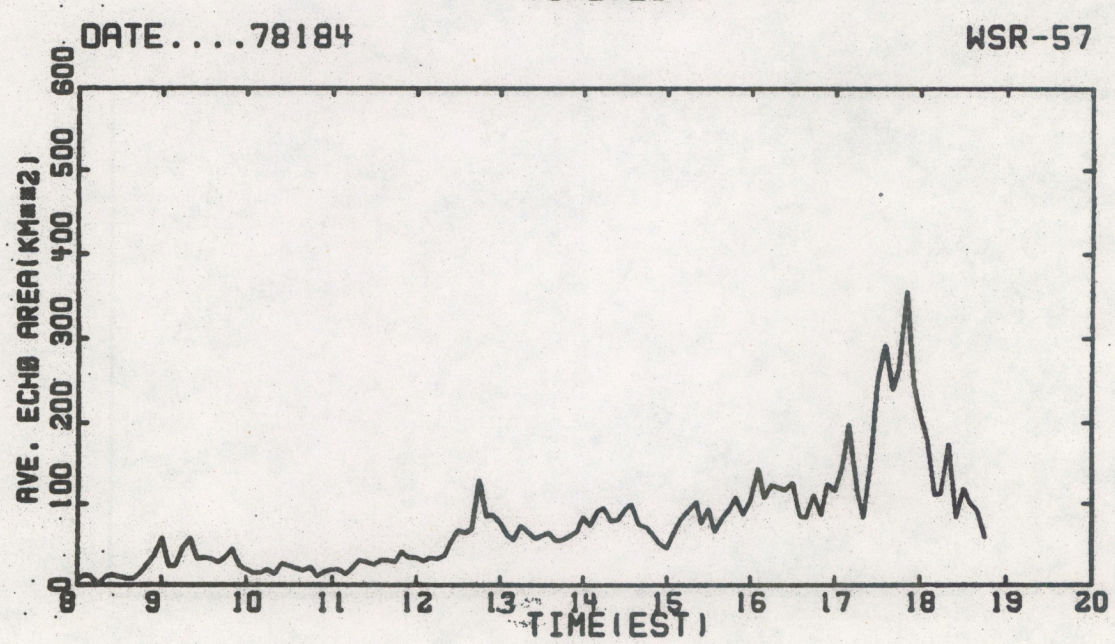

DATE....78184
WSR-57
AVE, CELL AREA(KM**2)
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TIME(EST)

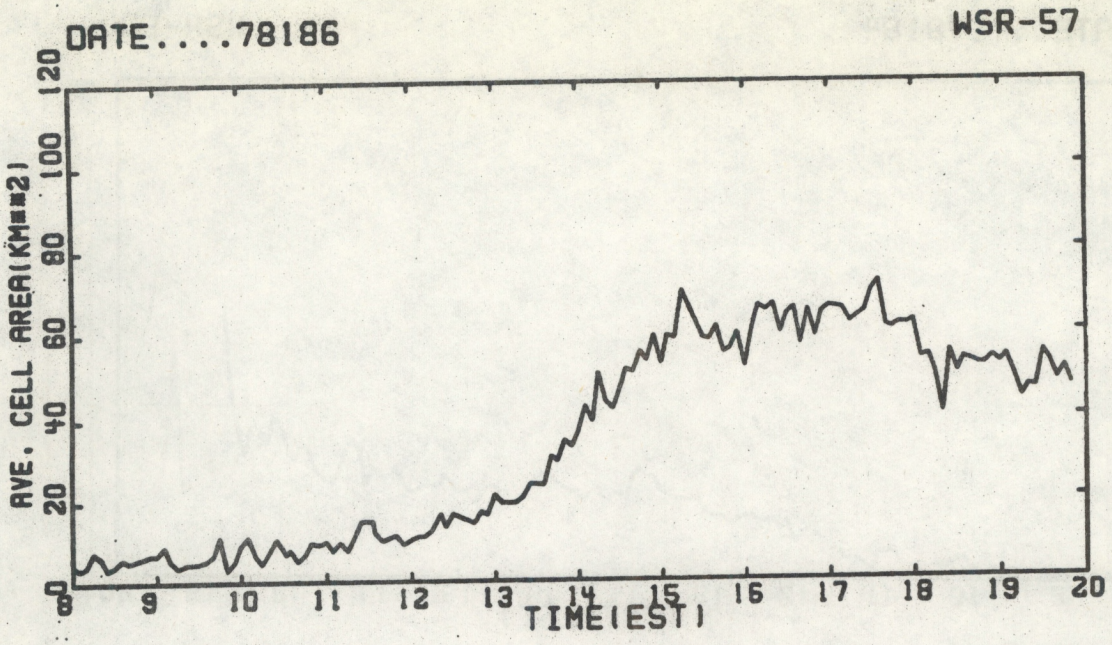

DATE....78184
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
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TIME(EST)

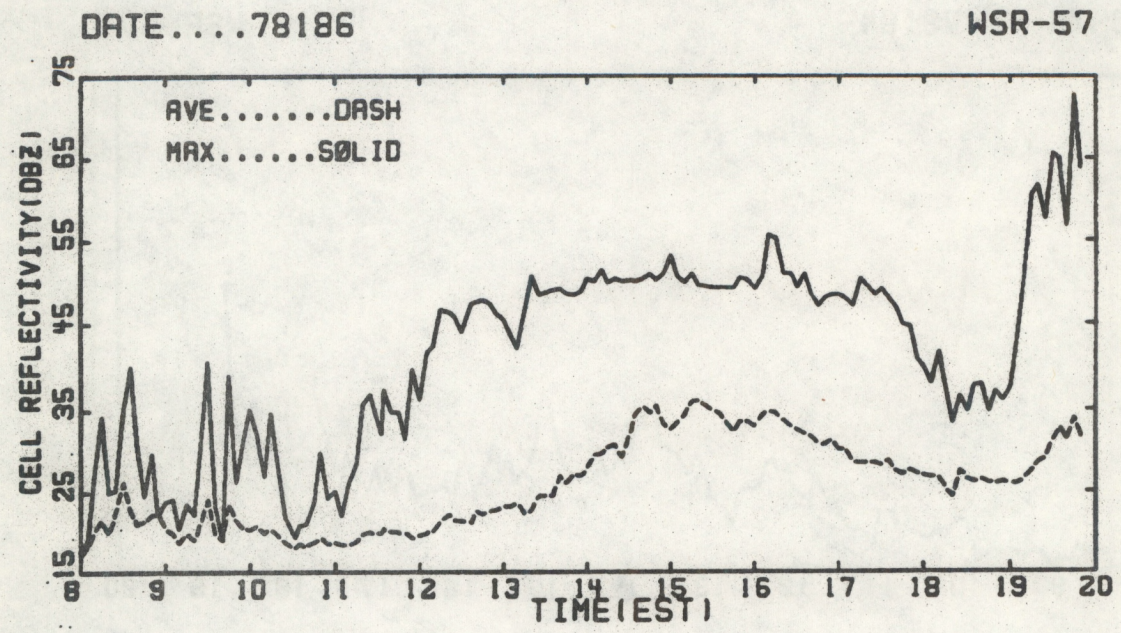


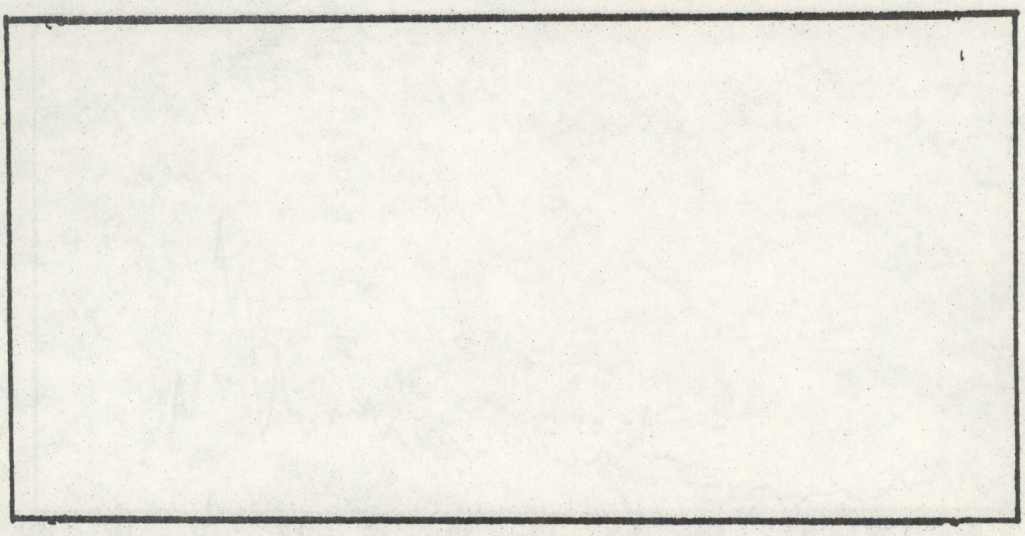

DATE....78184
WSR-57
NUMBER ØF CELLS
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TIME(EST)

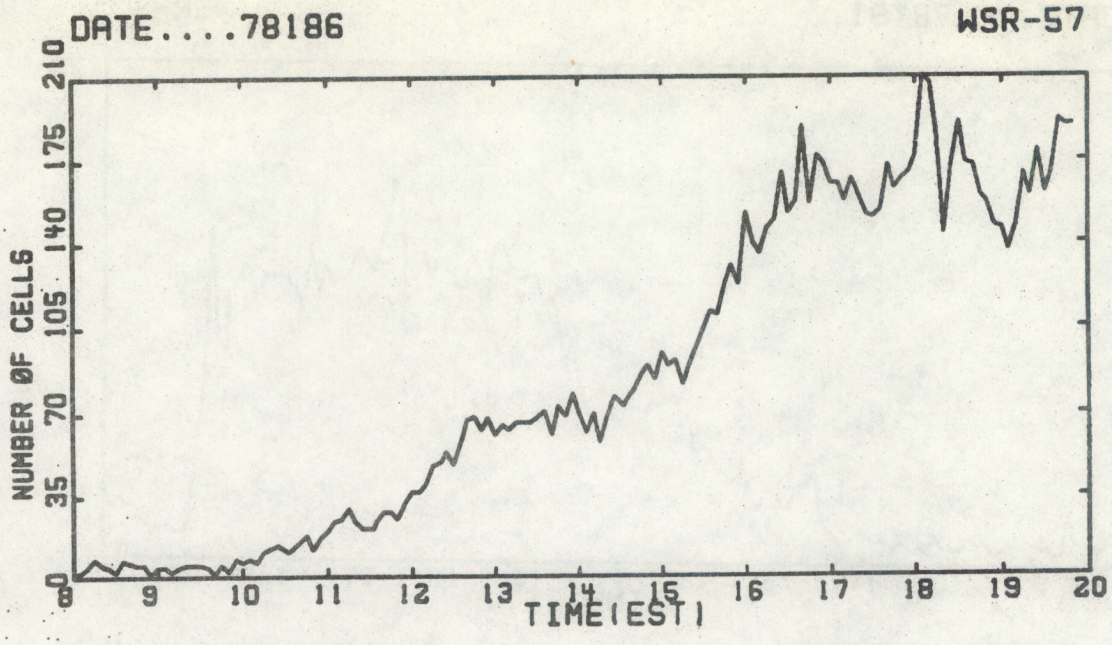

DATE....78184
WSR-57
NUMBER ØF ECHØES
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TIME(EST)

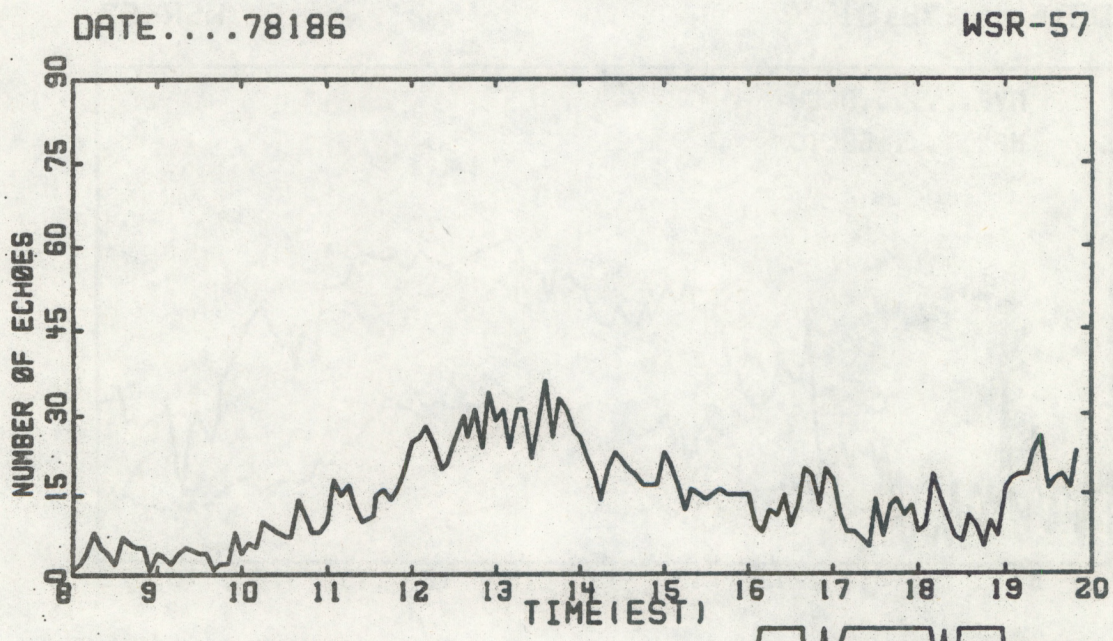

DATE....78184
WSR-57
AVE. ECHØ AREA(KM**2)
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TIME(EST)

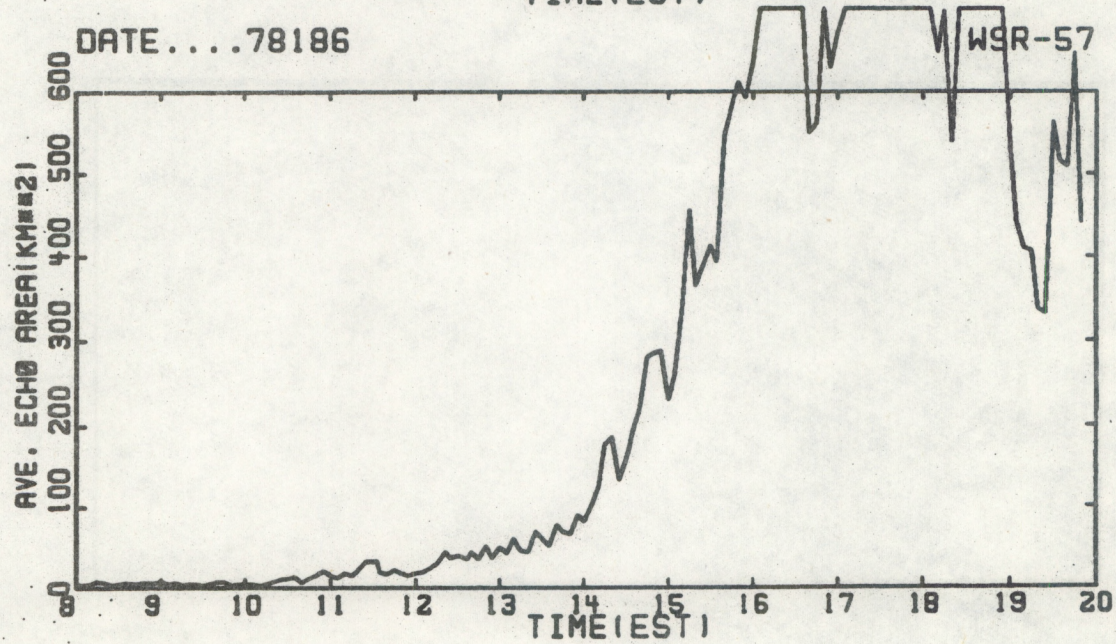

DATE....78186
WSR-57
AVE. CELL AREA(KM**2)
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TIME(EST)

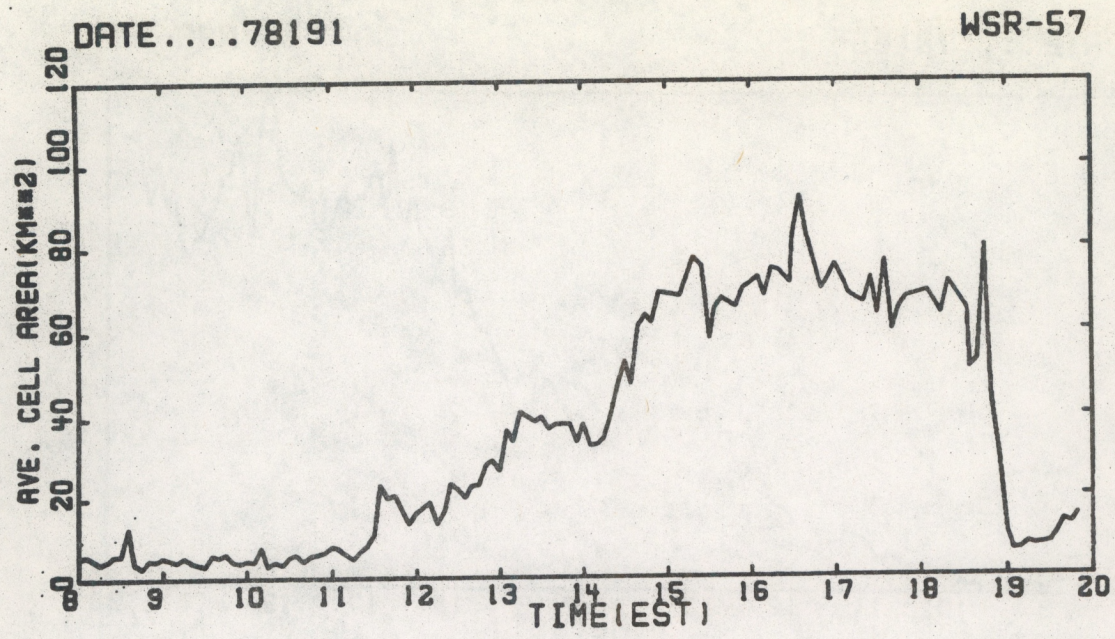

DATE....78186
WSR-57
AVE.....DASH
MAX.....SOLID
CELL REFLECTIVITY(DBZ)
15
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TIME(EST)

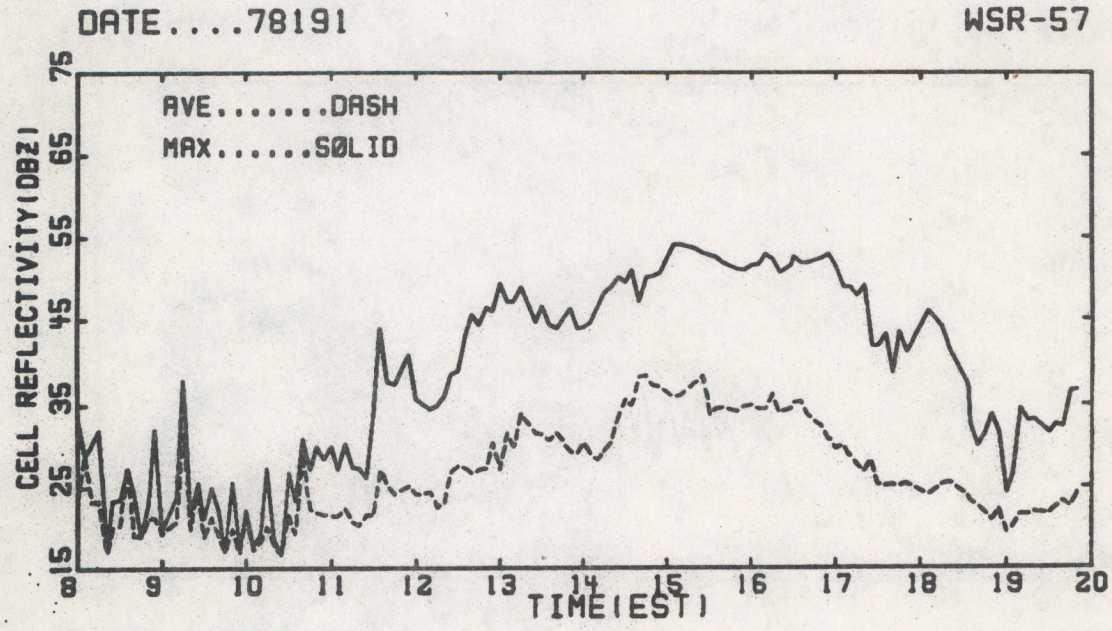


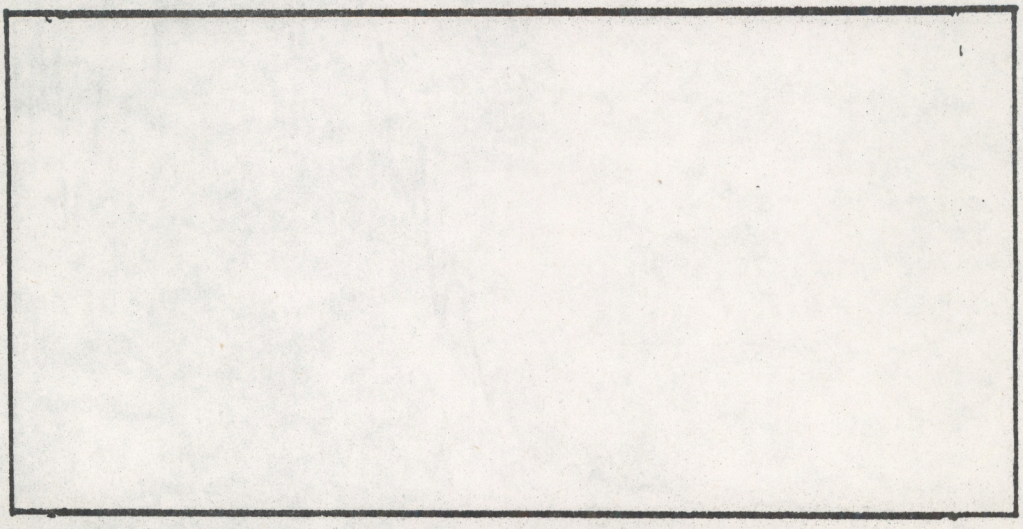

DATE....78186
WSR-57
NUMBER OF CELLS
0
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TIME(EST)

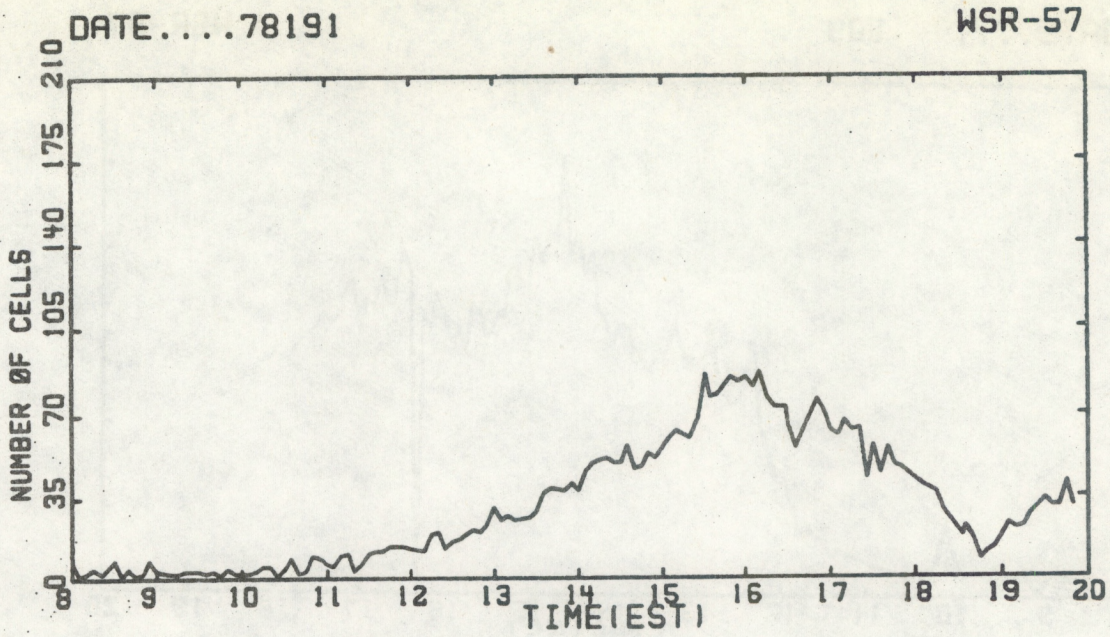

DATE....78186
WSR-57
NUMBER OF ECHOES
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TIME(EST)

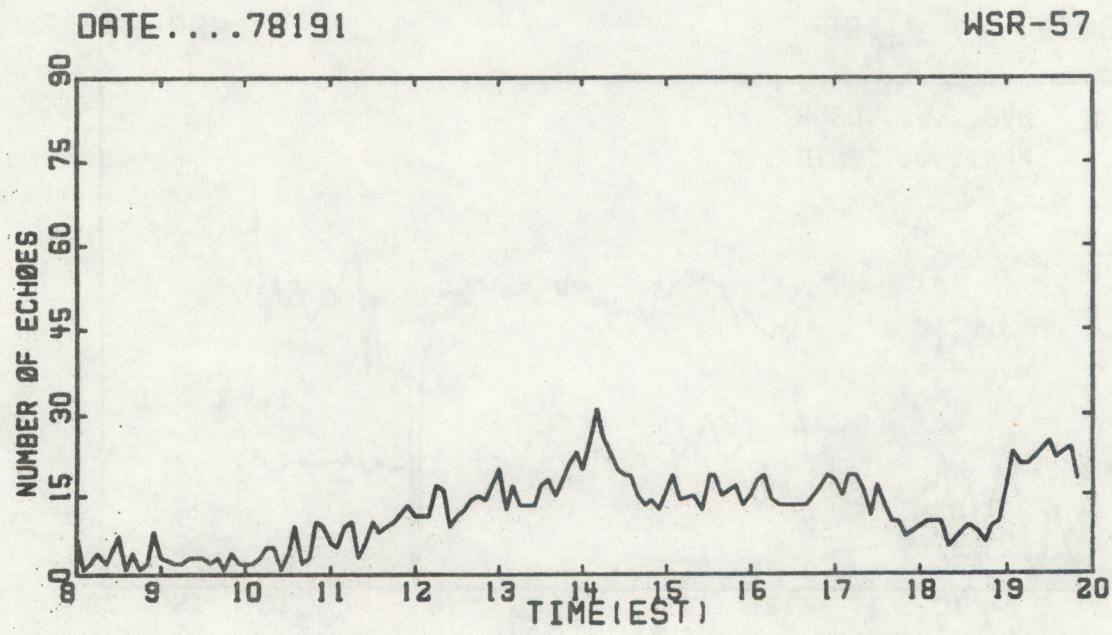

DATE....78186
WSR-57
AVE. ECHO AREA(KM**2)
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TIME(EST)

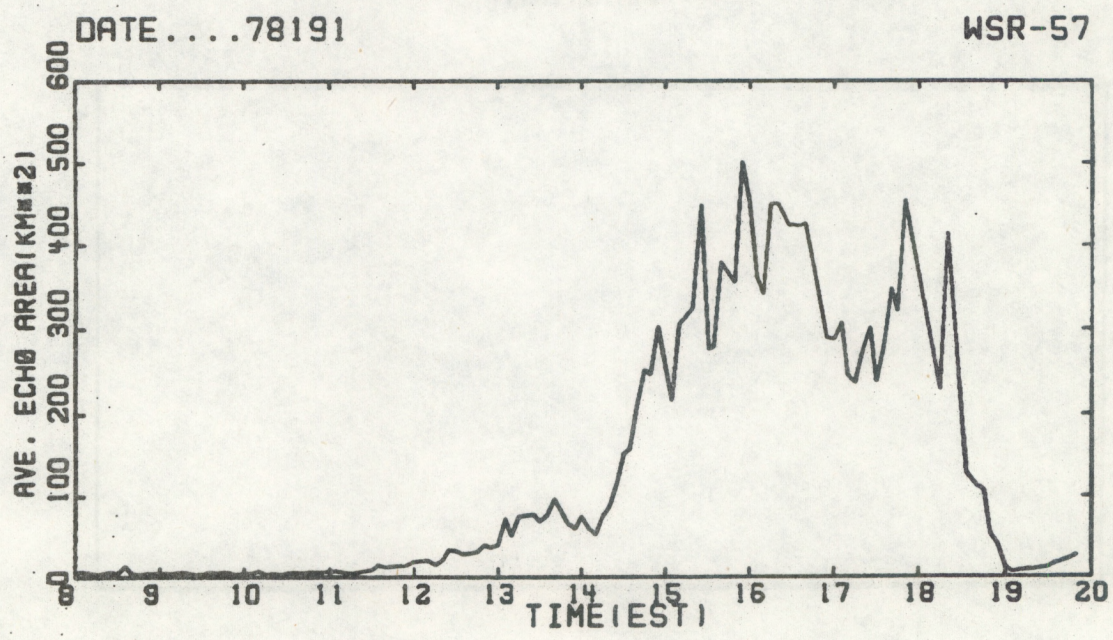

DATE....78191
WSR-57
AVE. CELL AREA(KM**2)
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TIME(EST)

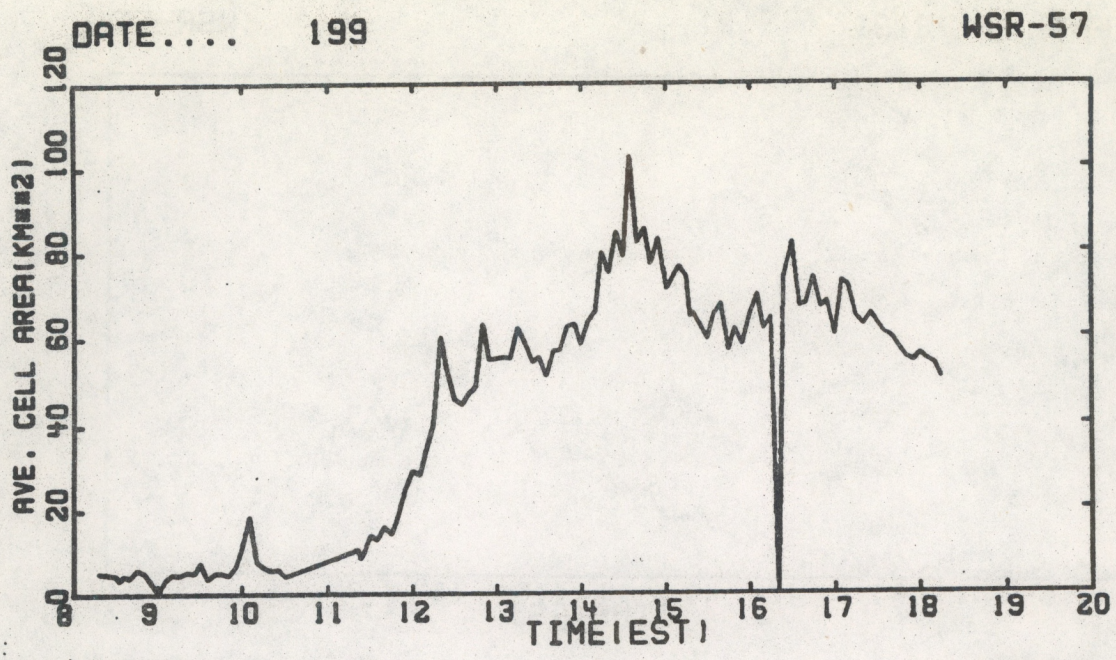

DATE....78191
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
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TIME(EST)

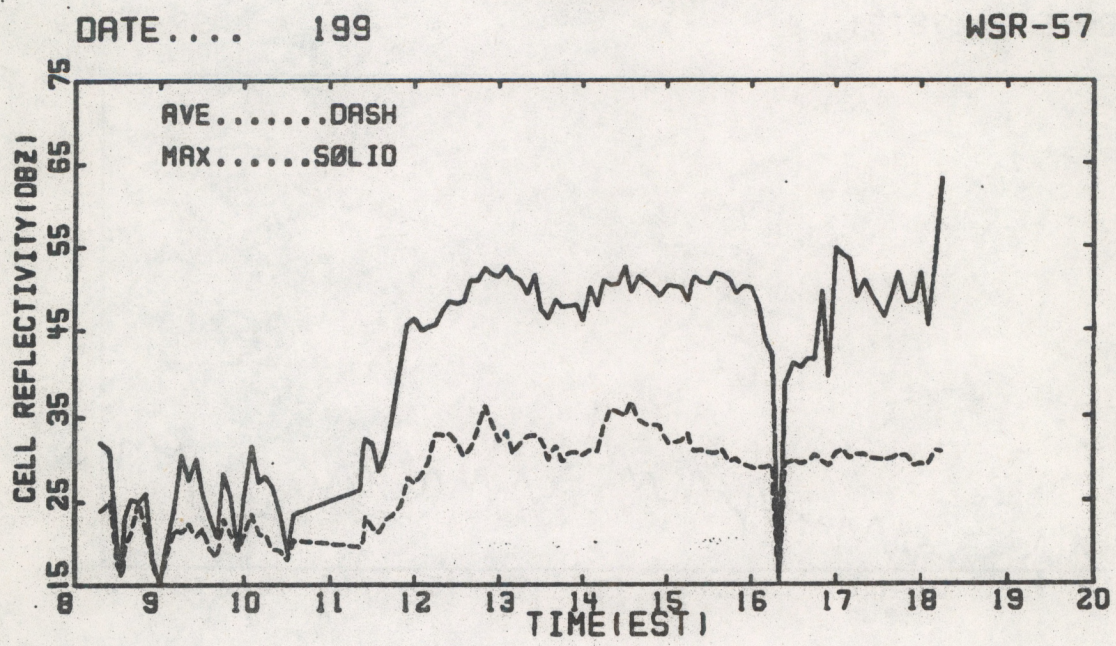


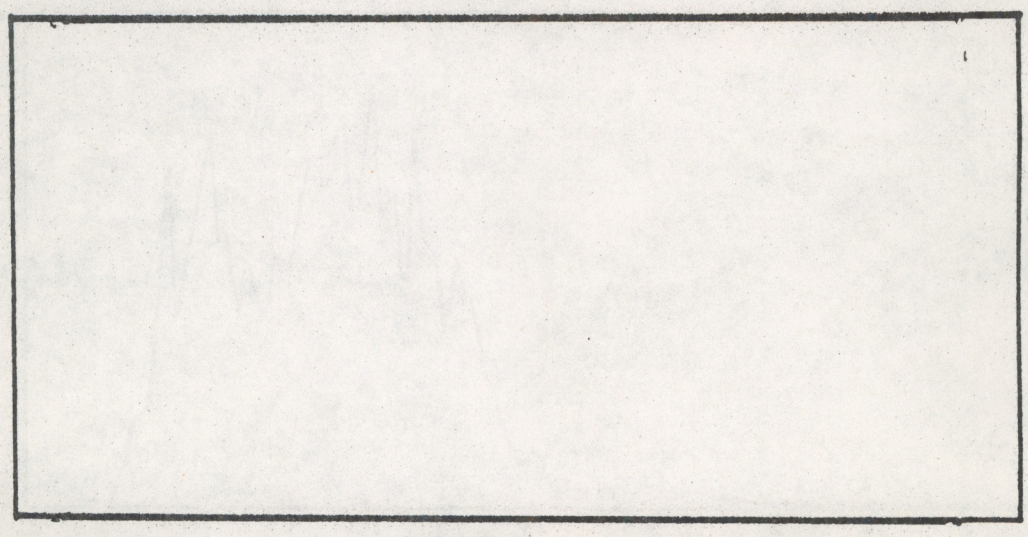

DATE....78191
WSR-57
NUMBER ØF CELLS
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35
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105
140
175
210
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20
TIME(EST)

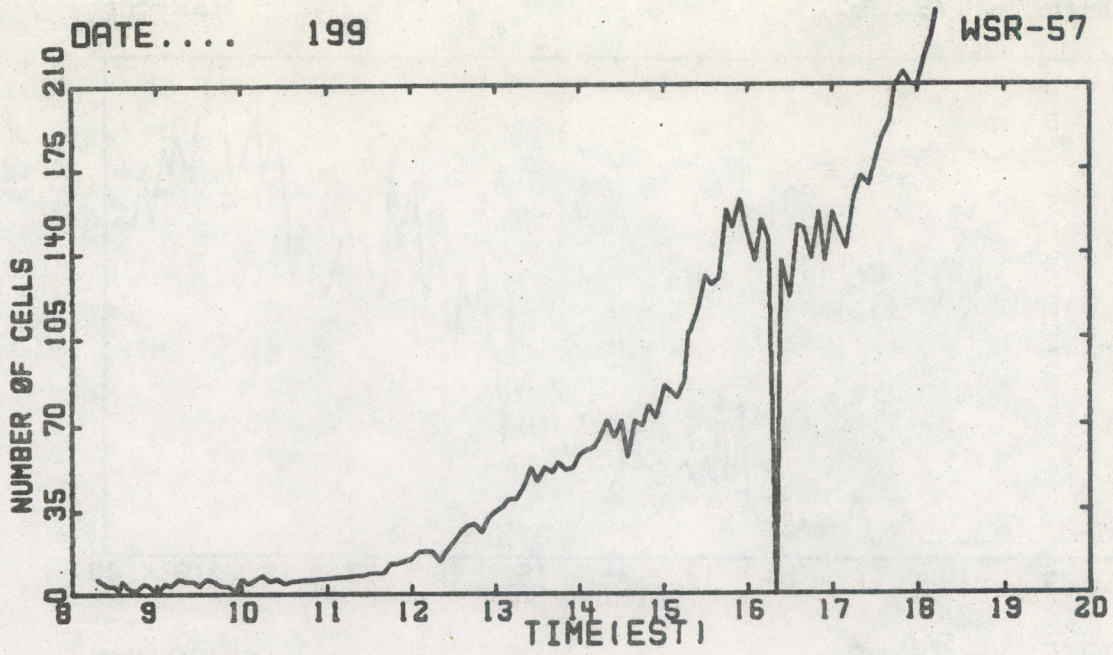

DATE....78191
WSR-57
NUMBER ØF ECHØES
0
15
30
45
60
75
90
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

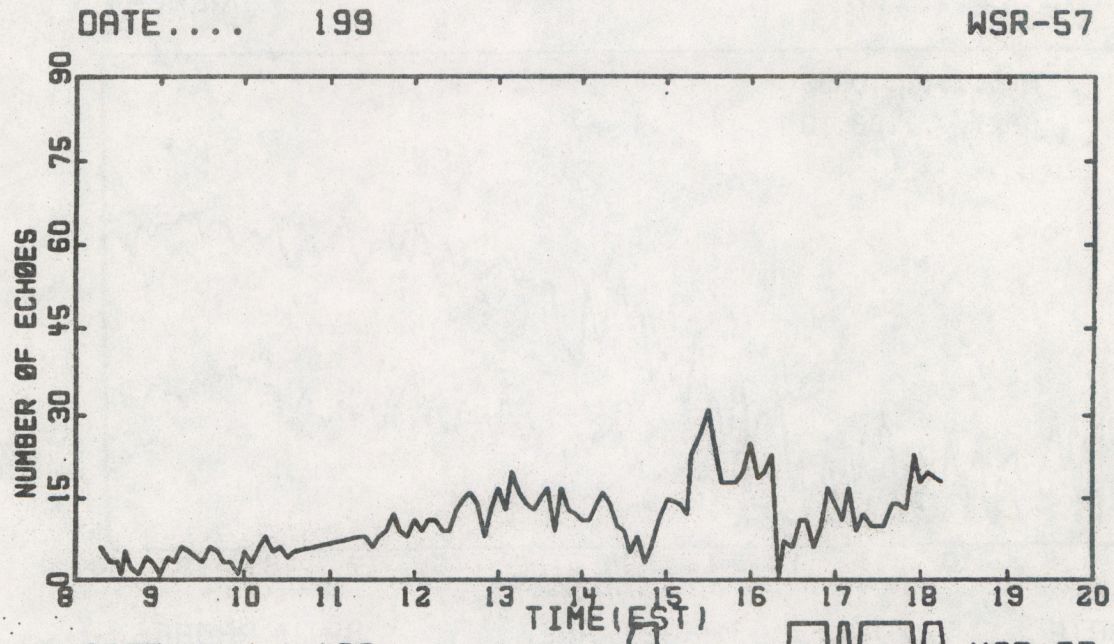

DATE....78191
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

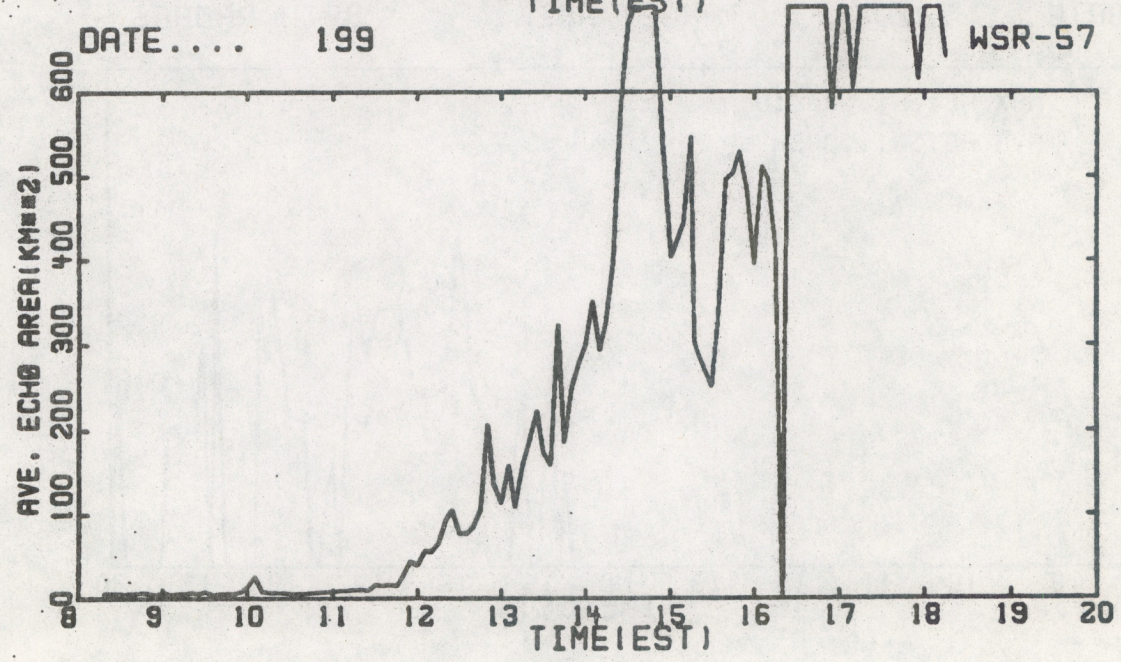

DATE.... 199
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

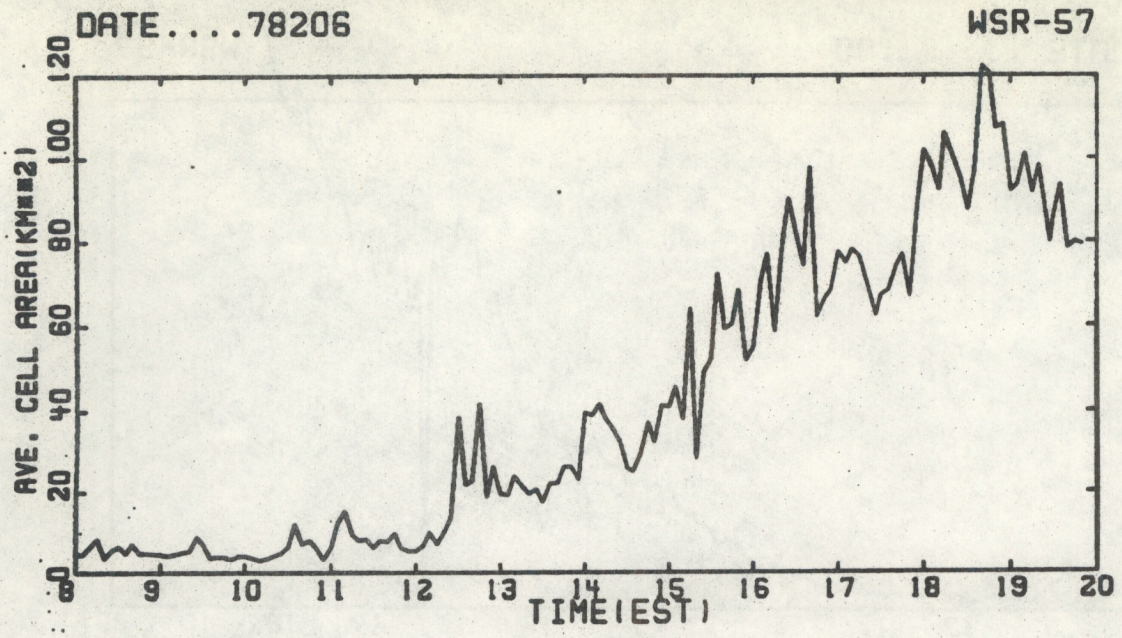

DATE.... 199
WSR-57
CELL REFLECTIVITY(DBZ)
AVE.....DASH
MAX.....SØLID
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

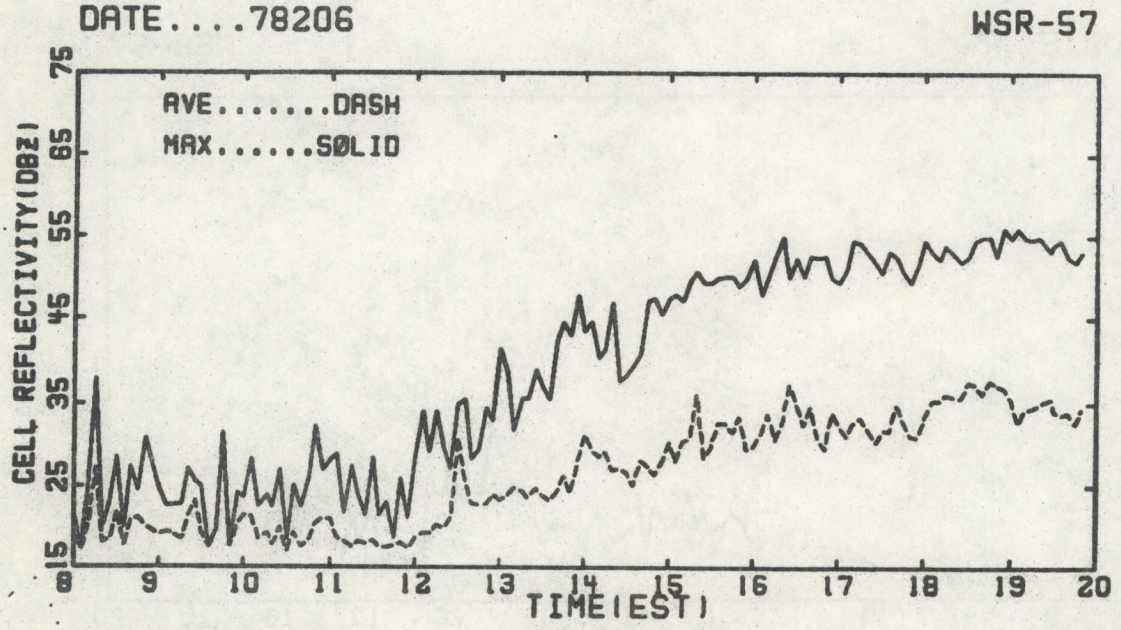


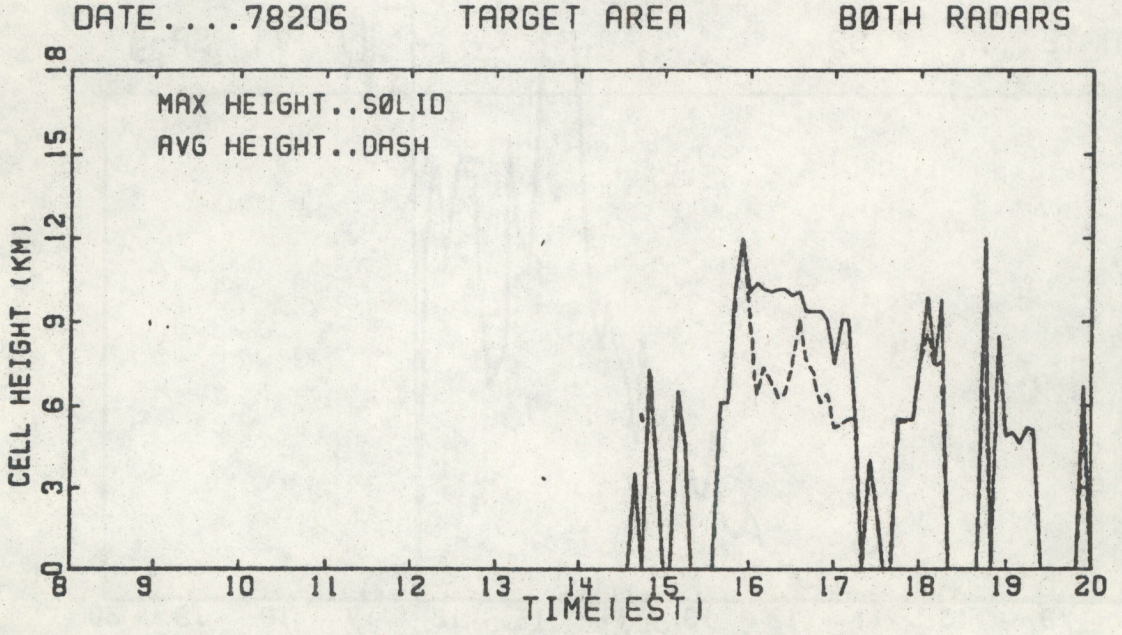

DATE.... 199
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

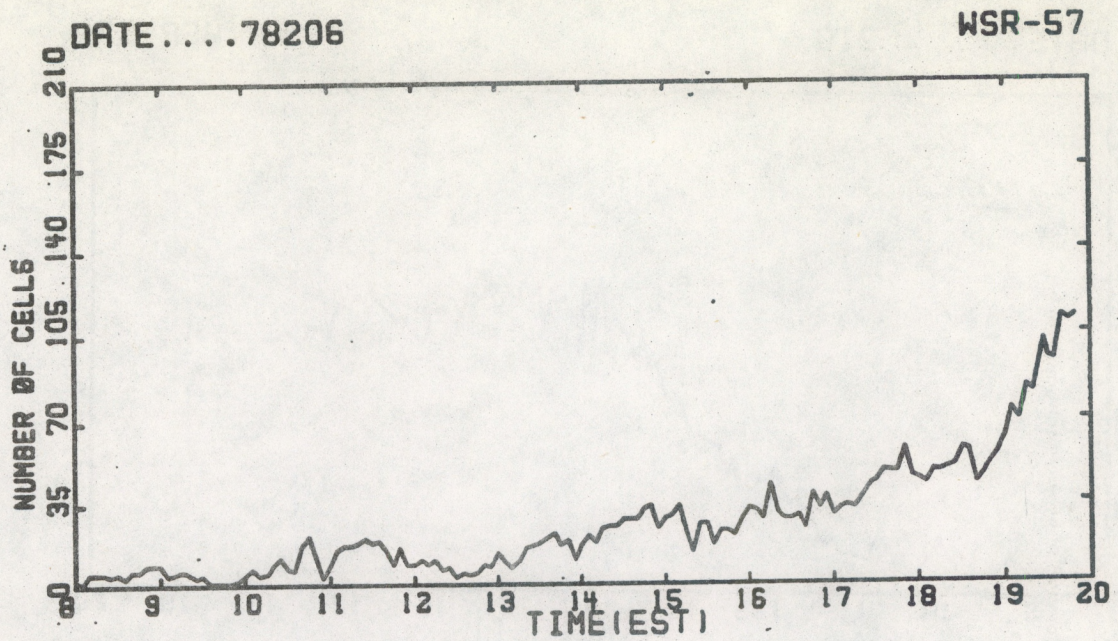

DATE.... 199
WSR-57
NUMBER ØF ECHØES
0
15
30
45
60
75
90
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

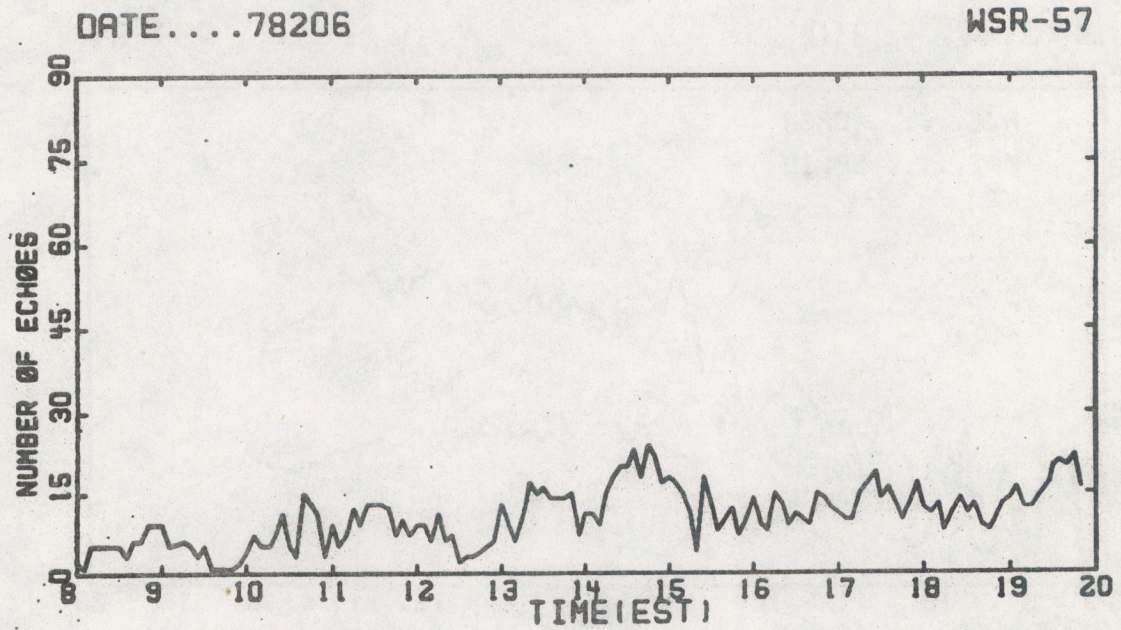

DATE.... 199
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

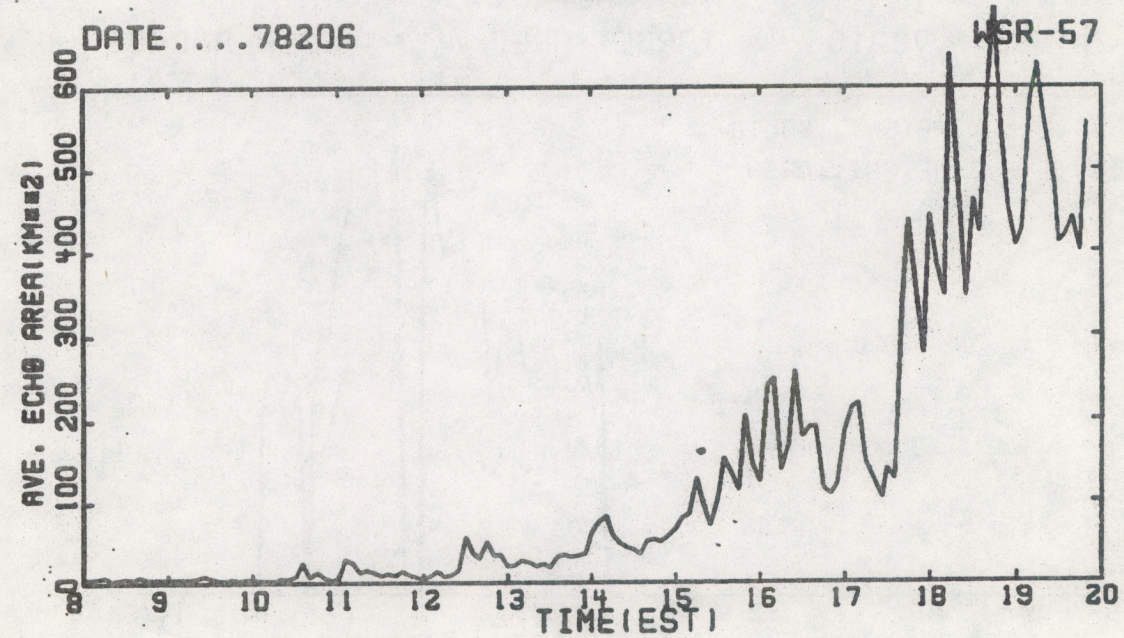

DATE....78206
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

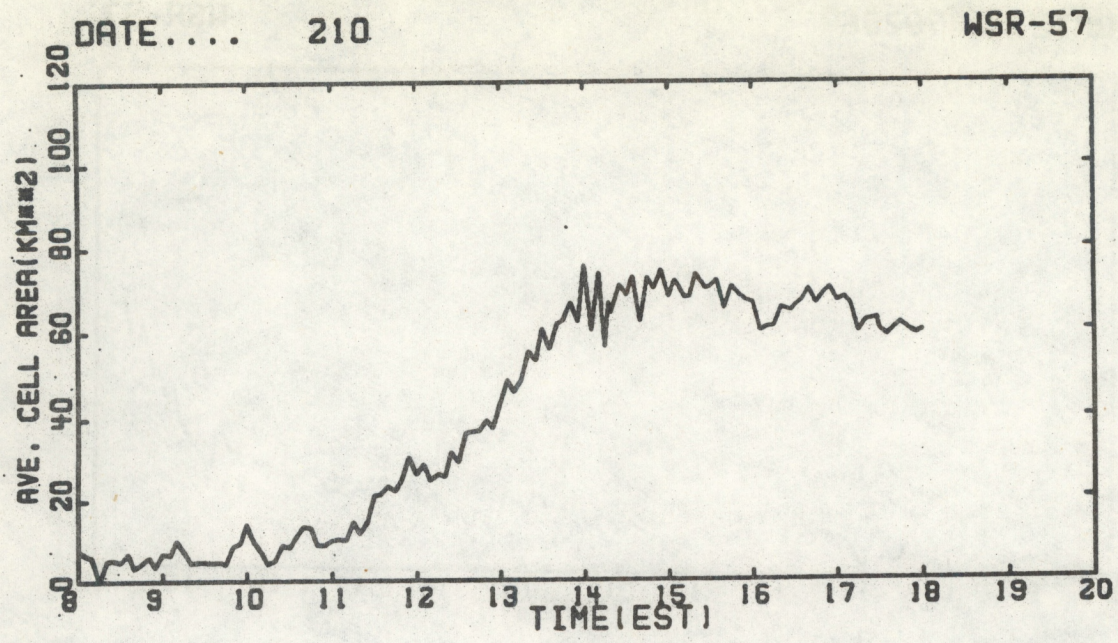

DATE....78206
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

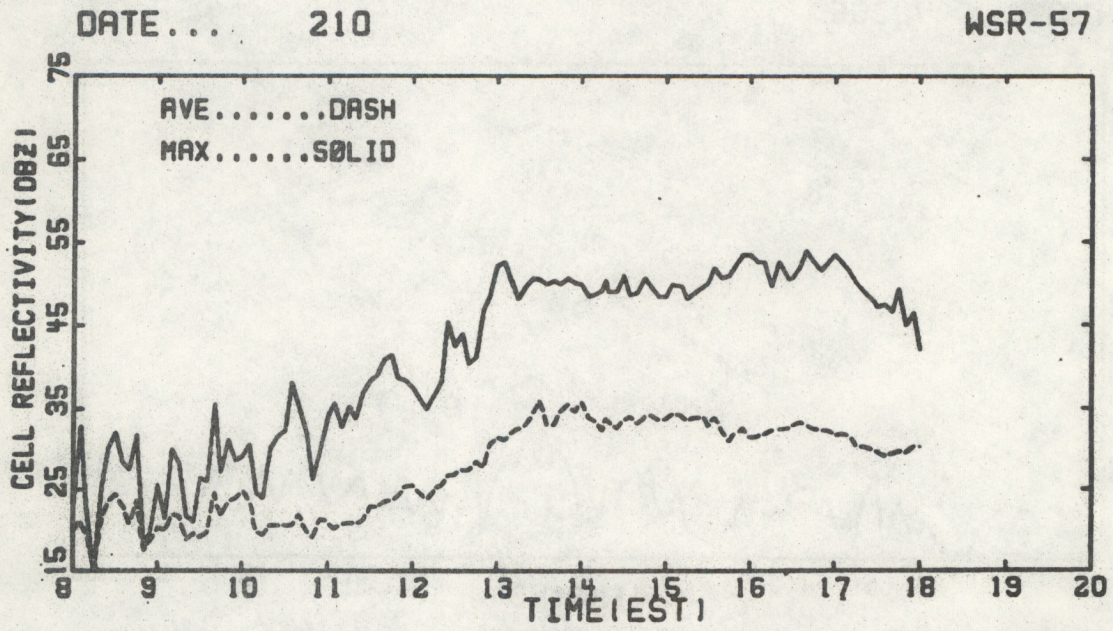

DATE....78206
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

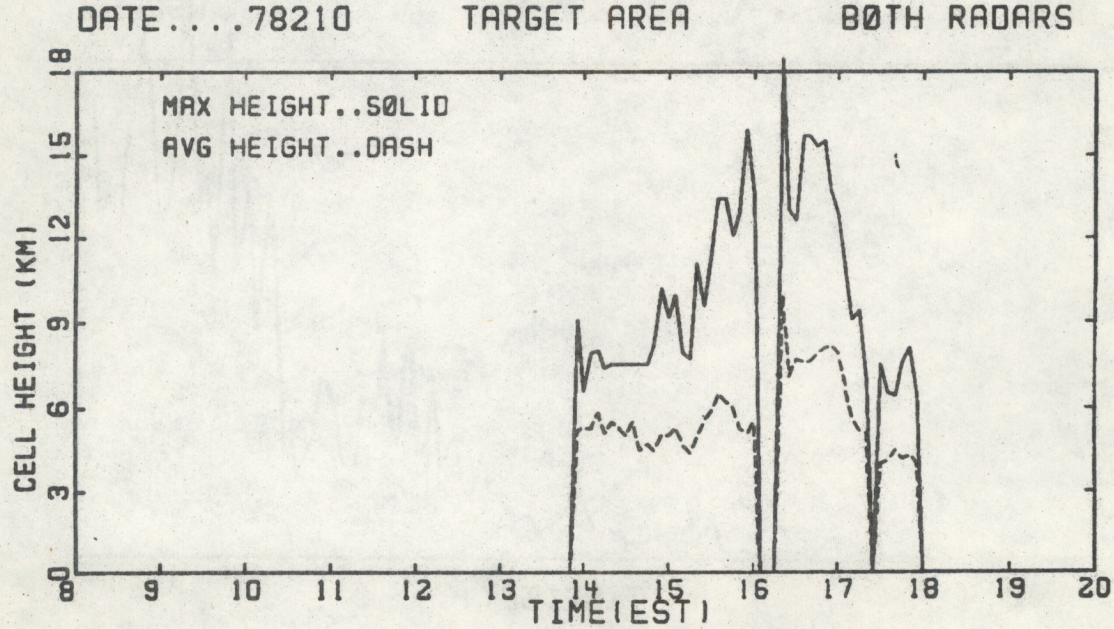

DATE....78206
WSR-57
NUMBER OF CELLS
0
35
70
105
140
175
210
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

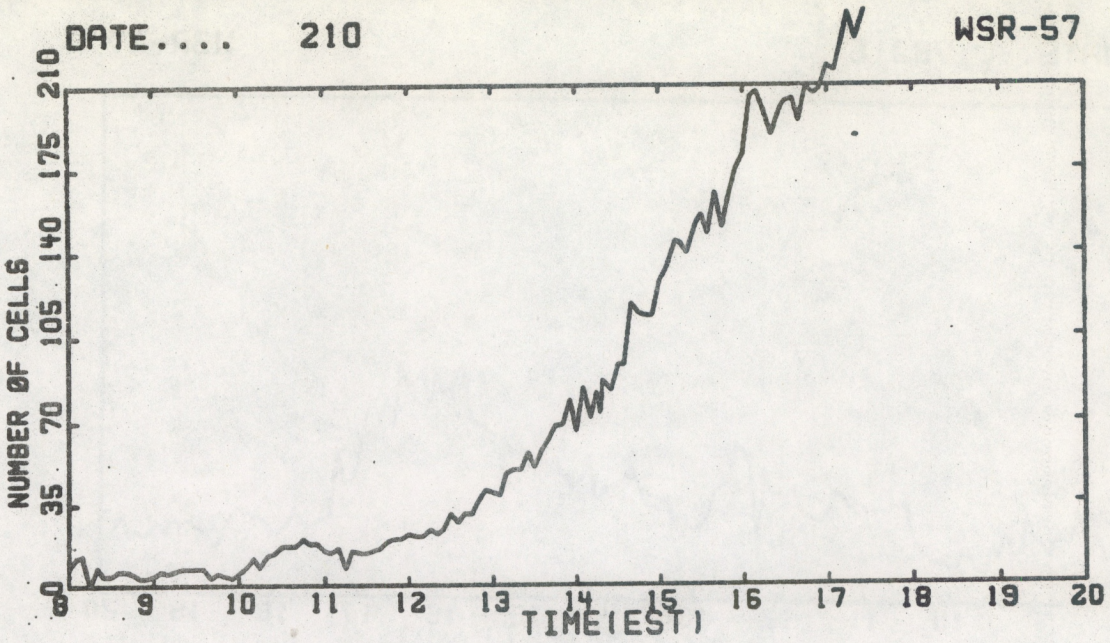

DATE....78206
WSR-57
NUMBER OF ECHOES
0
15
30
45
60
75
90
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

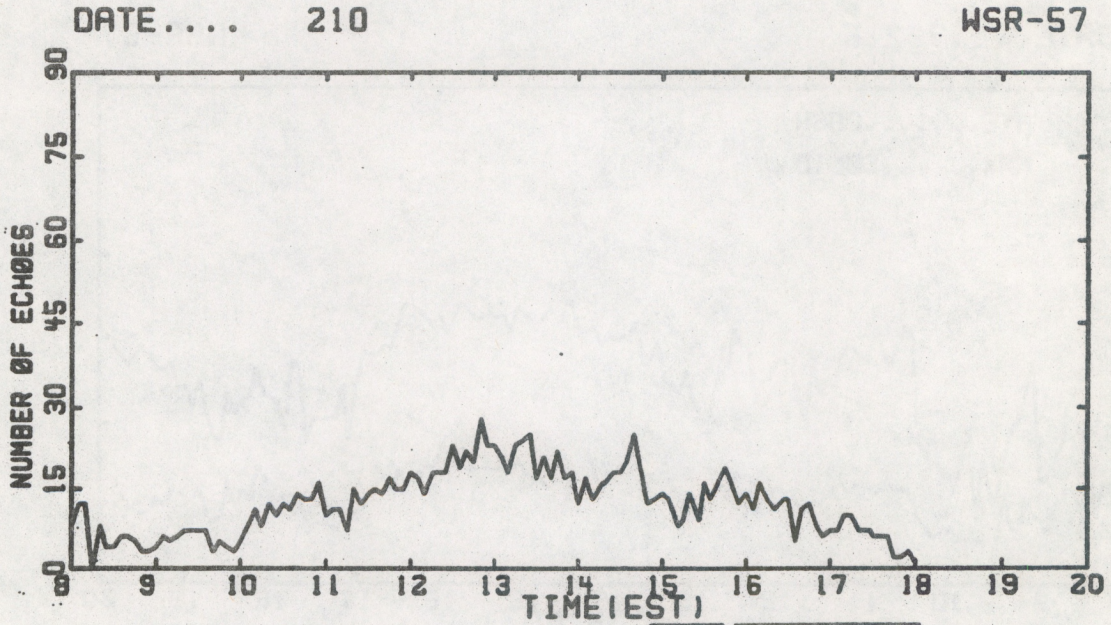

DATE....78206
WSR-57
AVE. ECHO AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

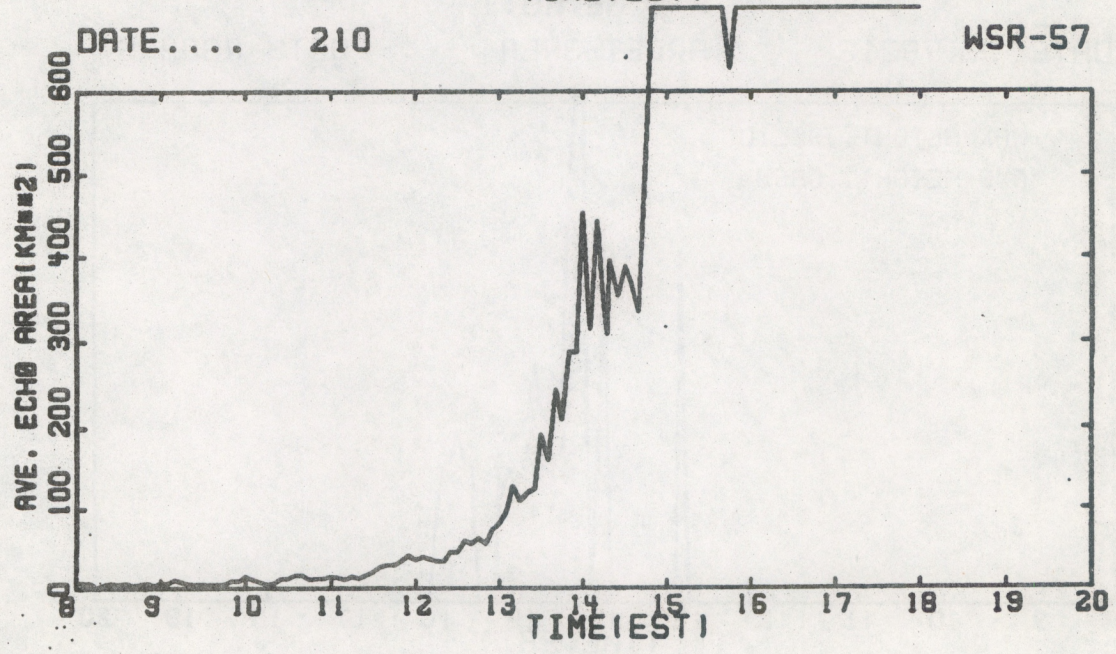

DATE.... 210
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

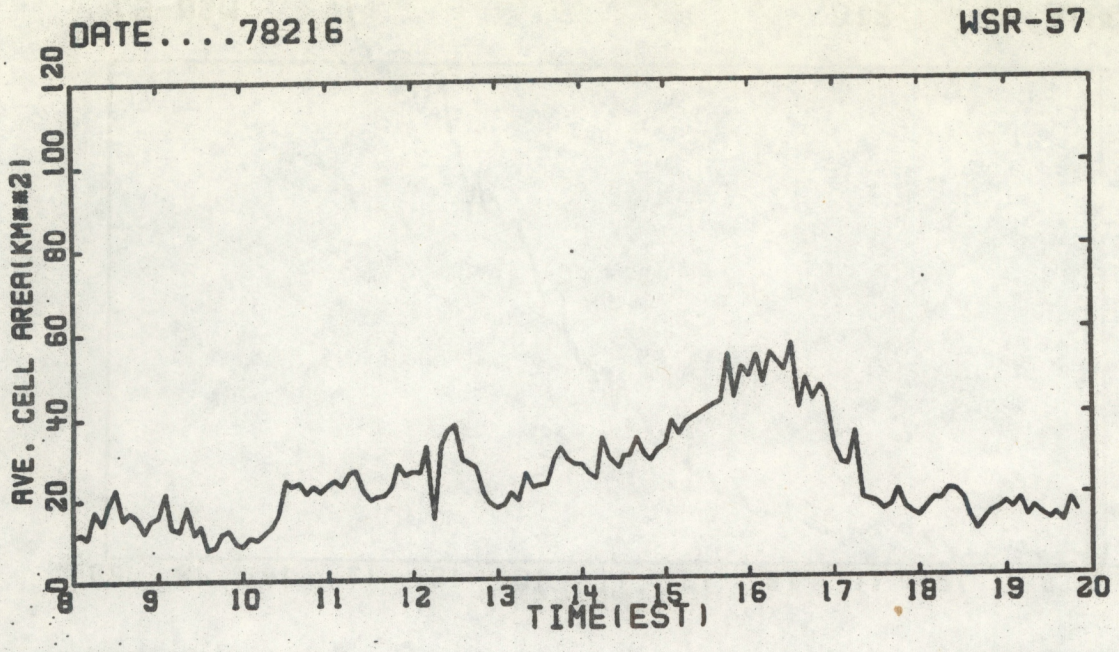

DATE... 210
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

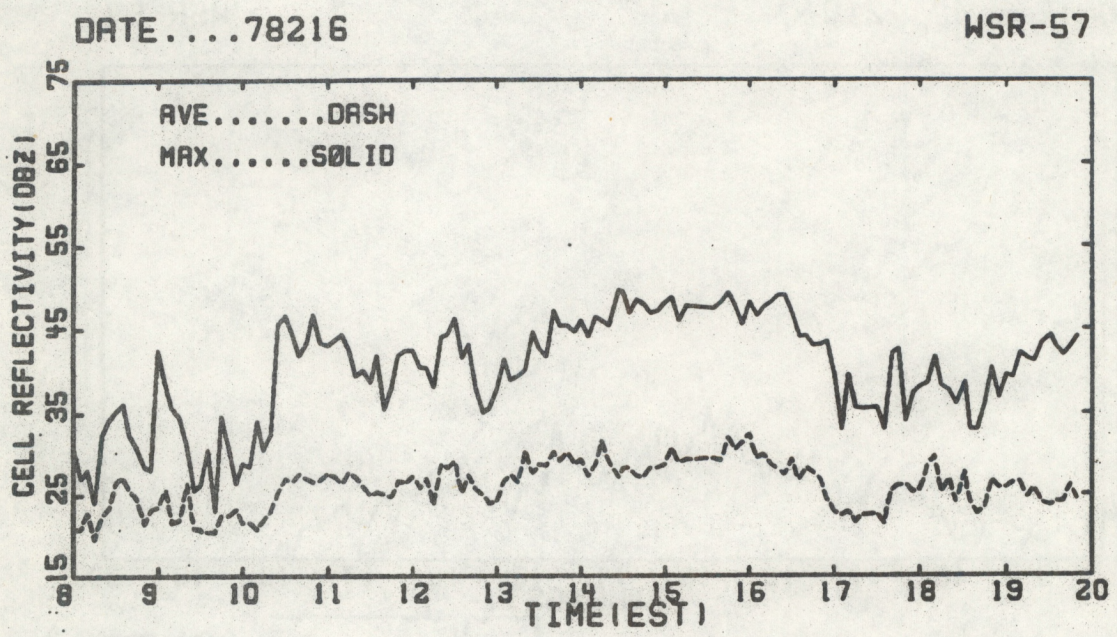

DATE....78210 TARGET AREA BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

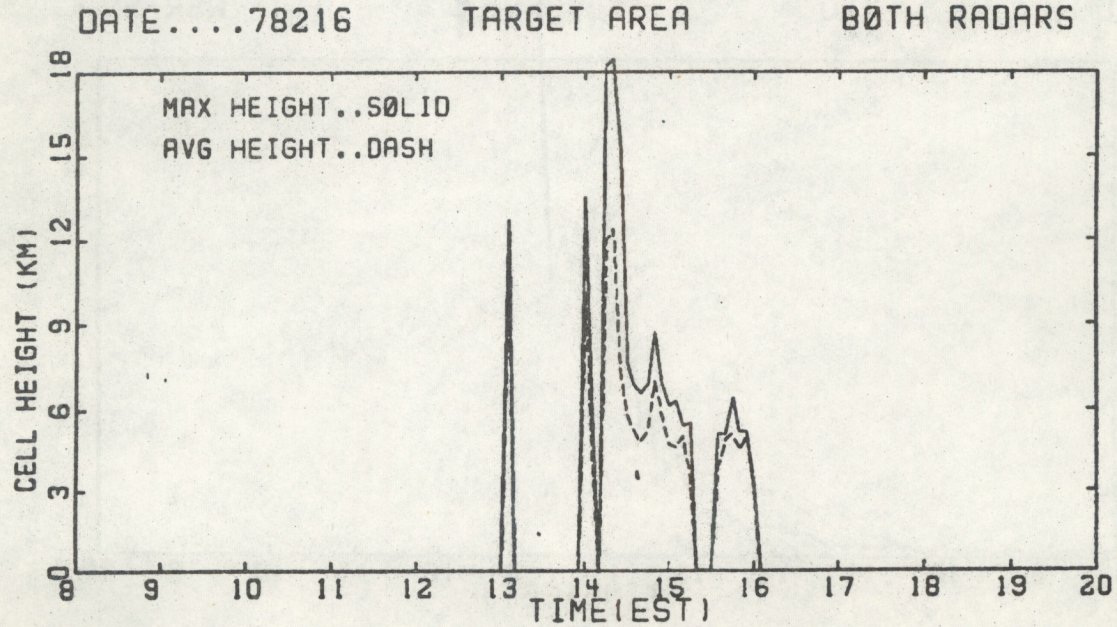

DATE.... 210
WSR-57
NUMBER OF CELLS
0
35
70
105
140
175
210
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

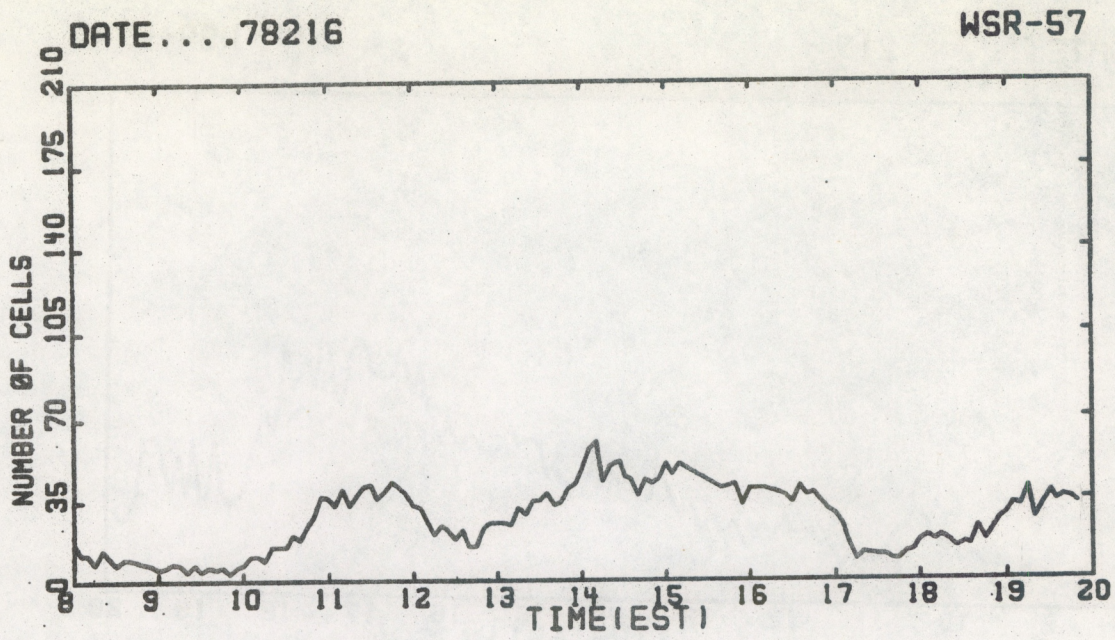

DATE.... 210
WSR-57
NUMBER OF ECHOES
0
15
30
45
60
75
90
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

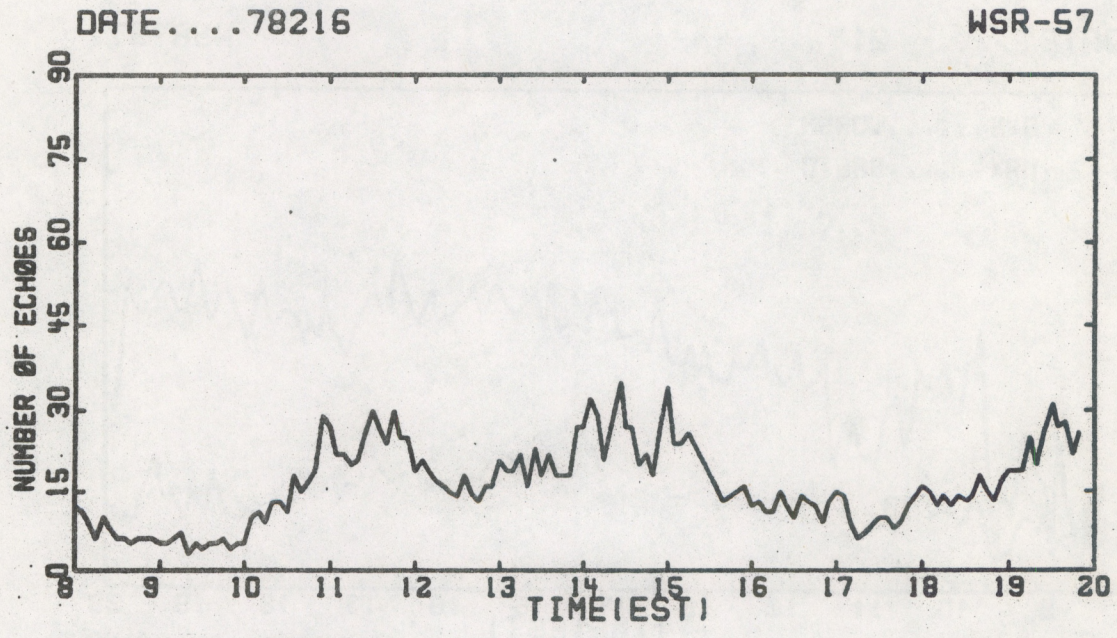

DATE.... 210
WSR-57
AVE. ECHO AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

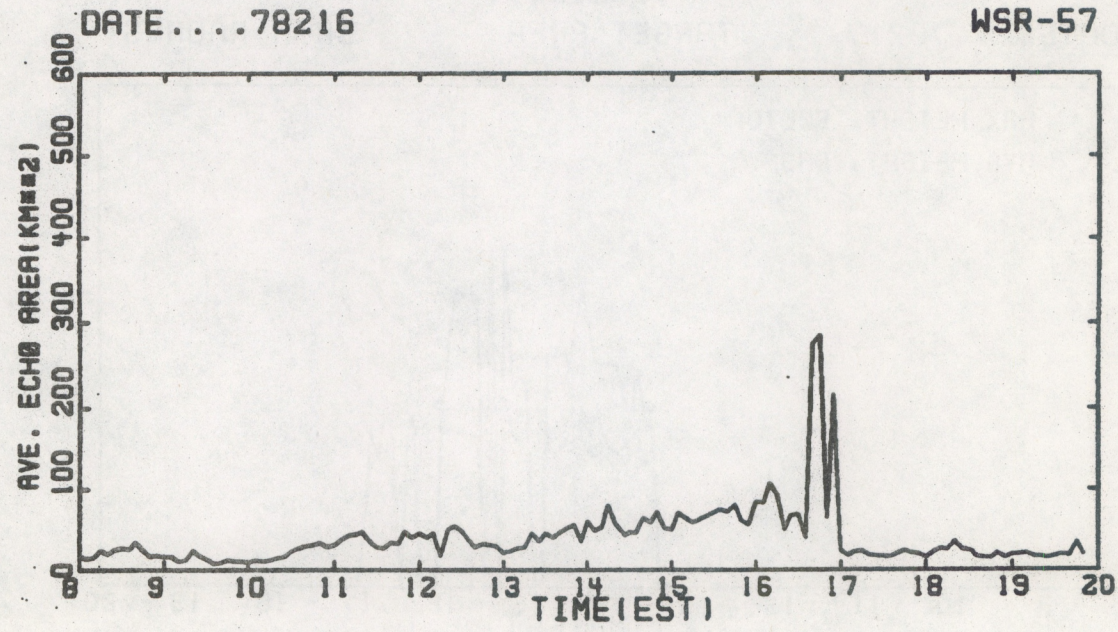

DATE....78216
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

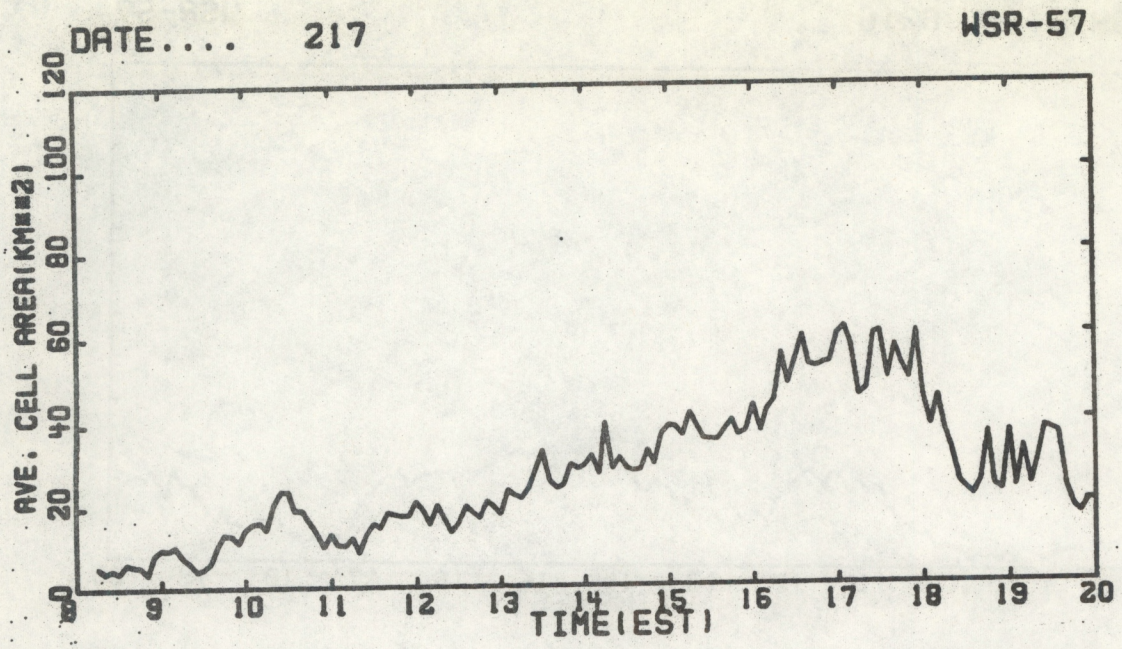

DATE....78216
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

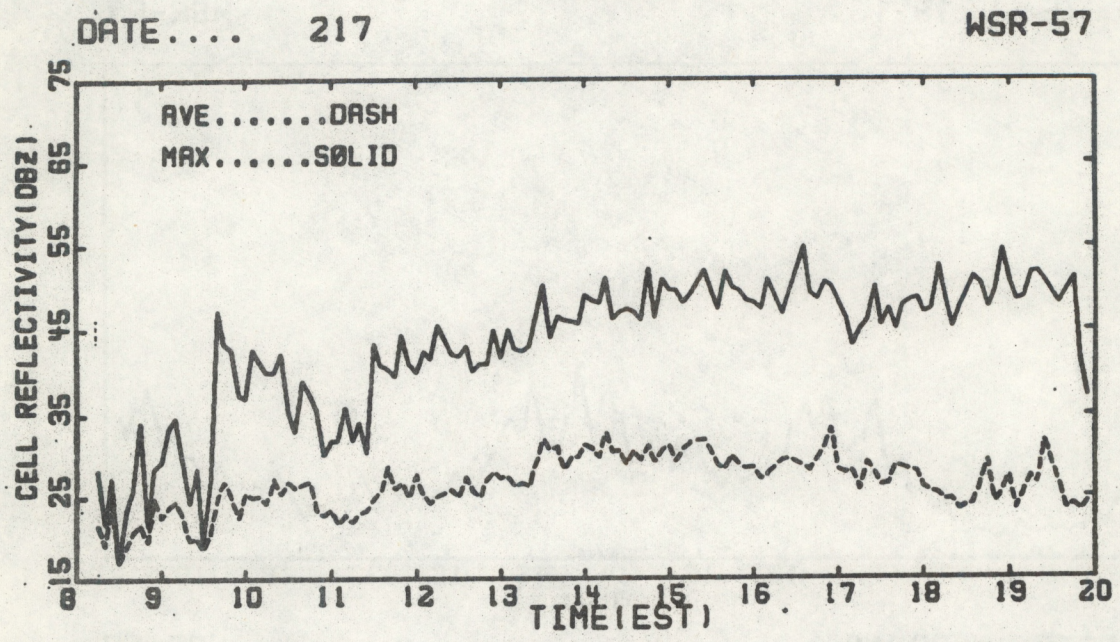

DATE....78216
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

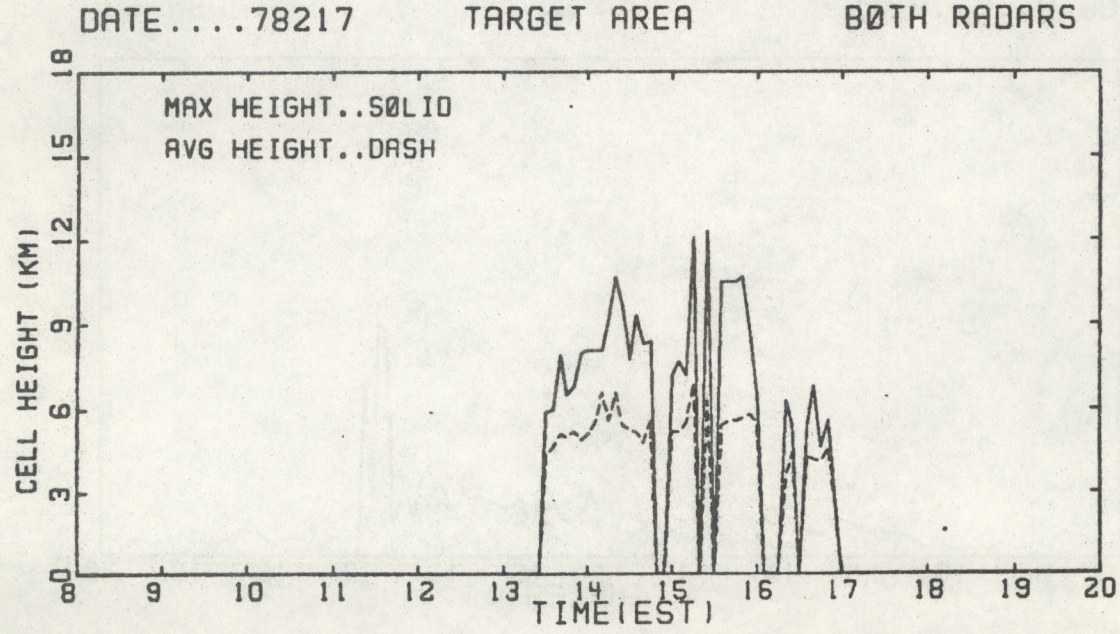

DATE....78216
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

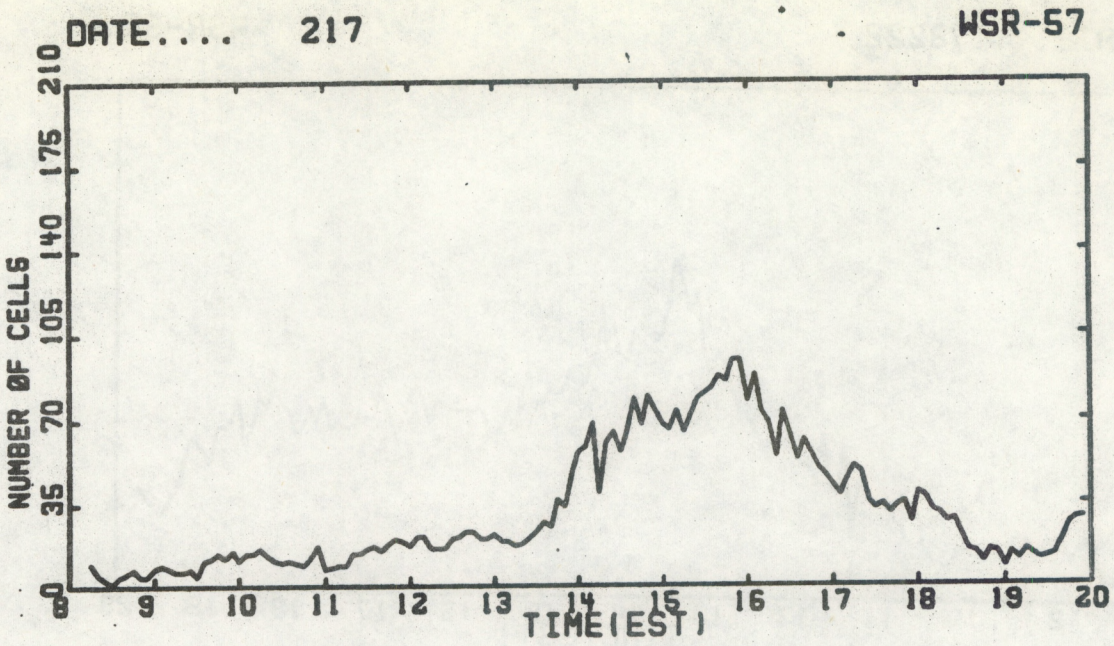

DATE....78216
WSR-57
NUMBER ØF ECHØES
0
15
30
45
60
75
90
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

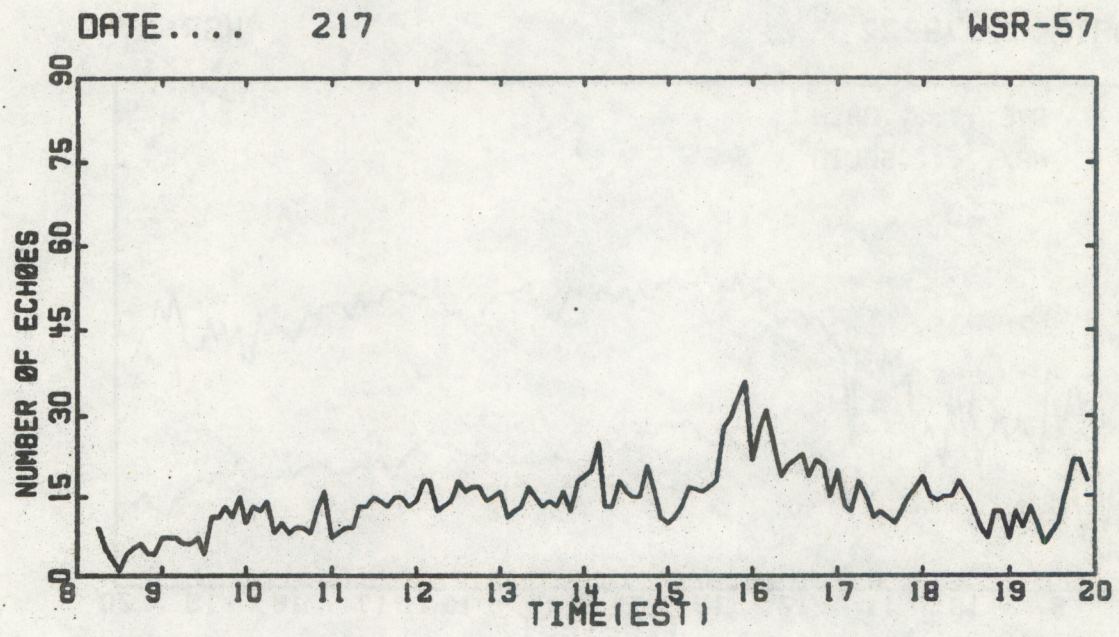

DATE....78216
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

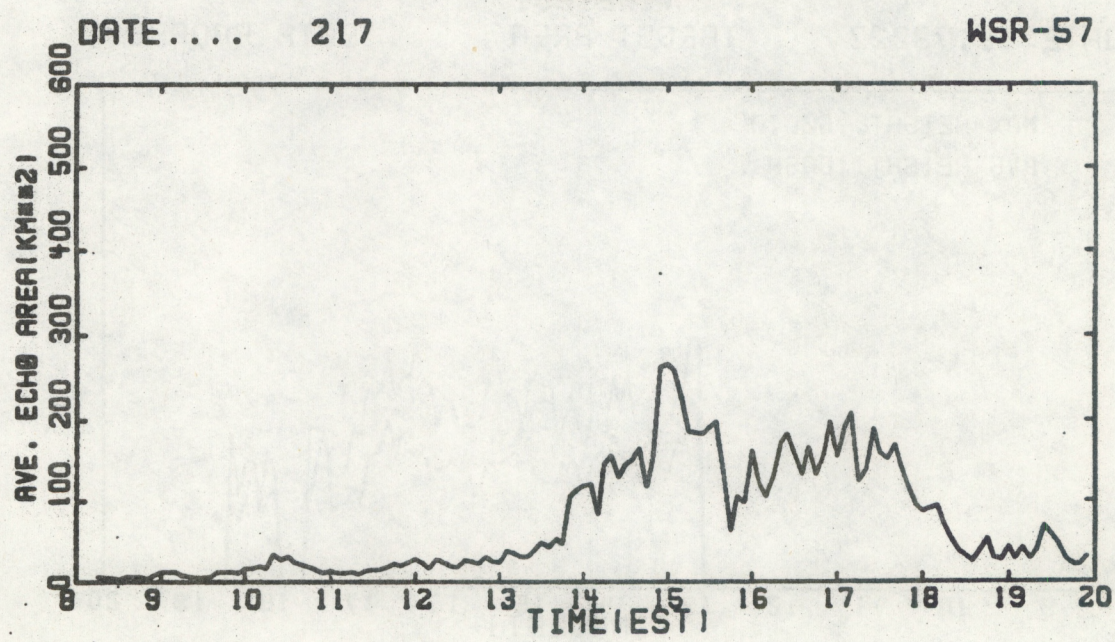

DATE.... 217
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

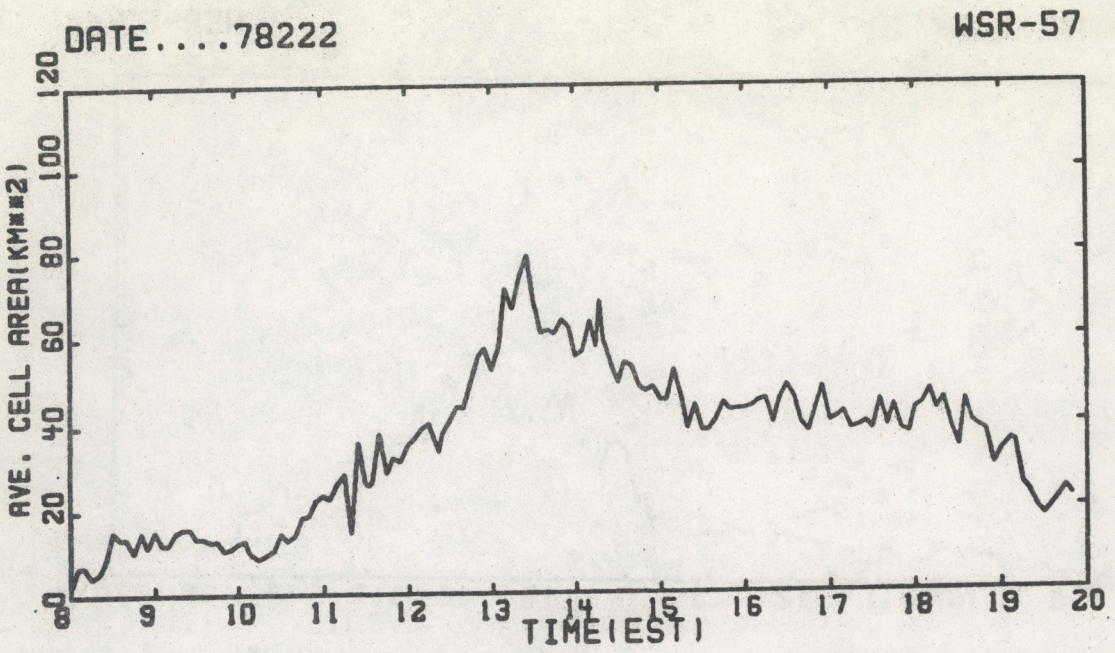

DATE.... 217
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

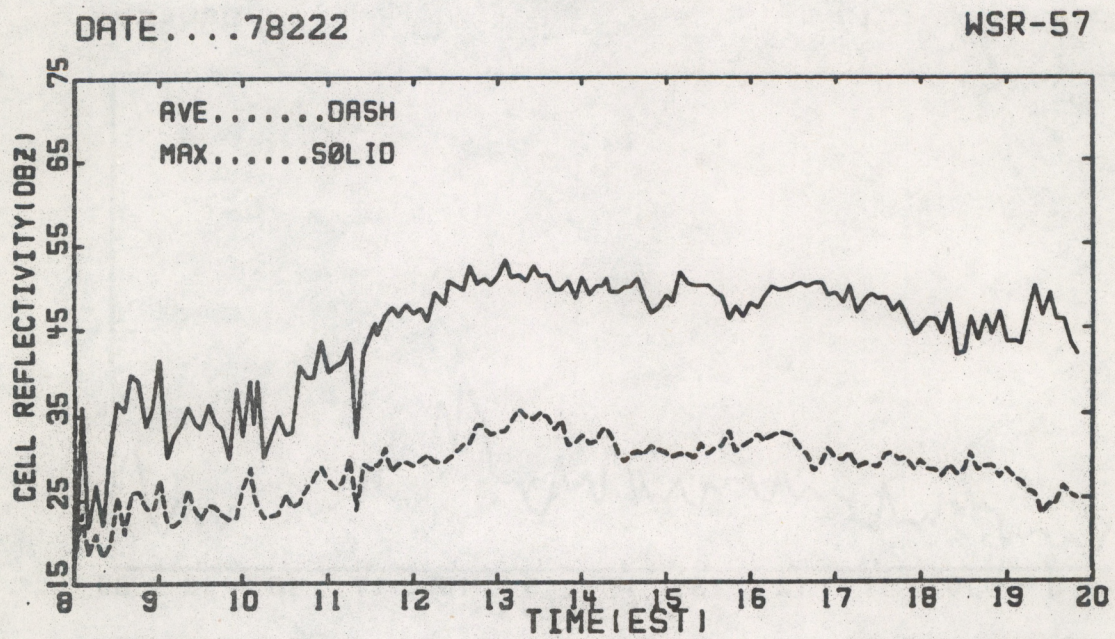

DATE....78217 TARGET AREA BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

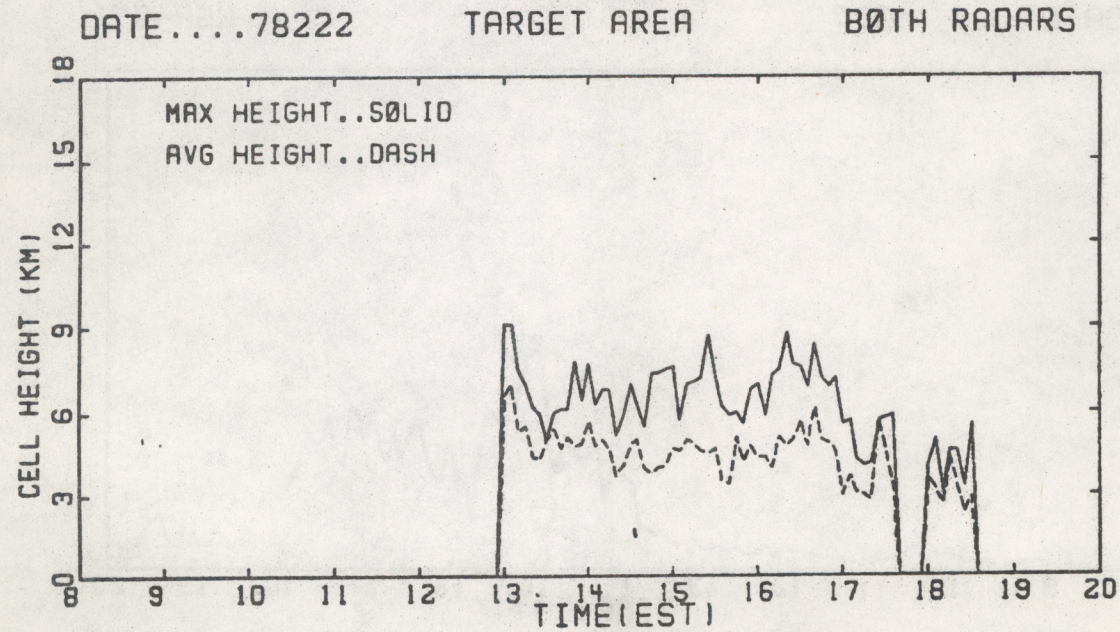

DATE.... 217
WSR-57
NUMBER OF CELLS
0
35
70
105
140
175
210
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

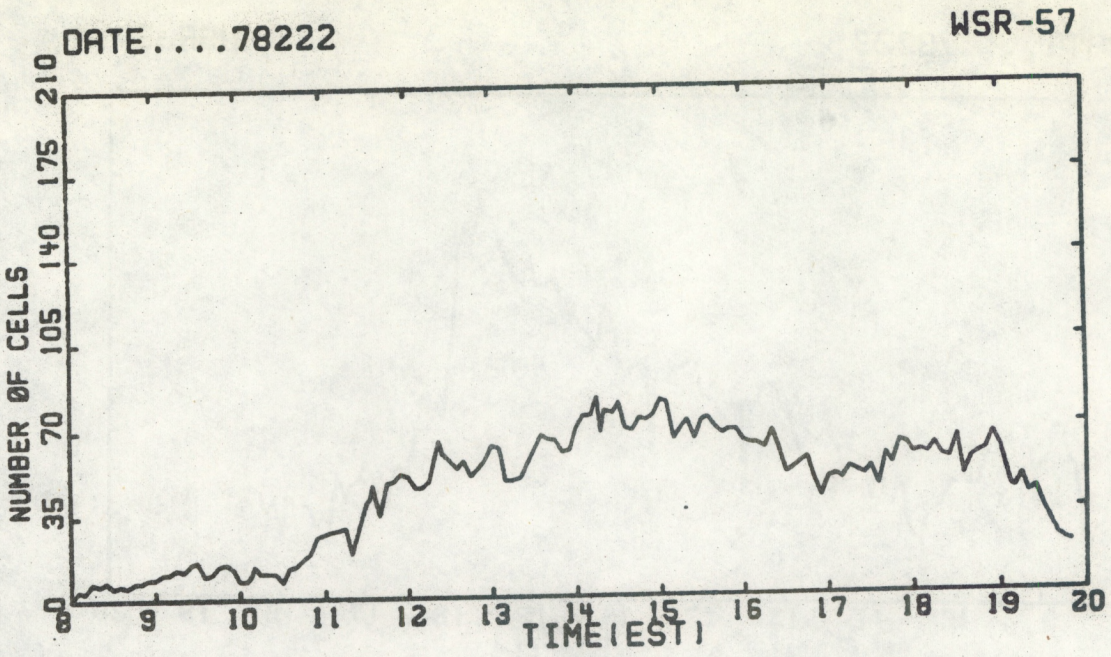

DATE.... 217
WSR-57
NUMBER OF ECHOES
0
15
30
45
60
75
90
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

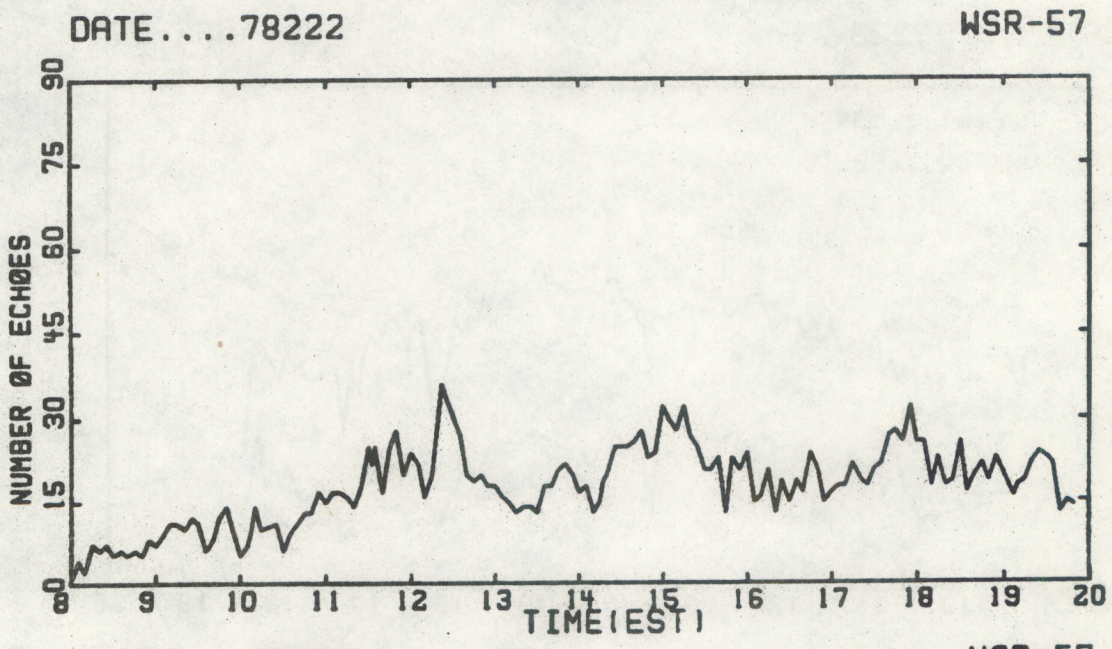

DATE.... 217
WSR-57
AVE. ECHO AREA(KM**2)
0
100
200
300
400
500
600
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

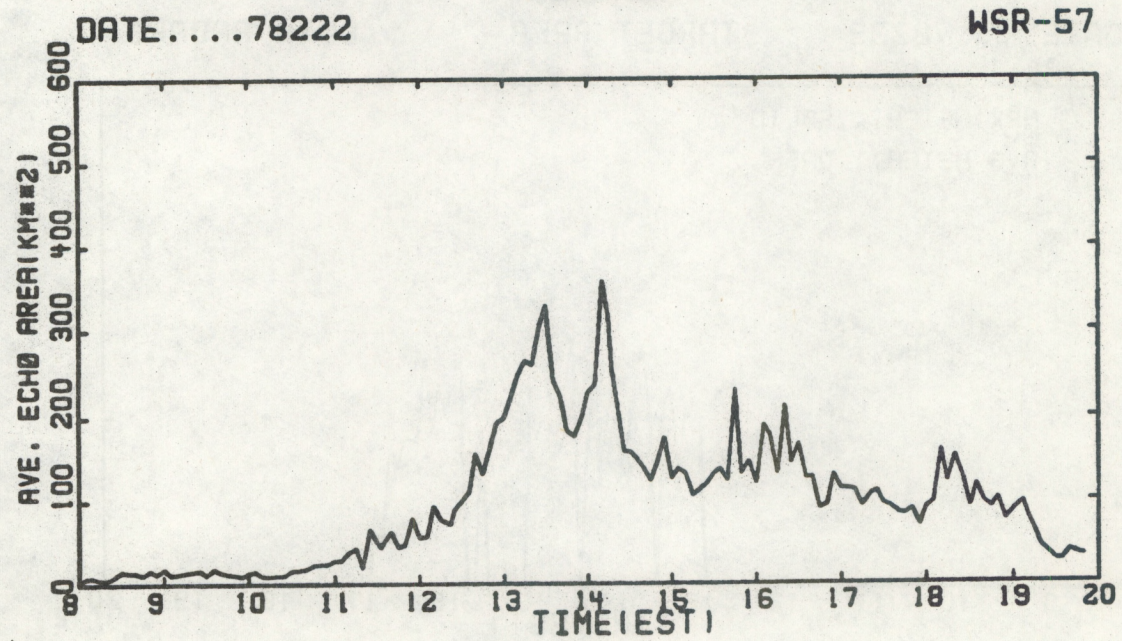

DATE....78222
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

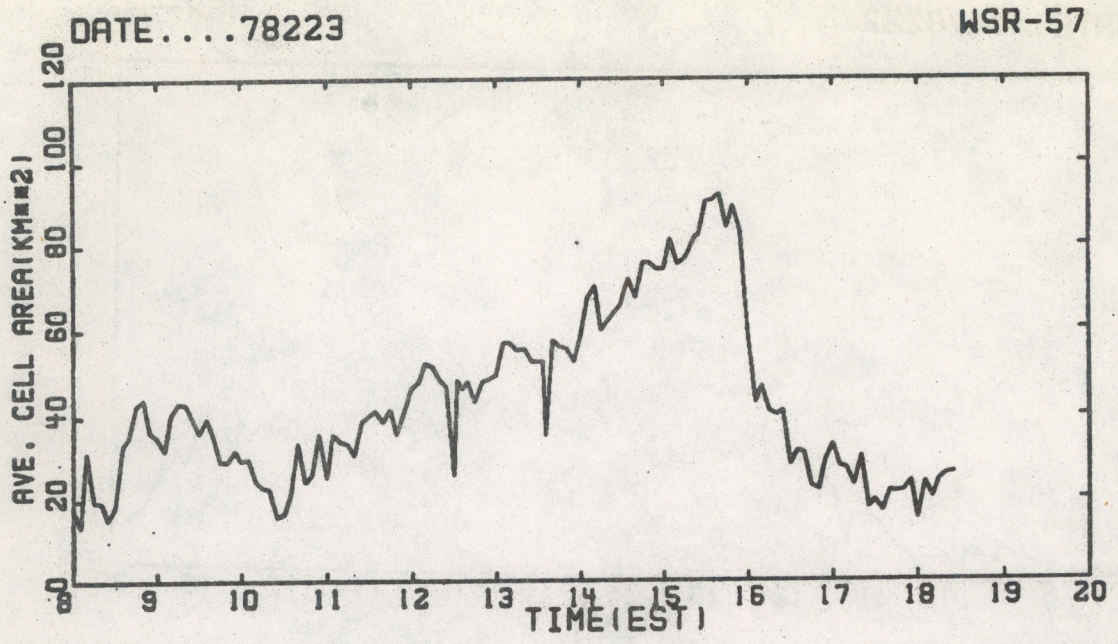

DATE....78222
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

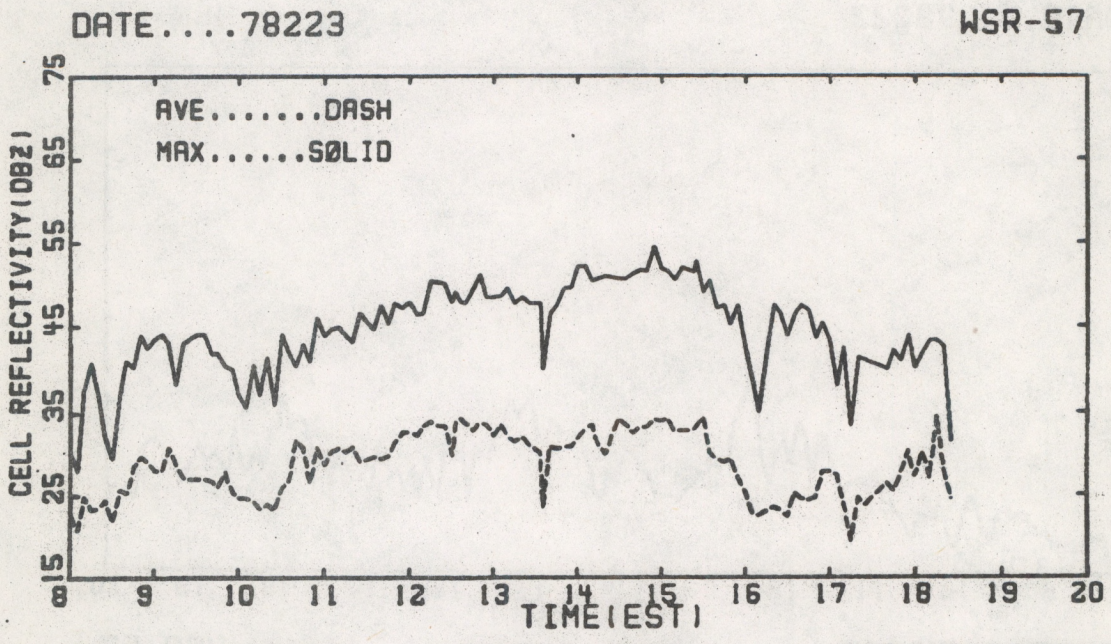

DATE....78222
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

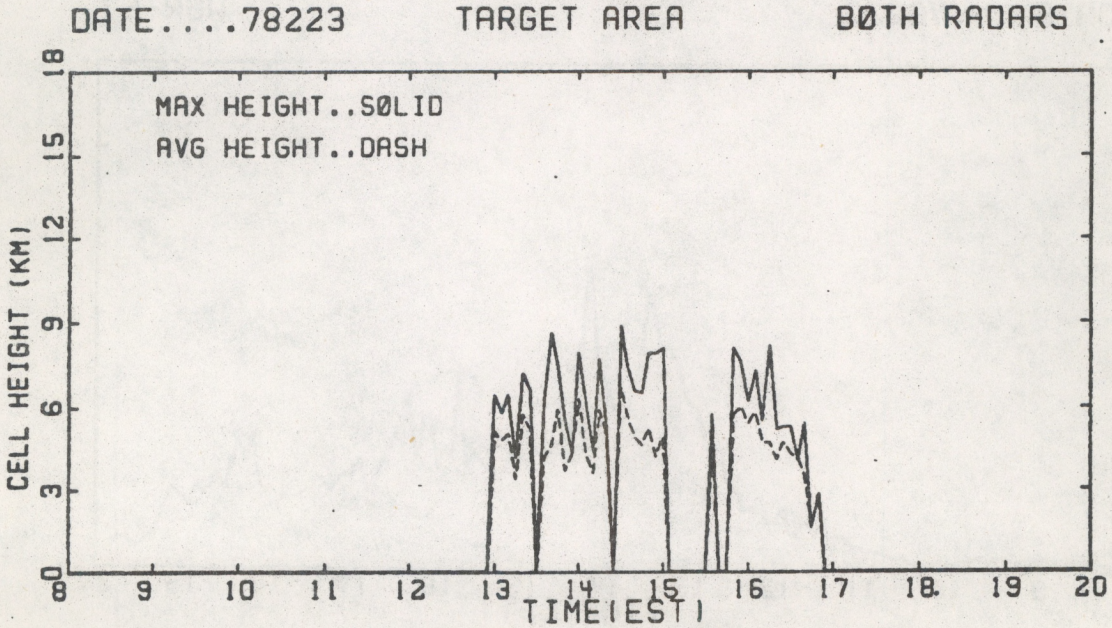

DATE....78222
WSR-57
NUMBER ØF CELLS
0
35
70
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210
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18
19
20
TIME(EST)

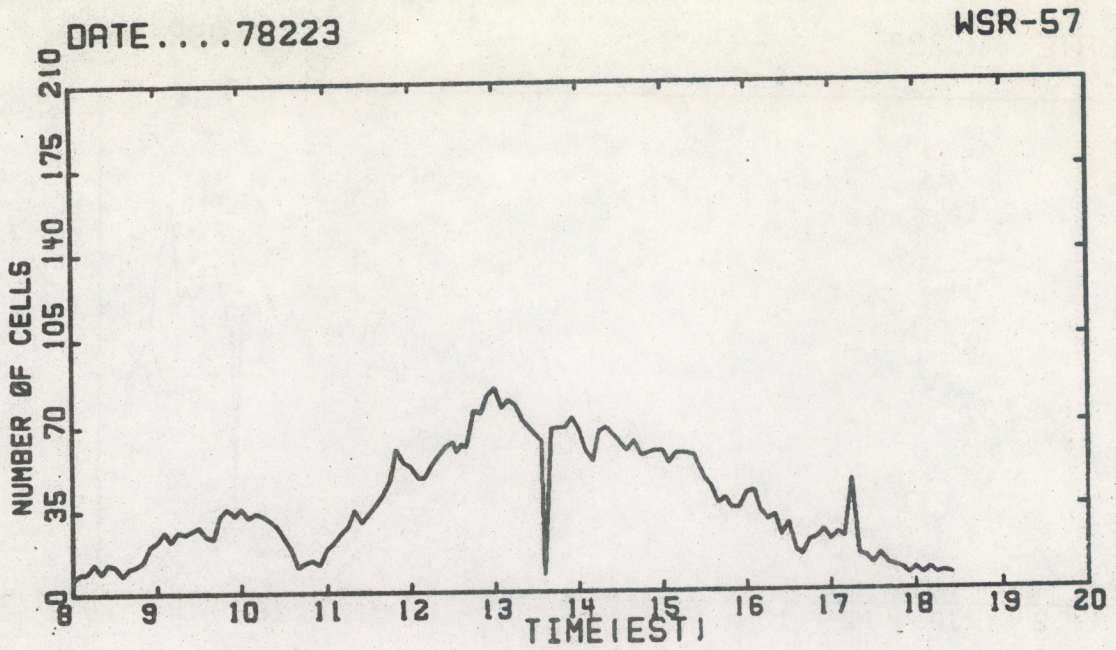

DATE....78222
WSR-57
NUMBER ØF ECHØES
0
15
30
45
60
75
90
8
9
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11
12
13
14
15
16
17
18
19
20
TIME(EST)

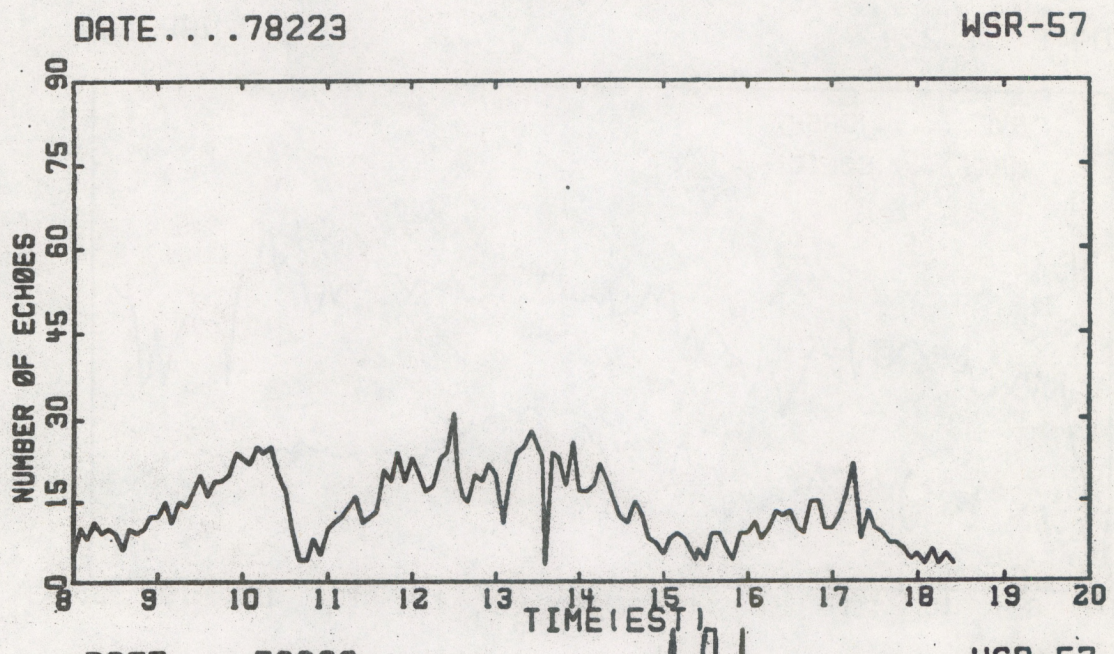

DATE....78222
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
9
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11
12
13
14
15
16
17
18
19
20
TIME(EST)

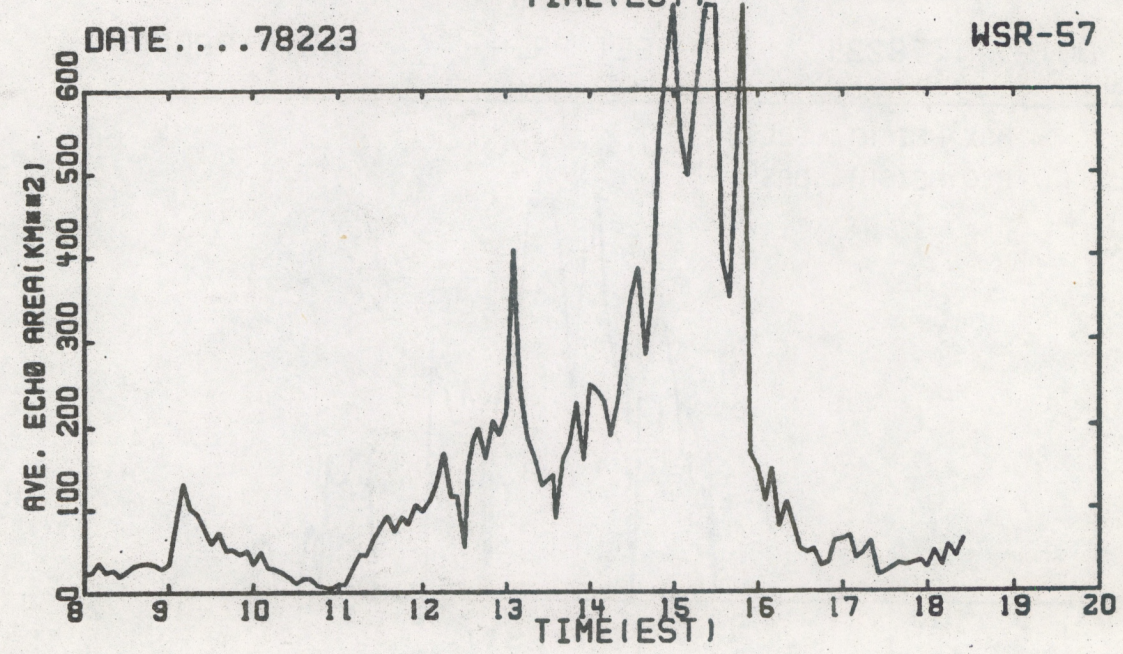

DATE....78223
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
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11
12
13
14
15
16
17
18
19
20
TIME(EST)

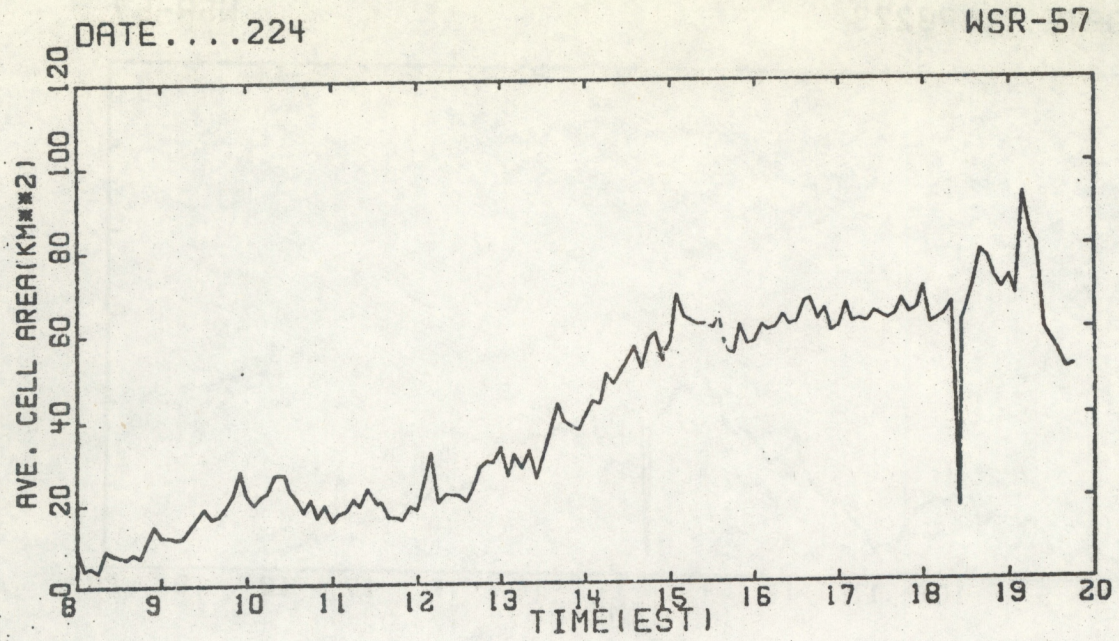

DATE....78223
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
10
11
12
13
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15
16
17
18
19
20
TIME(EST)

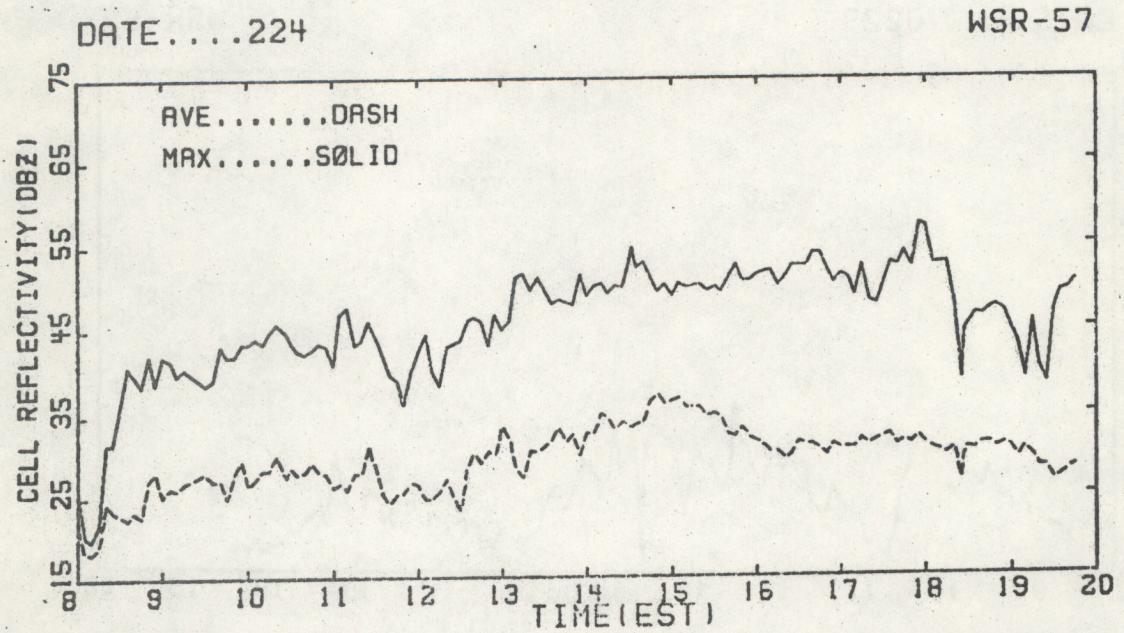

DATE....78223
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

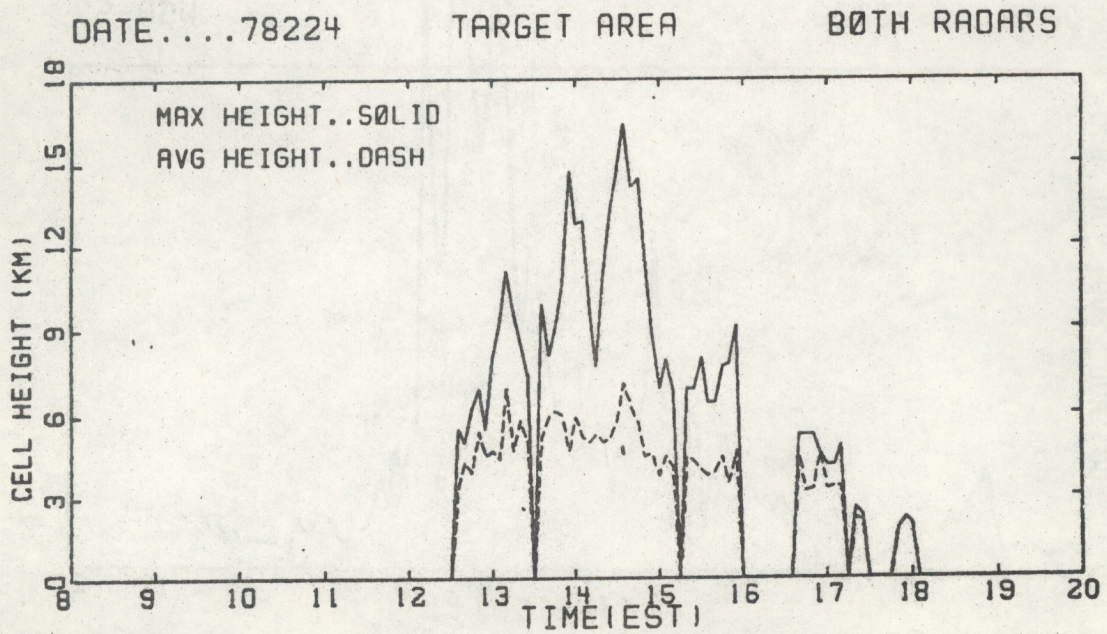

DATE....78223
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
8
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15
16
17
18
19
20
TIME(EST)

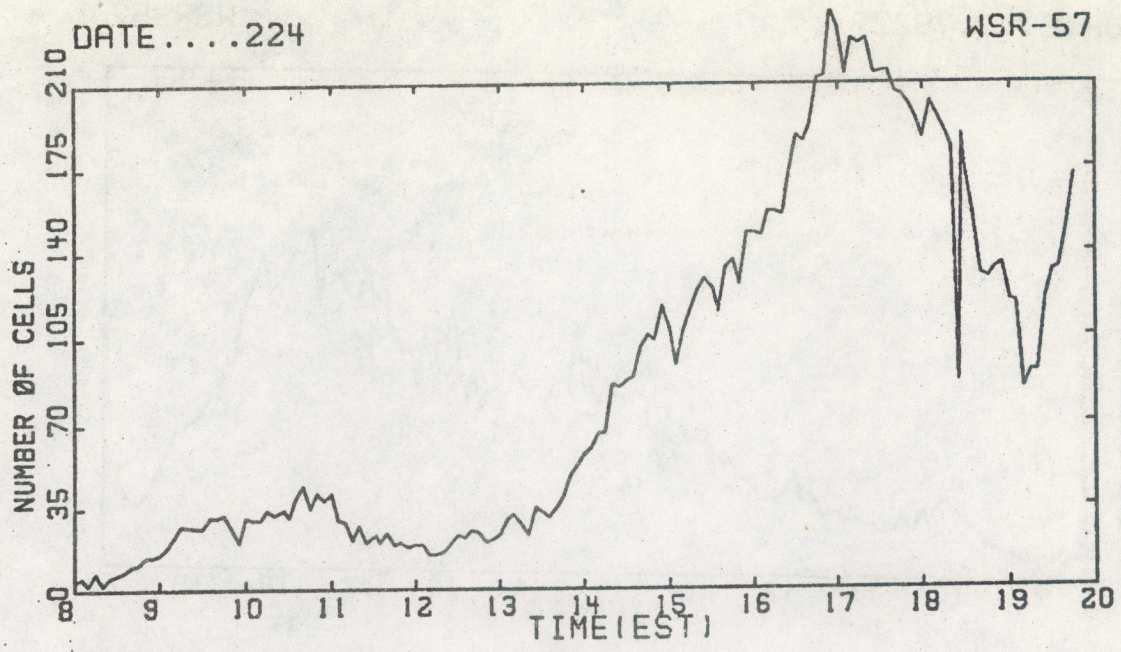

DATE....78223
WSR-57
NUMBER ØF ECHØES
0
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30
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75
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TIME(EST)

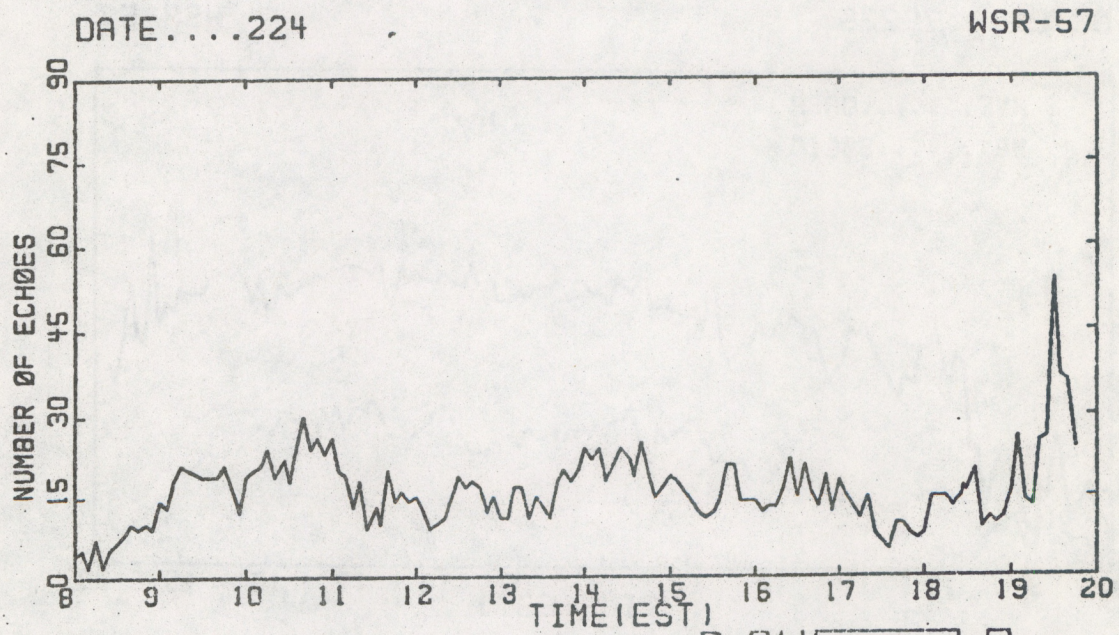

DATE....78223
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
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19
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TIME(EST)

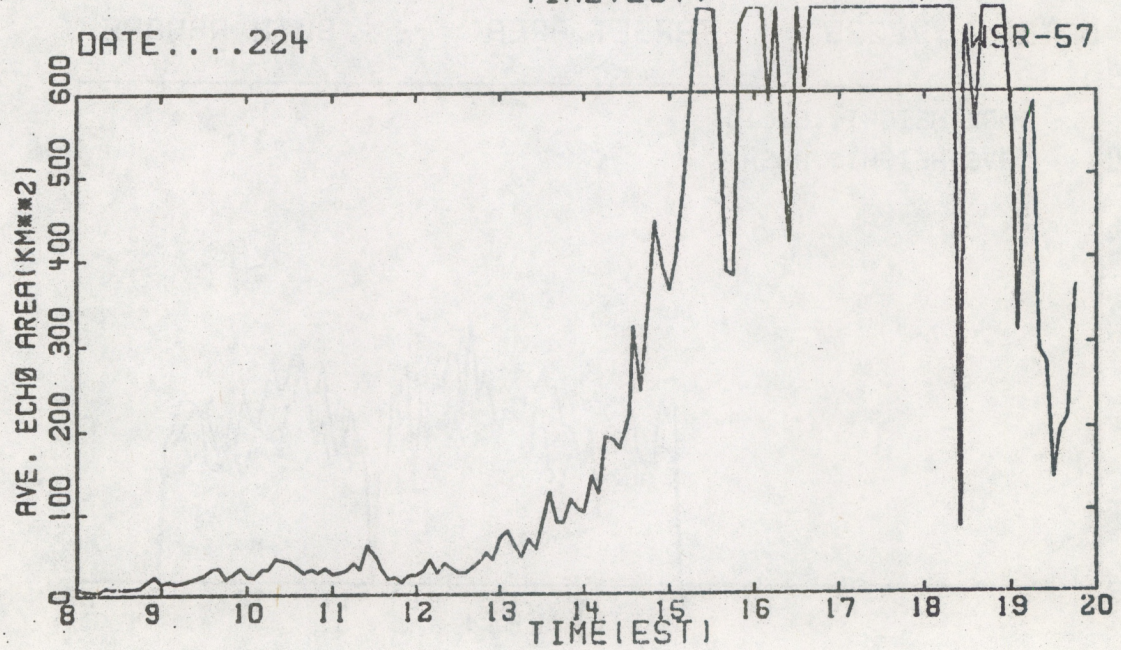

DATE....224
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
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TIME(EST)

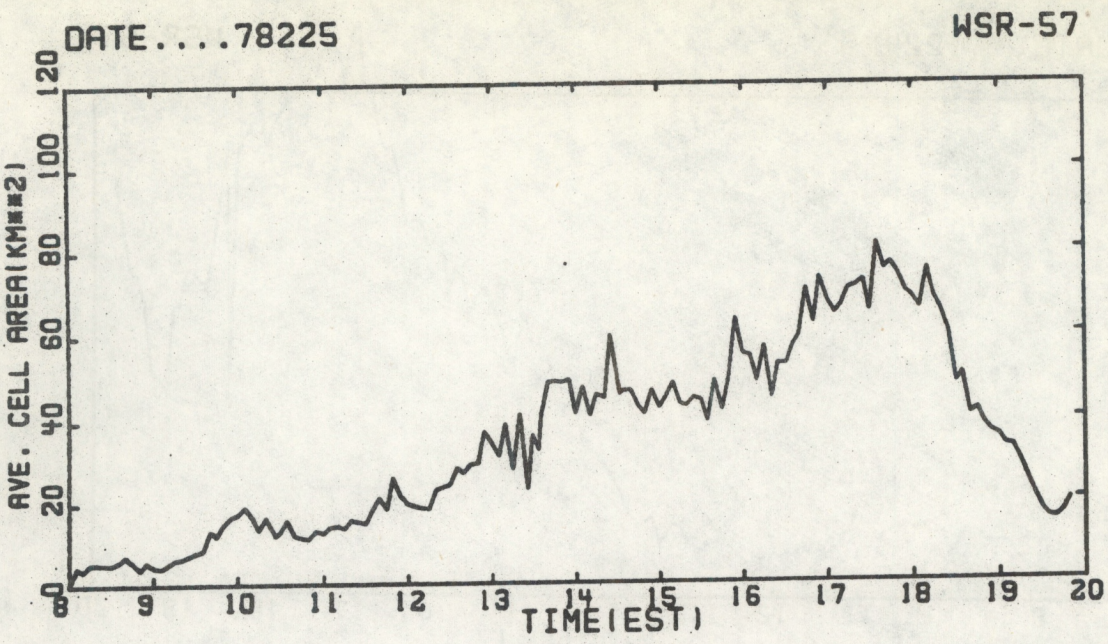

DATE....224
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
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19
20
TIME(EST)

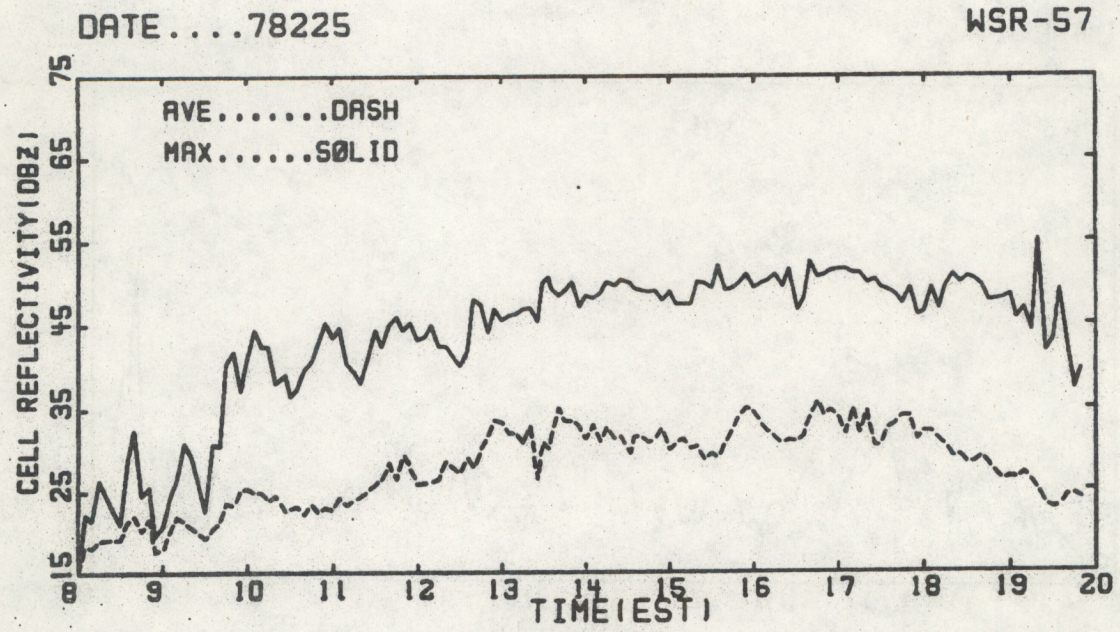

DATE....78224
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
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11
12
13
14
15
16
17
18
19
20
TIME(EST)

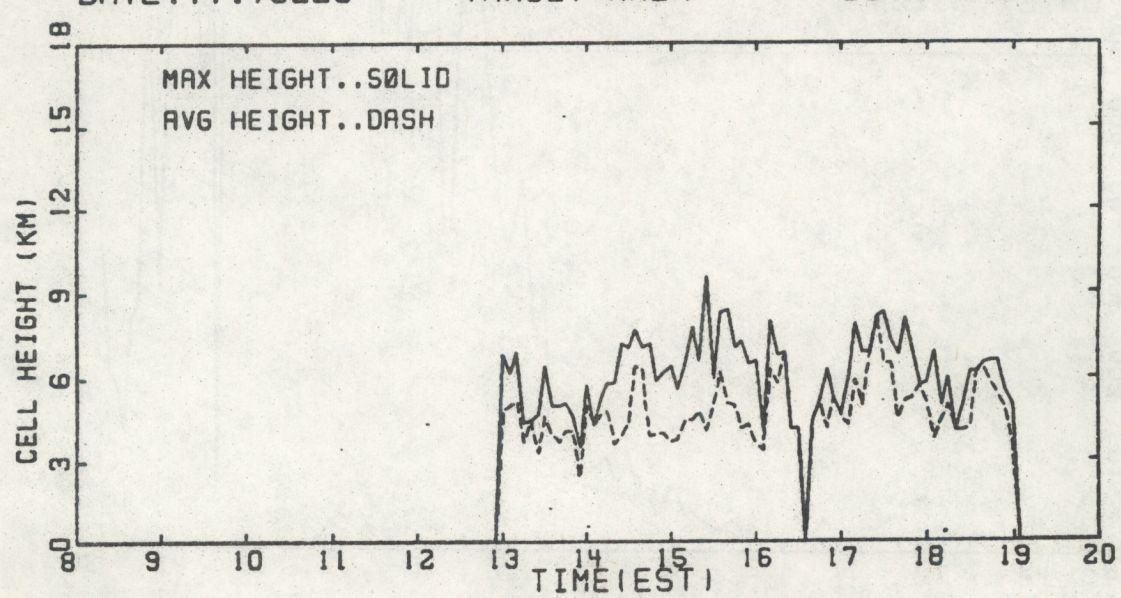

DATE....224
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
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210
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18
19
20
TIME(EST)

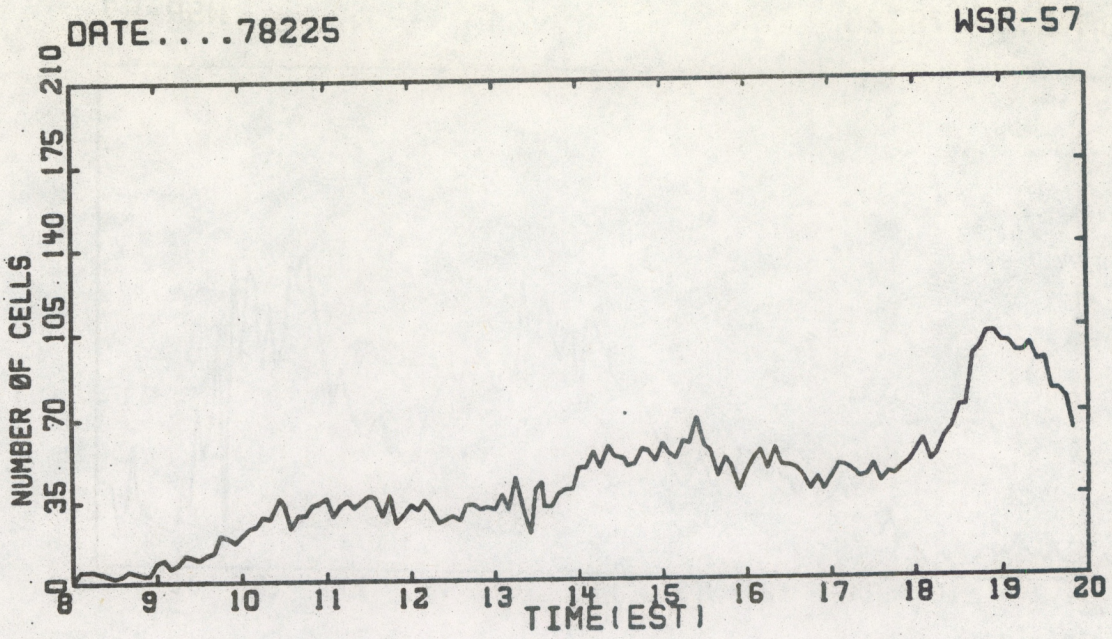

DATE....224
WSR-57
NUMBER ØF ECHØES
0
15
30
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60
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TIME(EST)

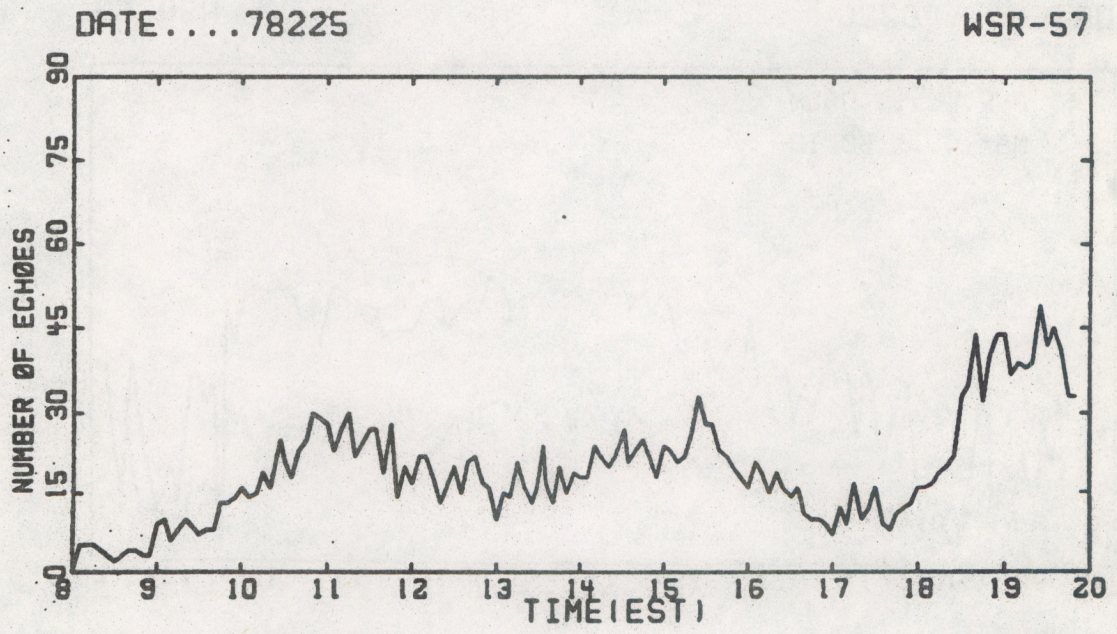

DATE....224
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
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11
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15
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19
20
TIME(EST)

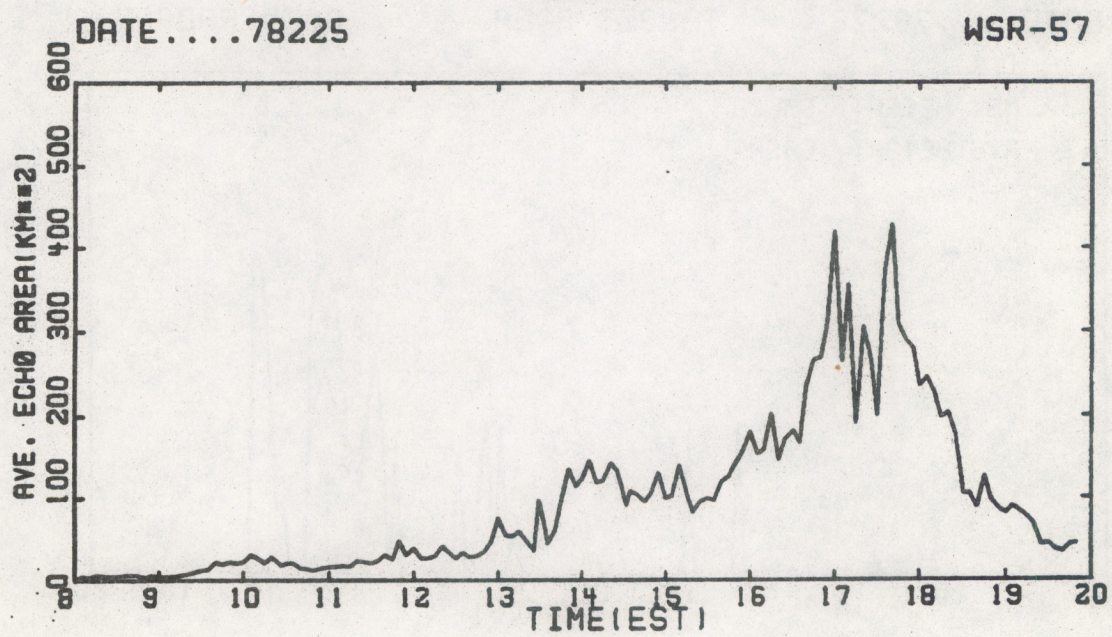

DATE....78225
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
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TIME(EST)

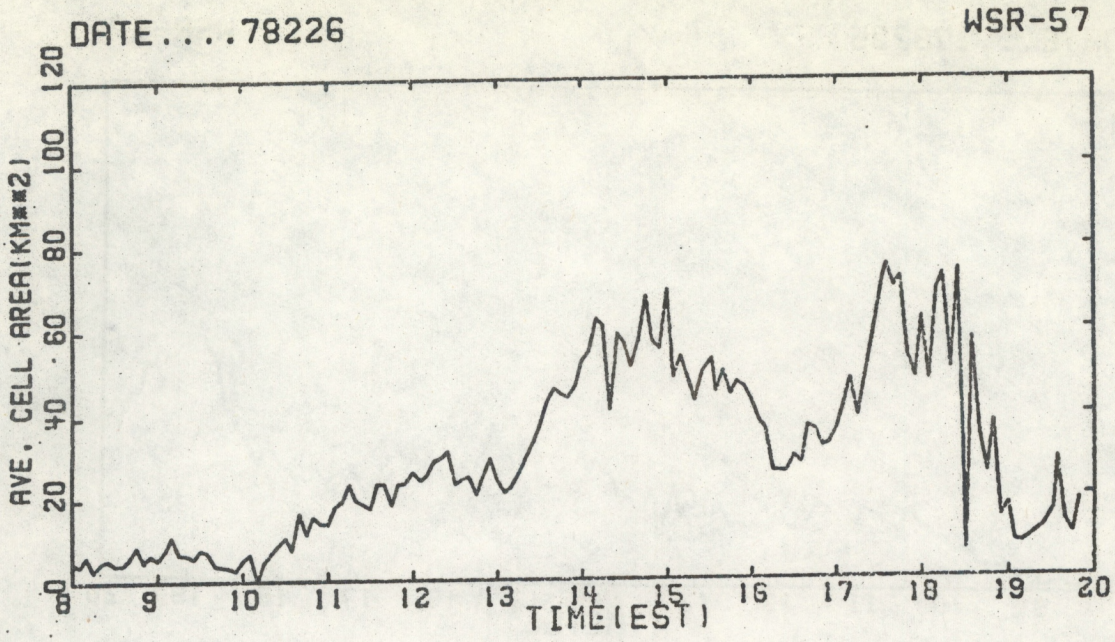

DATE....78225
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
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75
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TIME(EST)

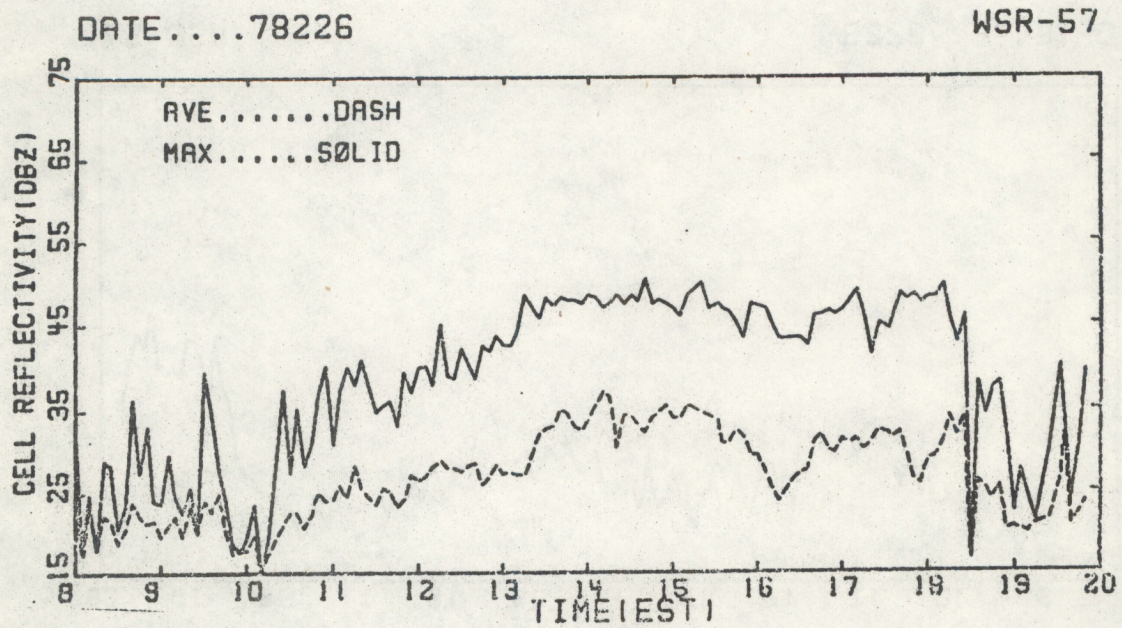

DATE....78225
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
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11
12
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15
16
17
18
19
20
TIME(EST)

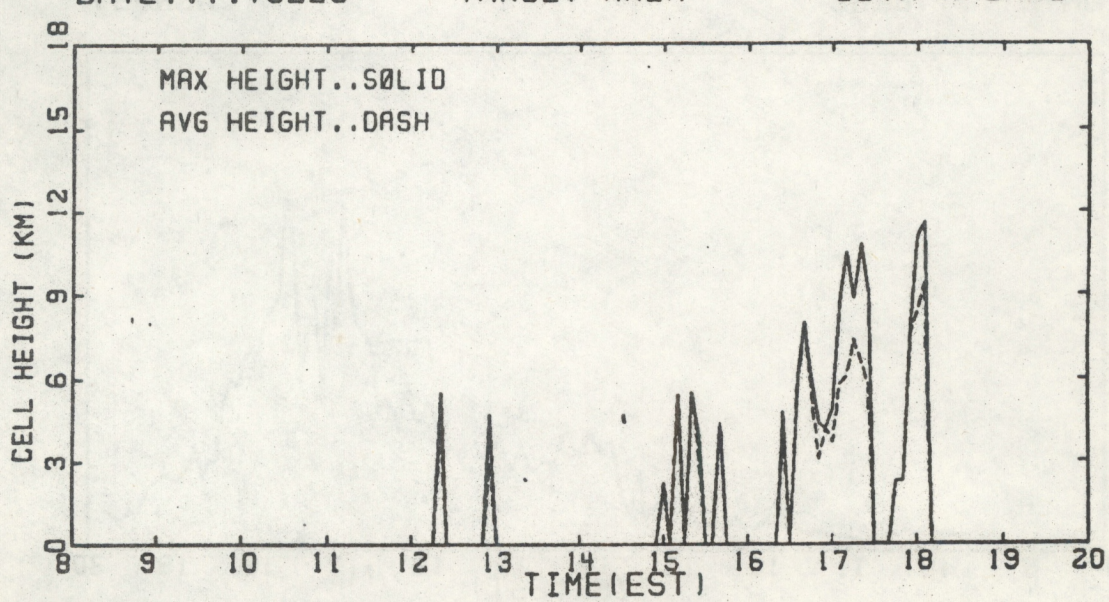

DATE....78225
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
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18
19
20
TIME(EST)

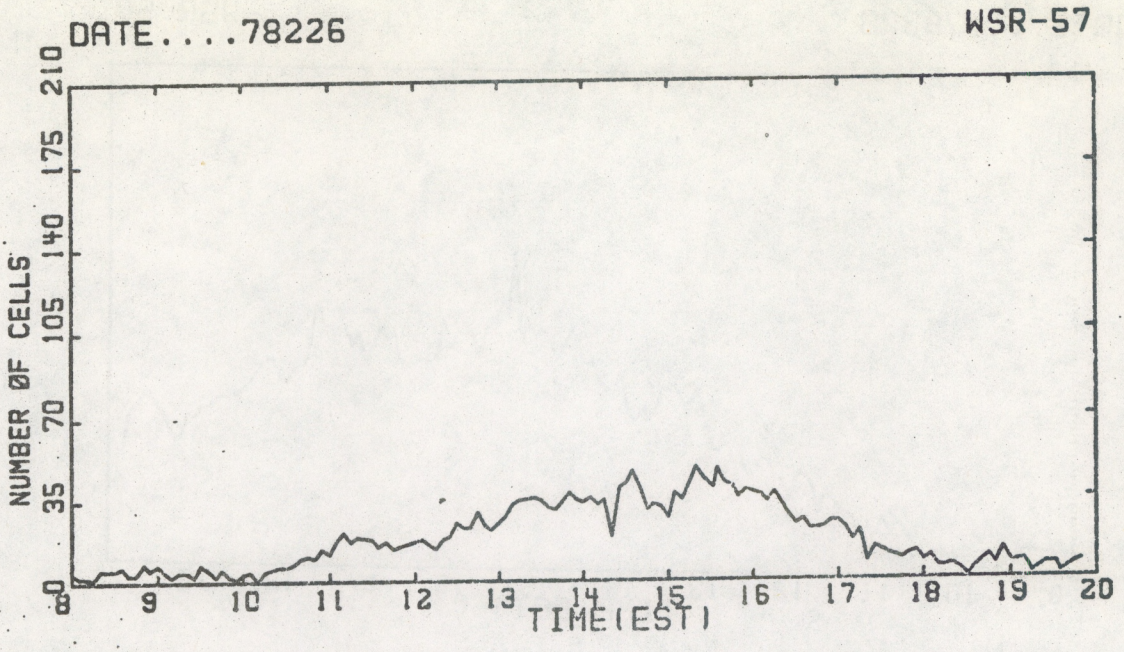

DATE....78225
WSR-57
NUMBER ØF ECHØES
0
15
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60
75
90
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19
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TIME(EST)

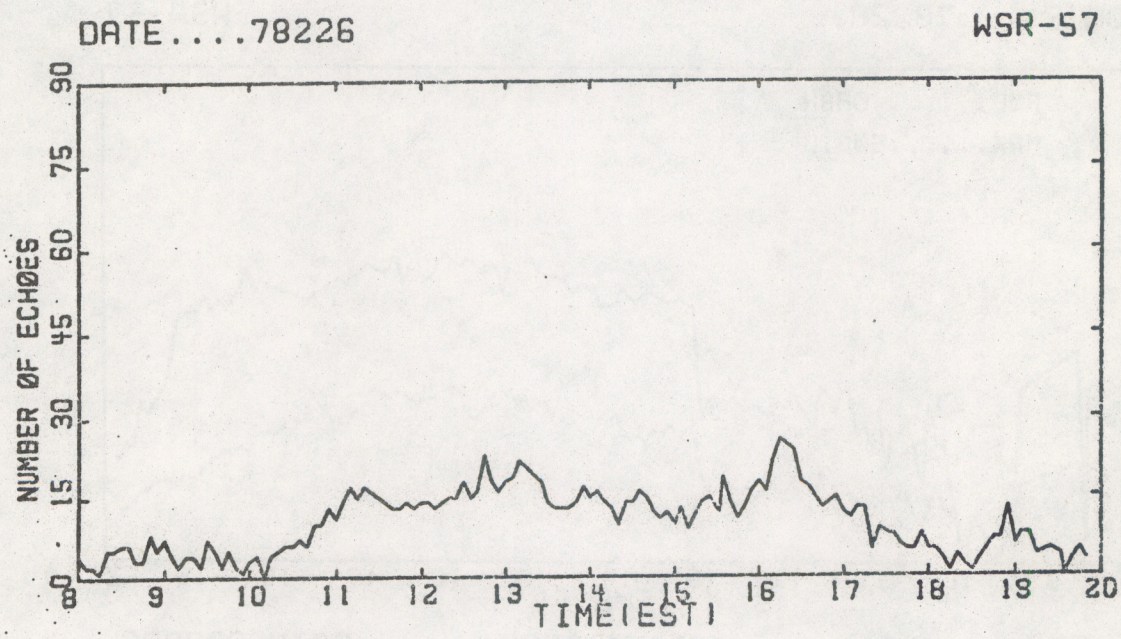

DATE....78225
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
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17
18
19
20
TIME(EST)

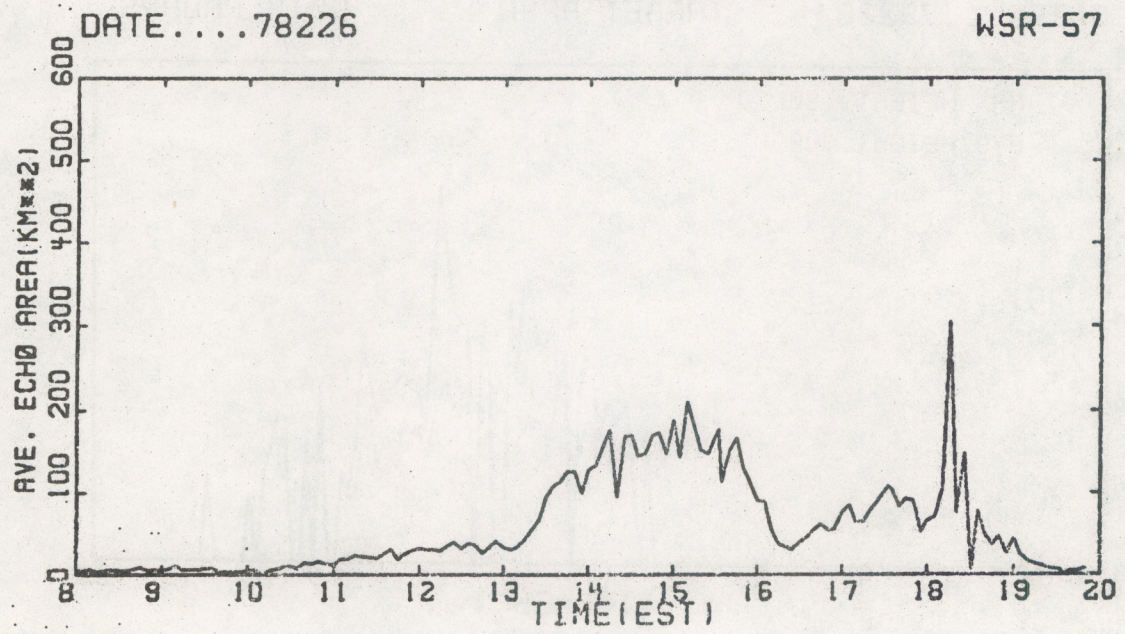

DATE....78226
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
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15
16
17
18
19
20
TIME(EST)

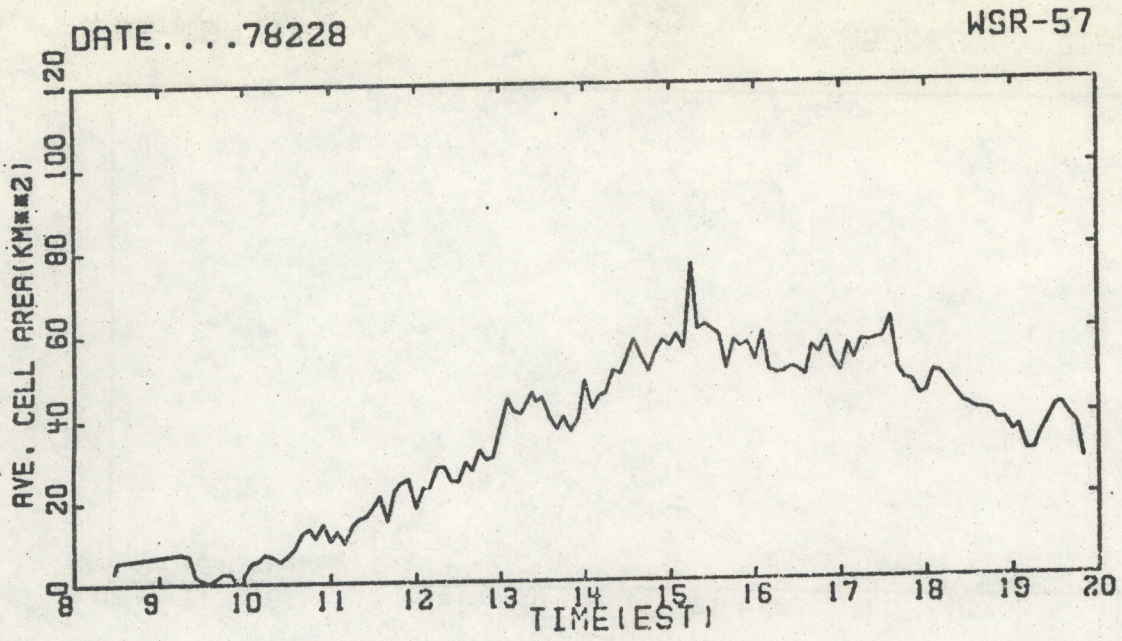

DATE....78226
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
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18
19
20
TIME(EST)

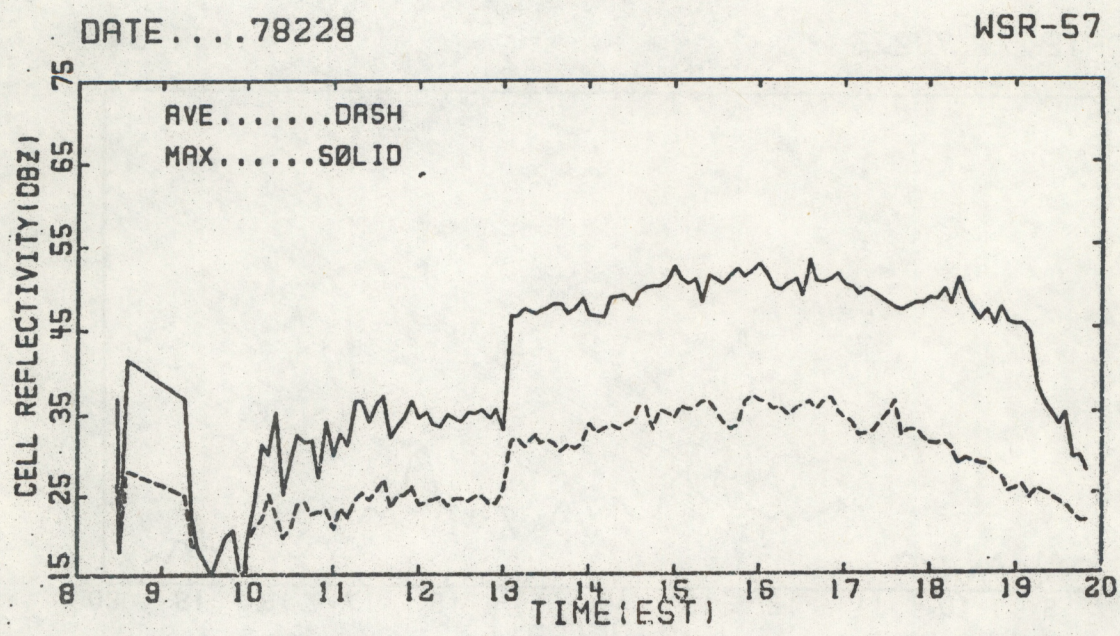

DATE....78226
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
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12
13
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15
16
17
18
19
20
TIME(EST)

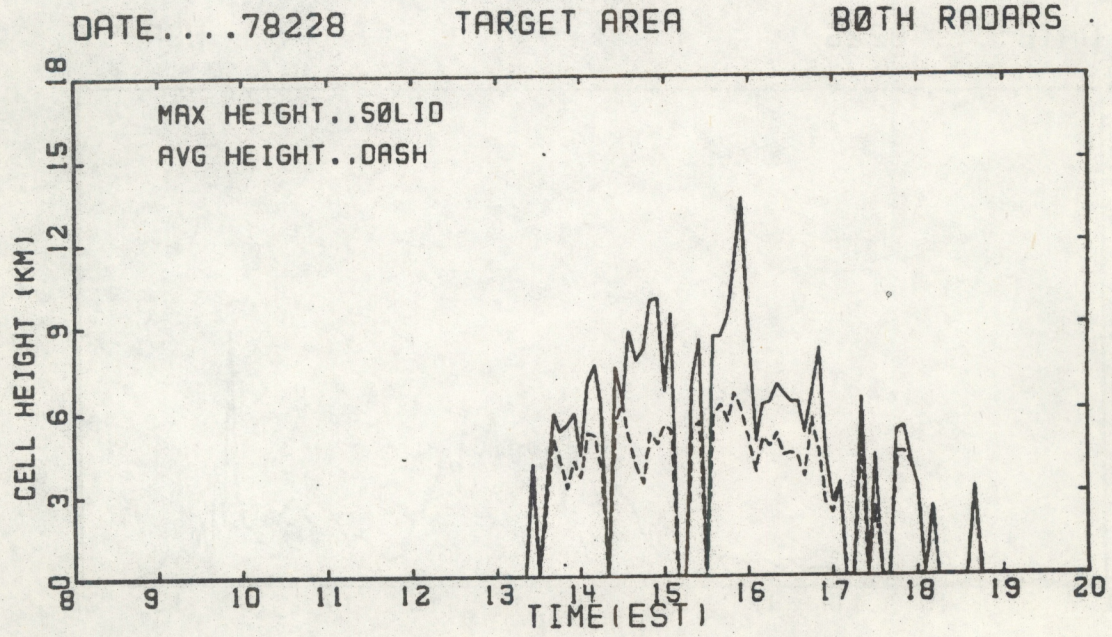

DATE....78226
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
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18
19
20
TIME(EST)

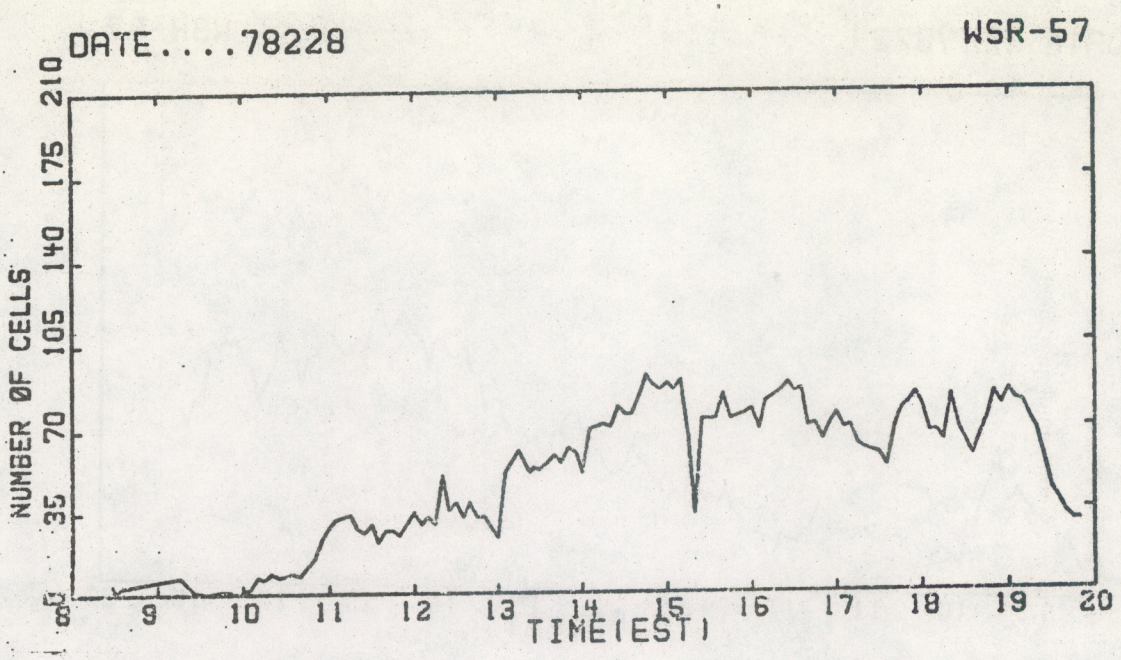

DATE....78226
WSR-57
NUMBER ØF ECHØES
0
15
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TIME(EST)

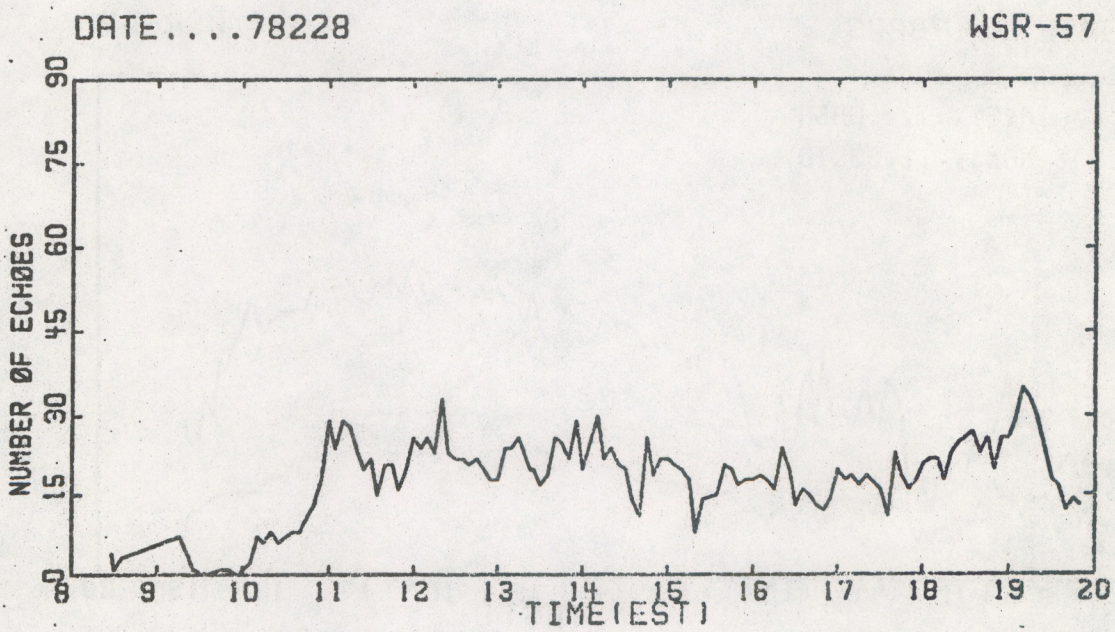

DATE....78226
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
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18
19
20
TIME(EST)

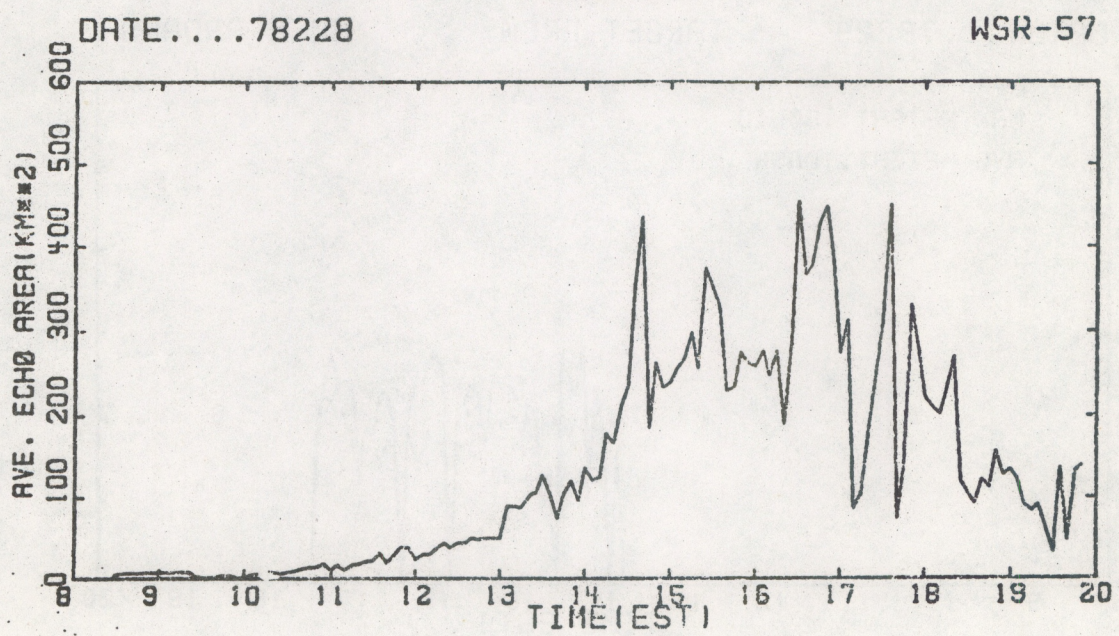

DATE....78228
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
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120
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TIME(EST)

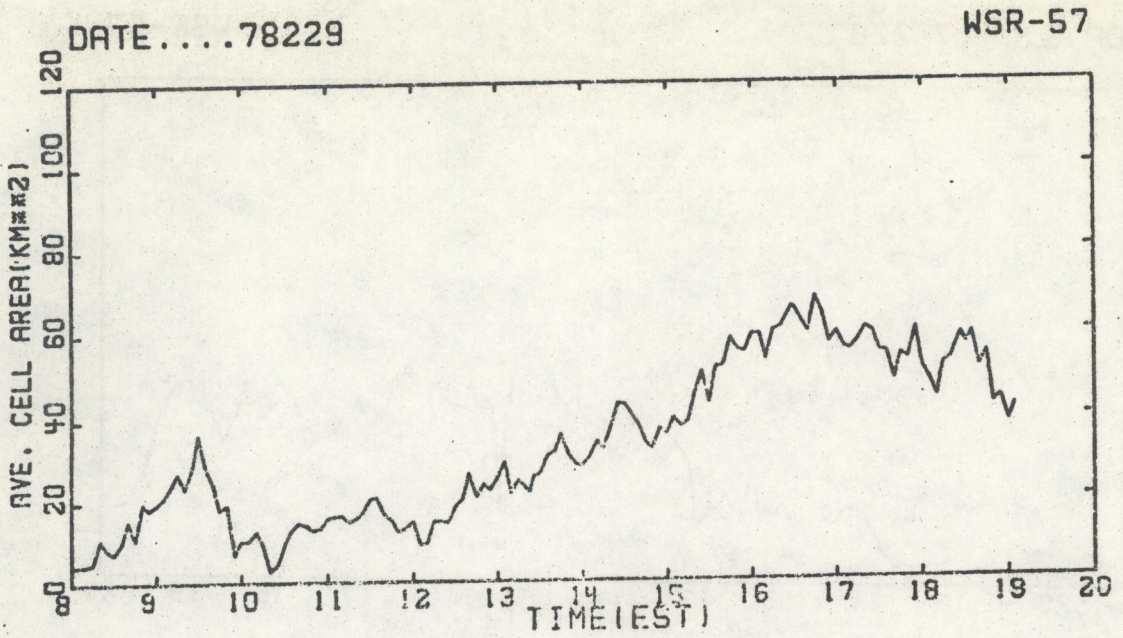

DATE....78228
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
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TIME(EST)

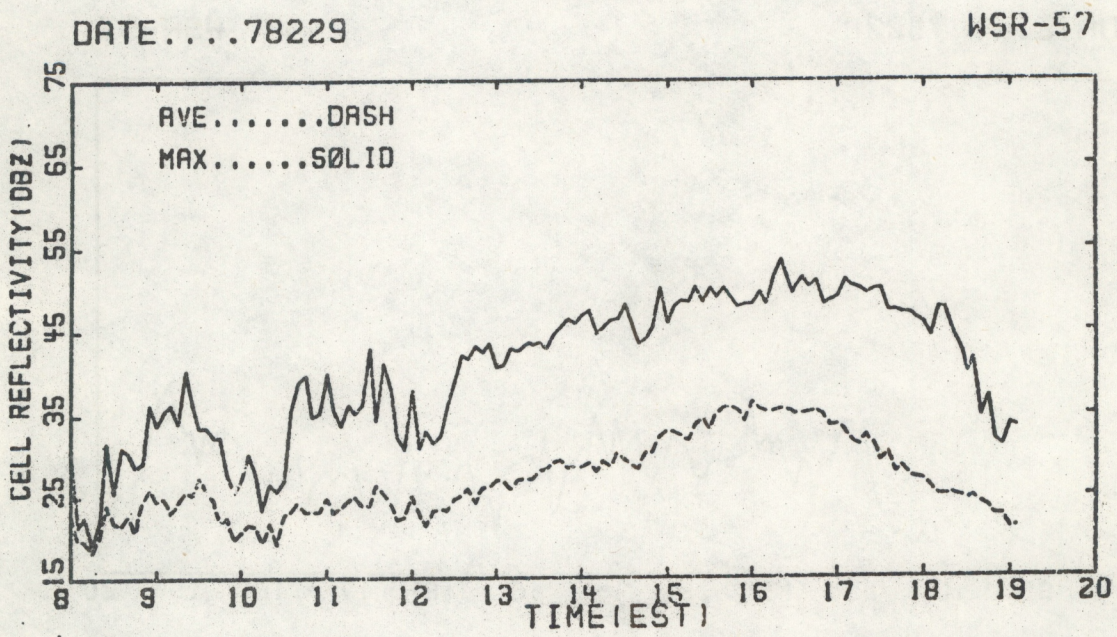

DATE....78228
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
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19
20
TIME(EST)

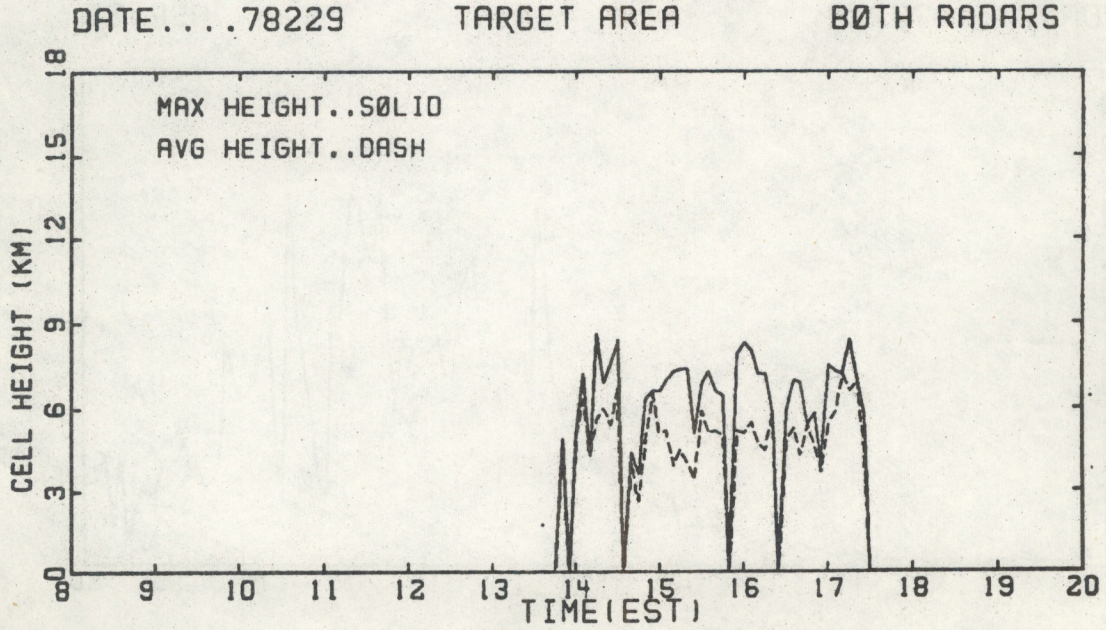

DATE....78228
WSR-57
NUMBER ØF CELLS
0
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20
TIME(EST)

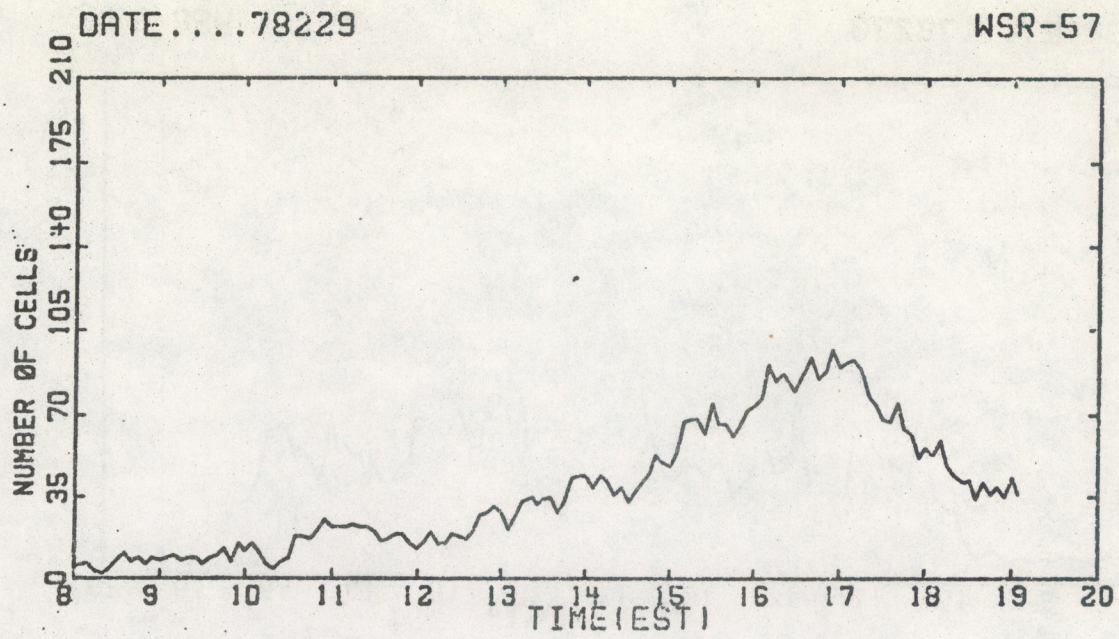

DATE....78228
WSR-57
NUMBER ØF ECHØES
0
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TIME(EST)

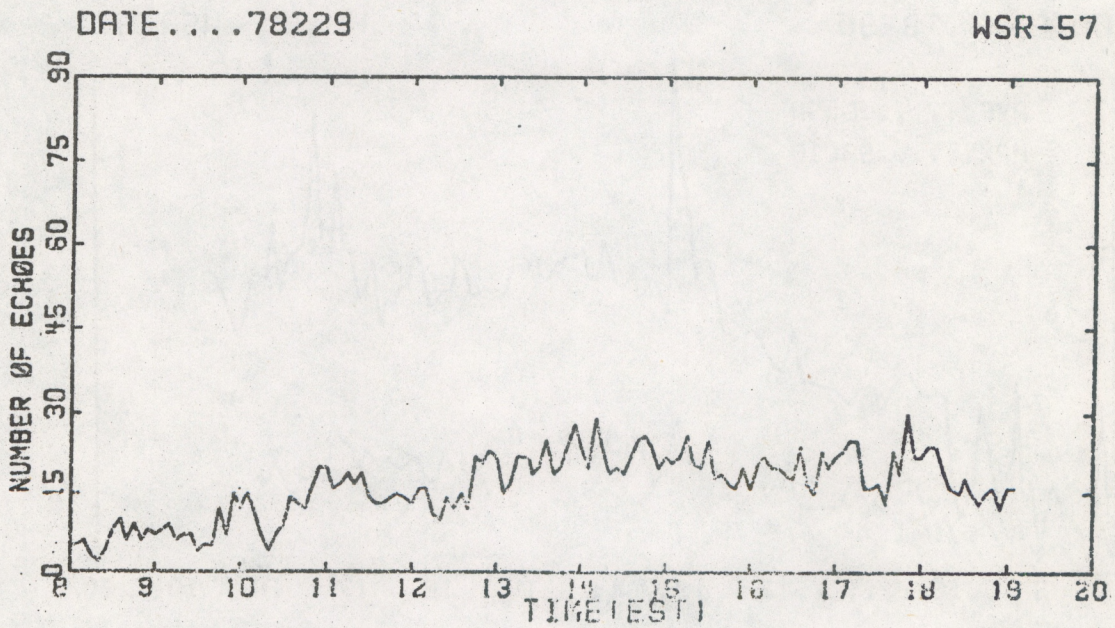

DATE....78228
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
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600
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TIME(EST)

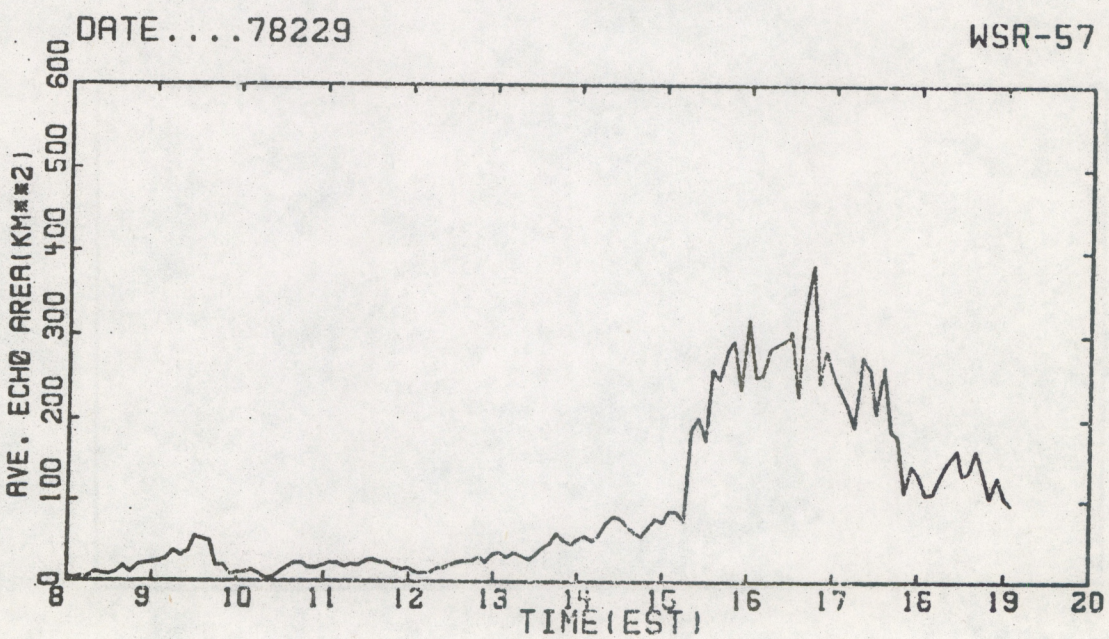

DATE....78229
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
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19
20
TIME(EST)

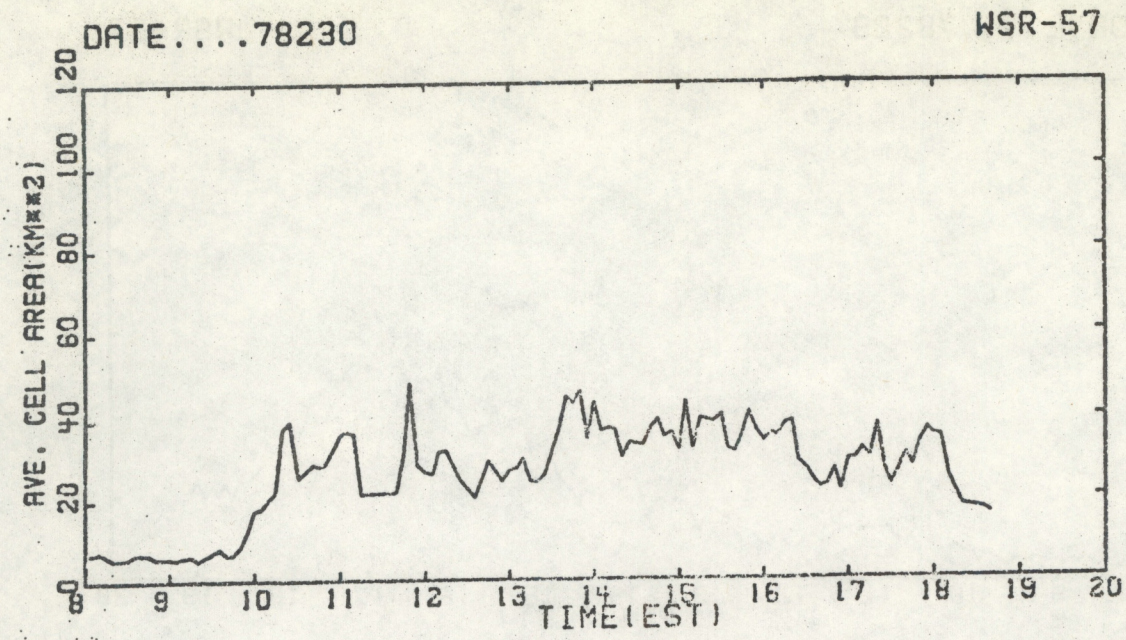

DATE....78229
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
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TIME(EST)

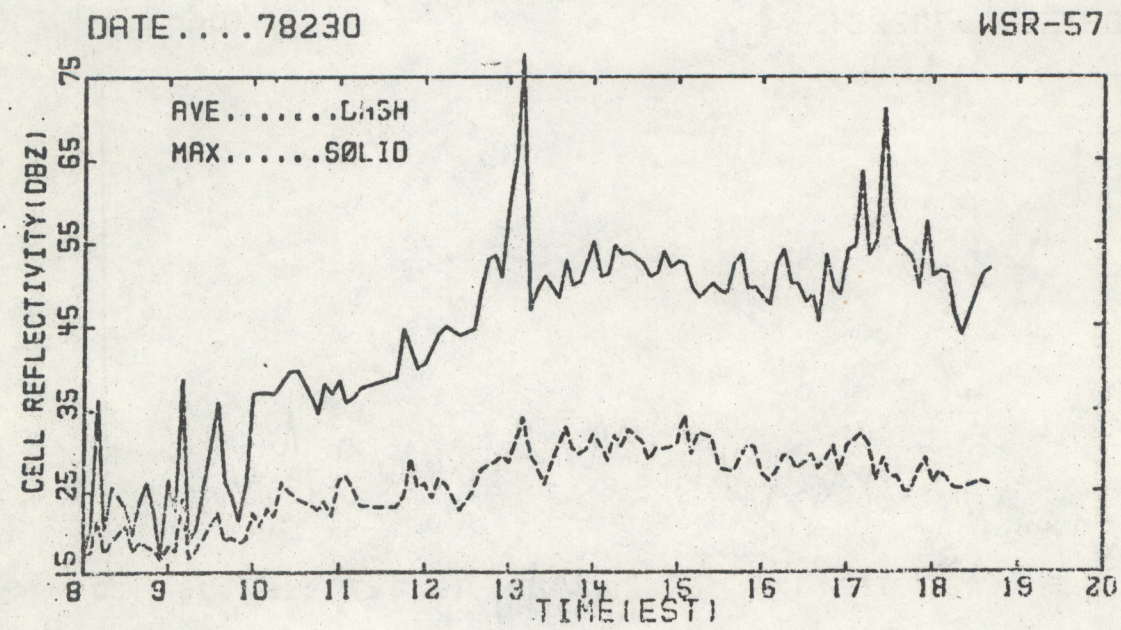

DATE....78229
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
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11
12
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20
TIME(EST)

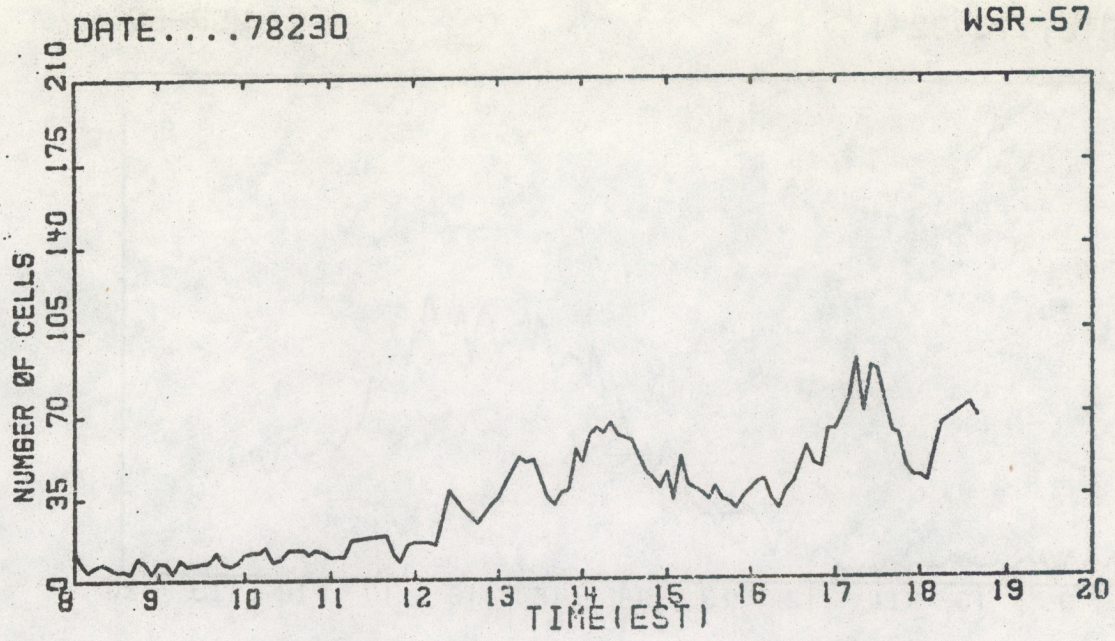

DATE....78229
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
8
9
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11
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19
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TIME(EST)

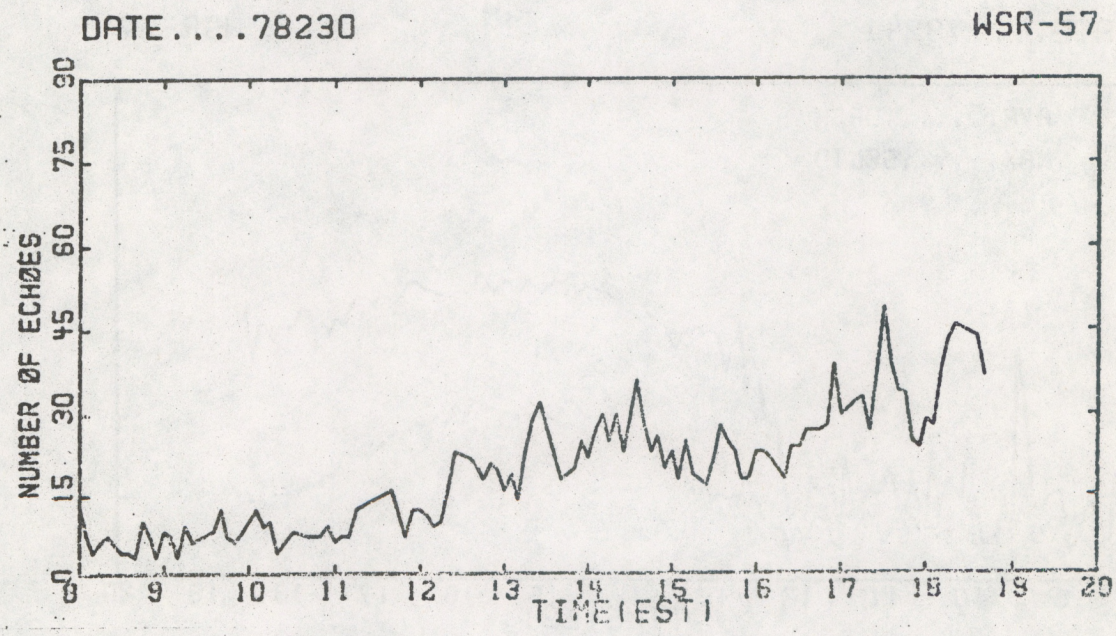

DATE....78229
WSR-57
NUMBER ØF ECHØES
0
15
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90
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15
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19
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TIME(EST)

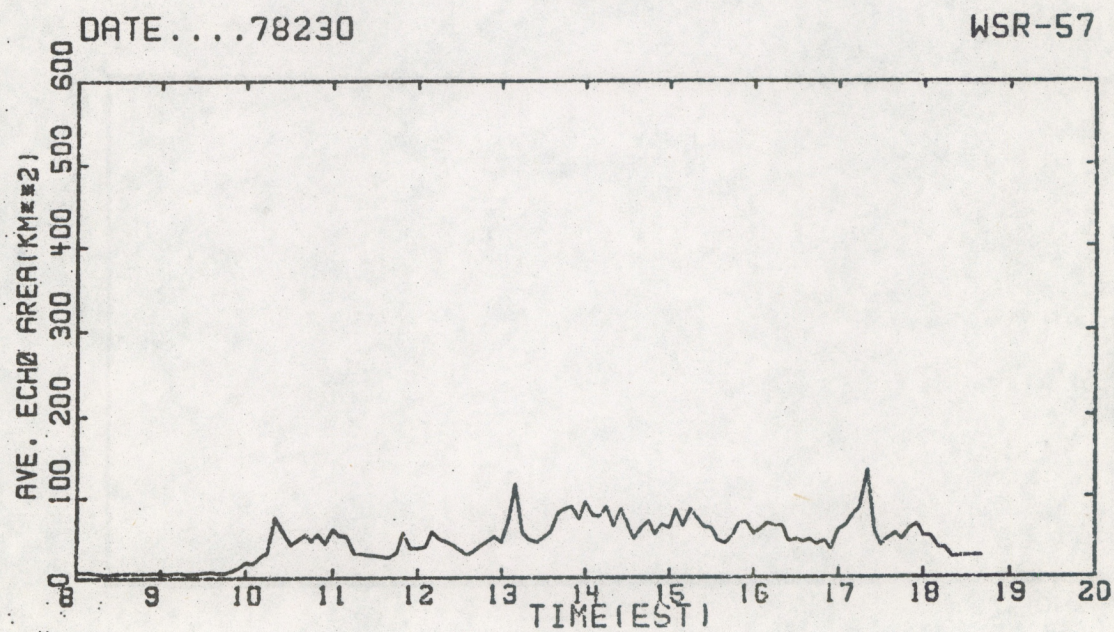

DATE....78229
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
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16
17
18
19
20
TIME(EST)

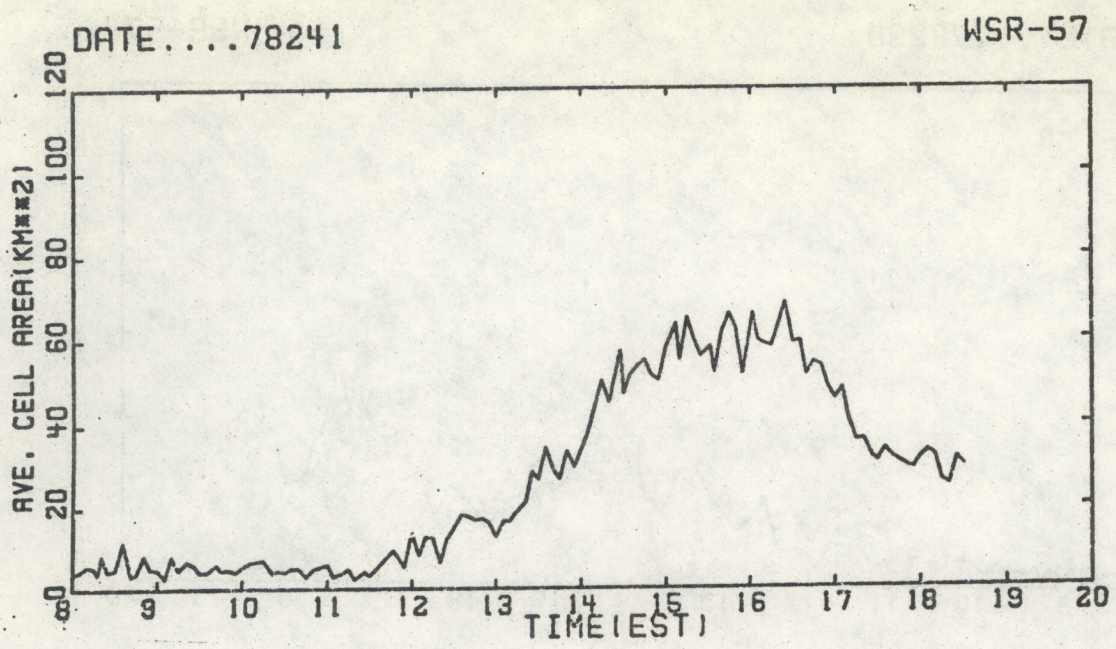

DATE....78230
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
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TIME(EST)

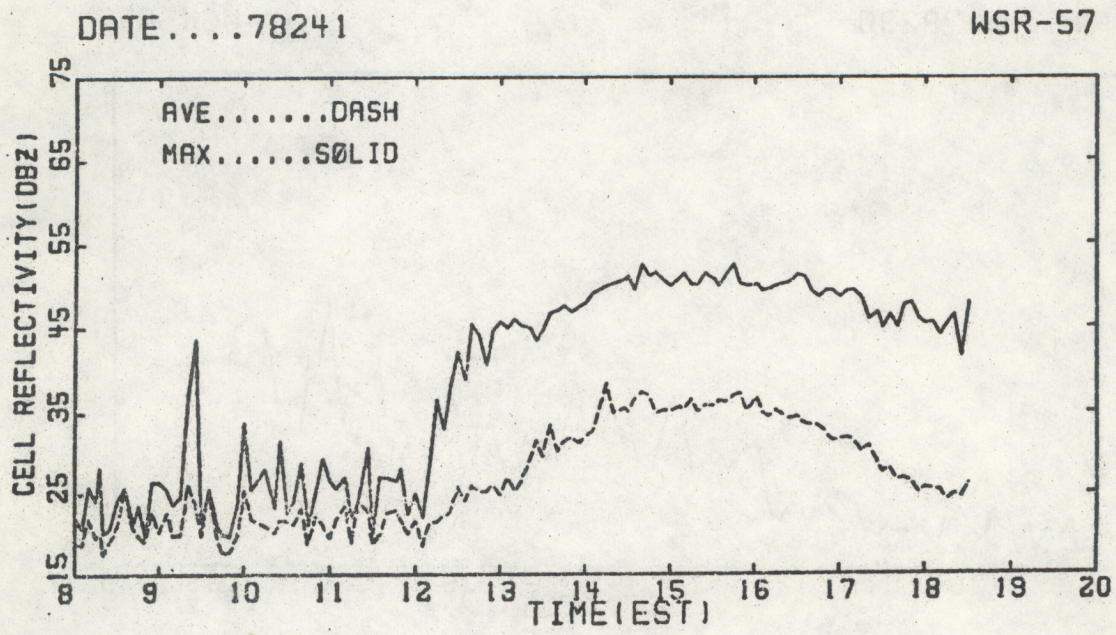

DATE....78230
WSR-57
CELL REFLECTIVITY(DBZ)
AVE.....DASH
MAX.....SOLID
15
25
35
45
55
65
75
8
9
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18
19
20
TIME(EST)

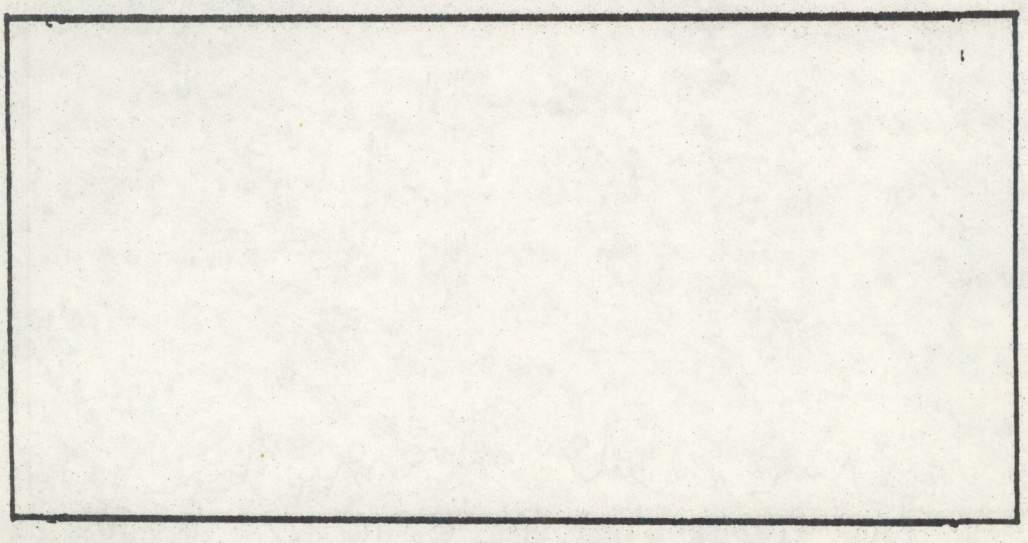

DATE....78230
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
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TIME(EST)

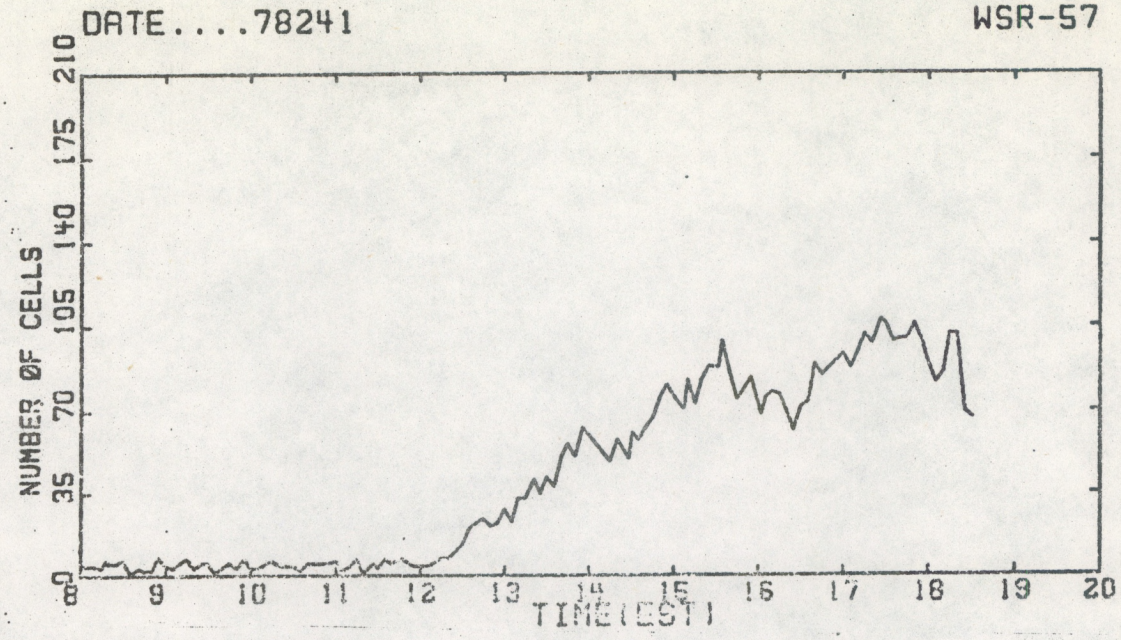

DATE....78230
WSR-57
NUMBER ØF ECHØES
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TIME(EST)

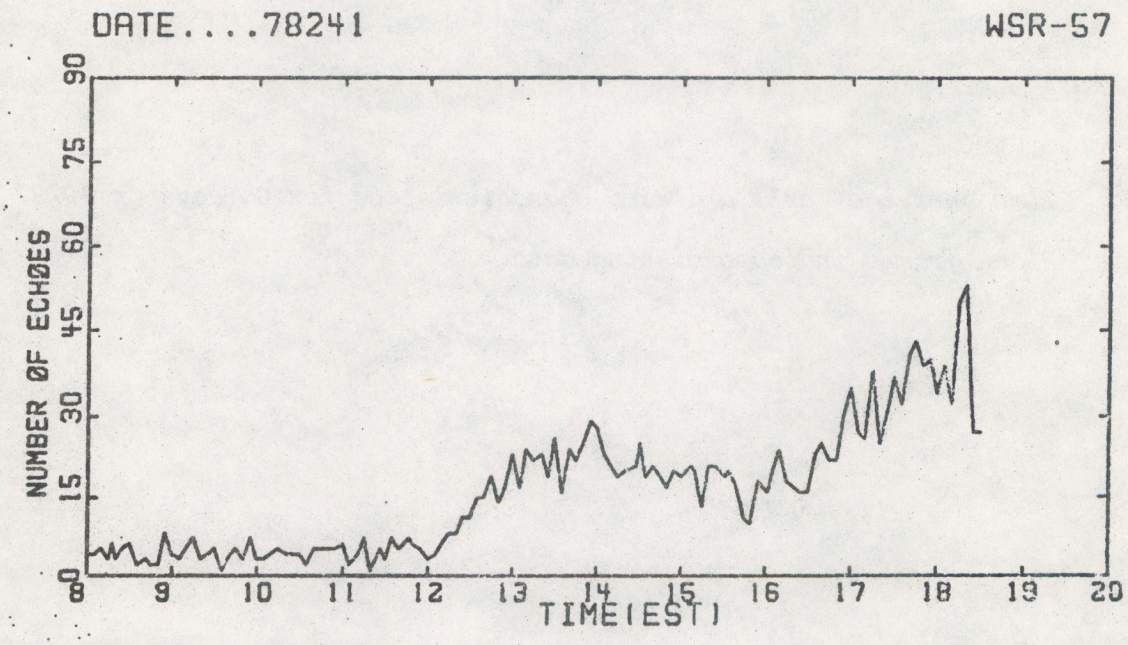

DATE....78230
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
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600
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TIME(EST)


DATE....78241
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
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19
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TIME(EST)


DATE....78241
WSR-57
CELL REFLECTIVITY(DBZ)
AVE.....DASH
MAX.....SØLID
15
25
35
45
55
65
75
8
9
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11
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17
18
19
20
TIME(EST)




DATE....78241
WSR-57
NUMBER ØF CELLS
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70
105
140
175
210
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16
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19
20
TIME(EST)


DATE....78241
WSR-57
NUMBER ØF ECHØES
0
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TIME(EST)

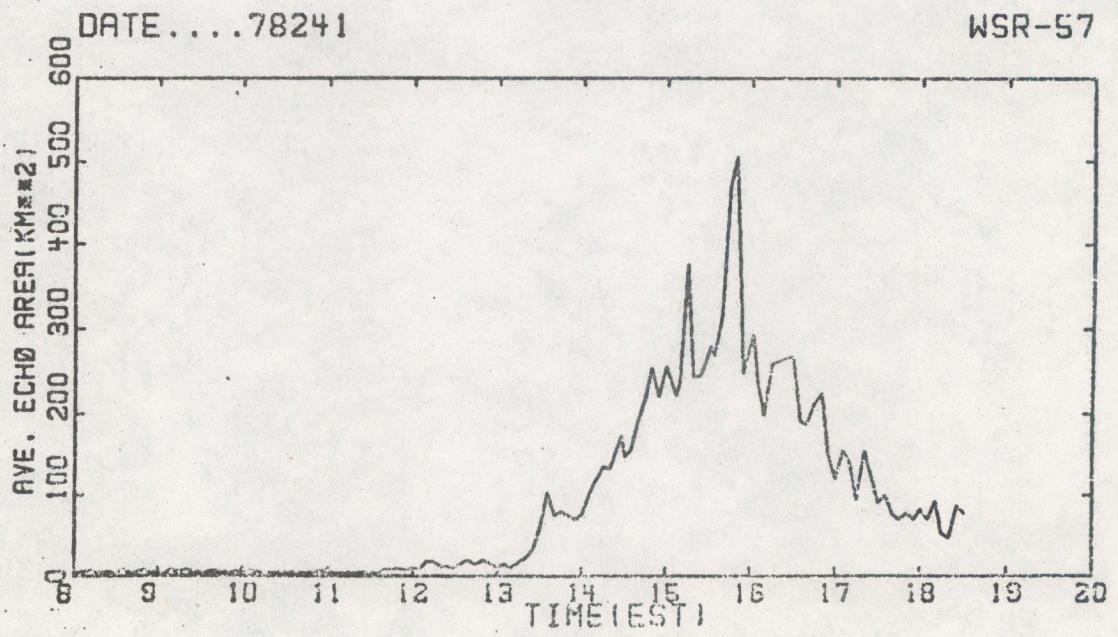
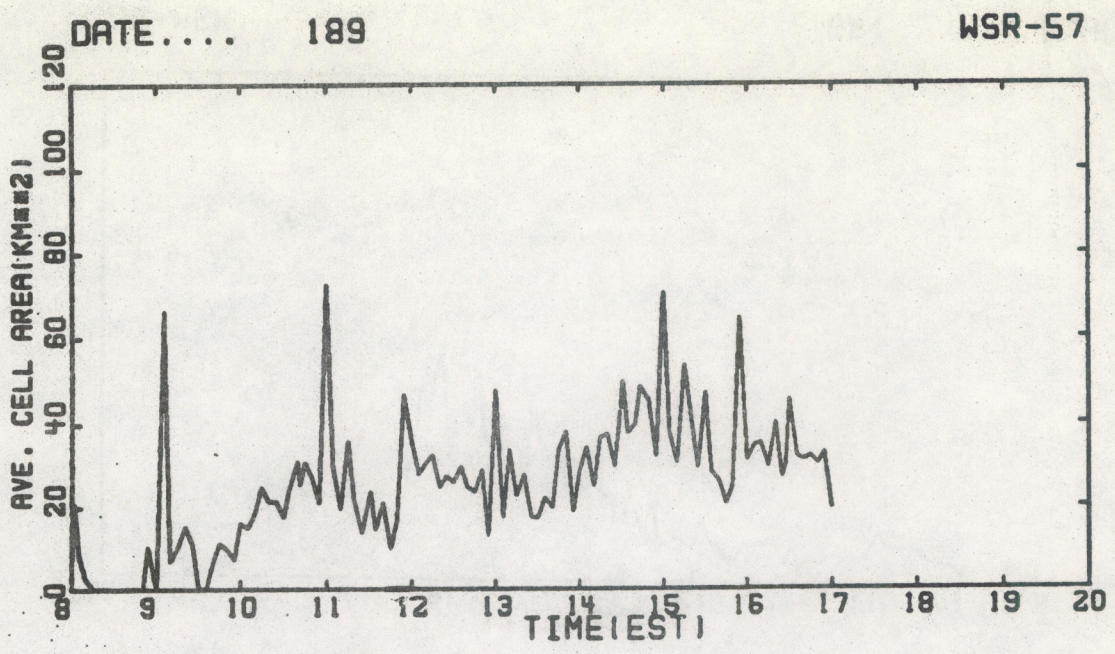
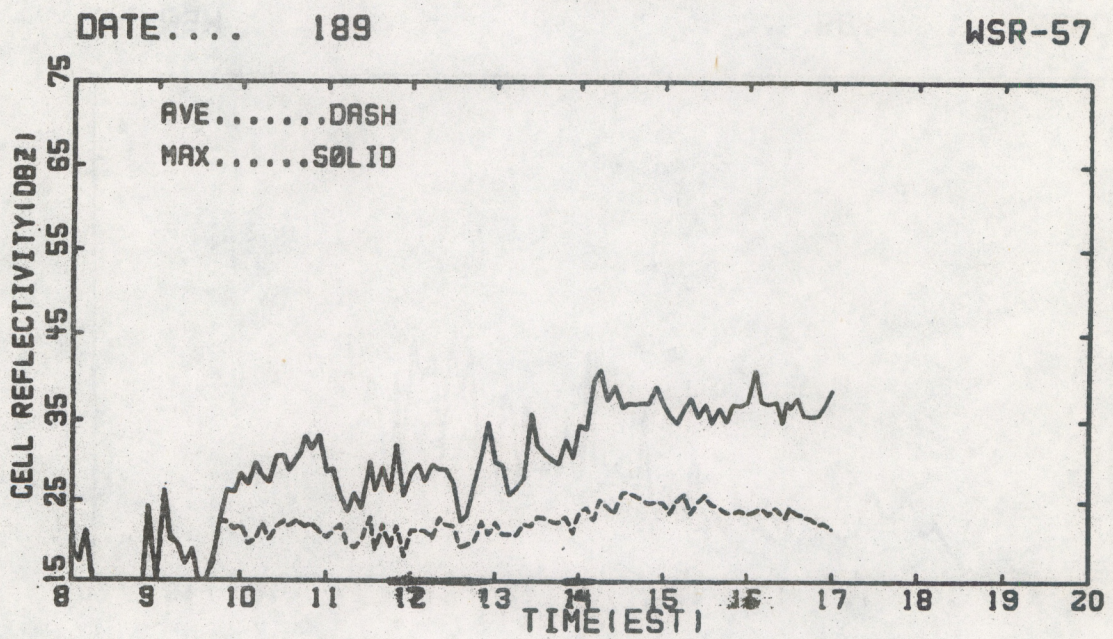
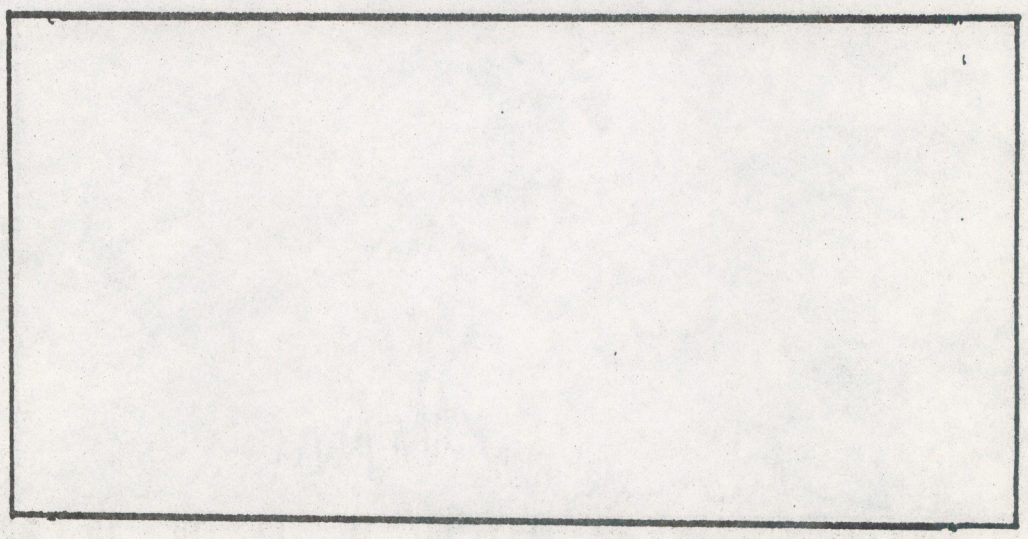
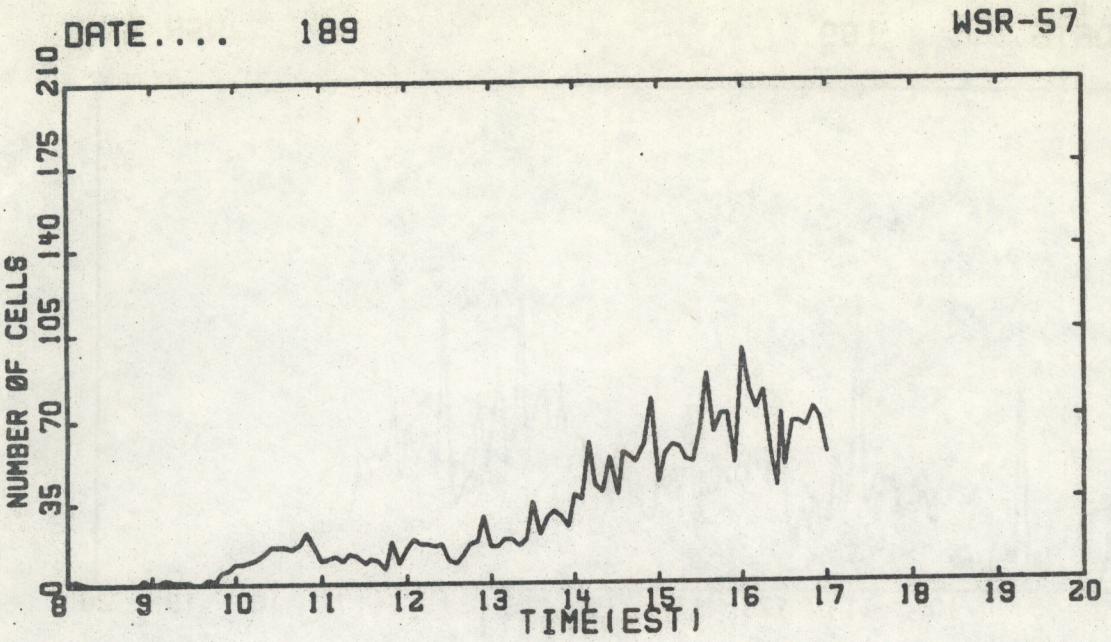

DATE....78241
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
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15
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18
19
20
TIME(EST)

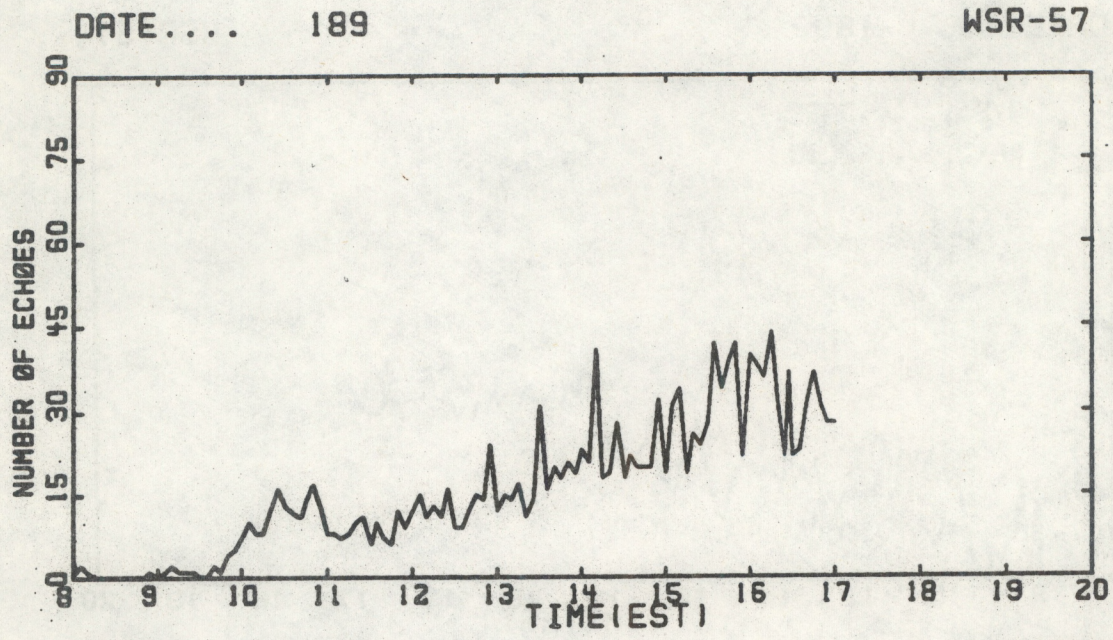
*Fig. 8. Time series of cell and echo characteristics for 60 days in 1979. Blank frames indicate missing data.*

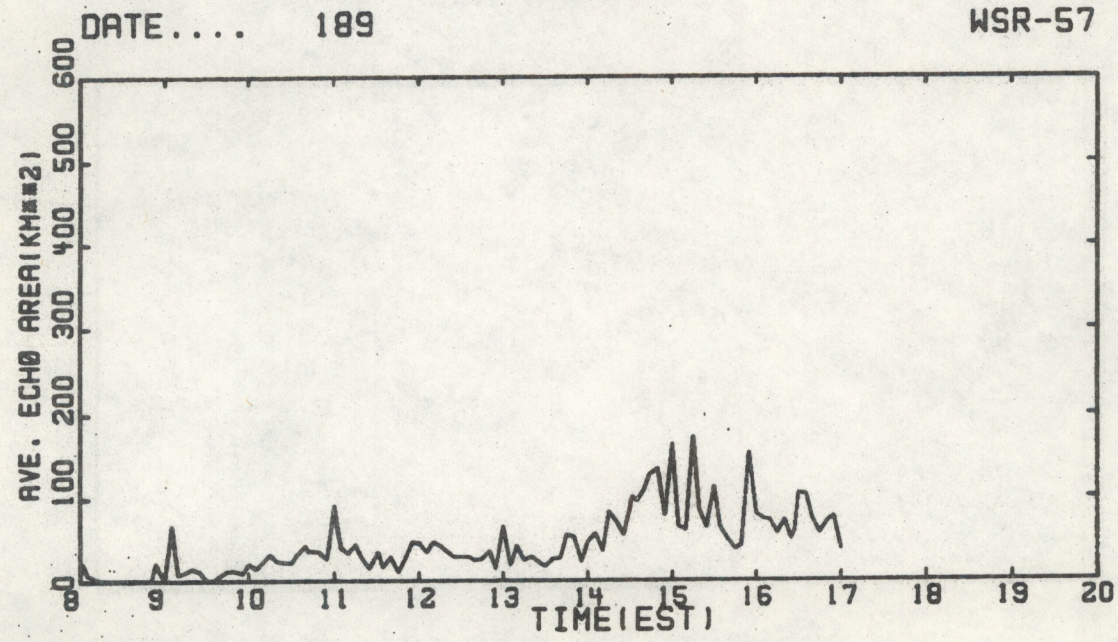

DATE.... 189
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
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11
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13
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15
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19
20
TIME(EST)

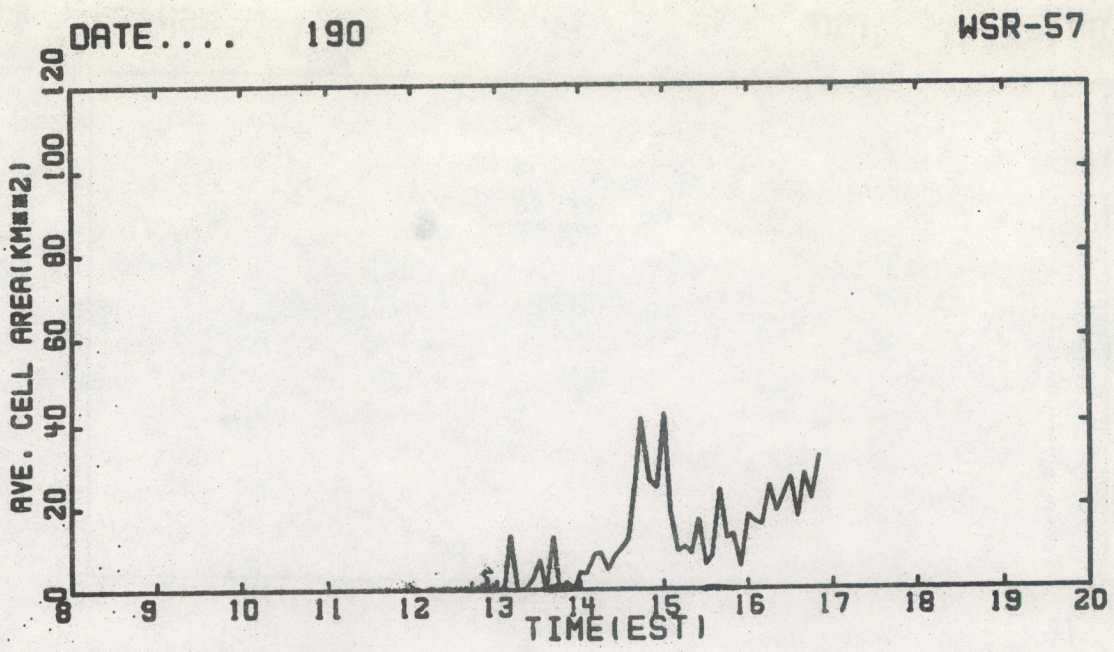

DATE.... 189
WSR-57
CELL REFLECTIVITY(DBZ)
AVE.....DASH
MAX.....SOLID
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

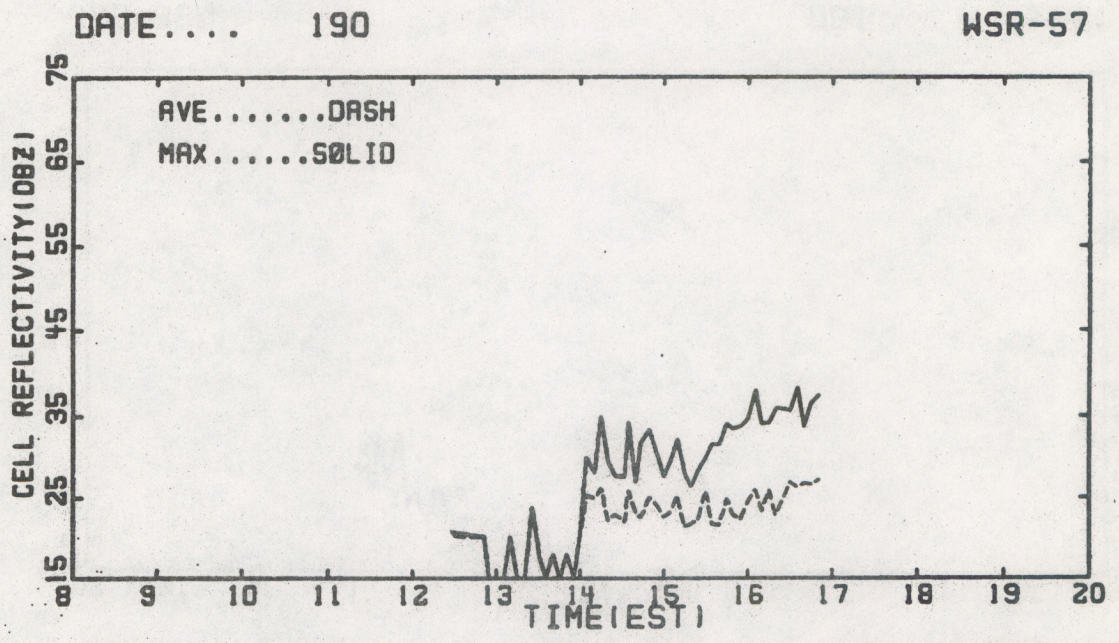


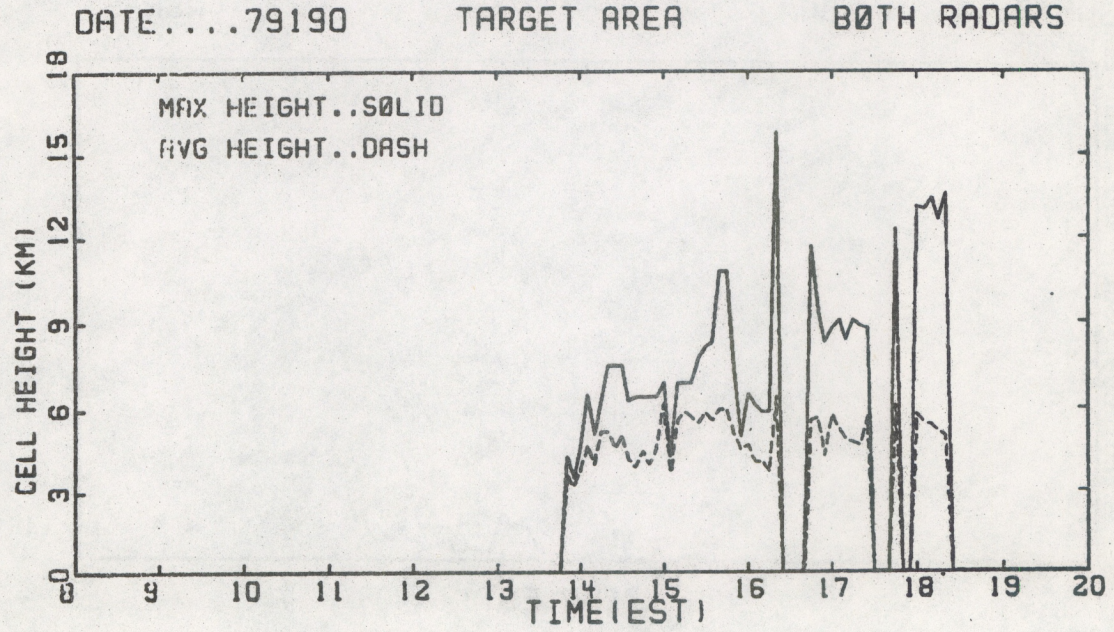

DATE.... 189
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
8
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11
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13
14
15
16
17
18
19
20
TIME(EST)

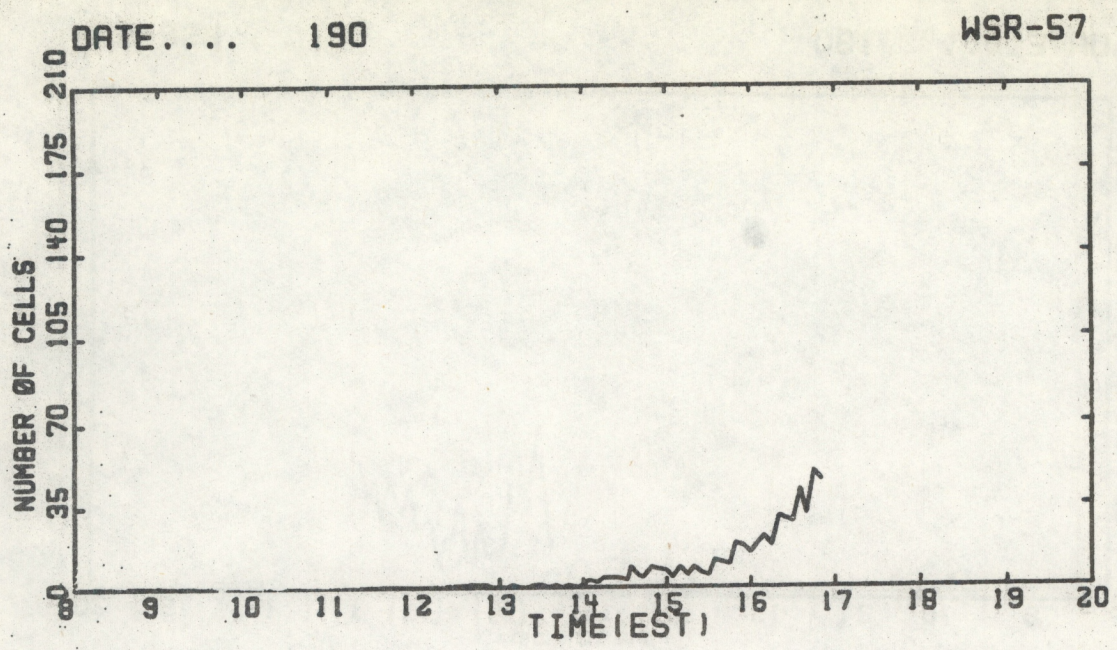

DATE.... 189
WSR-57
NUMBER ØF ECHØES
0
15
30
45
60
75
90
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15
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TIME(EST)

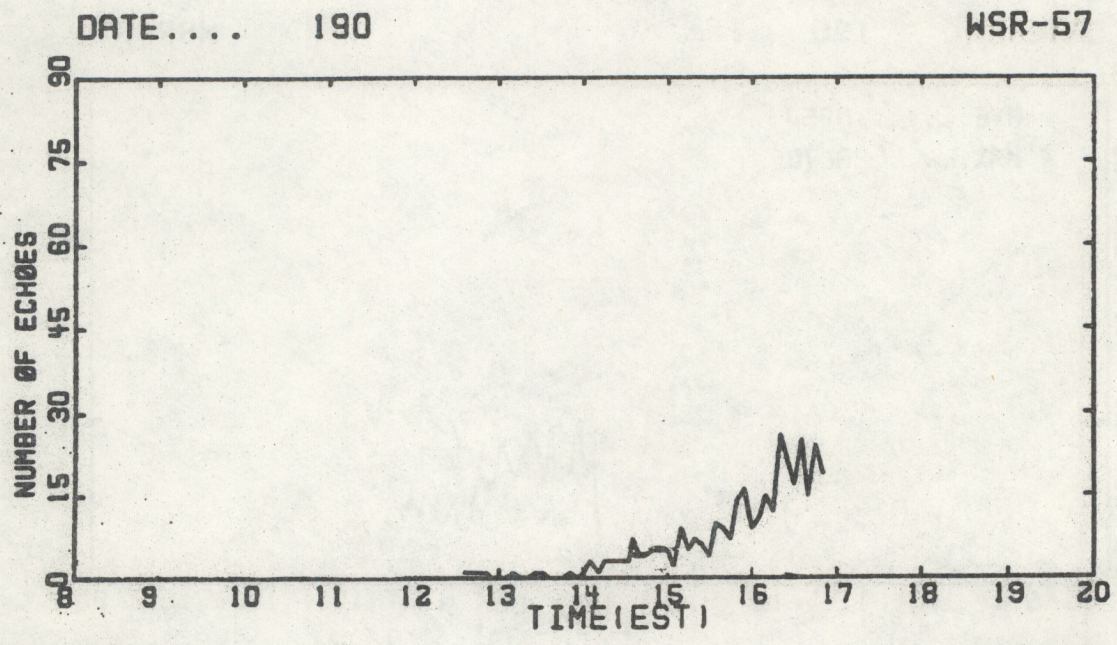

DATE.... 189
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

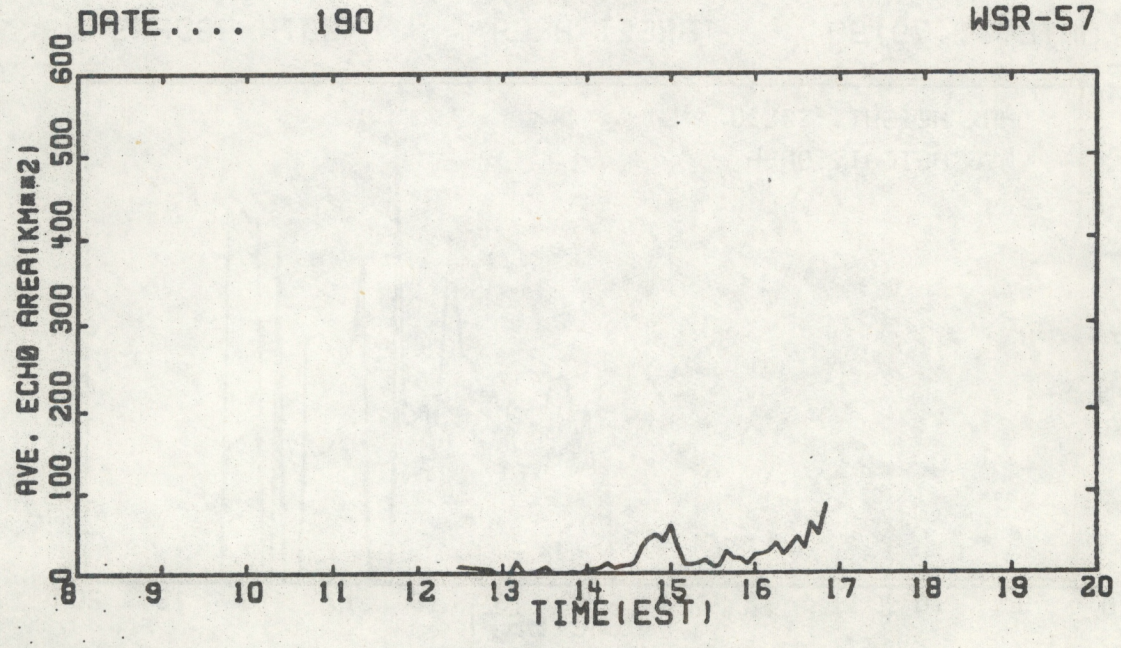

DATE.... 190
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
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12
13
14
15
16
17
18
19
20
TIME(EST)

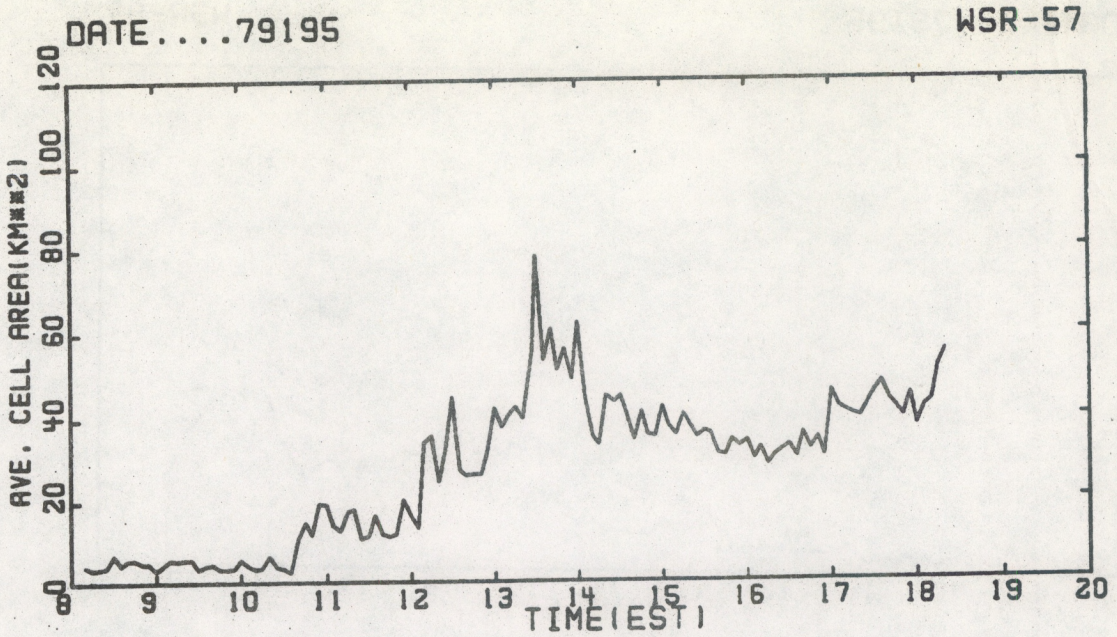

DATE.... 190
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
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11
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16
17
18
19
20
TIME(EST)

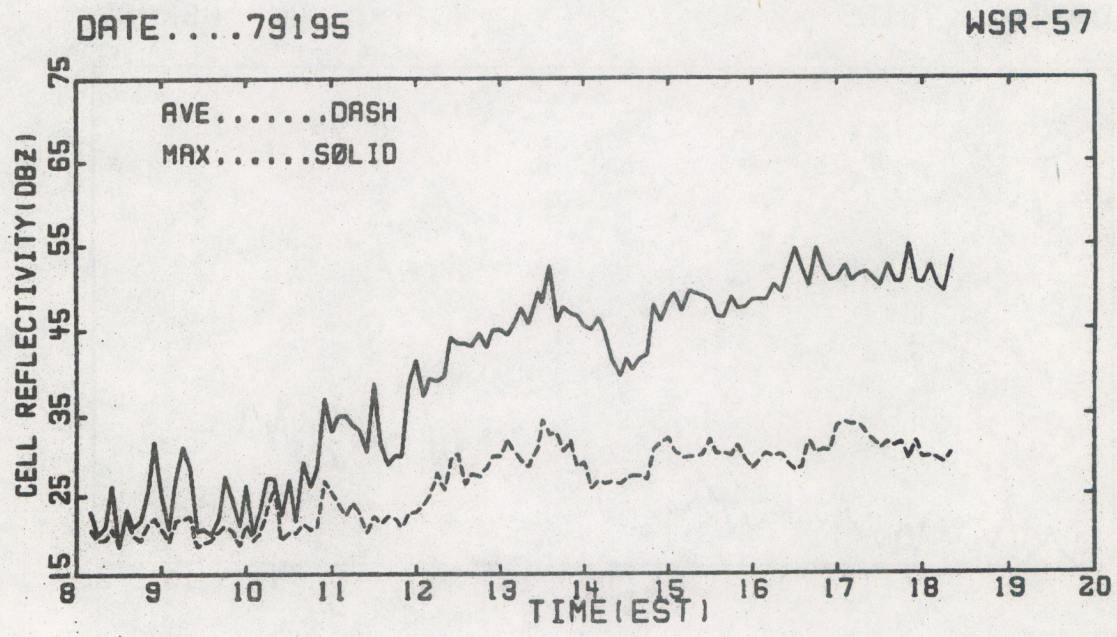

DATE....79190
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

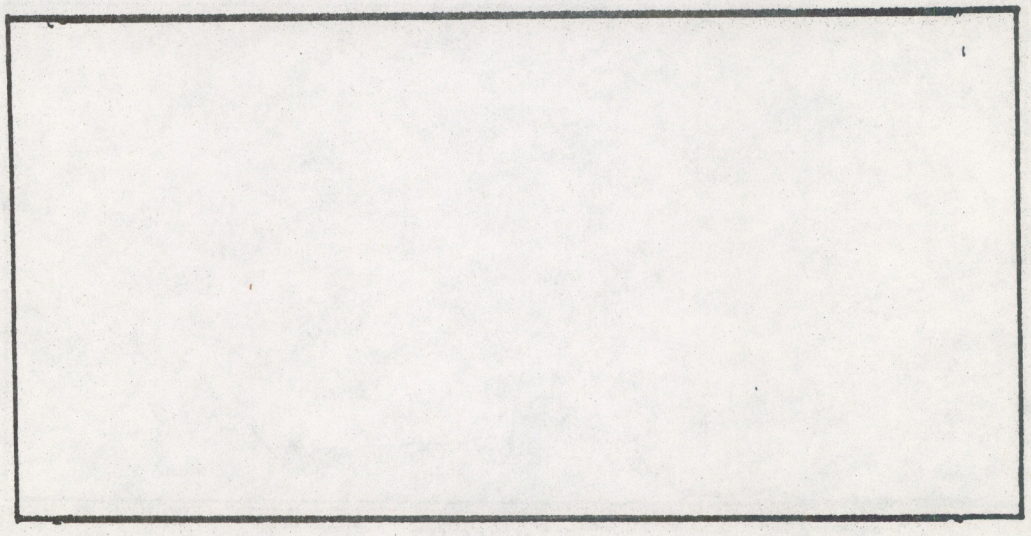

DATE.... 190
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
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19
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TIME(EST)

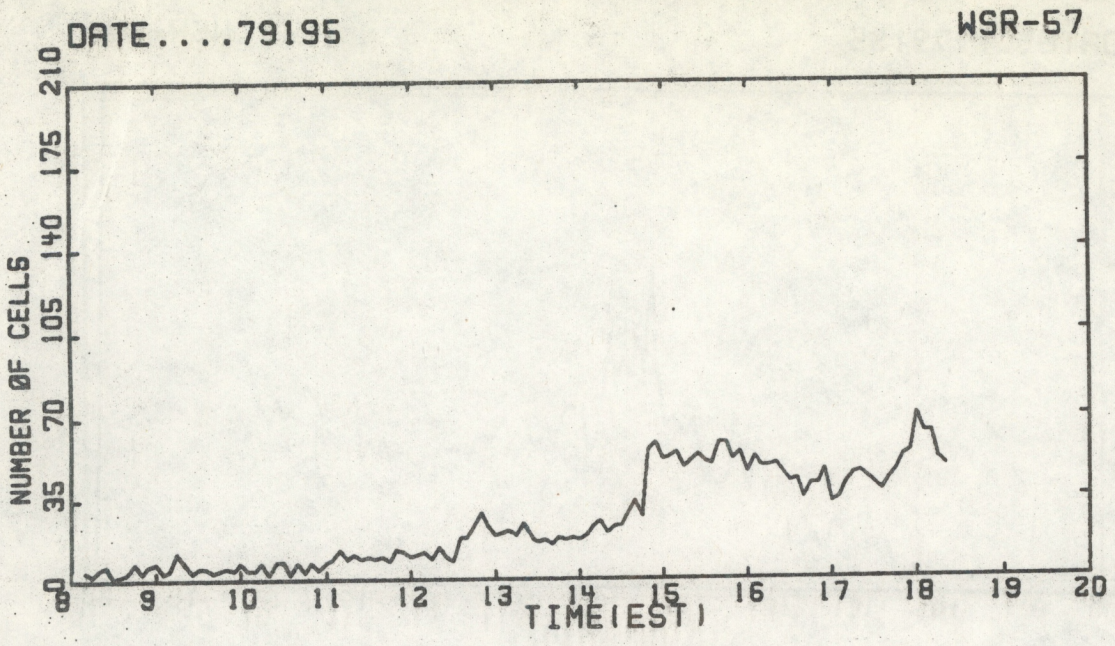

DATE.... 190
WSR-57
NUMBER ØF ECHØES
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15
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TIME(EST)

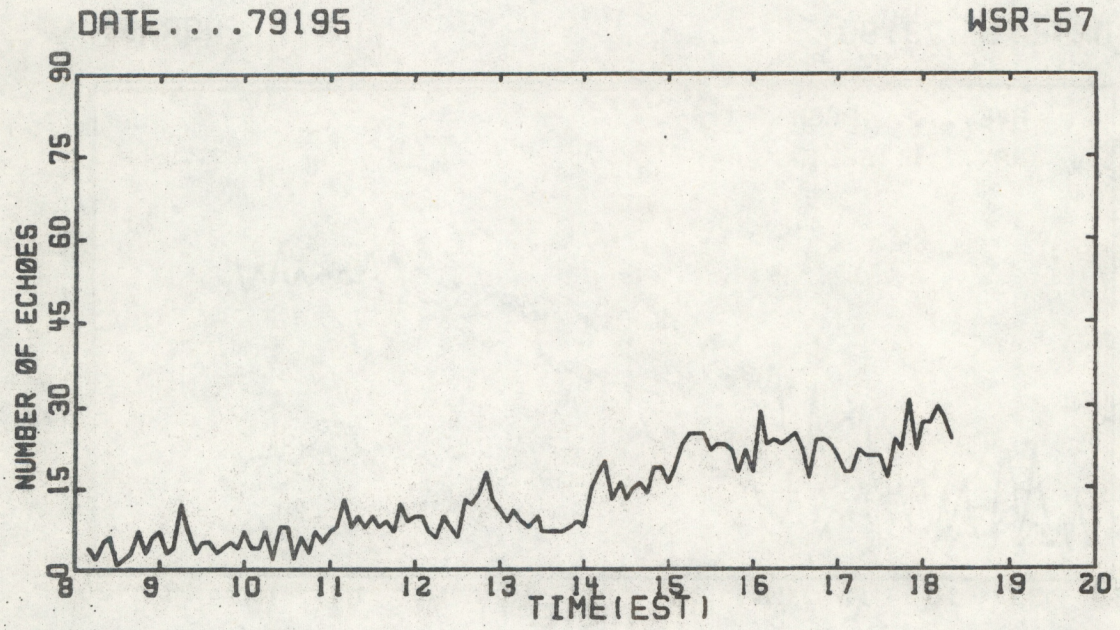

DATE.... 190
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
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600
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TIME(EST)

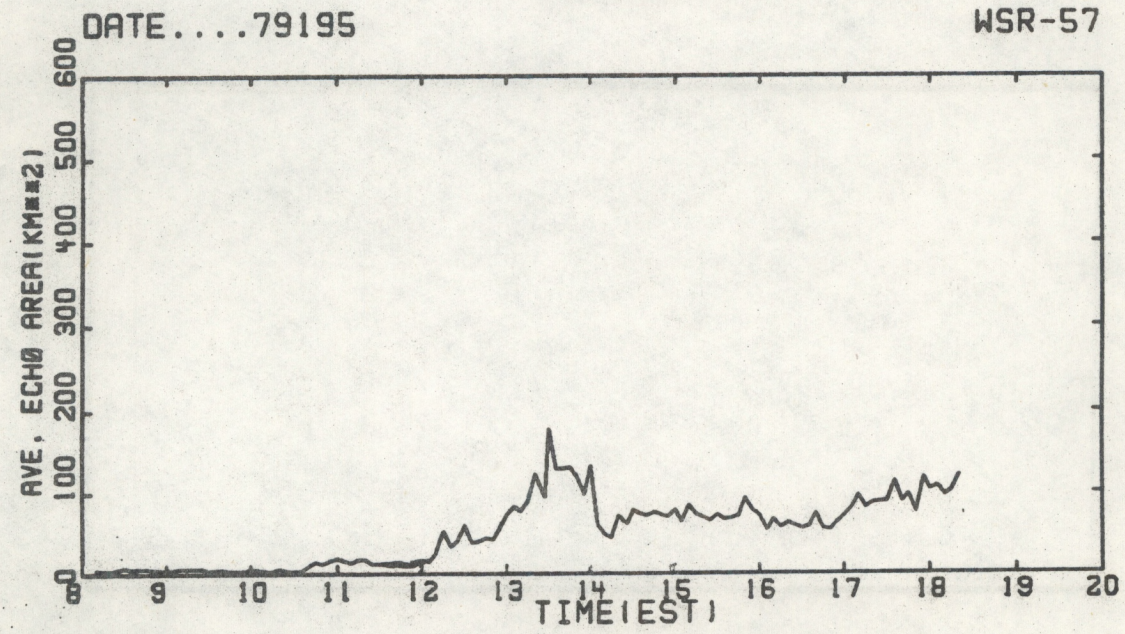

DATE....79195
WSR-57
AVE. CELL AREA(KM**2)
0
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80
100
120
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TIME(EST)

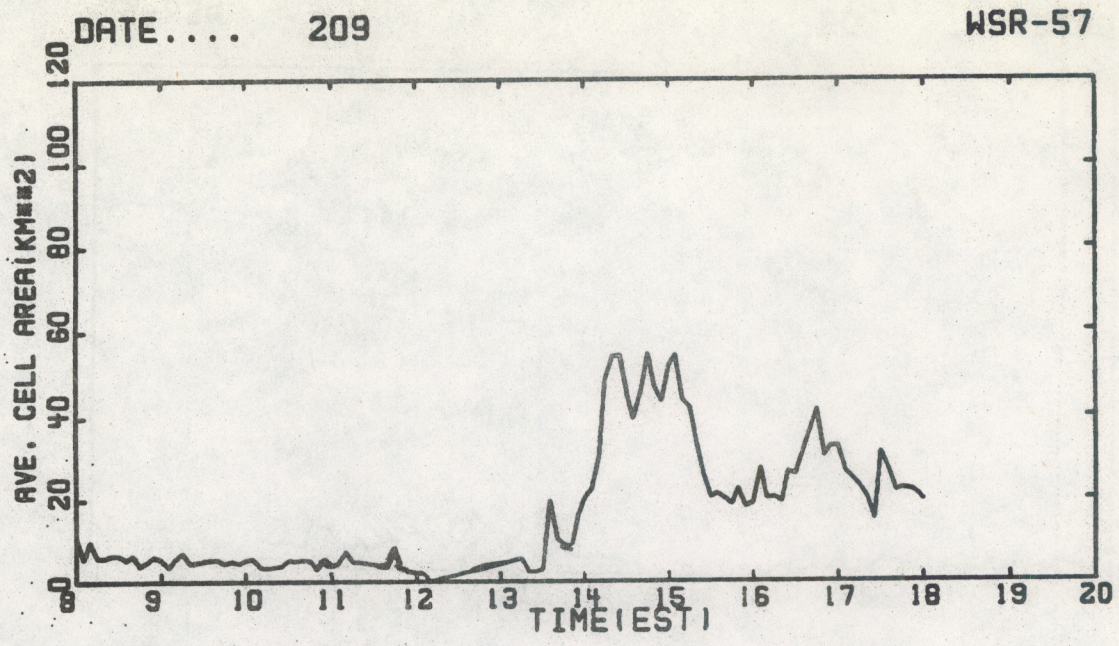

DATE....79195
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
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65
75
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TIME(EST)

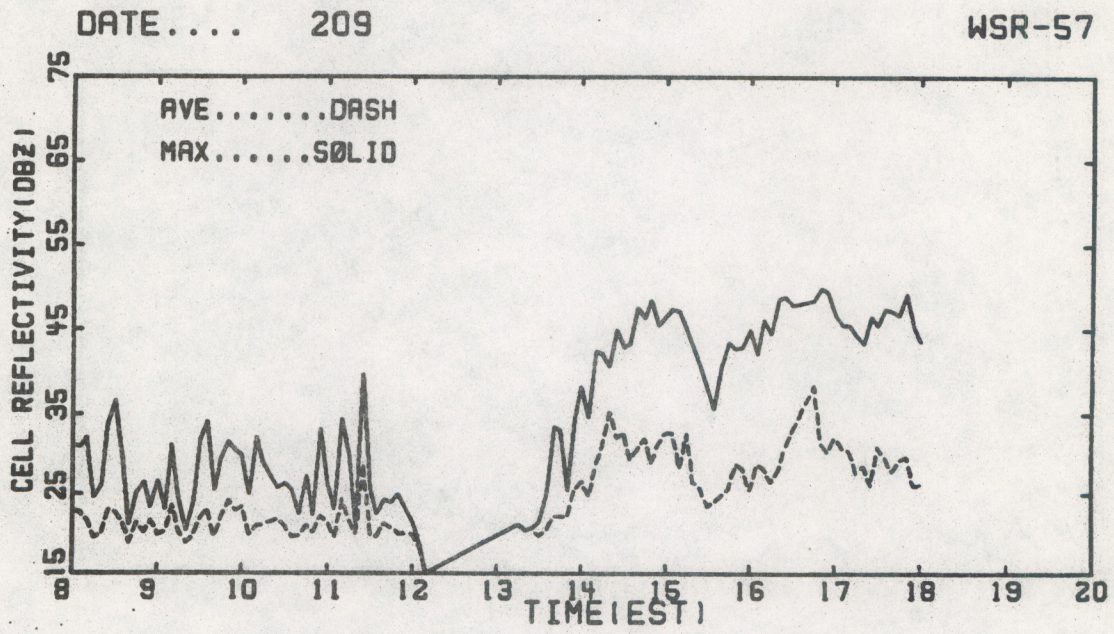


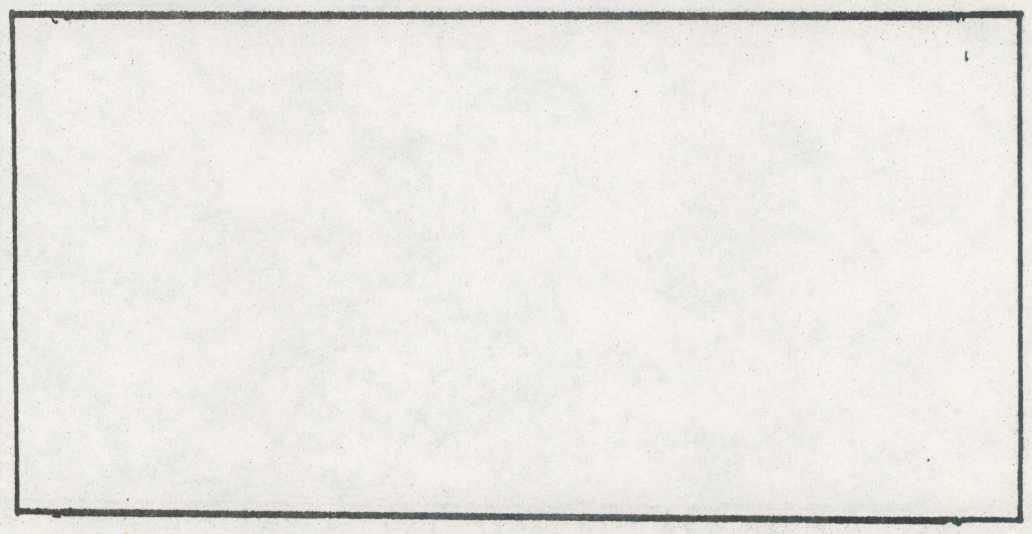

DATE....79195
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
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19
20
TIME(EST)

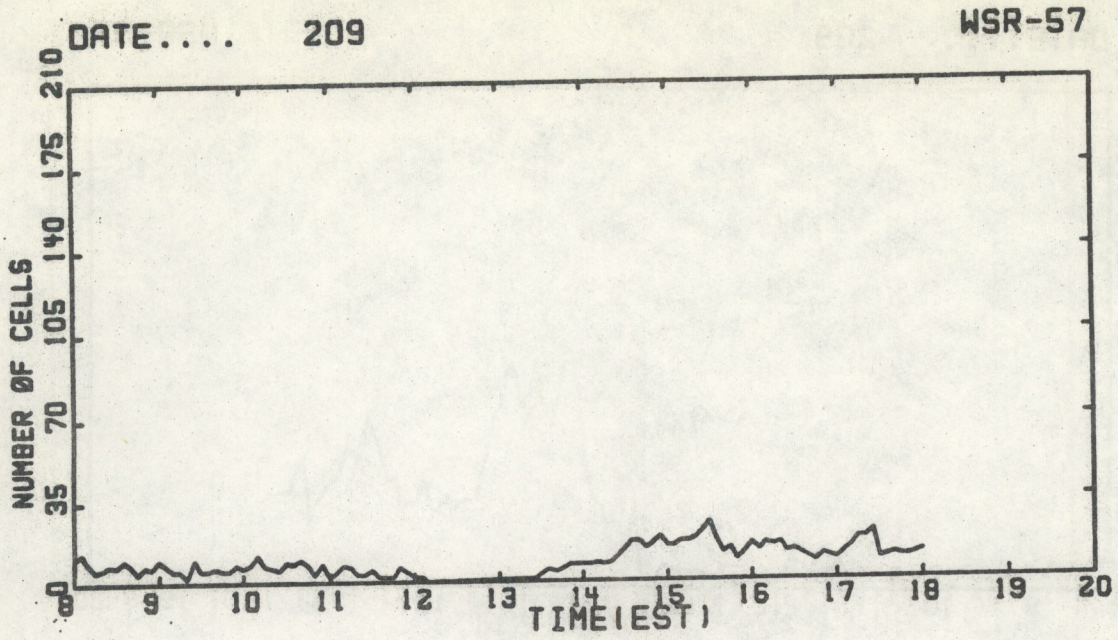

DATE....79195
WSR-57
NUMBER ØF ECHØES
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20
TIME(EST)

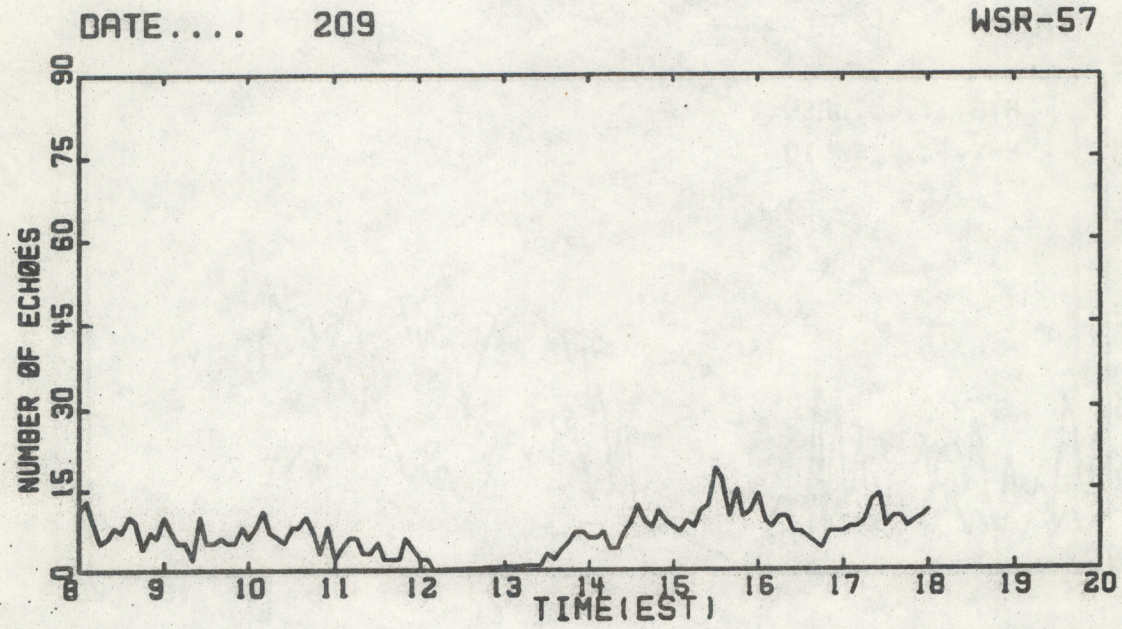

DATE....79195
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
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18
19
20
TIME(EST)

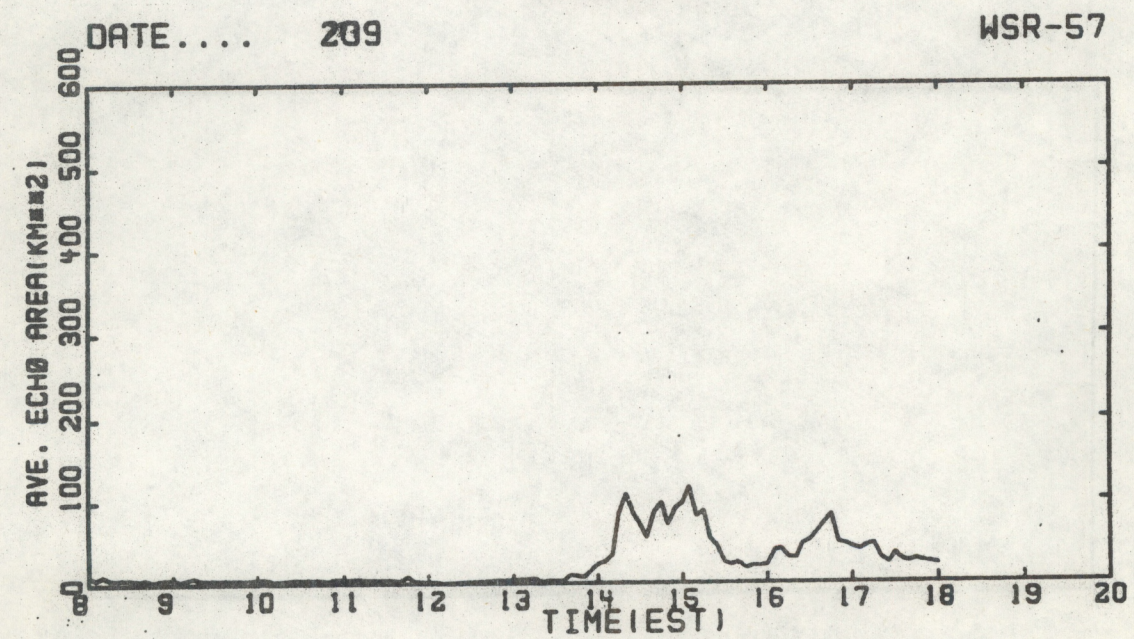

DATE.... 209
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
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TIME(EST)

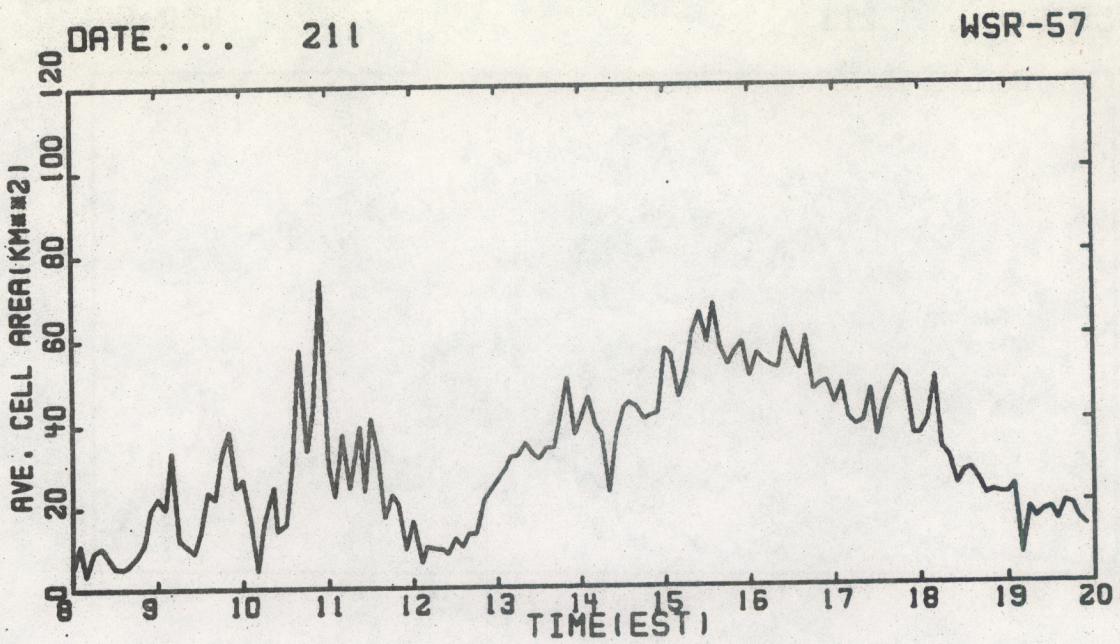

DATE.... 209
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
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75
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9
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18
19
20
TIME(EST)

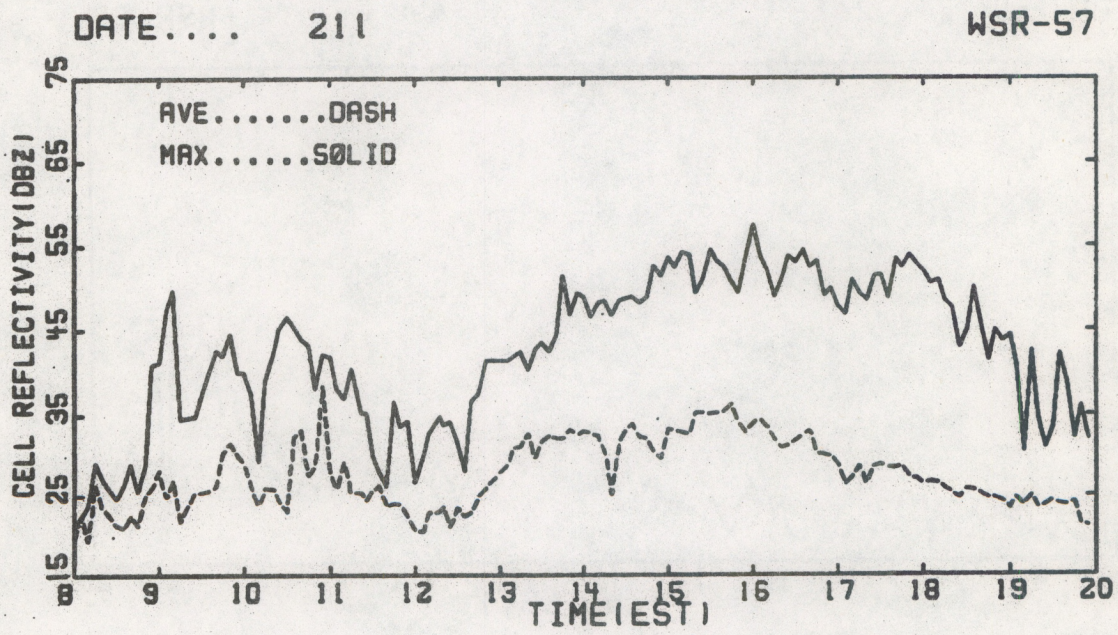


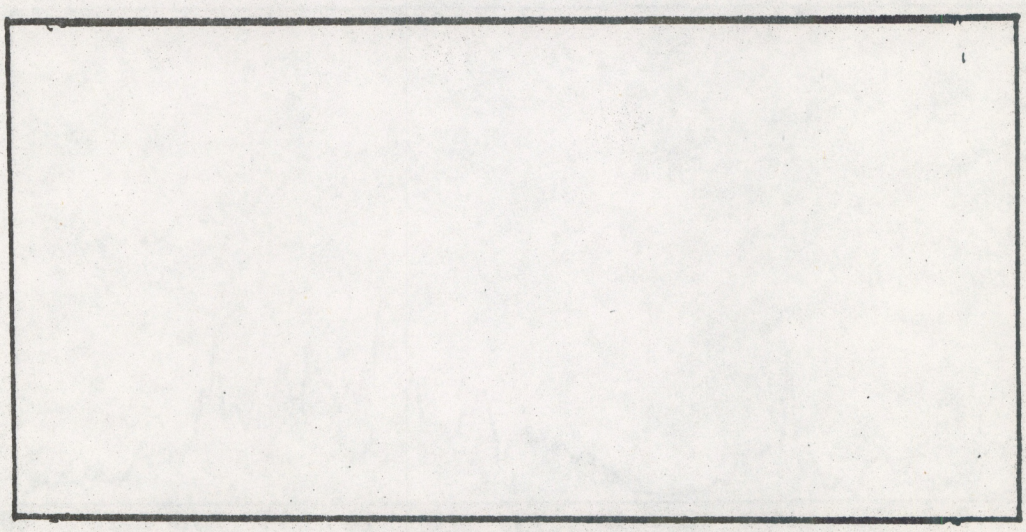

DATE.... 209
WSR-57
NUMBER OF CELLS
0
35
70
105
140
175
210
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14
15
16
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18
19
20
TIME(EST)

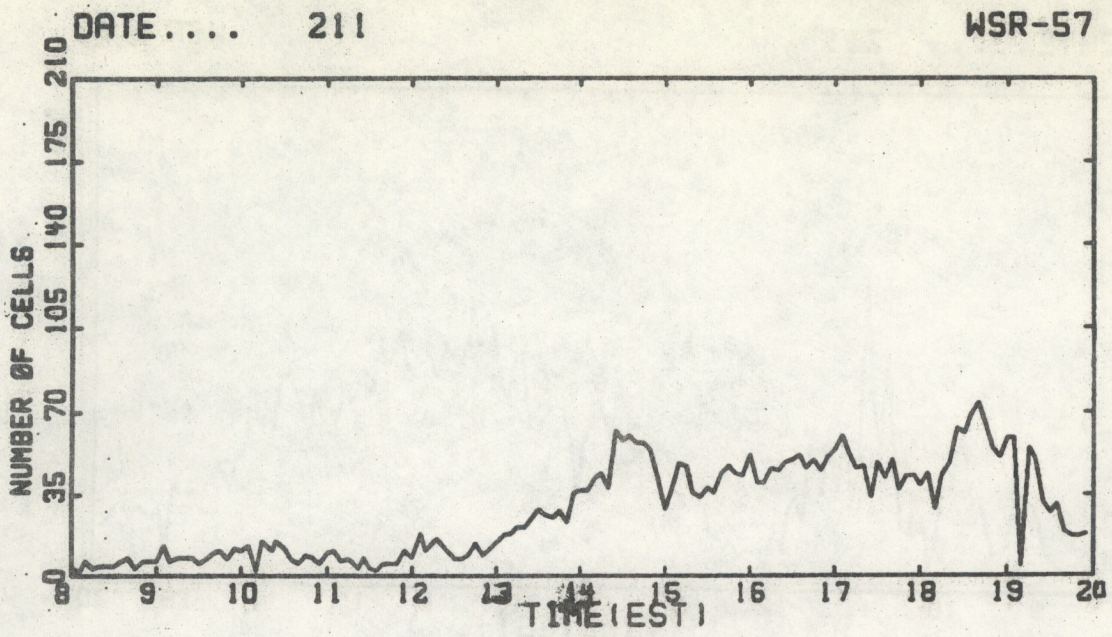

DATE.... 209
WSR-57
NUMBER OF ECHOES
0
15
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75
90
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16
17
18
19
20
TIME(EST)

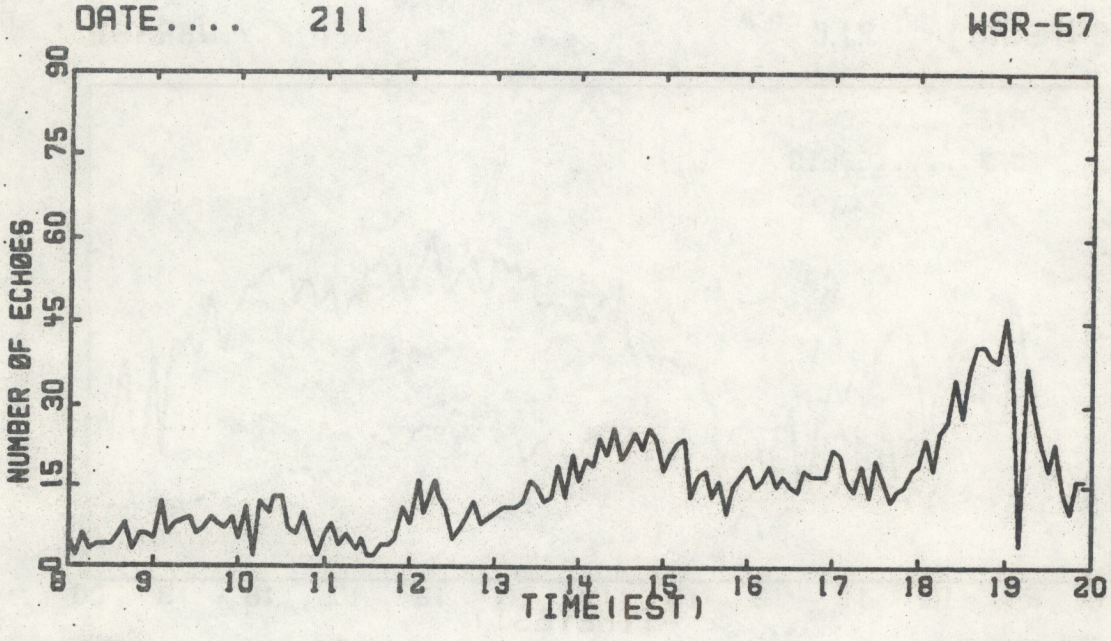

DATE.... 209
WSR-57
AVE. ECHO AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

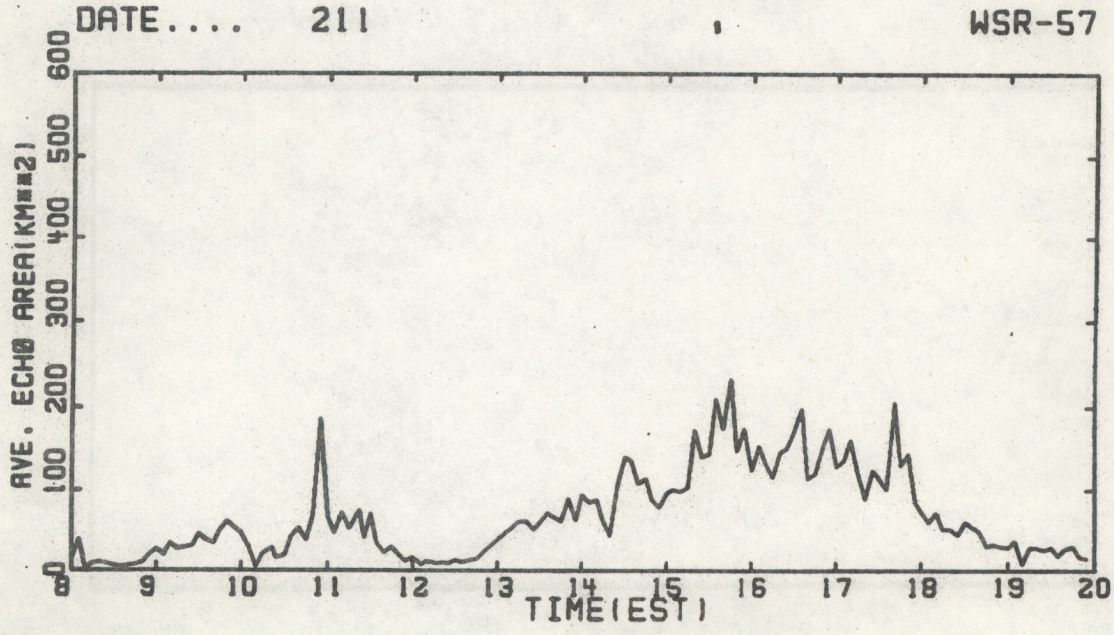

DATE.... 211
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

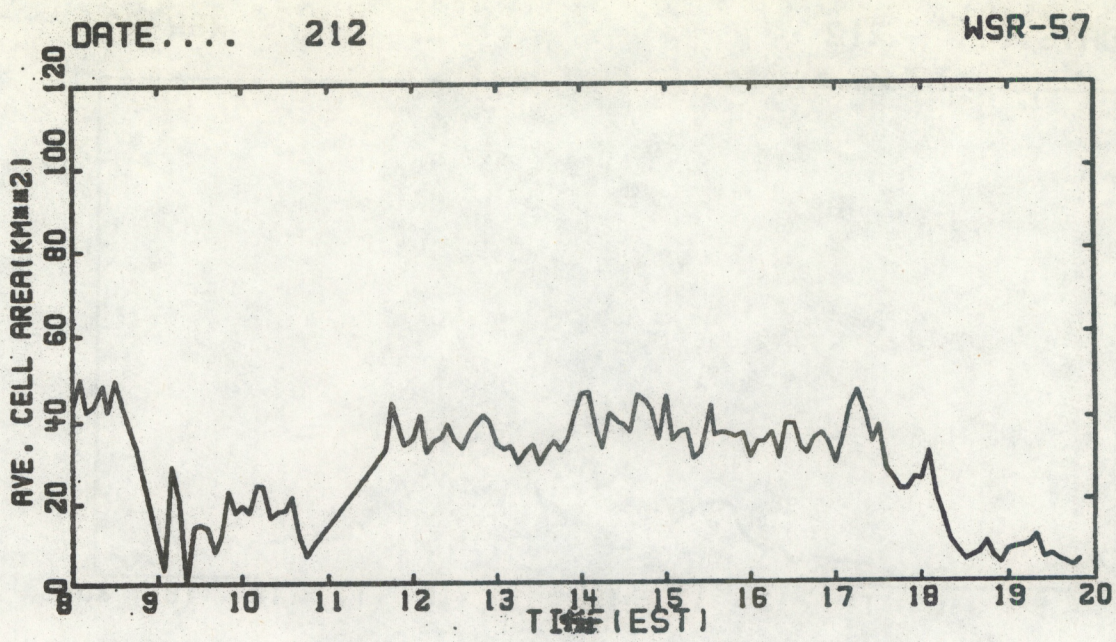

DATE.... 211
WSR-57
AVE.....DASH
MAX.....SOLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

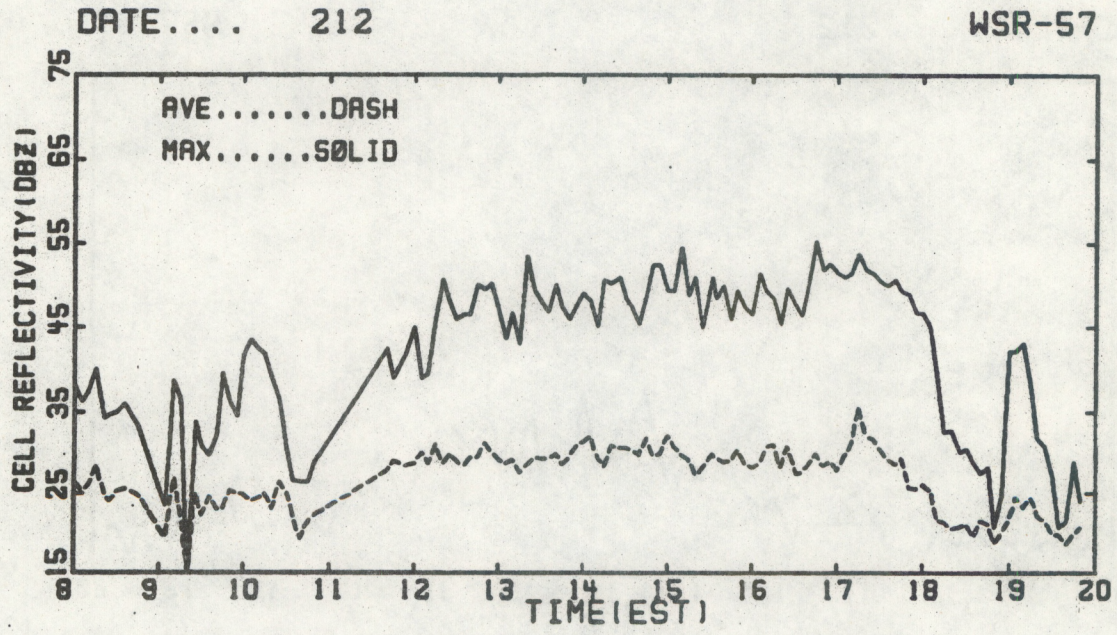


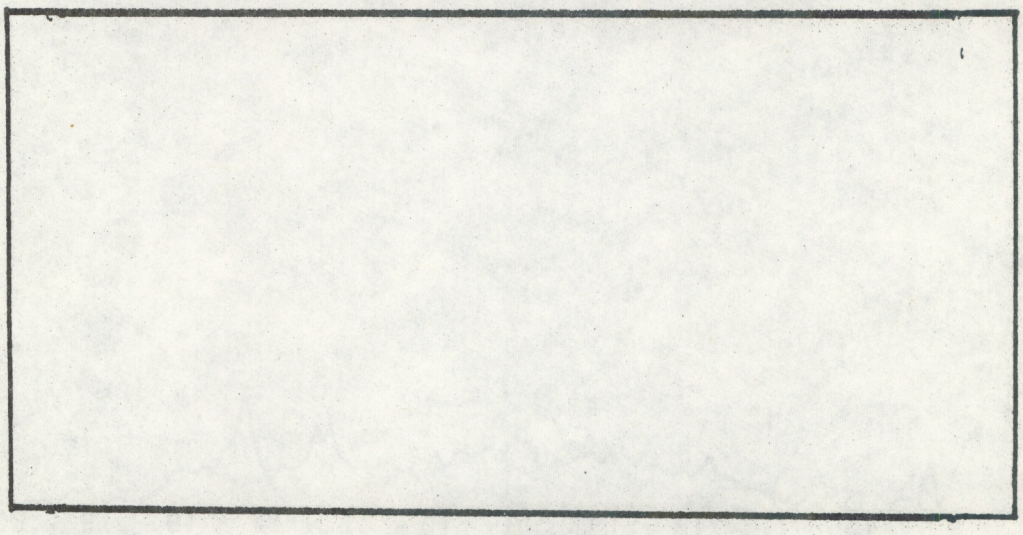

DATE.... 211
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

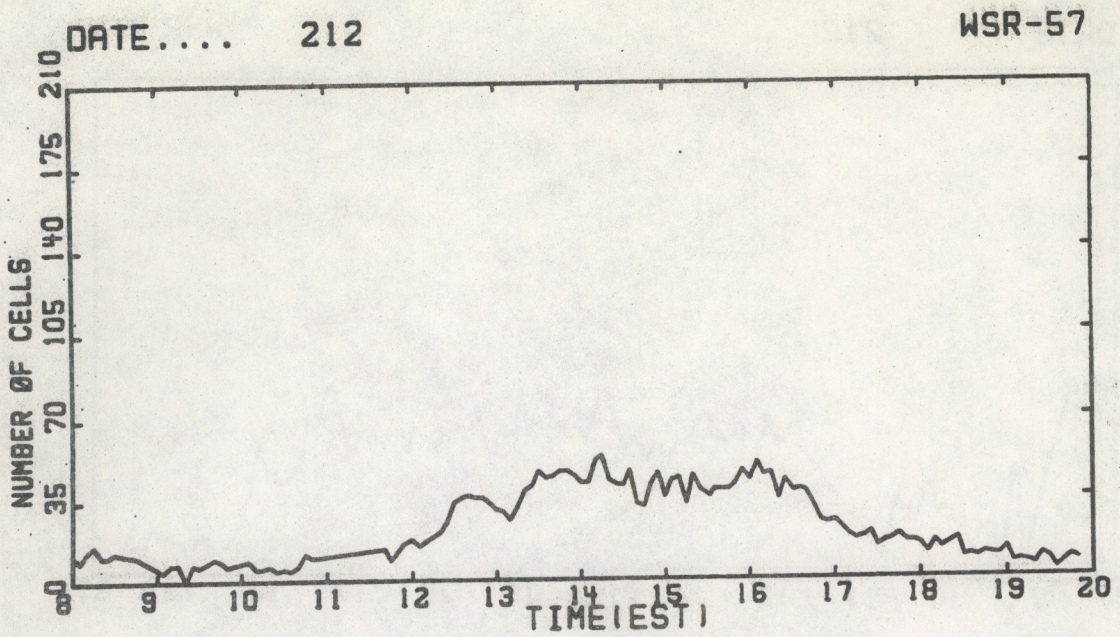

DATE.... 211
WSR-57
NUMBER ØF ECHØES
0
15
30
45
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75
90
8
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15
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17
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19
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TIME(EST)

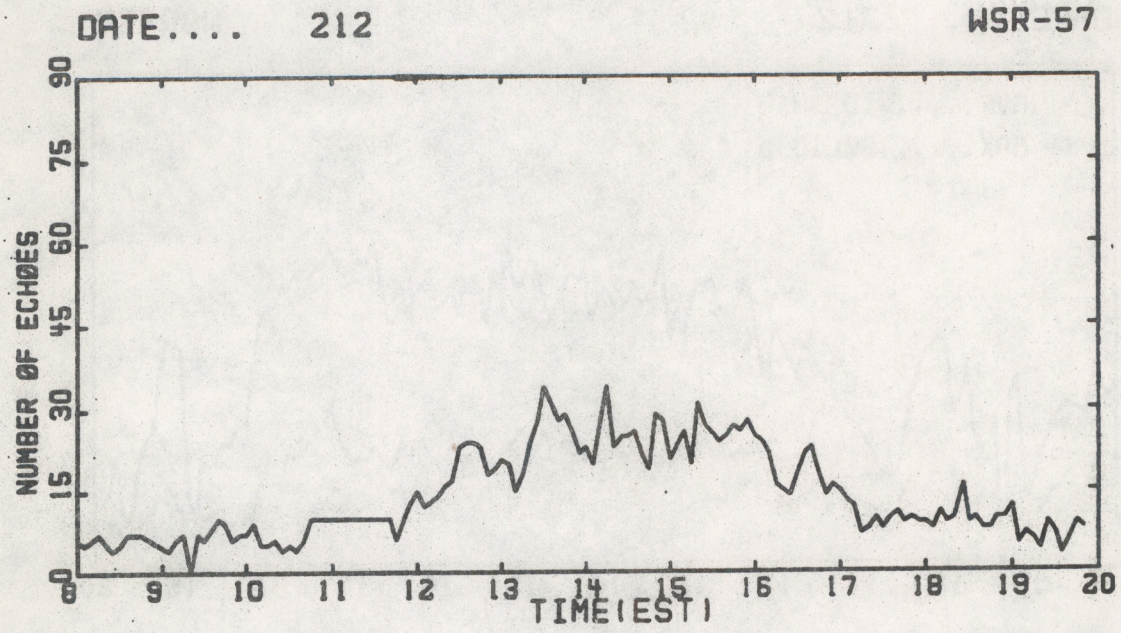

DATE.... 211
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
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20
TIME(EST)

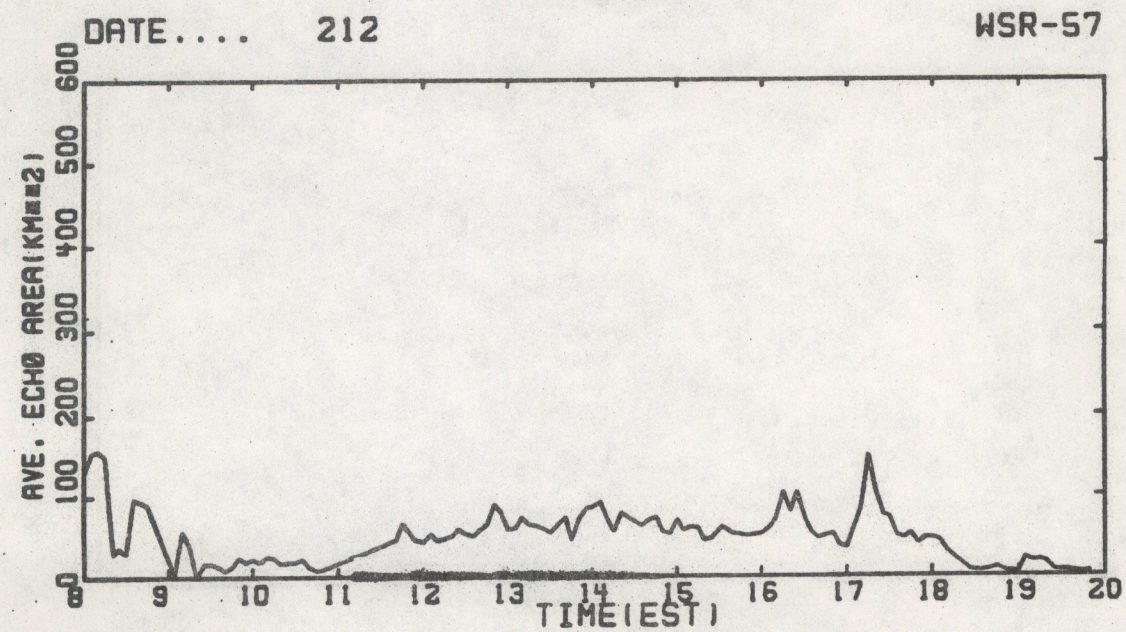

DATE.... 212
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
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80
100
120
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20
TIME(EST)

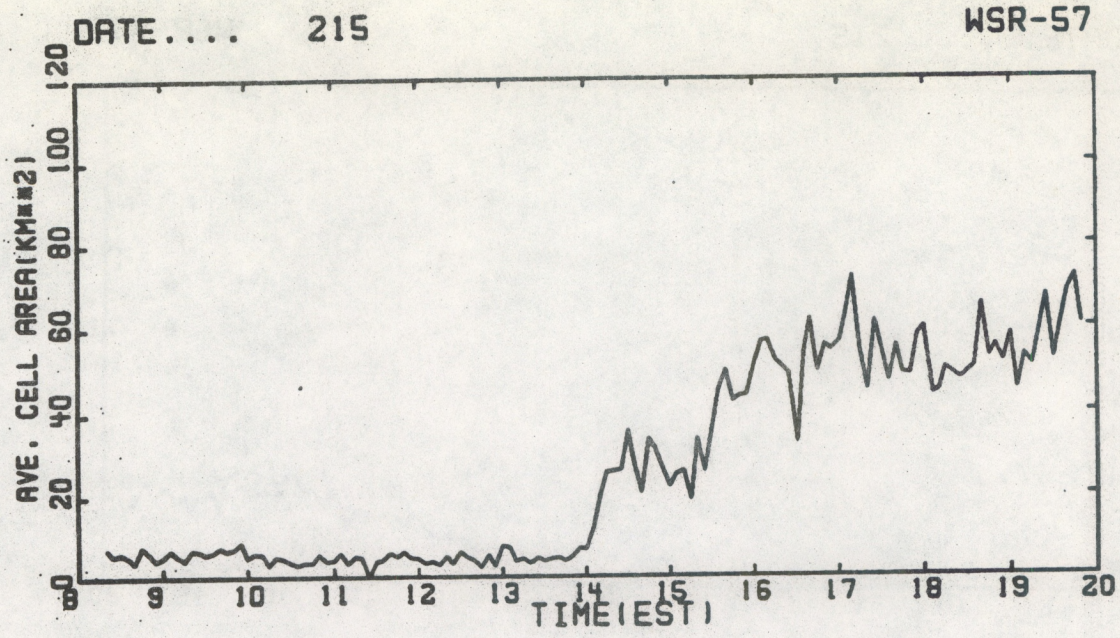

DATE.... 212
WSR-57
CELL REFLECTIVITY(DBZ)
AVE.....DASH
MAX.....SOLID
15
25
35
45
55
65
75
8
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11
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19
20
TIME(EST)

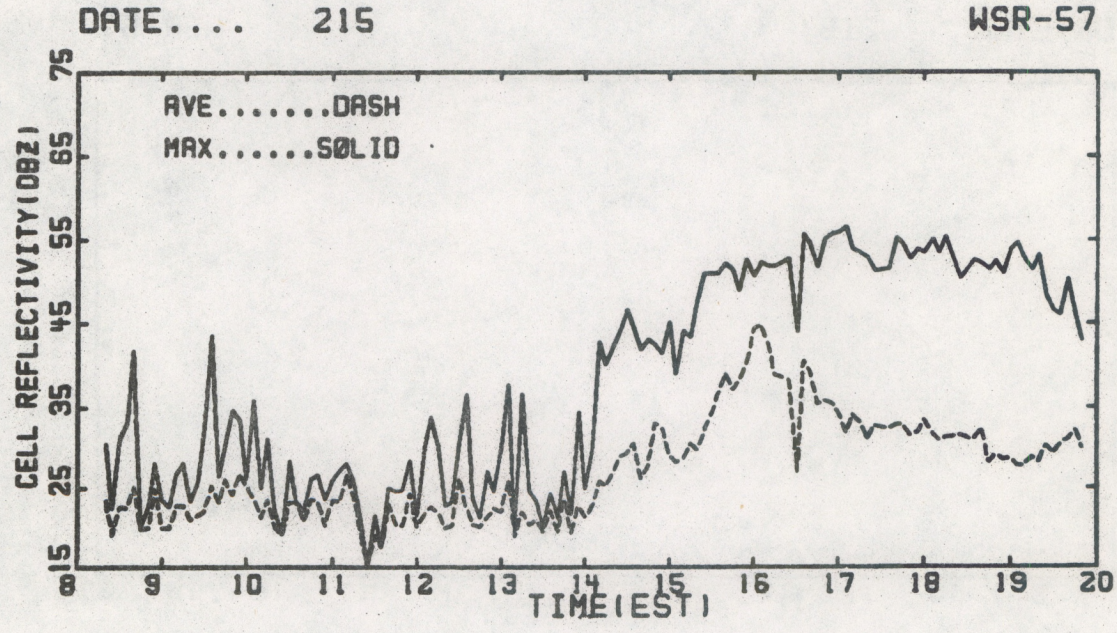


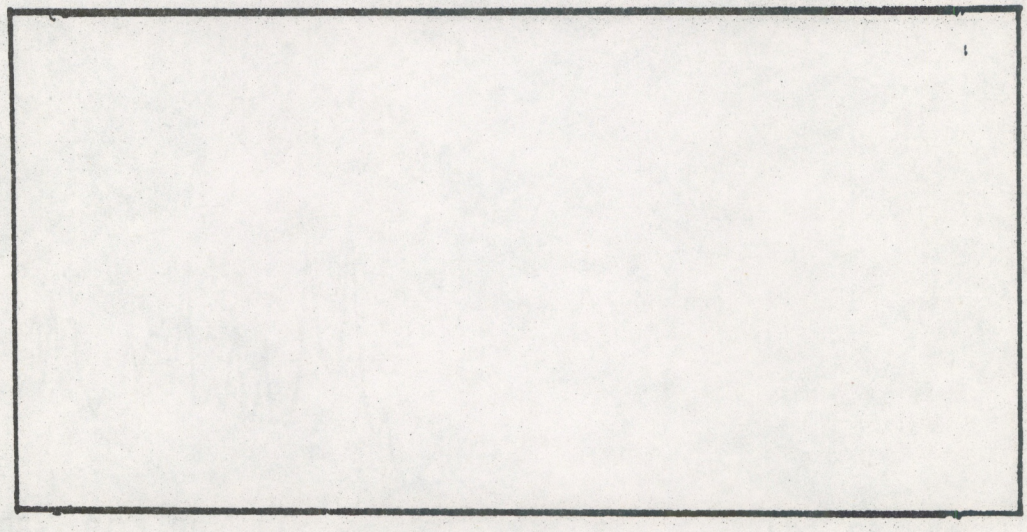

DATE.... 212
WSR-57
NUMBER OF CELLS
0
35
70
105
140
175
210
9
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15
16
17
18
19
20
TIME(EST)

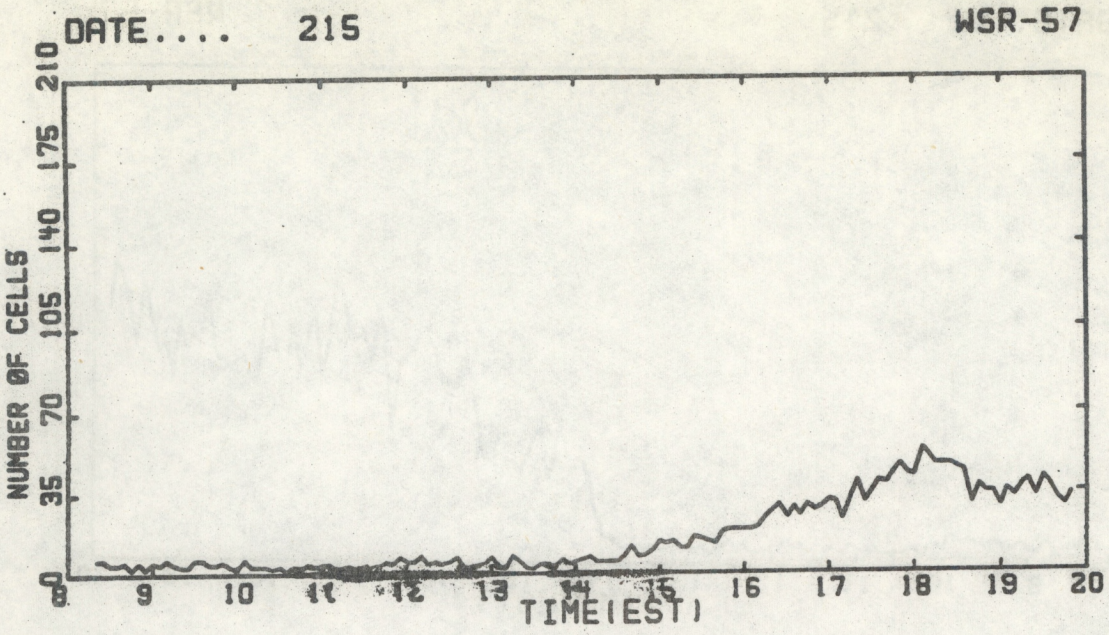

DATE.... 212
WSR-57
NUMBER OF ECHOES
0
15
30
45
60
75
90
9
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11
12
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15
16
17
18
19
20
TIME(EST)

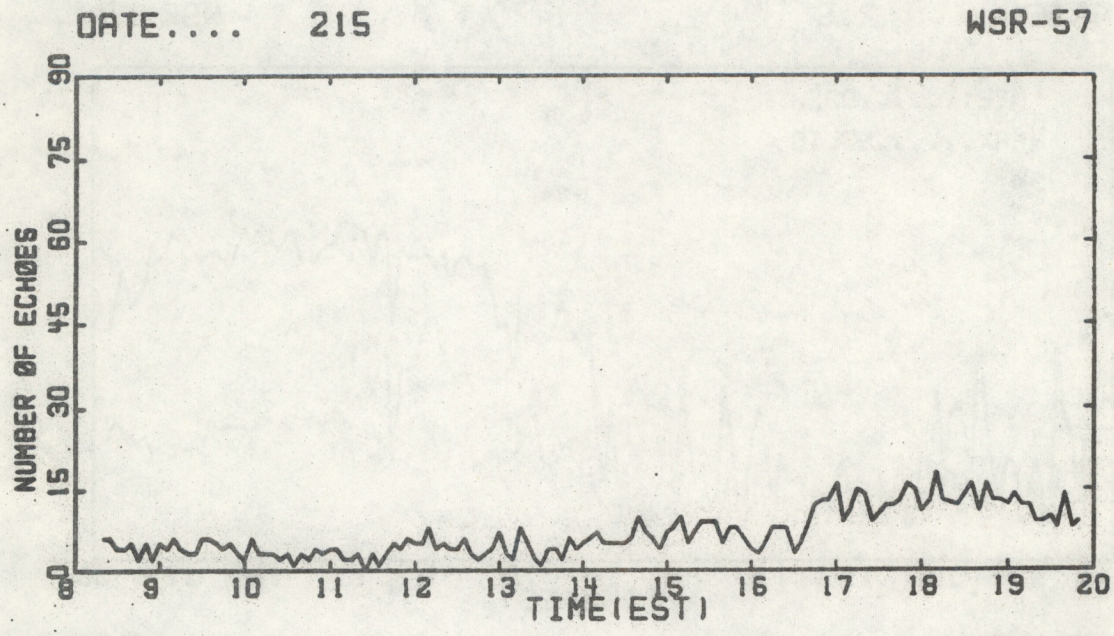

DATE.... 212
WSR-57
AVE. ECHO AREA(KM**2)
0
100
200
300
400
500
600
9
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15
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19
20
TIME(EST)

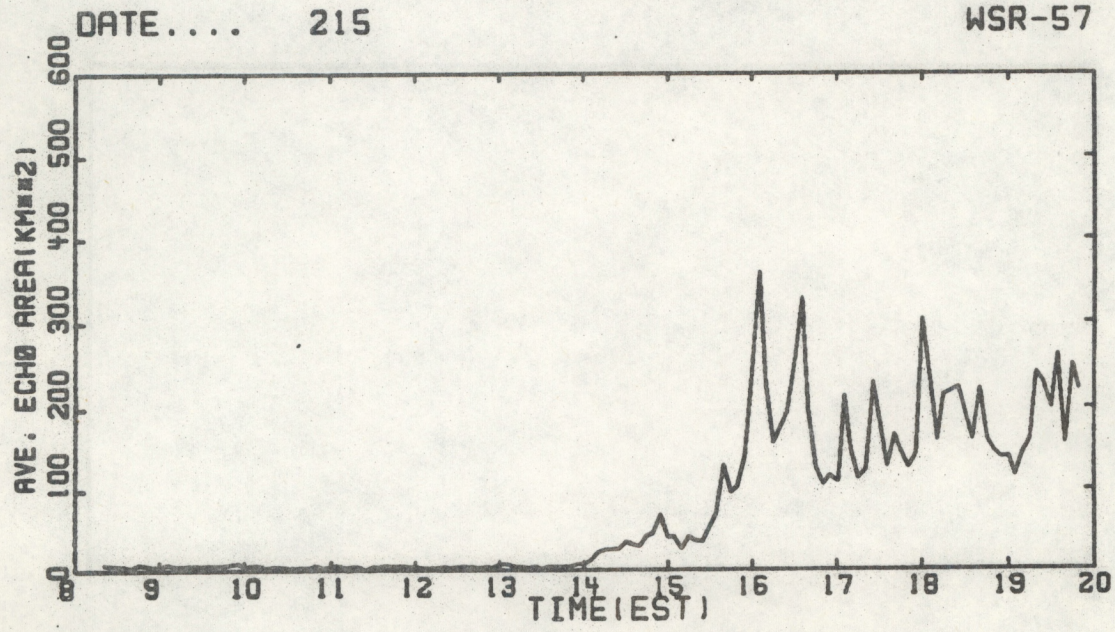

DATE.... 215
WSR-57
AVE. CELL AREA(KM**2)
0
20
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60
80
100
120
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20
TIME(EST)

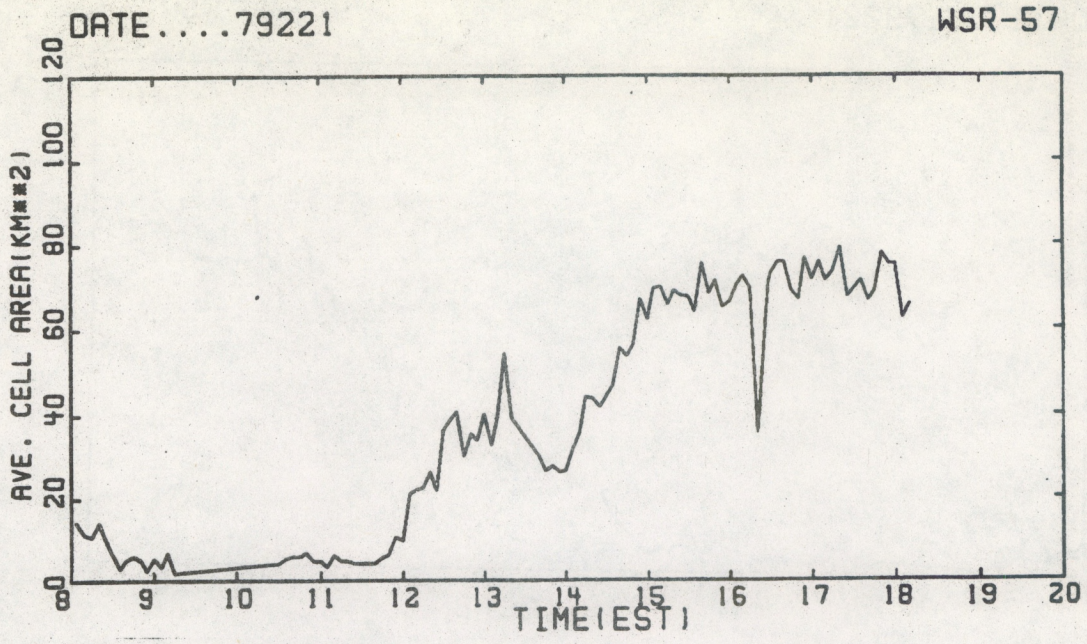

DATE.... 215
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
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11
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13
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16
17
18
19
20
TIME(EST)

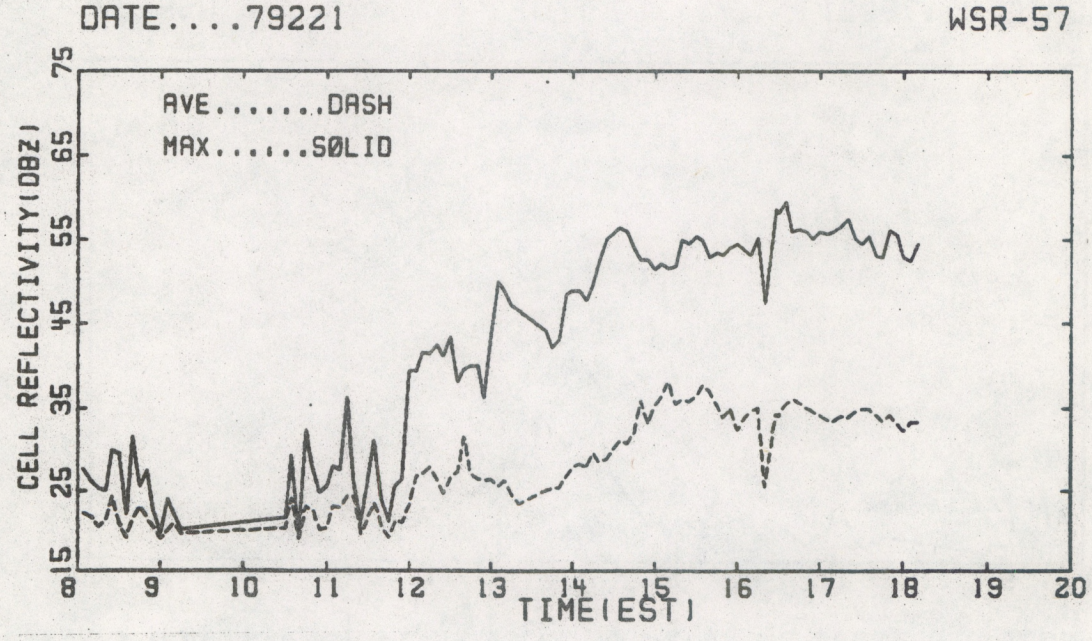


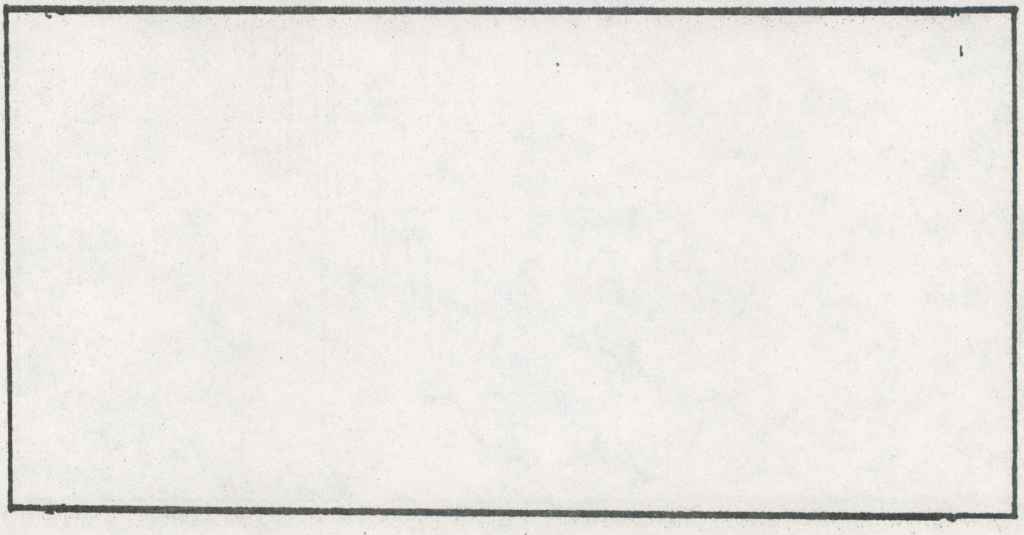

DATE.... 215
WSR-57
NUMBER OF CELLS
0
35
70
105
140
175
210
8
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11
12
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14
15
16
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18
19
20
TIME(EST)

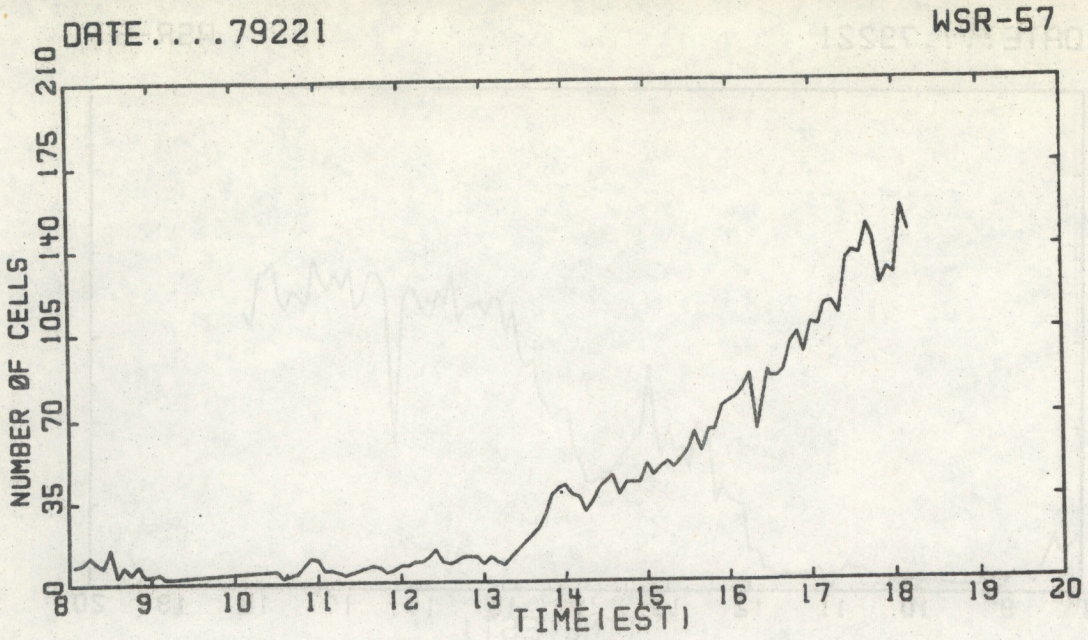

DATE.... 215
WSR-57
NUMBER OF ECHOES
0
15
30
45
60
75
90
8
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TIME(EST)

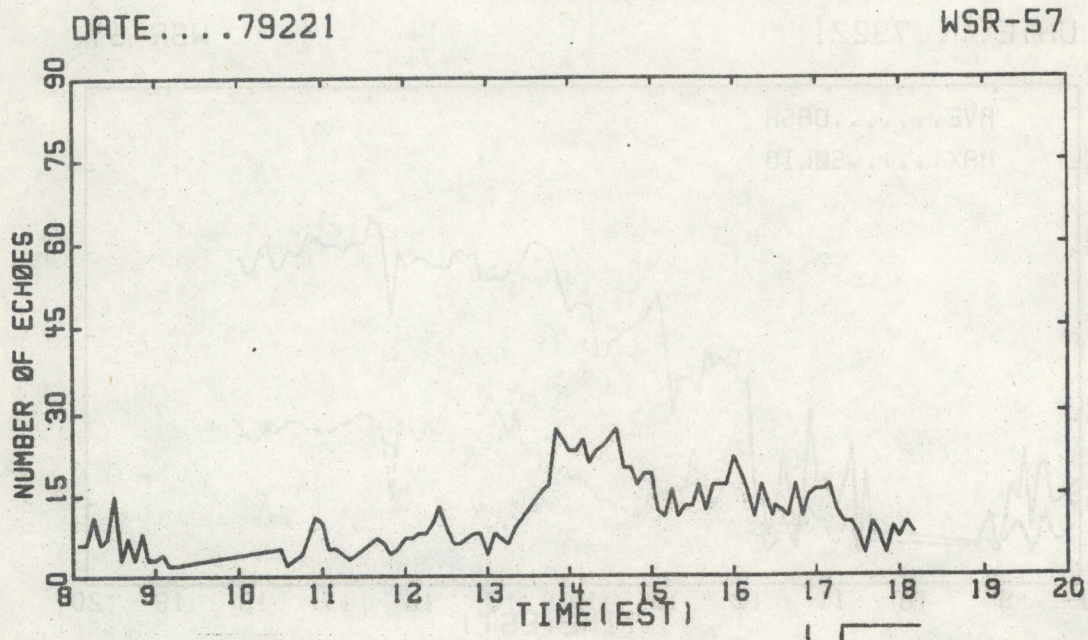

DATE.... 215
WSR-57
AVE. ECHO AREA(KM**2)
0
100
200
300
400
500
600
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11
12
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18
19
20
TIME(EST)

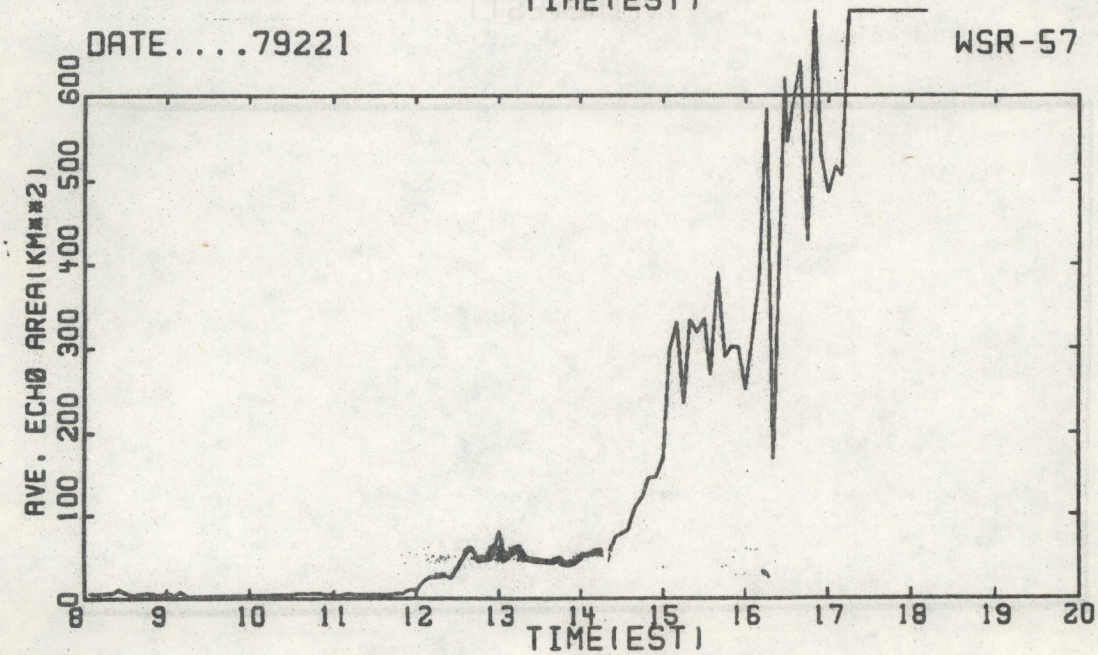

DATE....79221
WSR-57
AVE. CELL AREA(KM**2)
0
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80
100
120
8
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19
20
TIME(EST)

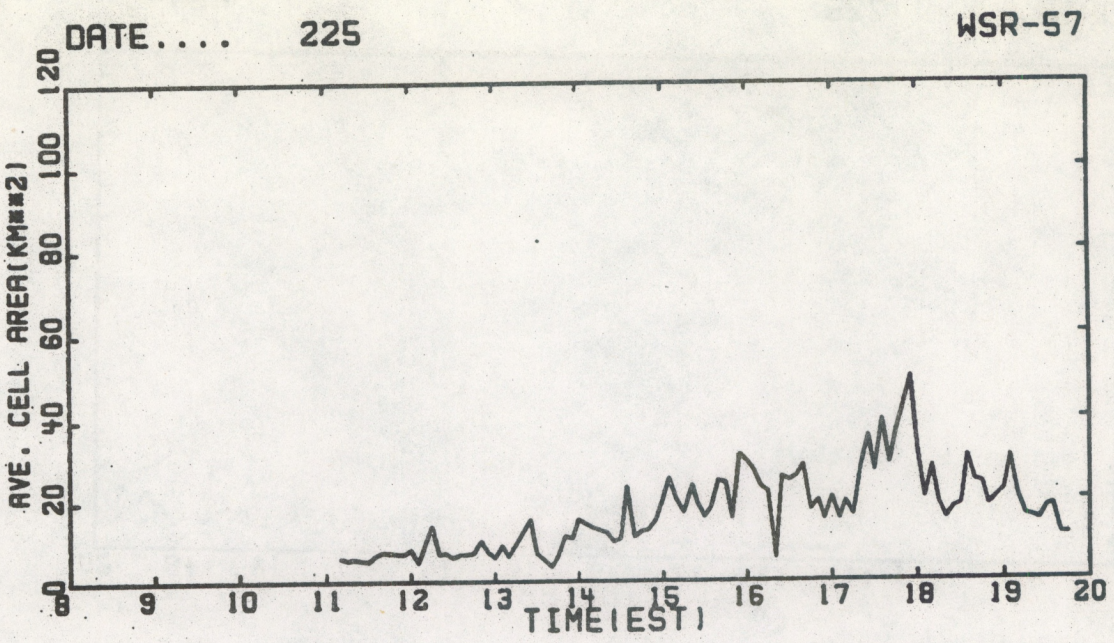

DATE....79221
WSR-57
CELL REFLECTIVITY(DBZ)
AVE.....DASH
MAX.....SØLID
15
25
35
45
55
65
75
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11
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18
19
20
TIME(EST)

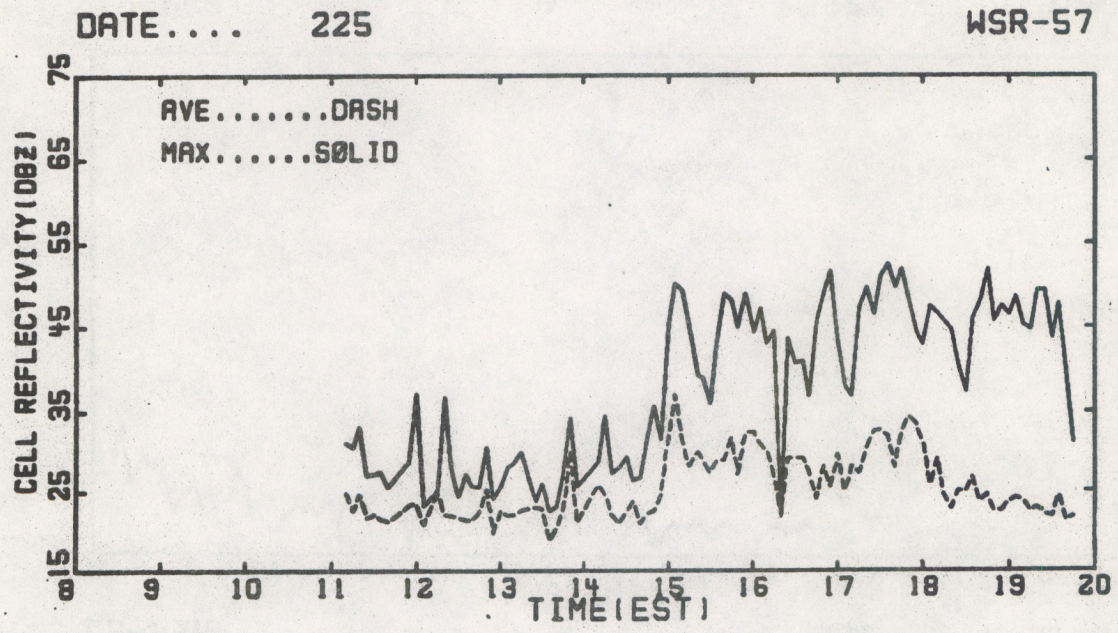


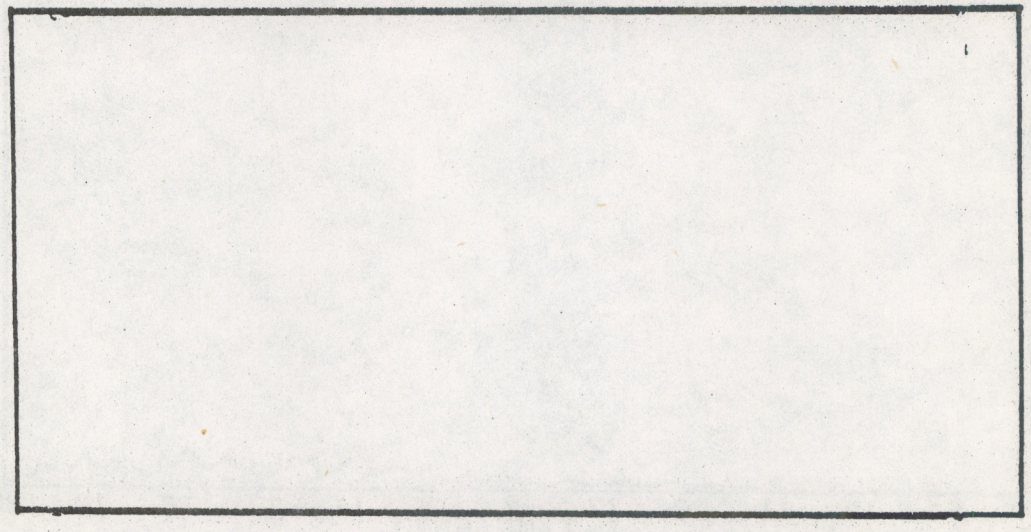

DATE....79221
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
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11
12
13
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15
16
17
18
19
20
TIME(EST)

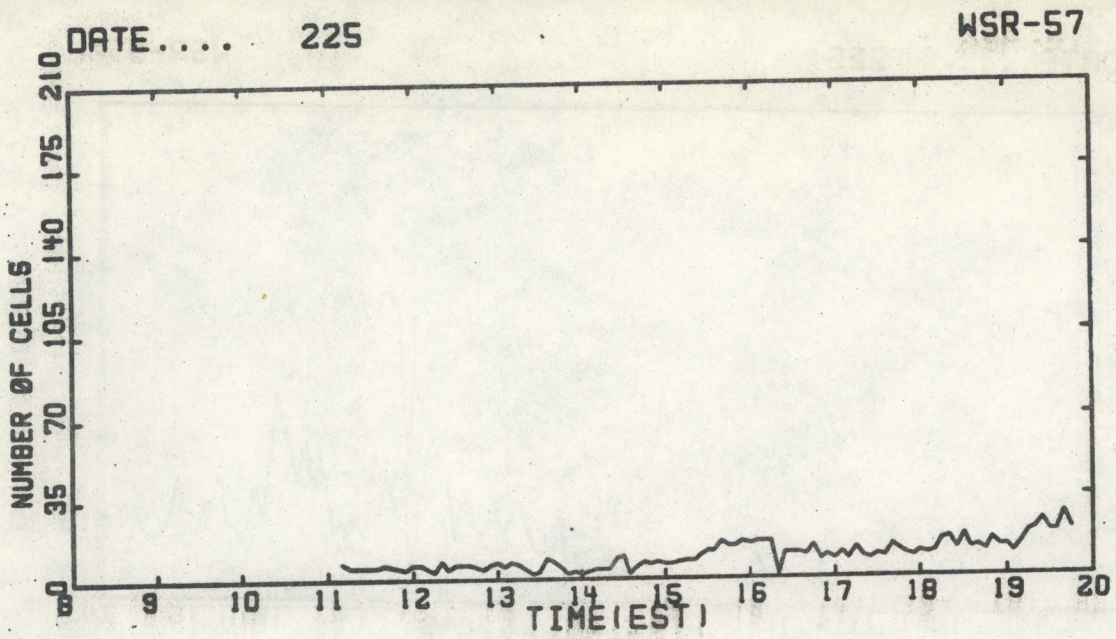

DATE....79221
WSR-57
NUMBER ØF ECHØES
0
15
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45
60
75
90
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18
19
20
TIME(EST)

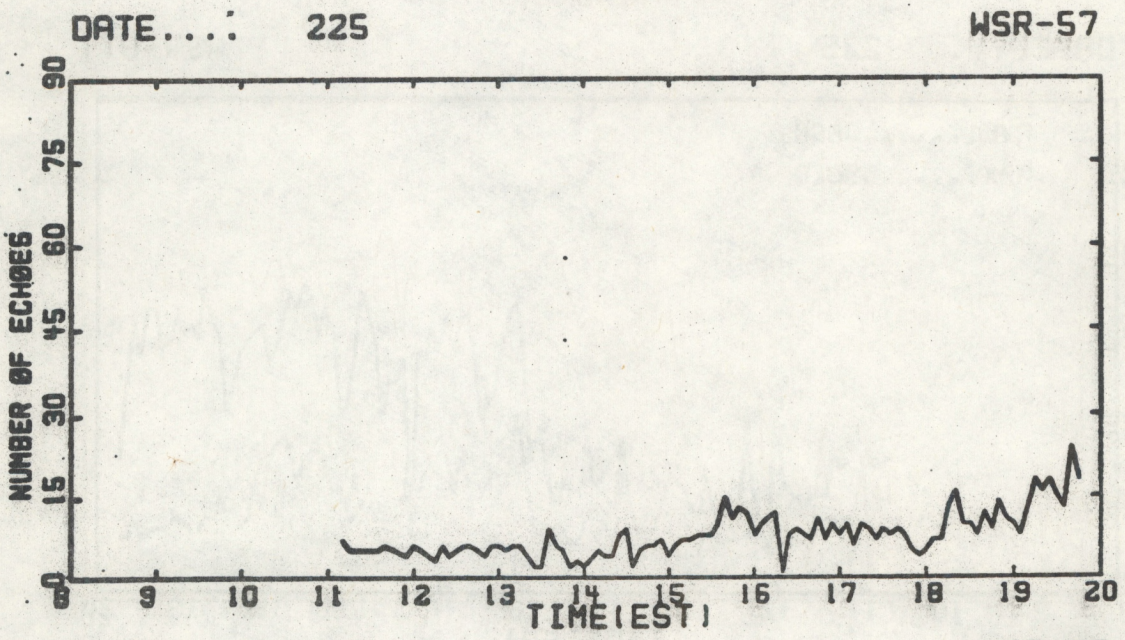

DATE....79221
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
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15
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18
19
20
TIME(EST)

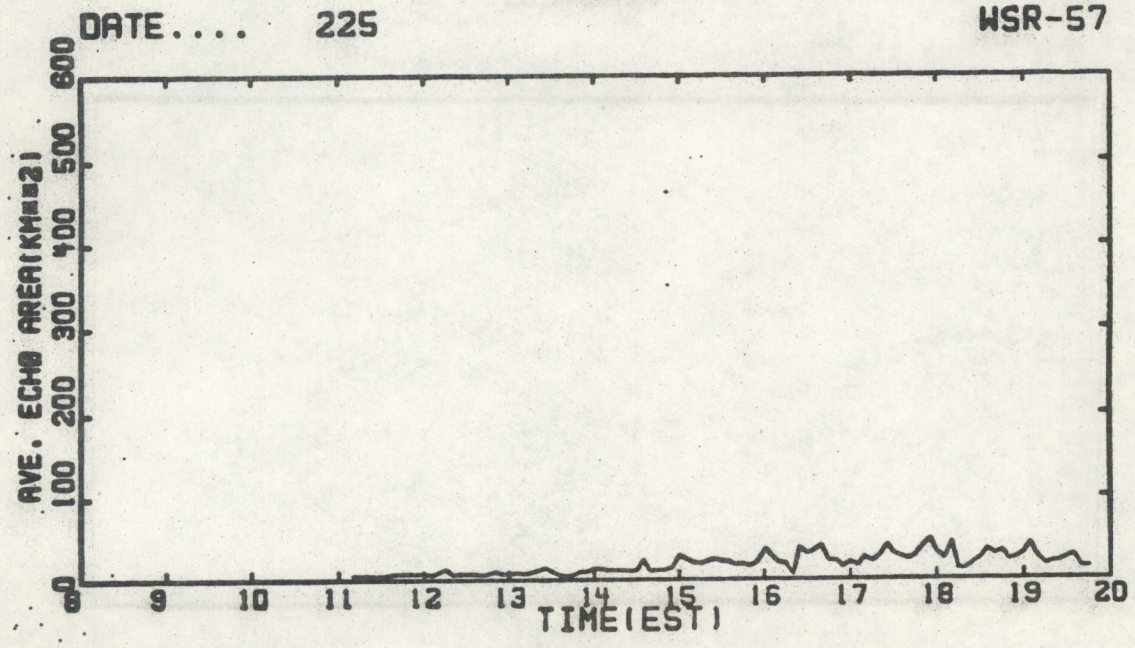

DATE.... 225
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
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80
100
120
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15
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17
18
19
20
TIME(EST)

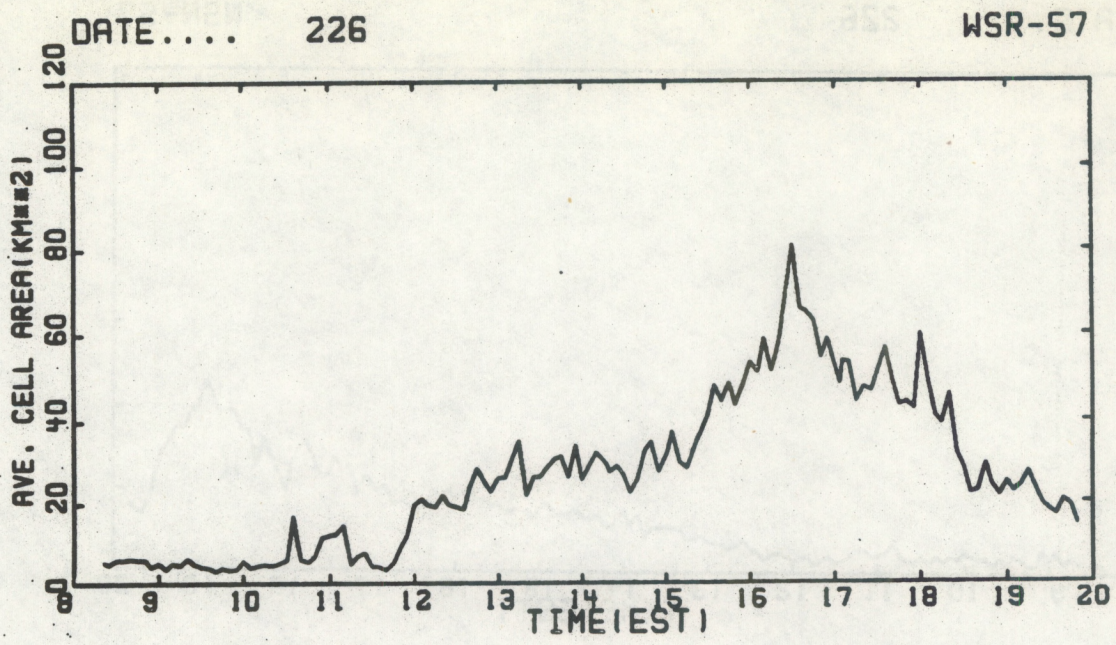

DATE.... 225
WSR-57
CELL REFLECTIVITY(DBZ)
AVE.....DASH
MAX.....SØLID
15
25
35
45
55
65
75
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18
19
20
TIME(EST)

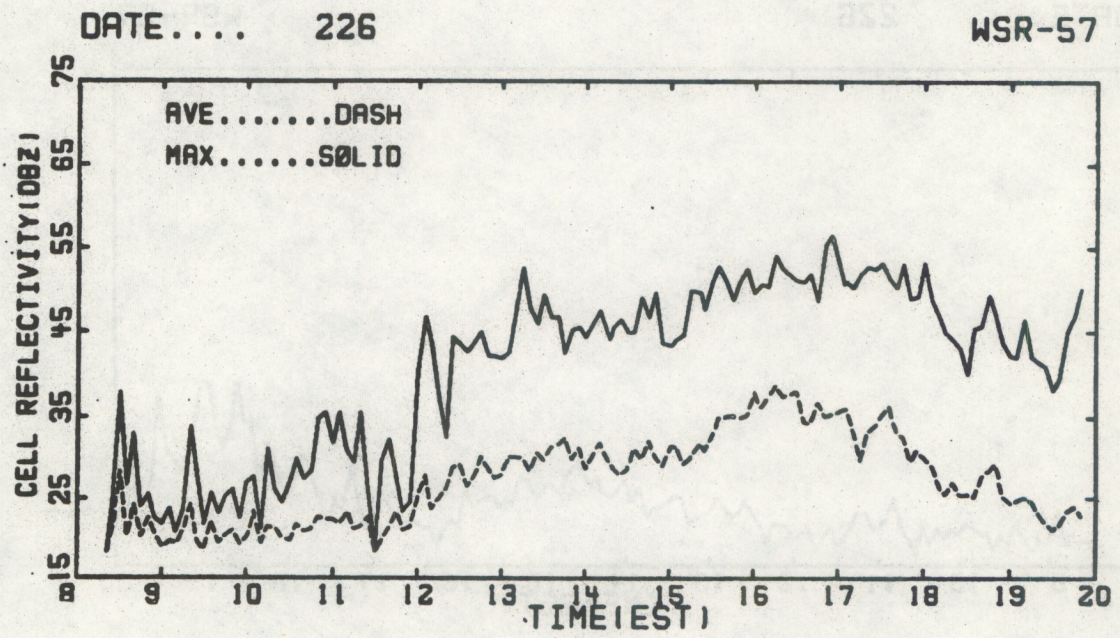


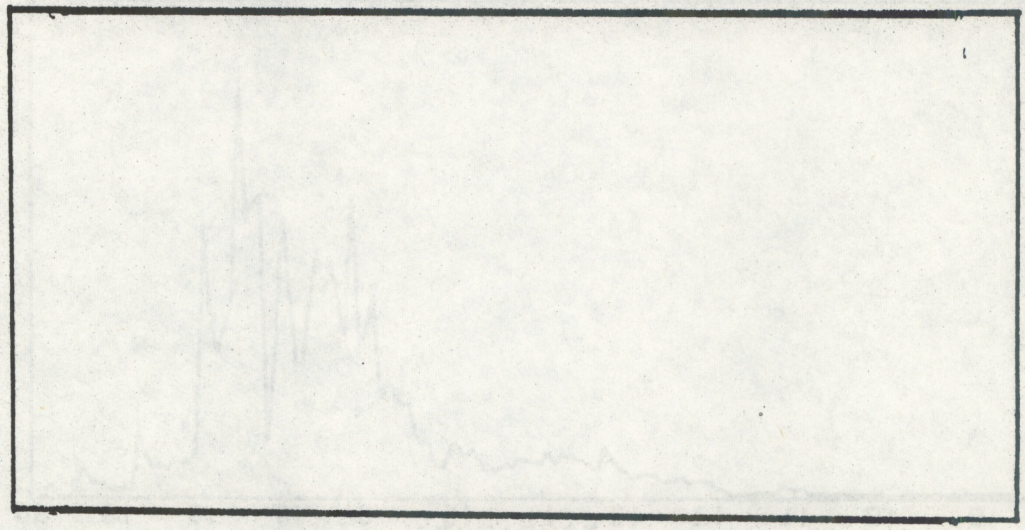

DATE.... 225
WSR-57
NUMBER OF CELLS
0
35
70
105
140
175
210
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15
16
17
18
19
20
TIME(EST)

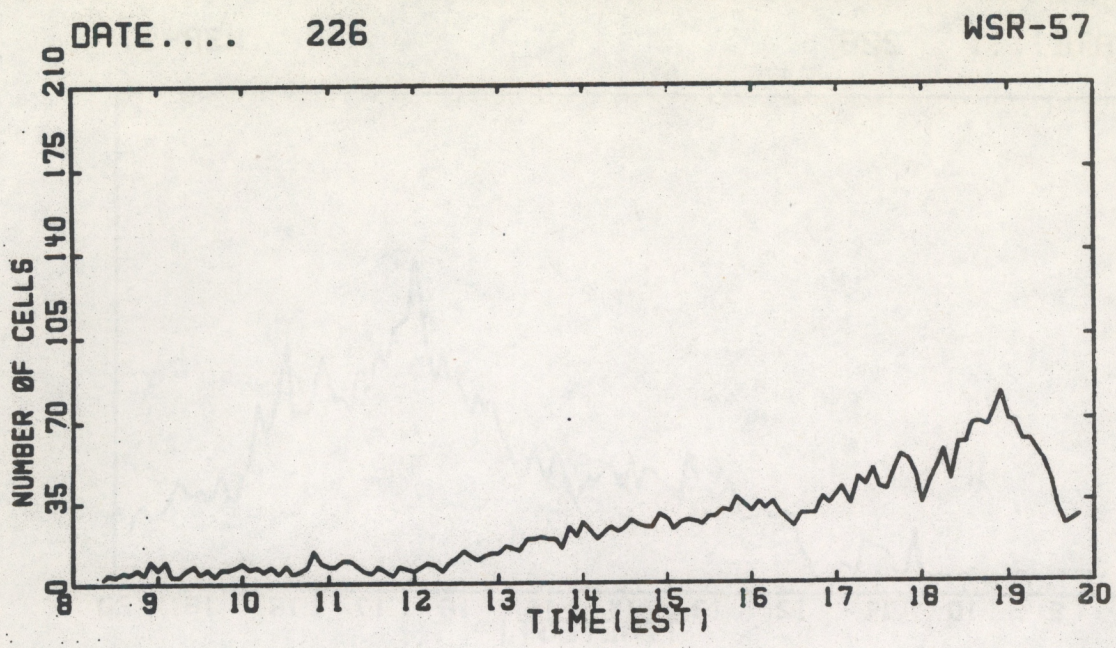

DATE.... 225
WSR-57
NUMBER OF ECHOES
0
15
30
45
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75
90
9
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15
16
17
18
19
20
TIME(EST)

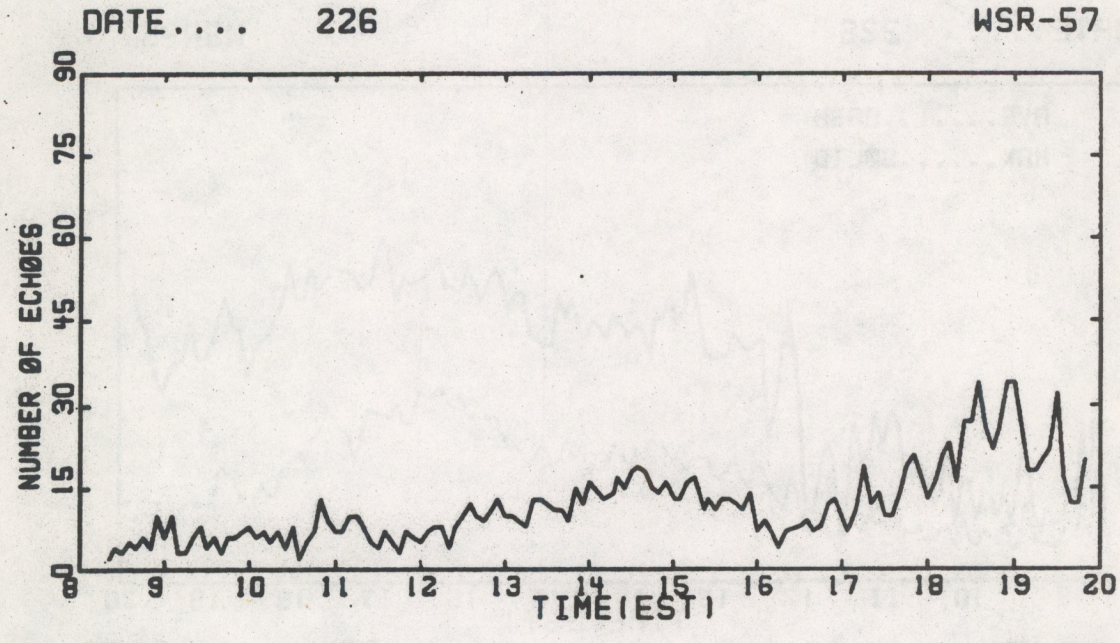

DATE.... 225
WSR-57
AVE. ECHO AREA(KM**2)
0
100
200
300
400
500
600
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11
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15
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18
19
20
TIME(EST)

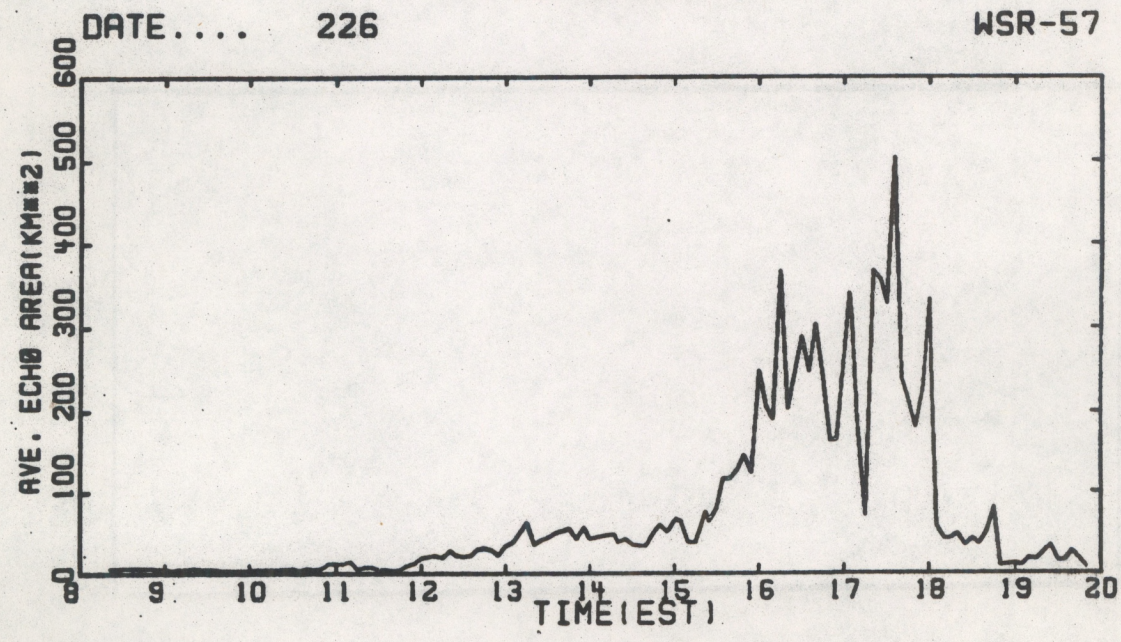

DATE.... 226
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
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19
20
TIME(EST)

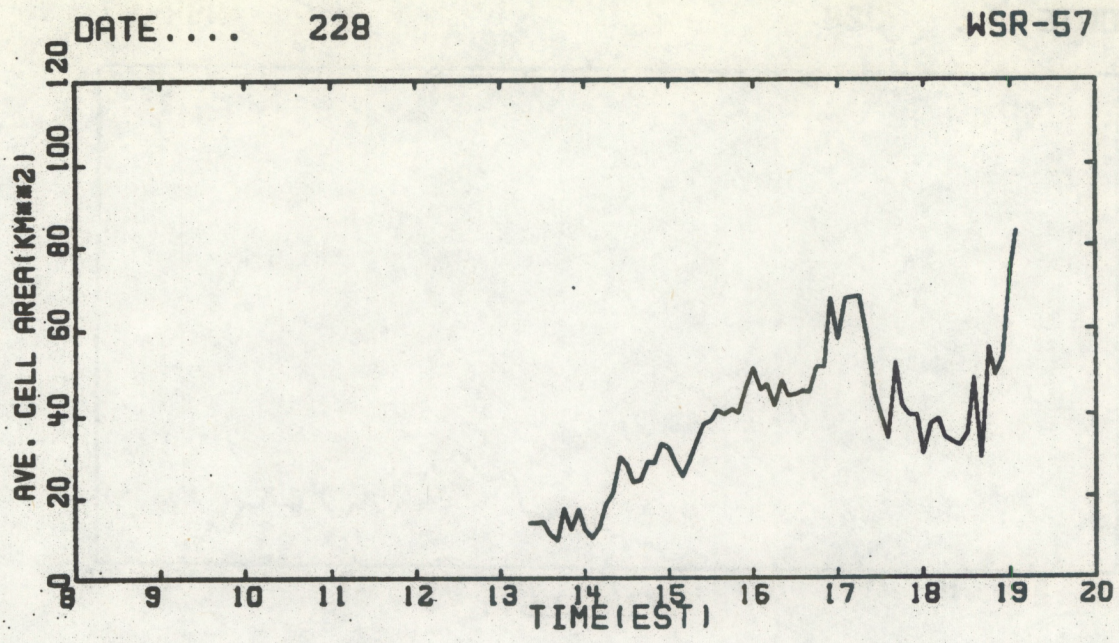

DATE.... 226
WSR-57
CELL REFLECTIVITY(DBZ)
AVE.....DASH
MAX.....SOLID
15
25
35
45
55
65
75
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19
20
TIME(EST)

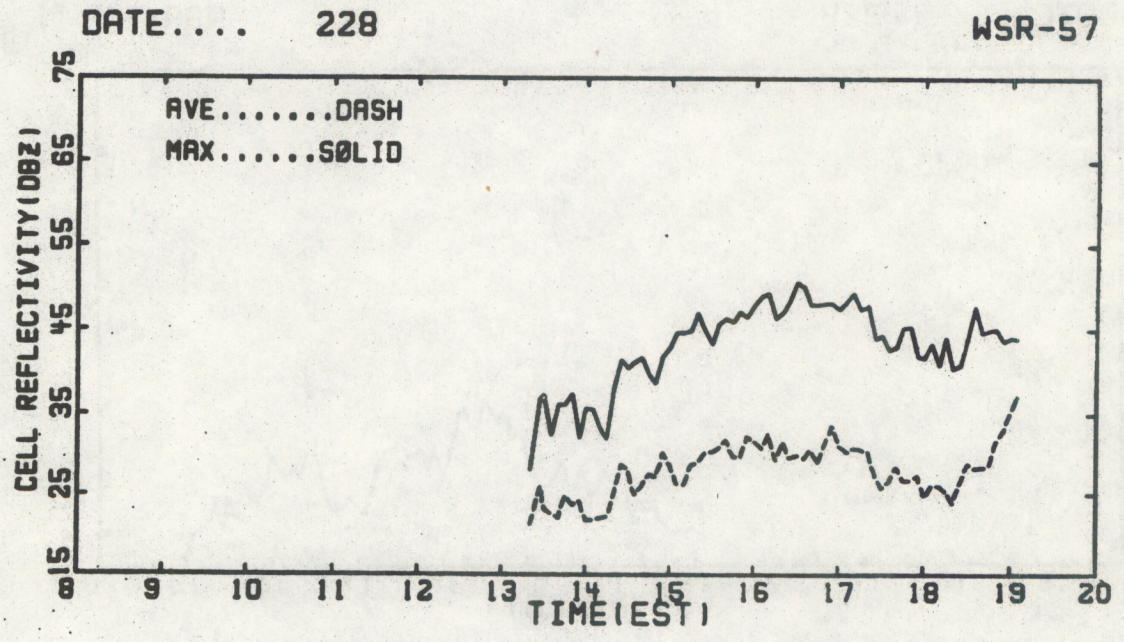


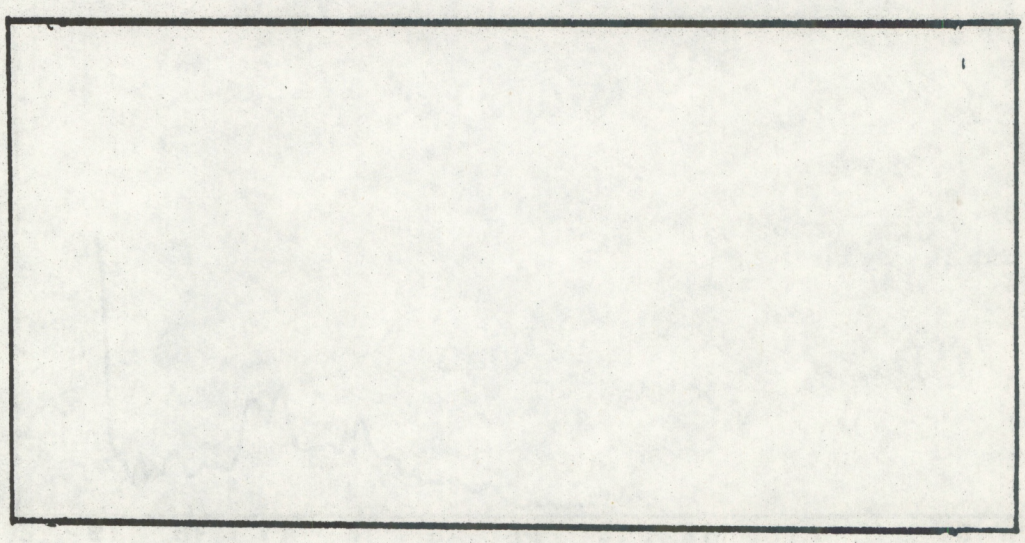

DATE.... 226
WSR-57
NUMBER OF CELLS
0
35
70
105
140
175
210
9
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15
16
17
18
19
20
TIME(EST)

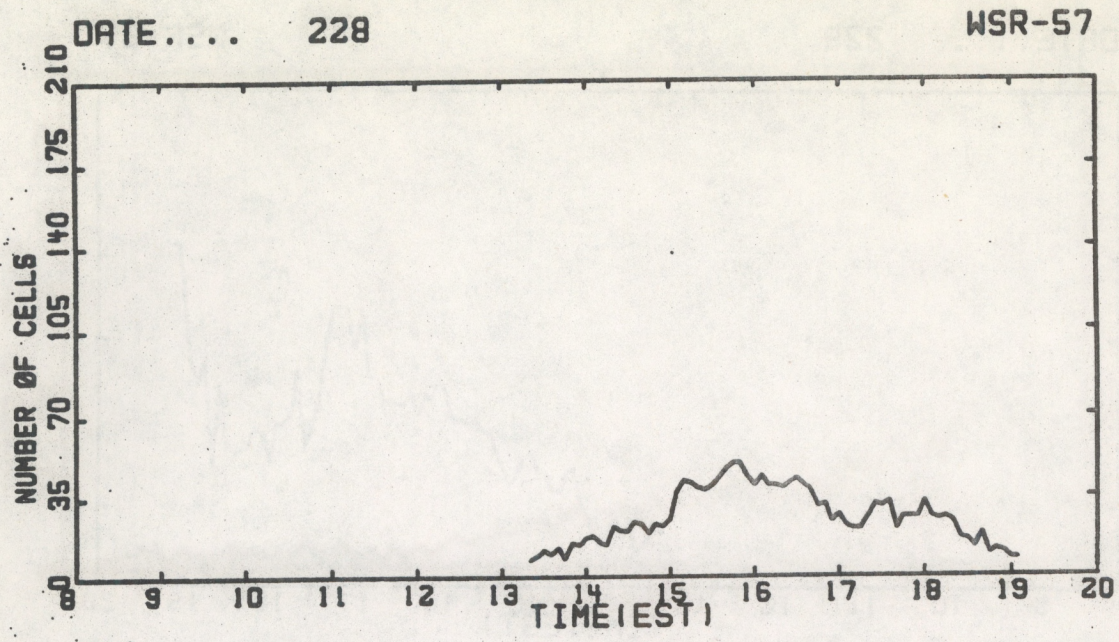

DATE.... 226
WSR-57
NUMBER OF ECHOES
0
15
30
45
60
75
90
9
10
11
12
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15
16
17
18
19
20
TIME(EST)

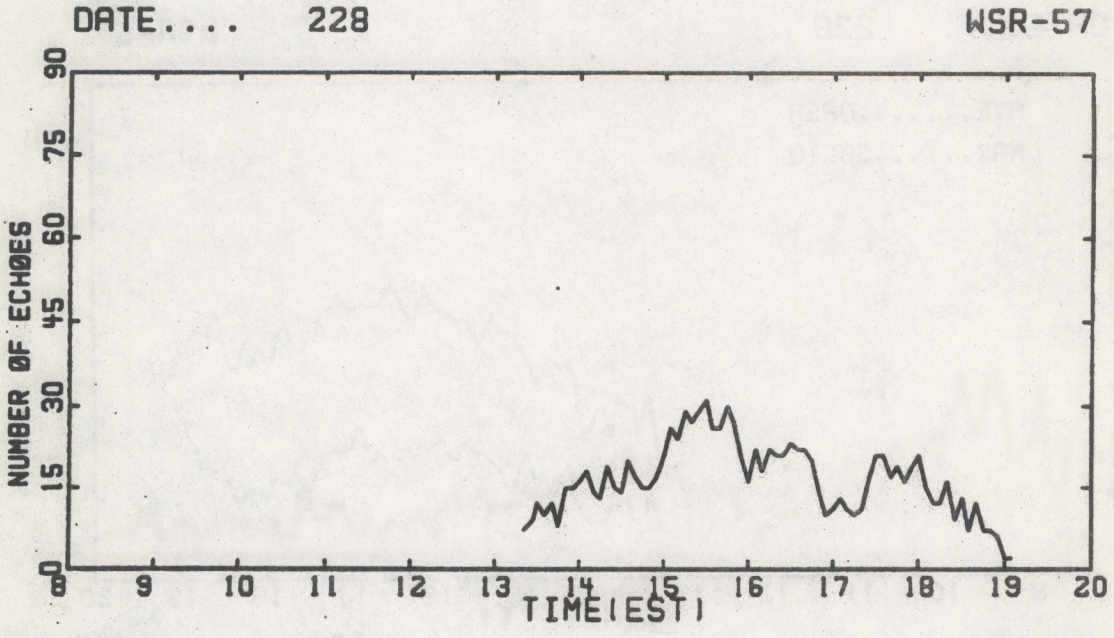

DATE.... 226
WSR-57
AVE. ECHO AREA(KM**2)
0
100
200
300
400
500
600
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18
19
20
TIME(EST)

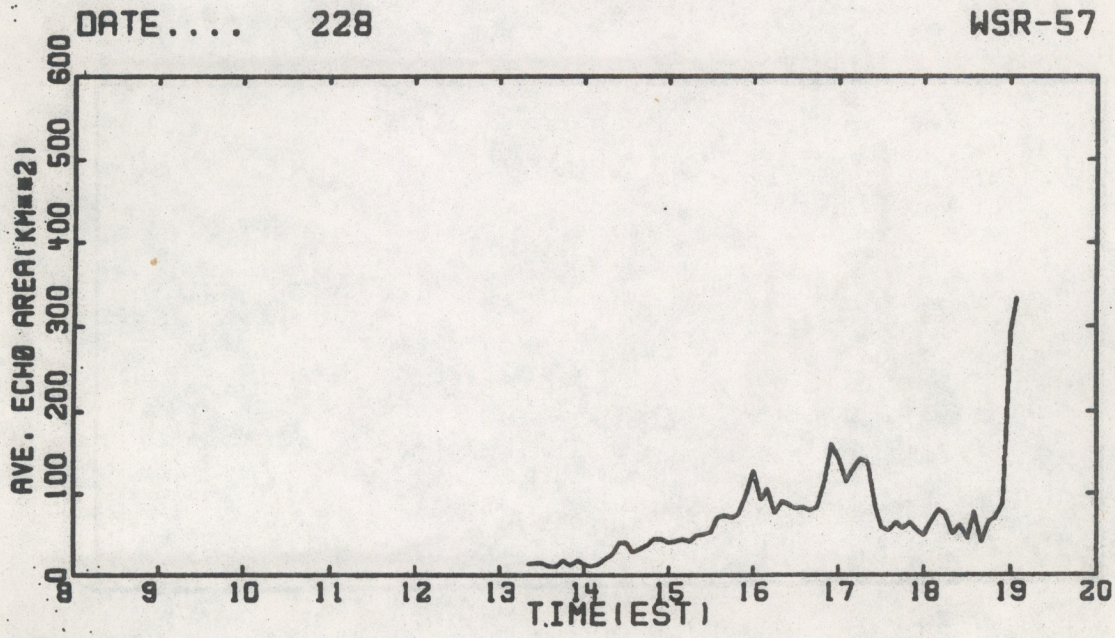

DATE.... 228
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
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19
20
TIME(EST)

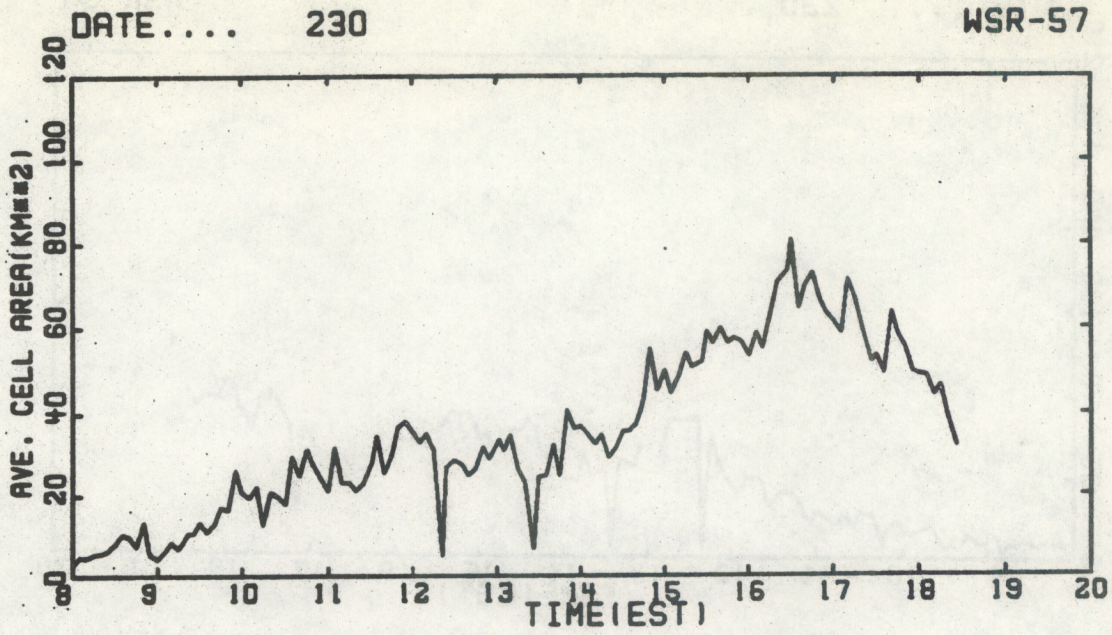

DATE.... 228
WSR-57
CELL REFLECTIVITY(DBZ)
AVE.....DASH
MAX.....SØLID
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

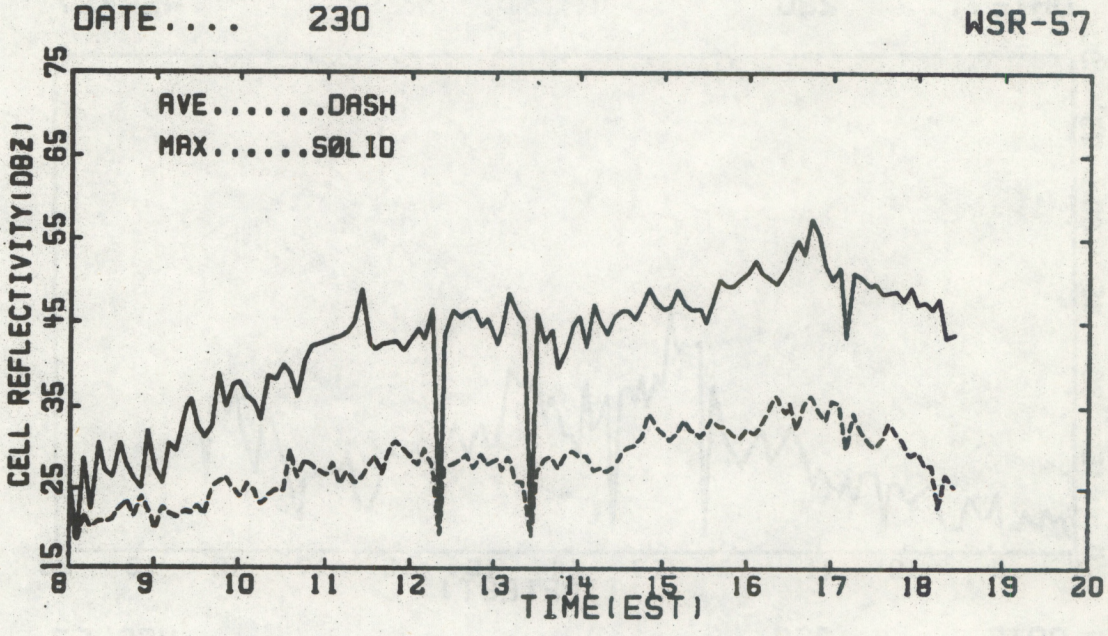


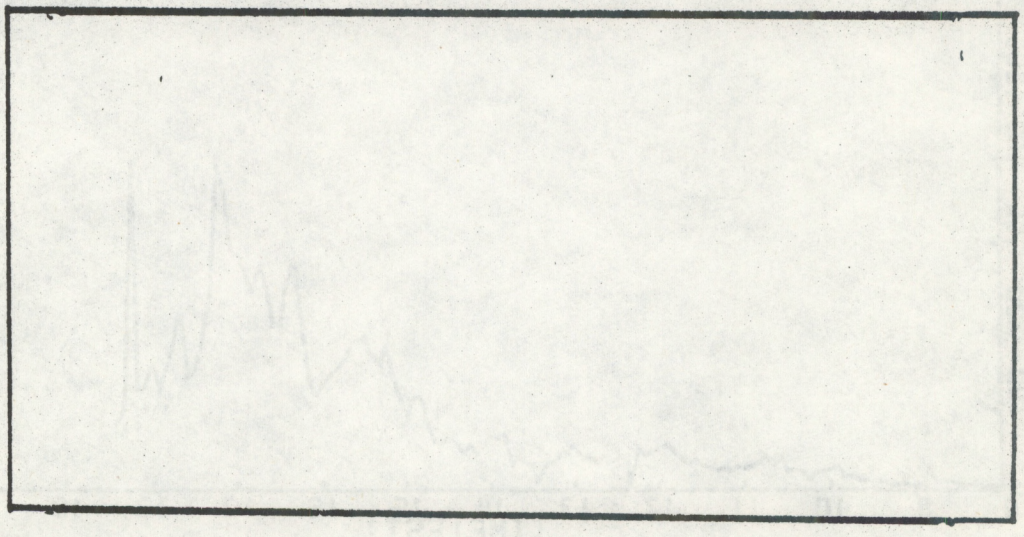

DATE.... 228
WSR-57
NUMBER OF CELLS
0
35
70
105
140
175
210
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

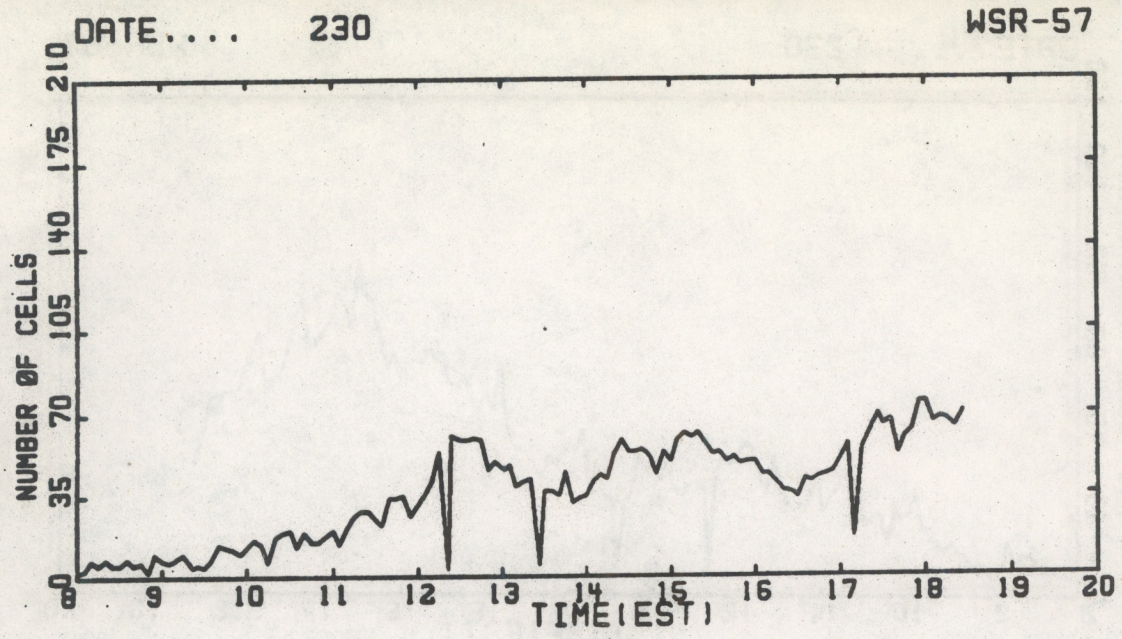

DATE.... 228
WSR-57
NUMBER OF ECHOES
0
15
30
45
60
75
90
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

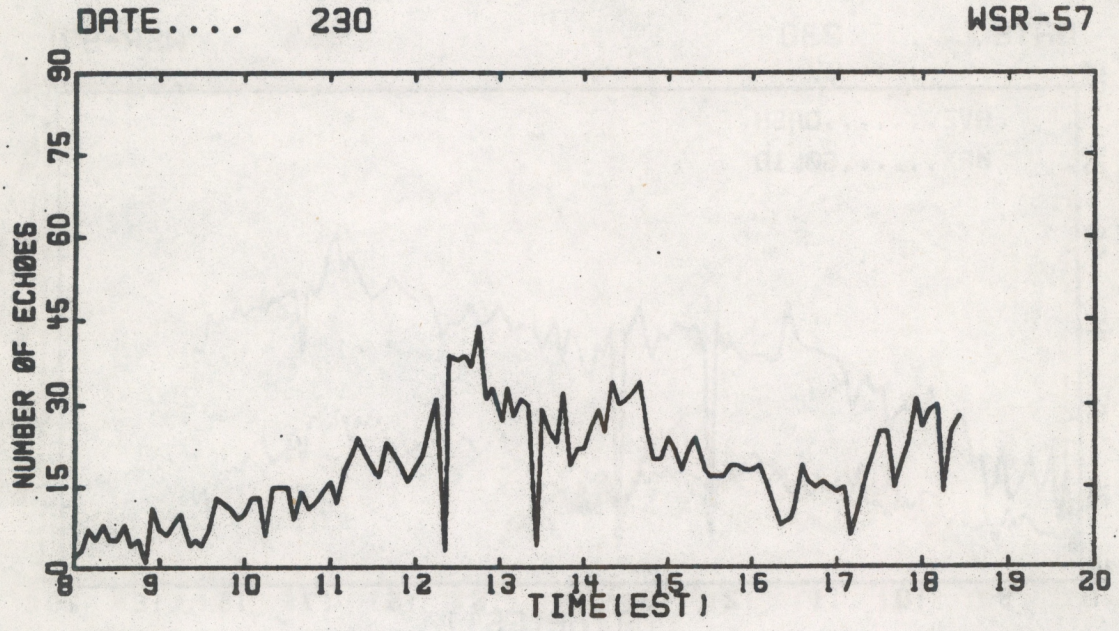

DATE.... 228
WSR-57
AVE. ECHO AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

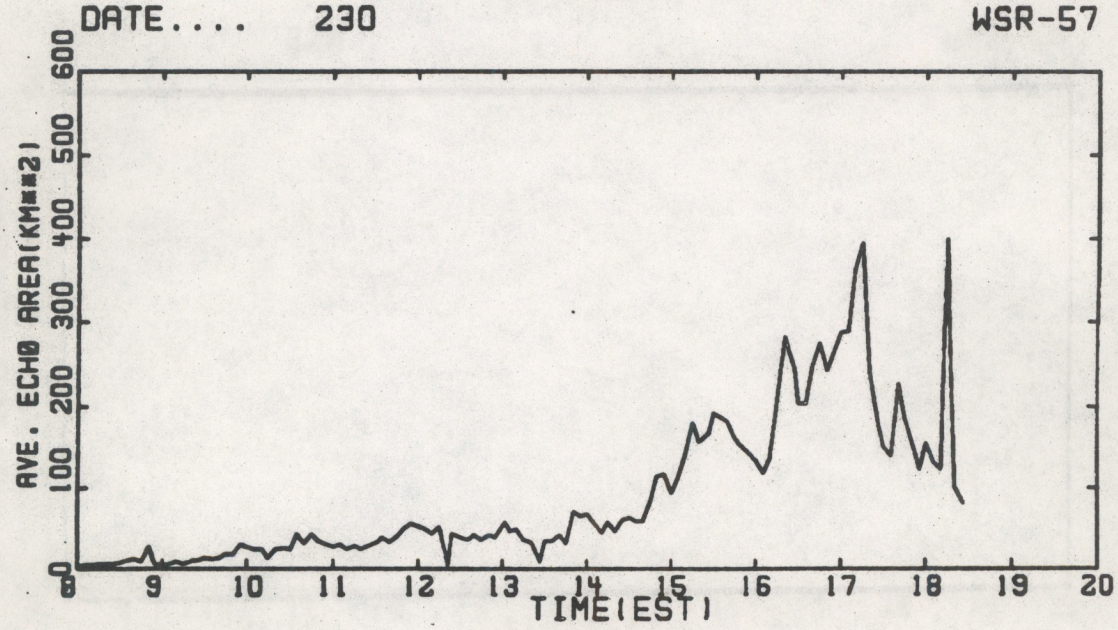

DATE.... 230
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

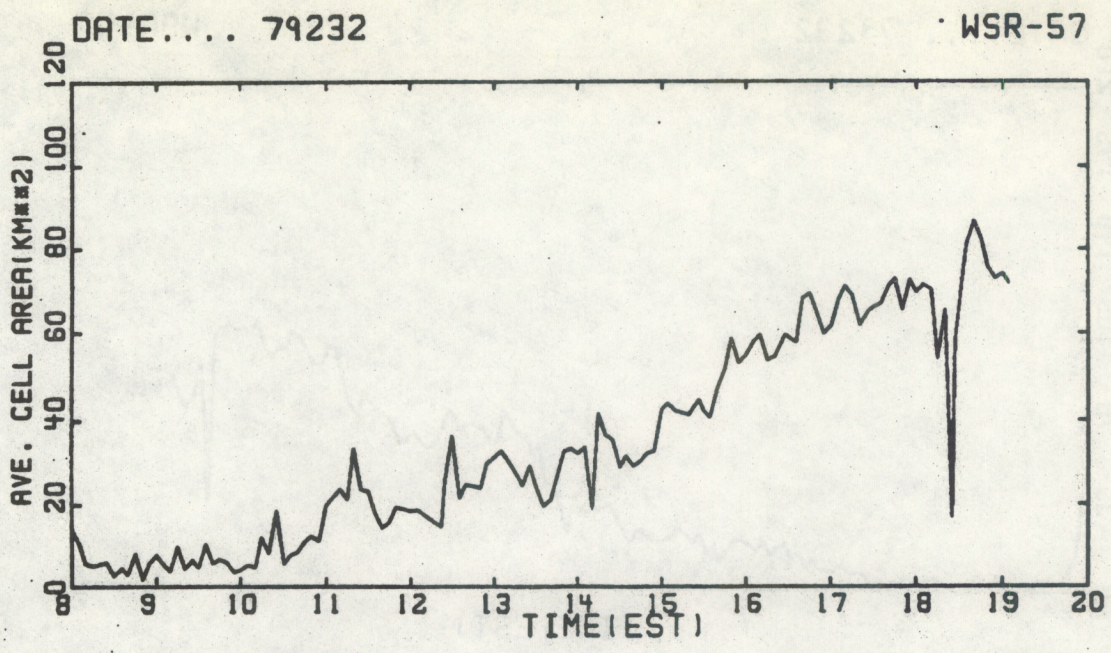

DATE.... 230
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

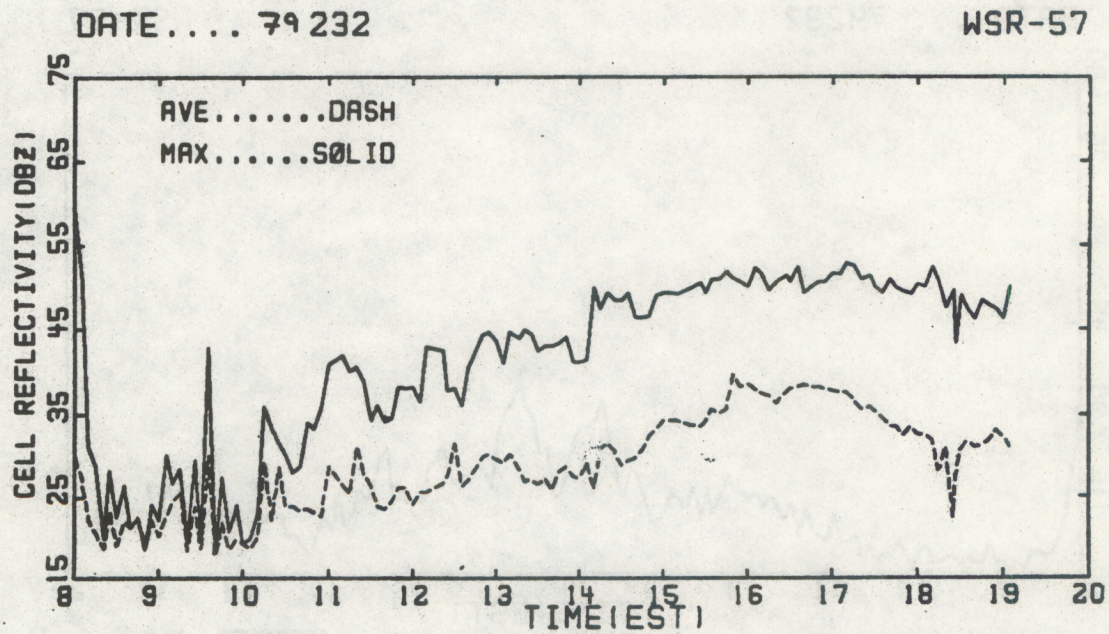


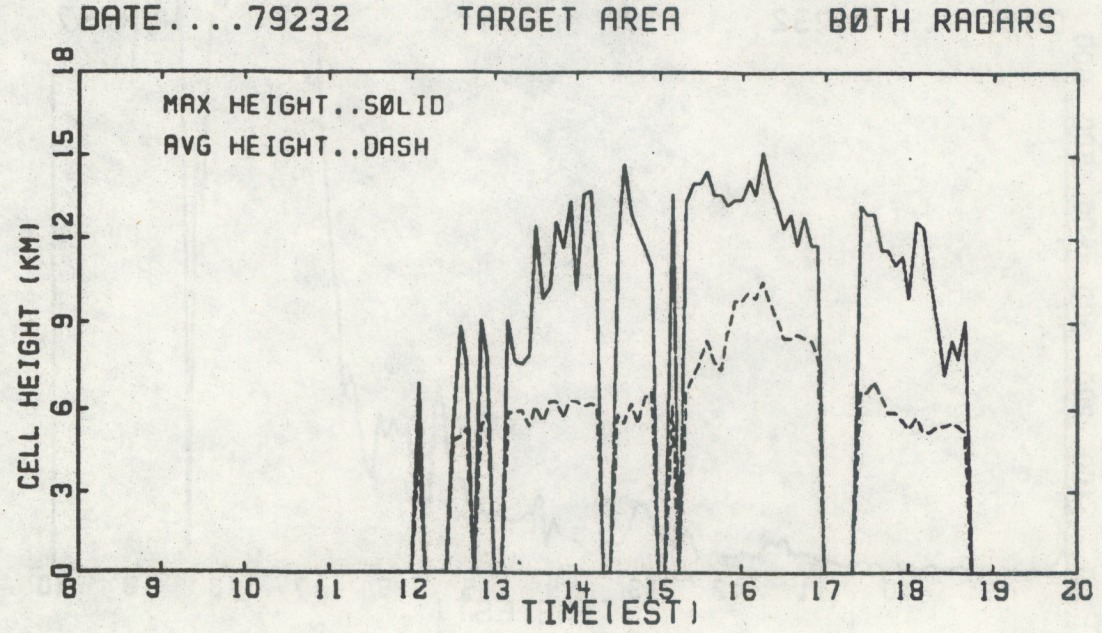

DATE.... 230
WSR-57
NUMBER 0F CELLS
0
35
70
105
140
175
210
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

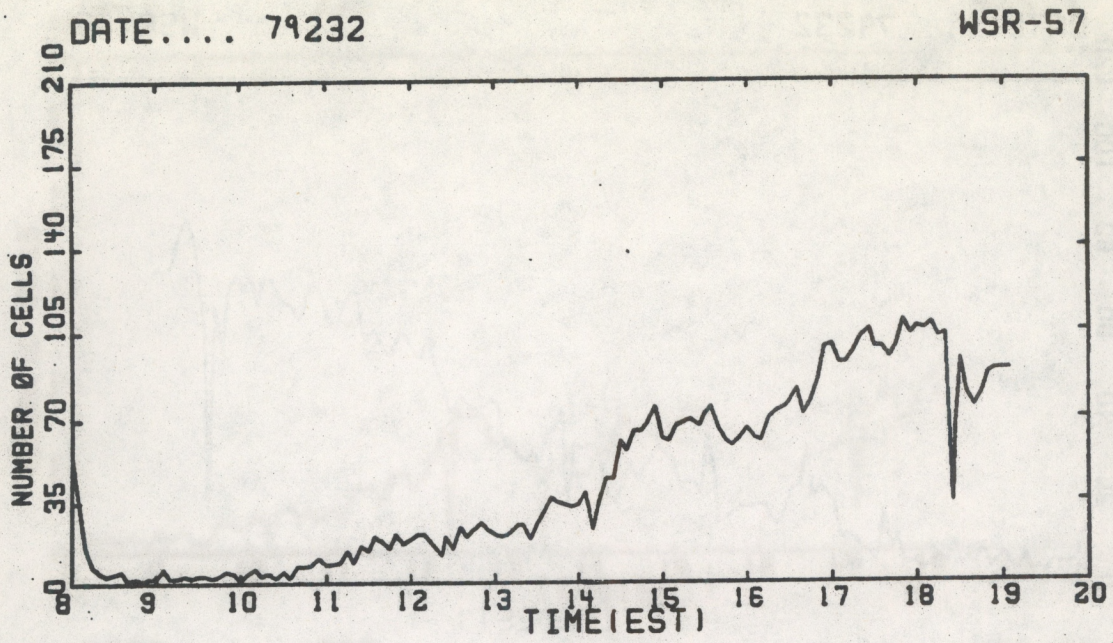

DATE.... 230
WSR-57
NUMBER 0F ECH0ES
0
15
30
45
60
75
90
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

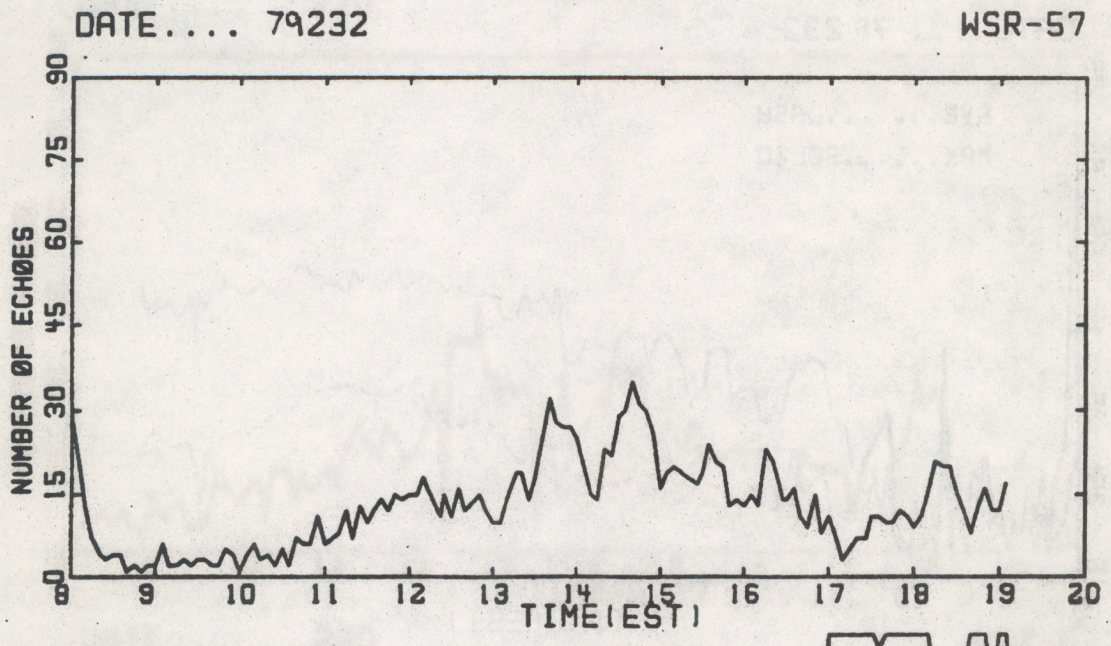

DATE.... 230
WSR-57
AVE. ECH0 AREA(KM**2)
0
100
200
300
400
500
600
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

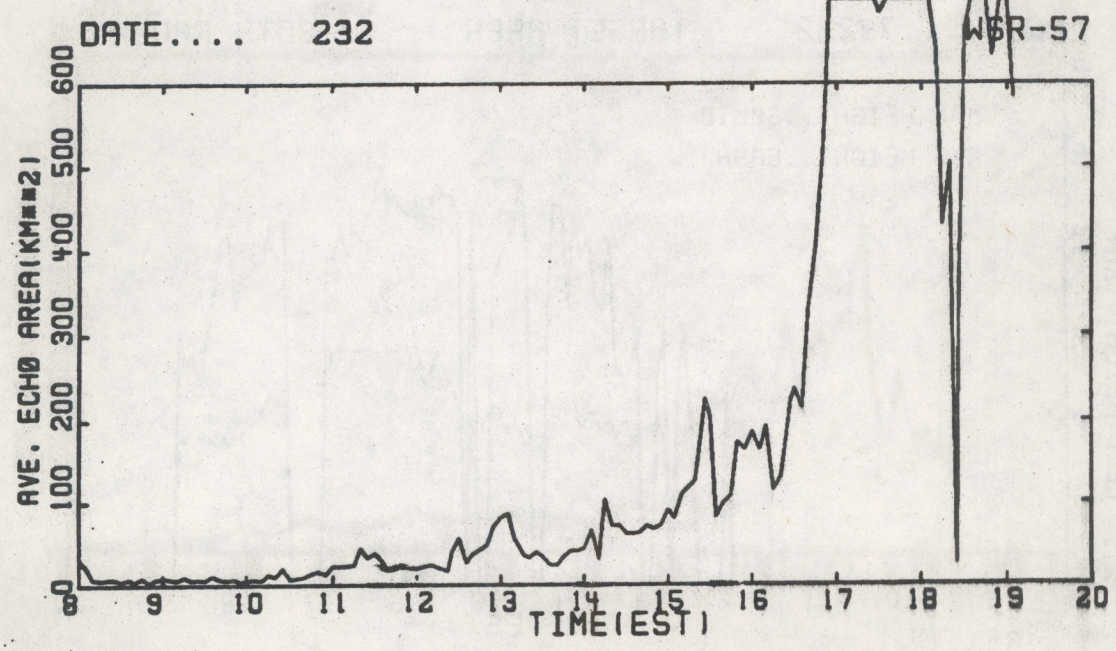

DATE.... 79232
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

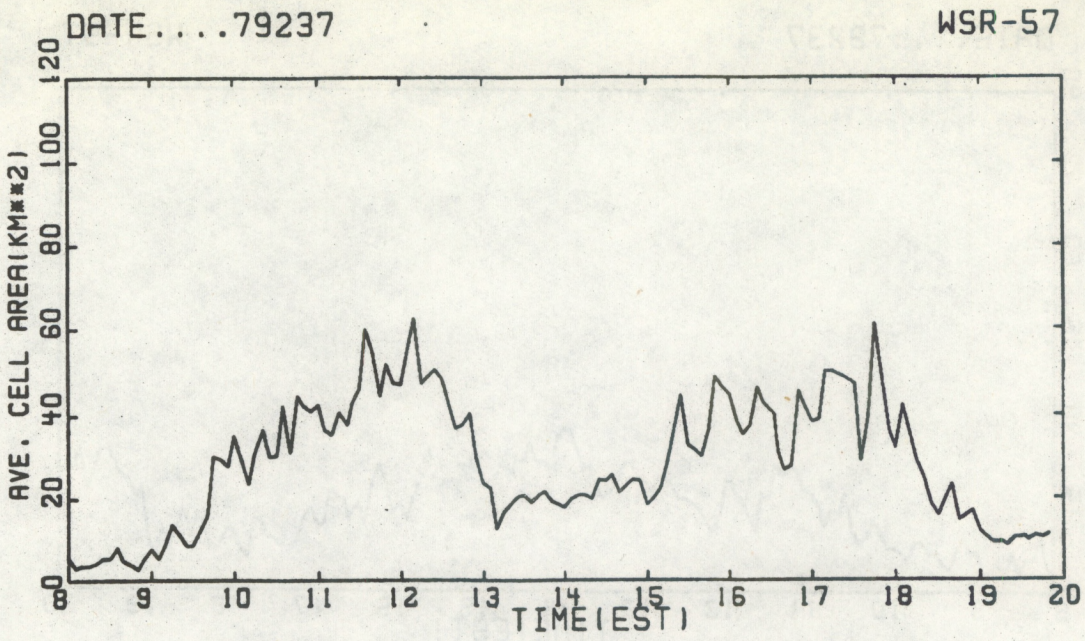

DATE.... 79232
WSR-57
CELL REFLECTIVITY(DBZ)
AVE.....DASH
MAX.....SØLID
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

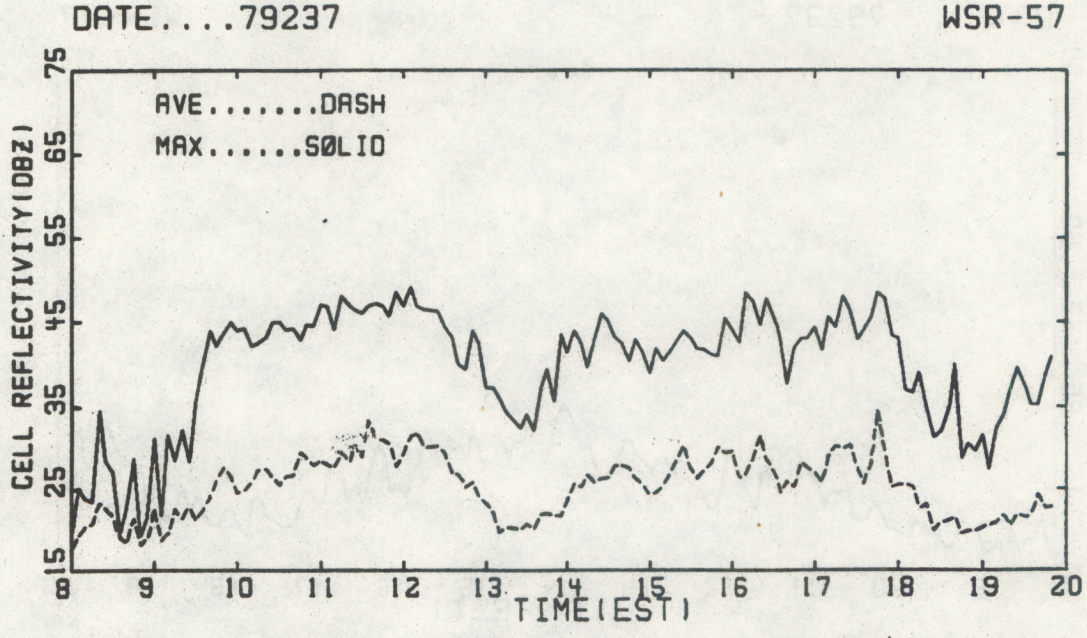

DATE....79232
TARGET AREA
BØTH RADARS
CELL HEIGHT (KM)
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

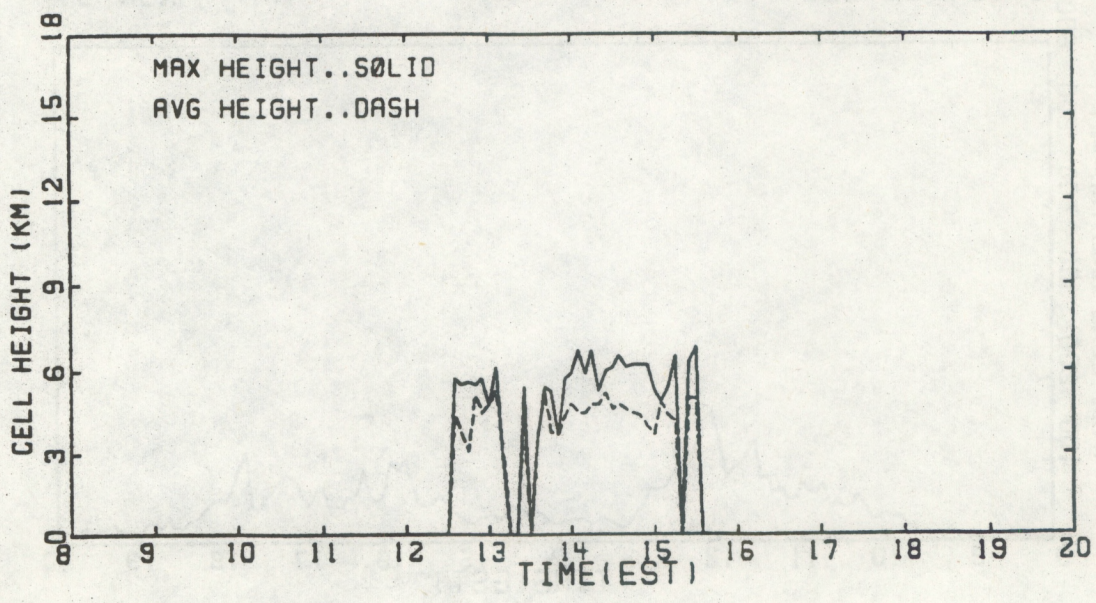

DATE.... 79232
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

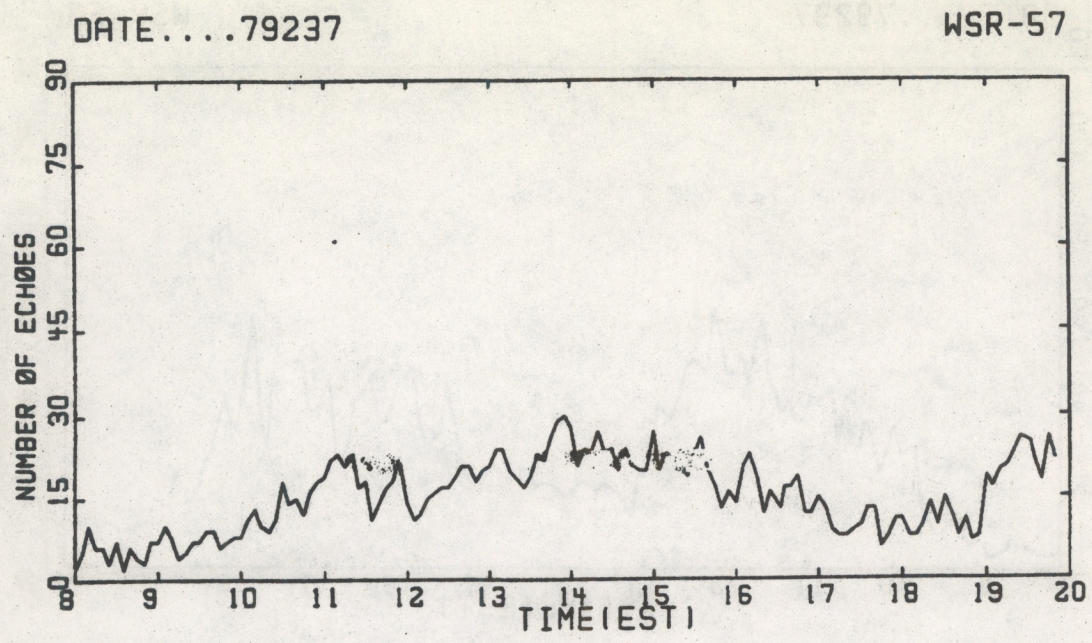

DATE.... 79232
WSR-57
NUMBER ØF ECHØES
0
15
30
45
60
75
90
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

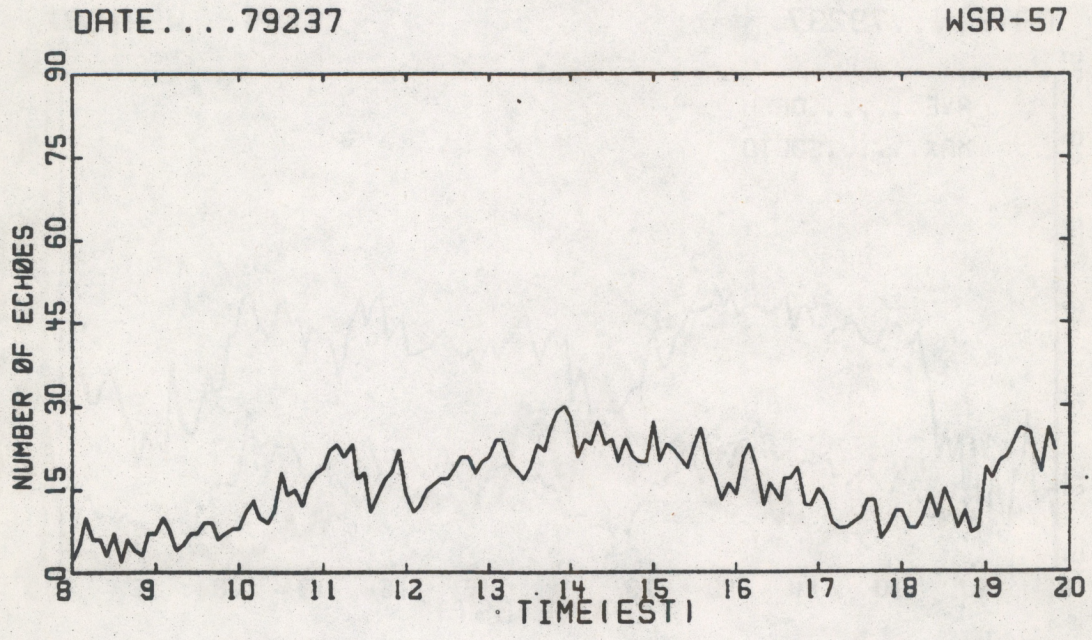

DATE.... 232
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

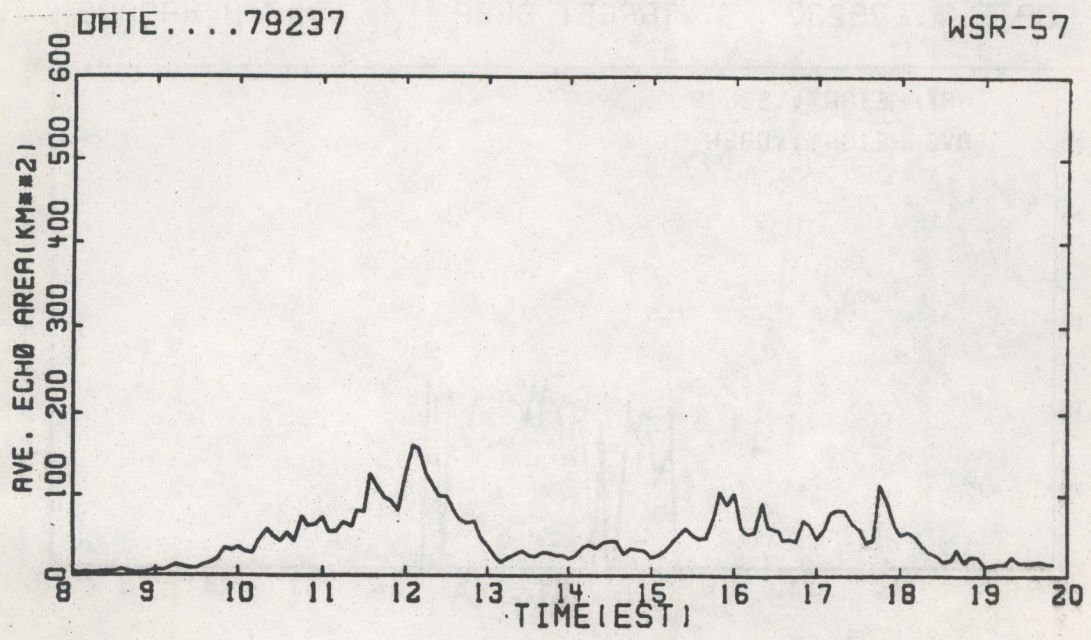

DATE....79237
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

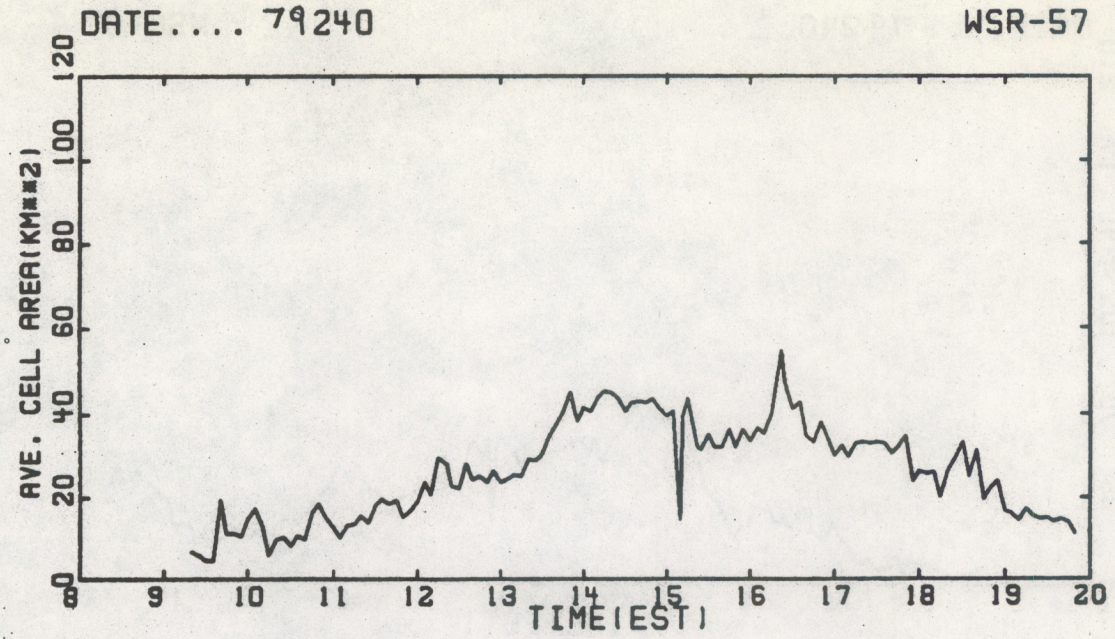

DATE....79237
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

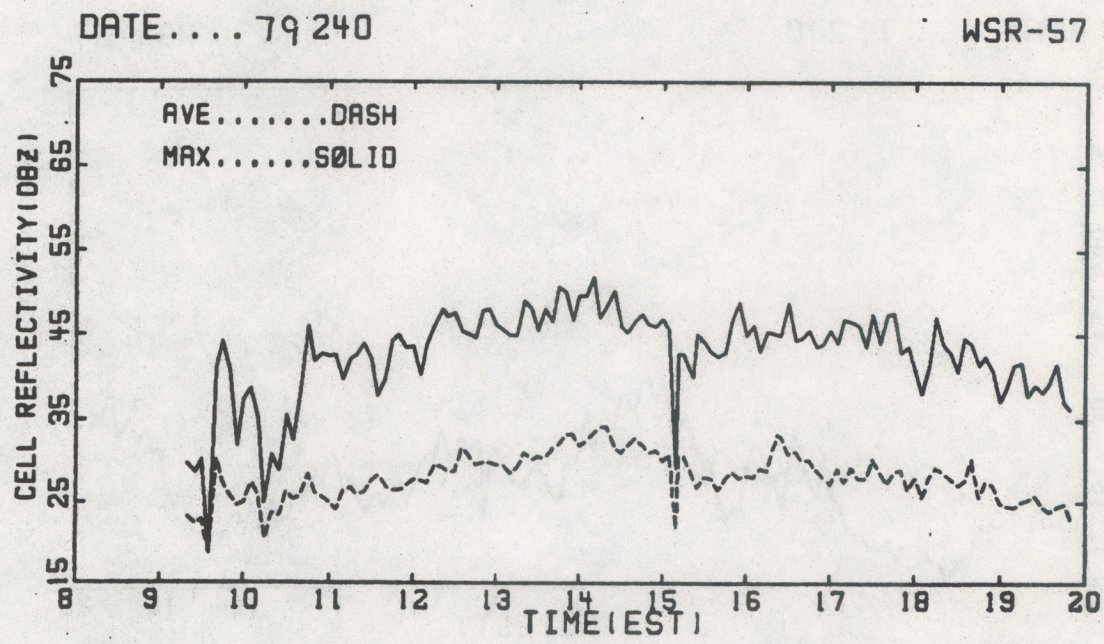

DATE....79237
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

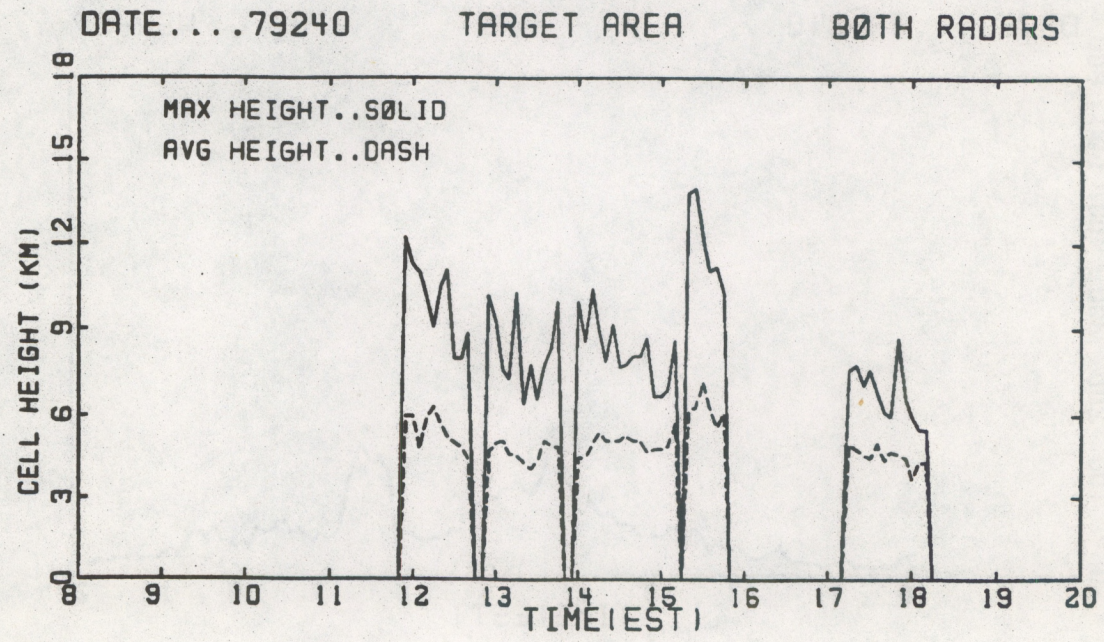

DATE....79237
WSR-57
NUMBER ØF ECHØES
0
15
30
45
60
75
90
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

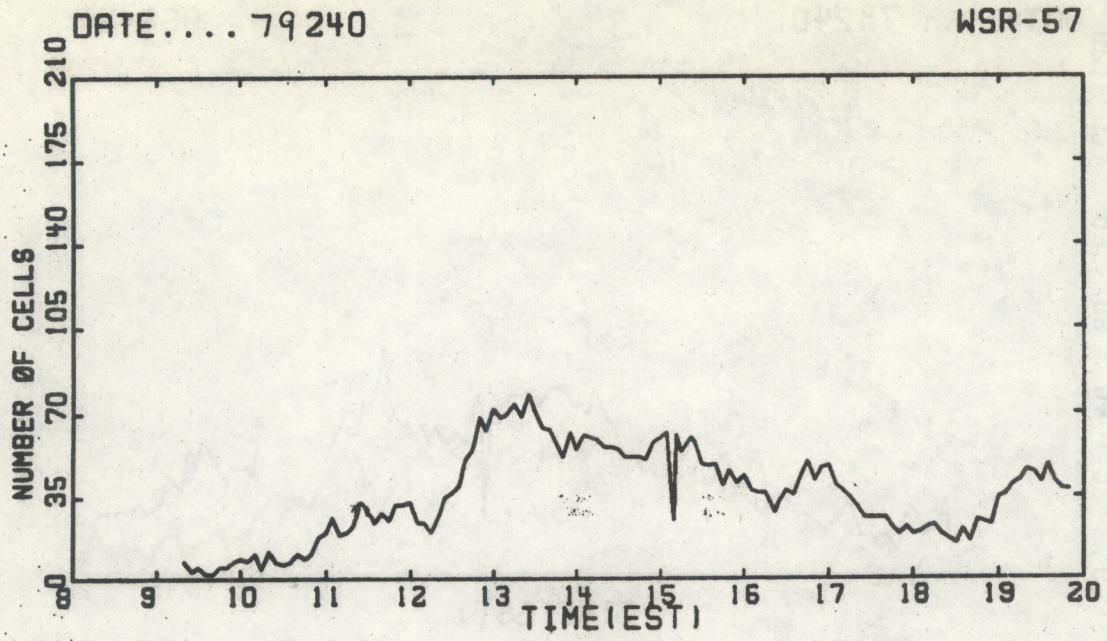

DATE....79237
WSR-57
NUMBER ØF ECHØES
0
15
30
45
60
75
90
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

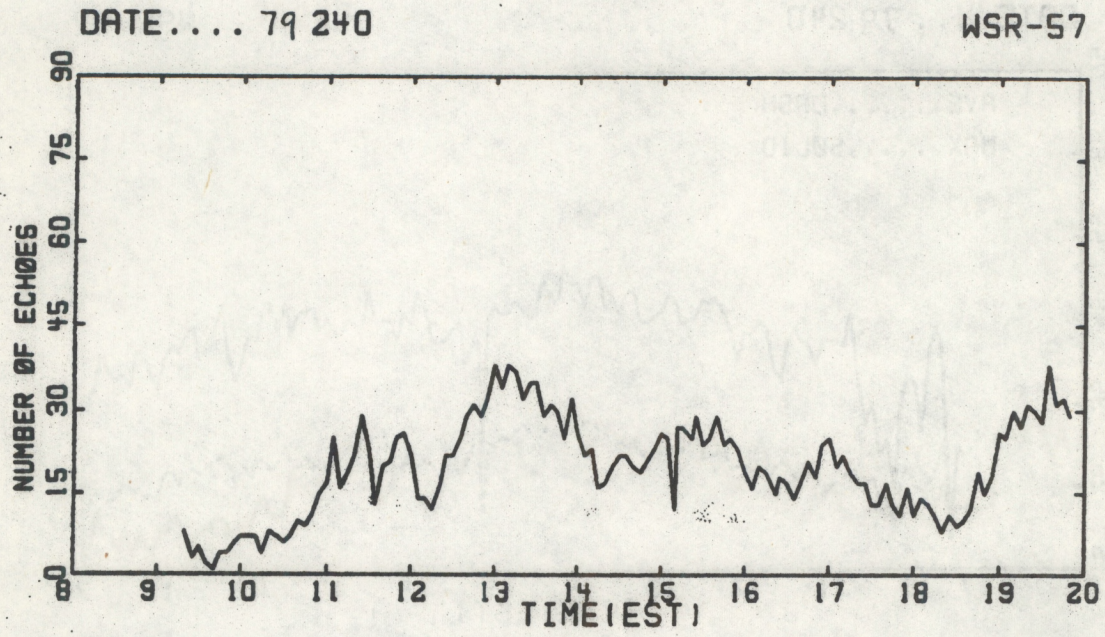

DATE....79237
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

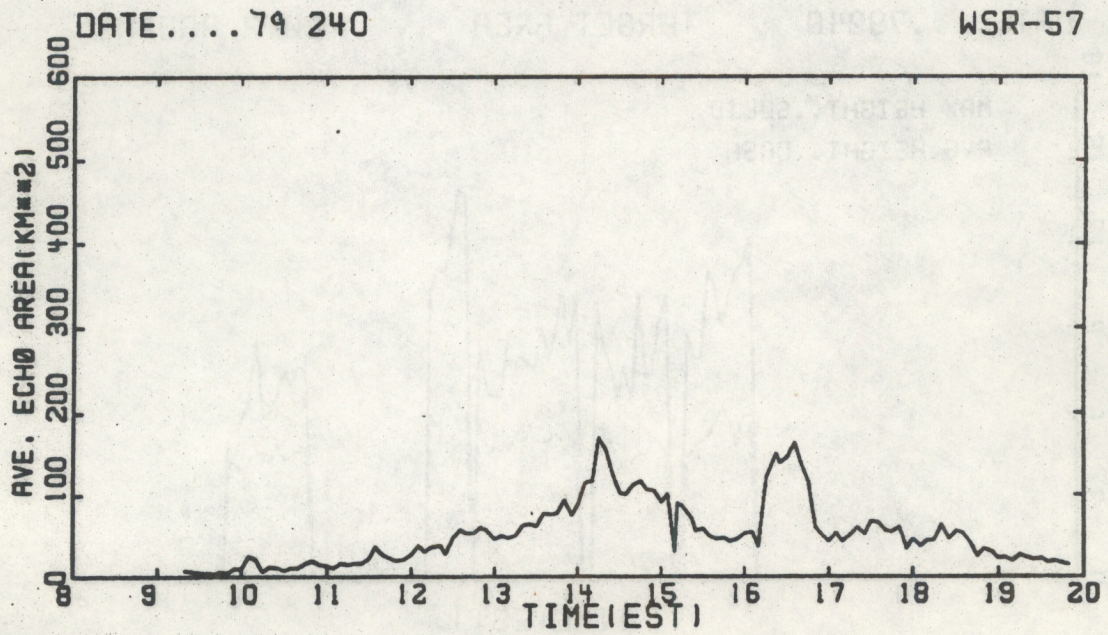

DATE.... 79240
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

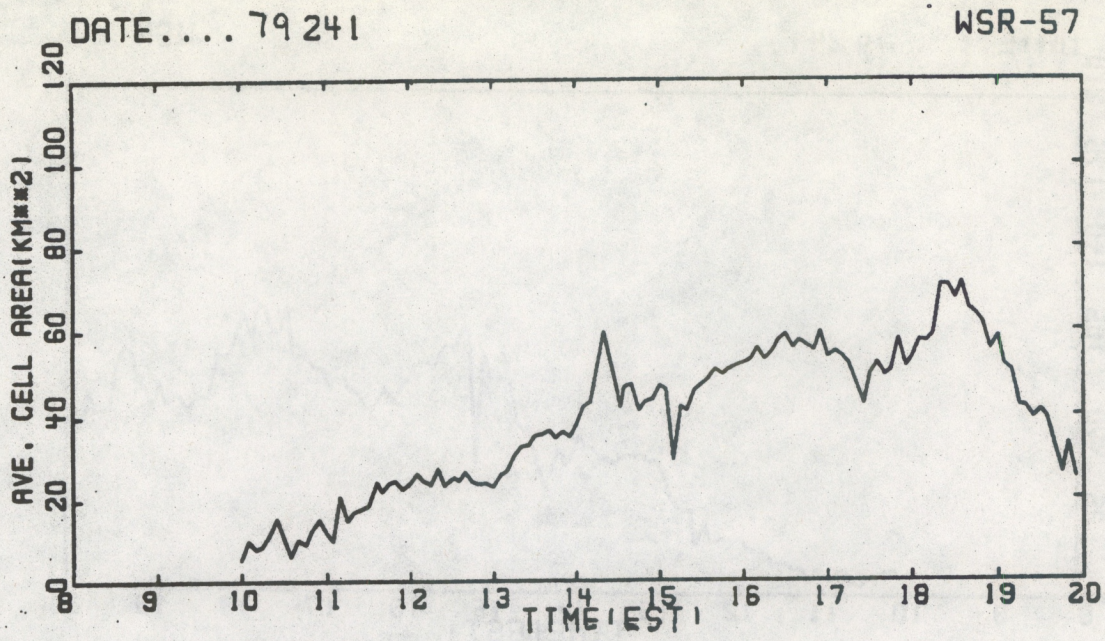

DATE.... 79240
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

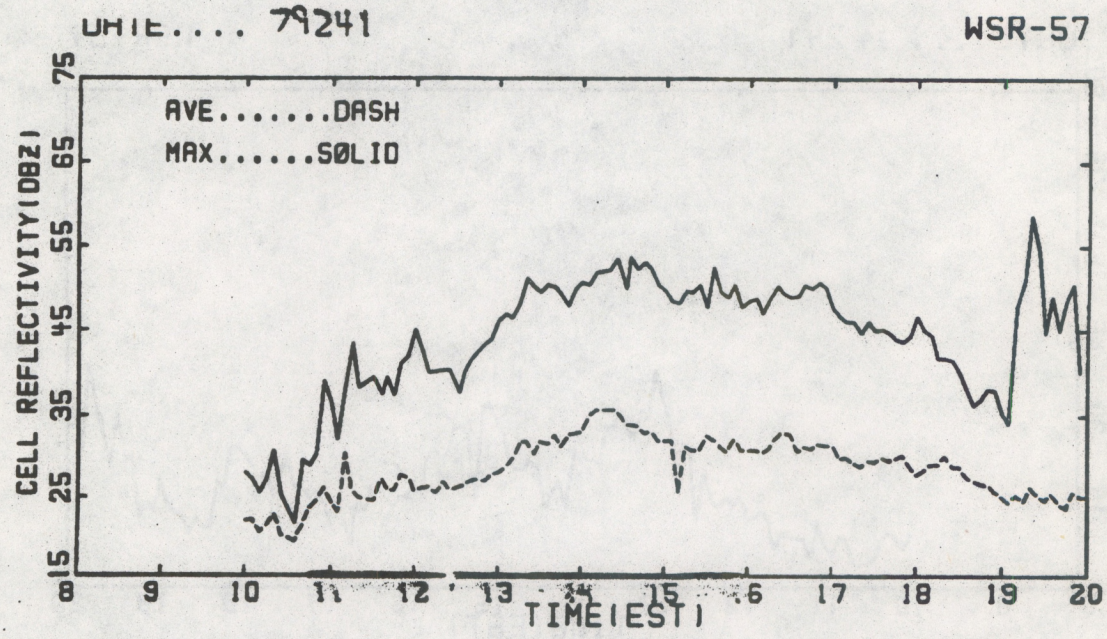

DATE....79240
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

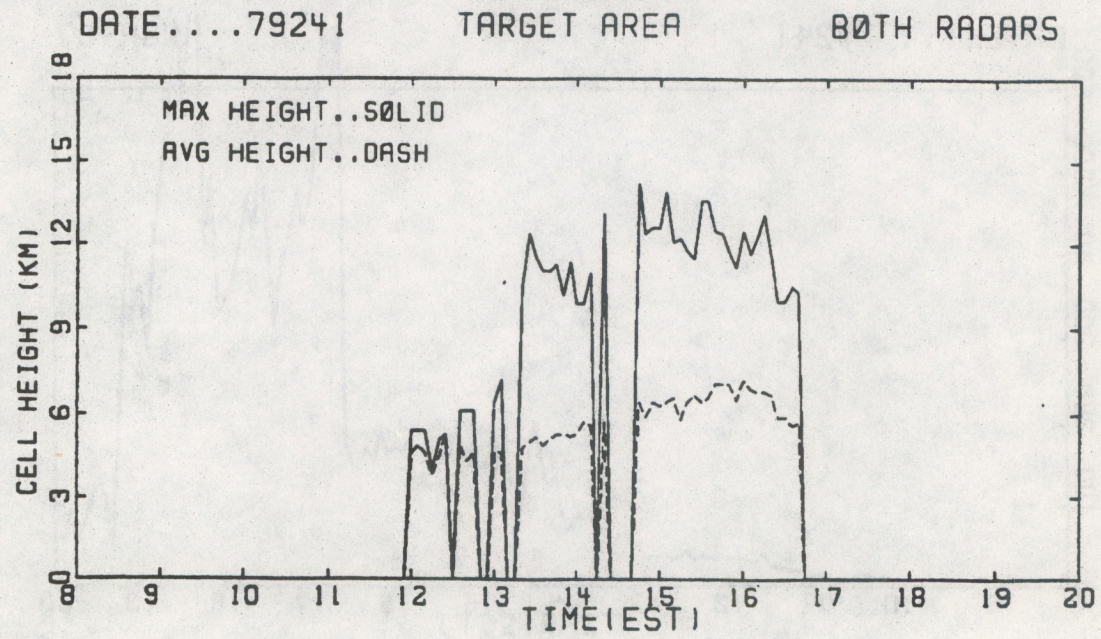

DATE.... 79 240
WSR-57
NUMBER OF CELLS
0
35
70
105
140
175
210
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

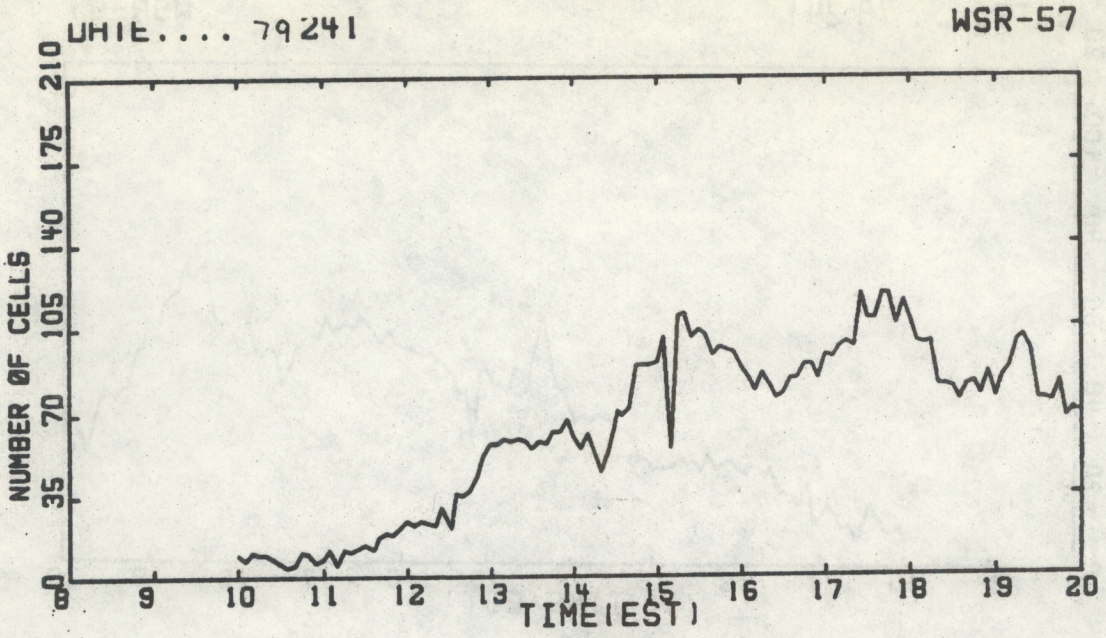

DATE.... 79 240
WSR-57
NUMBER OF ECHOES
0
15
30
45
60
75
90
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

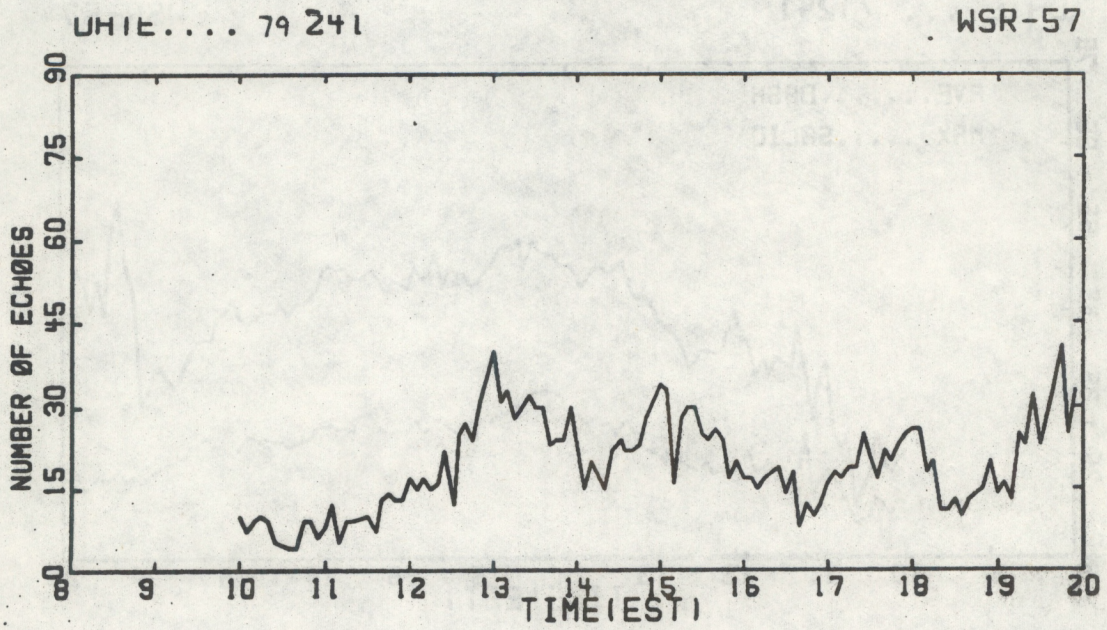

DATE.... 79 240
WSR-57
AVE. ECHO AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE.... 79 241
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE.... 79241
WSR-57
CELL REFLECTIVITY(DBZ)
AVE.....DASH
MAX.....SØLID
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE....79241
TARGET AREA
BØTH RADARS
CELL HEIGHT (KM)
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE.... 79241
WSR-57
NUMBER OF CELLS
0
35
70
105
140
175
210
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE.... 79241
WSR-57
NUMBER OF ECHOES
0
15
30
45
60
75
90
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

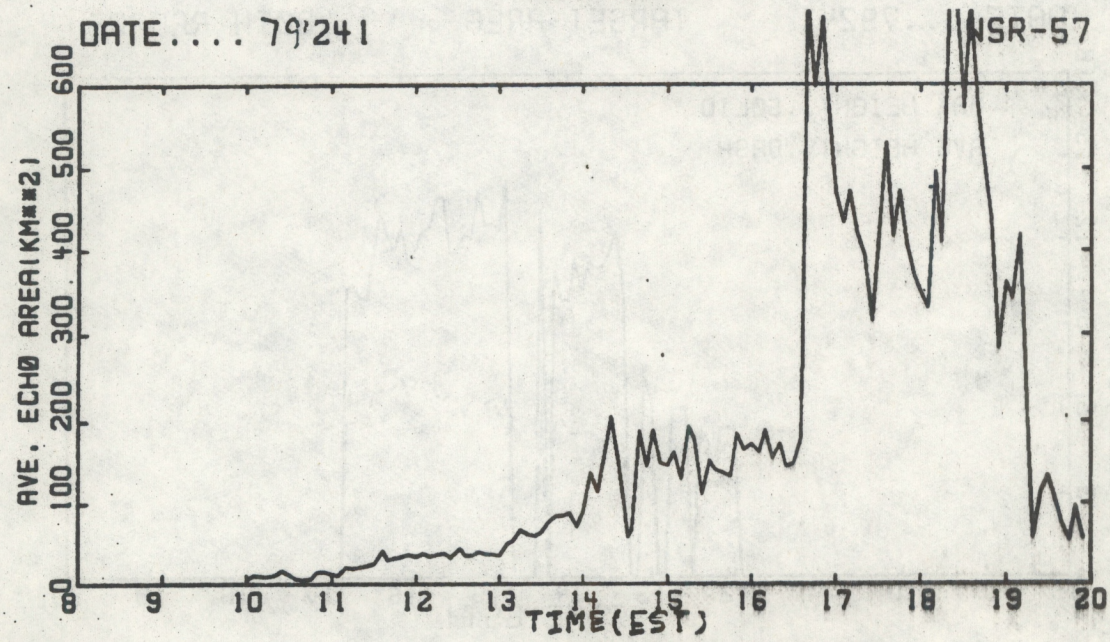
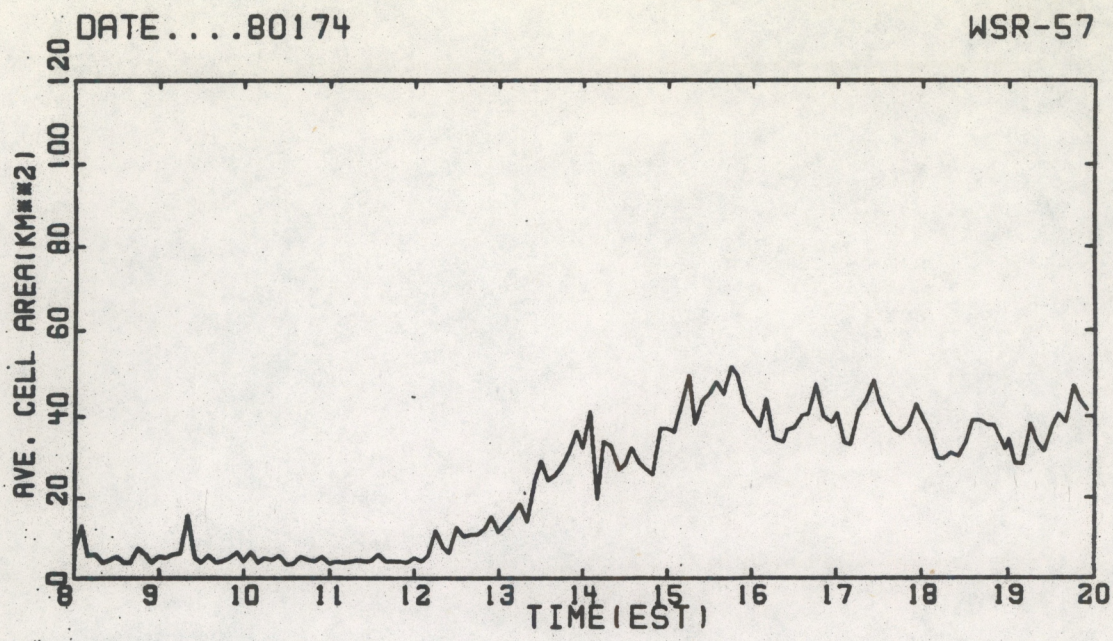
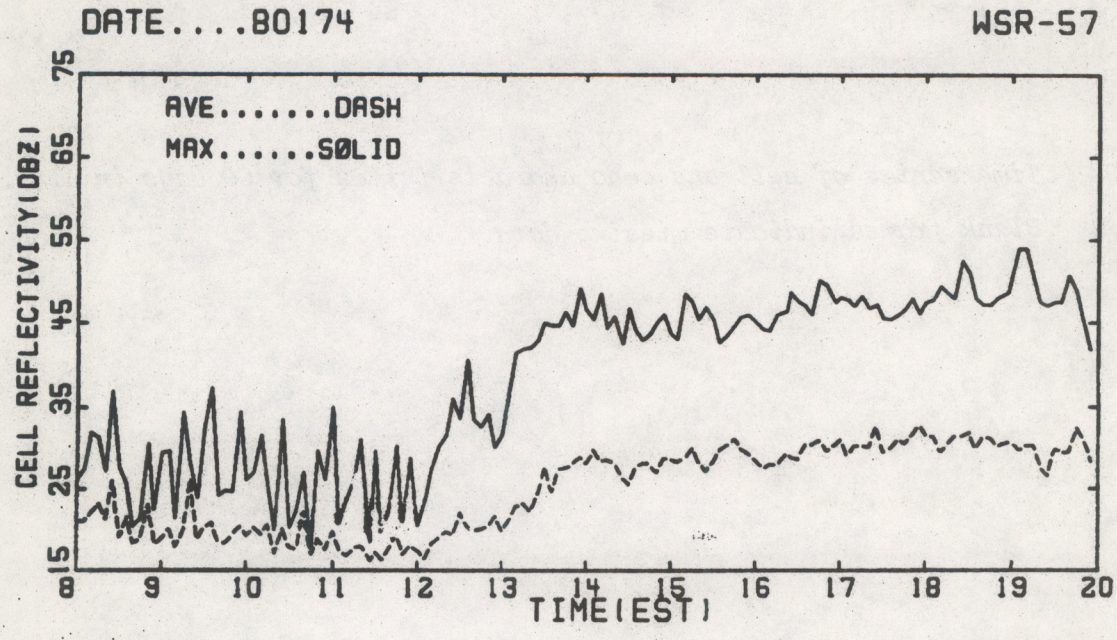
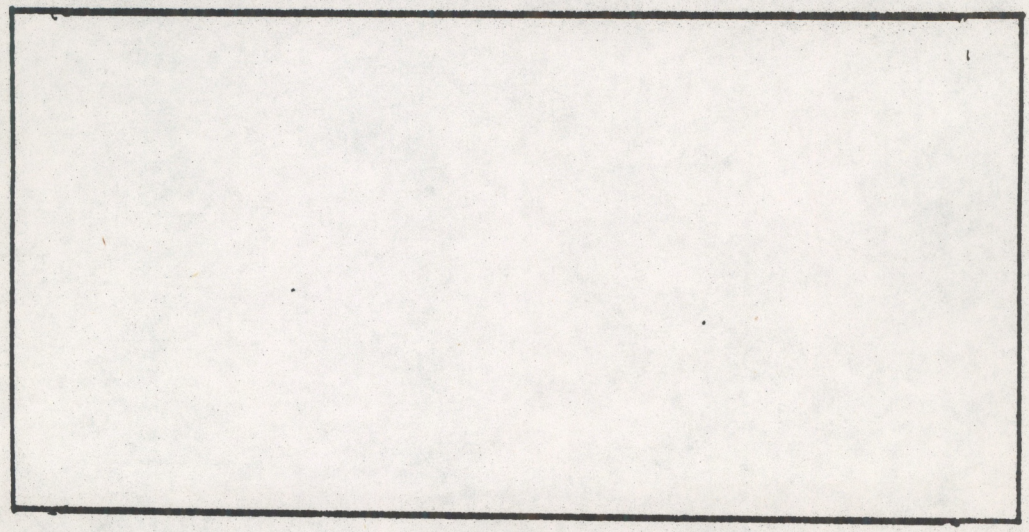
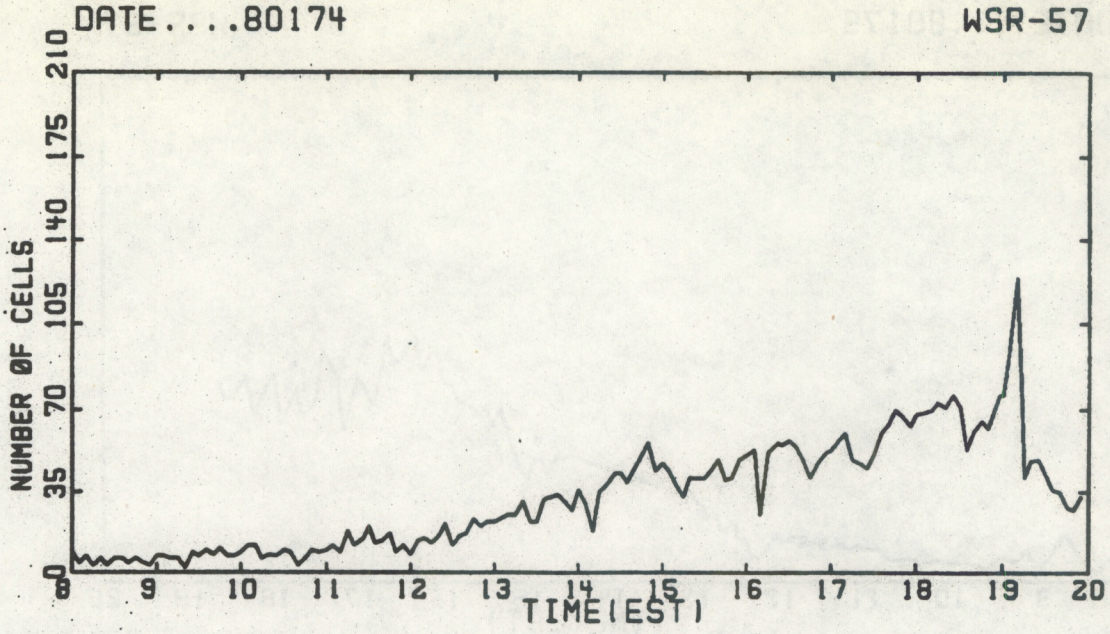

DATE.... 79241
WSR-57
AVE. ECHO AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

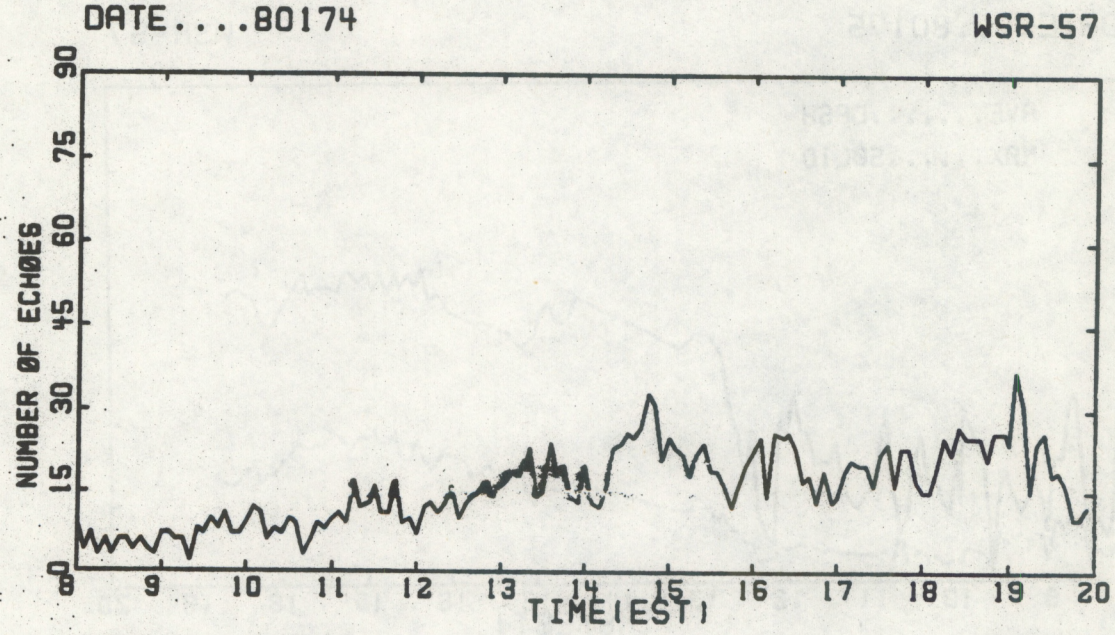
*Fig. 9. Time series of cell and echo characteristics for 60 days in 1980. Blank frames indicate missing data.*

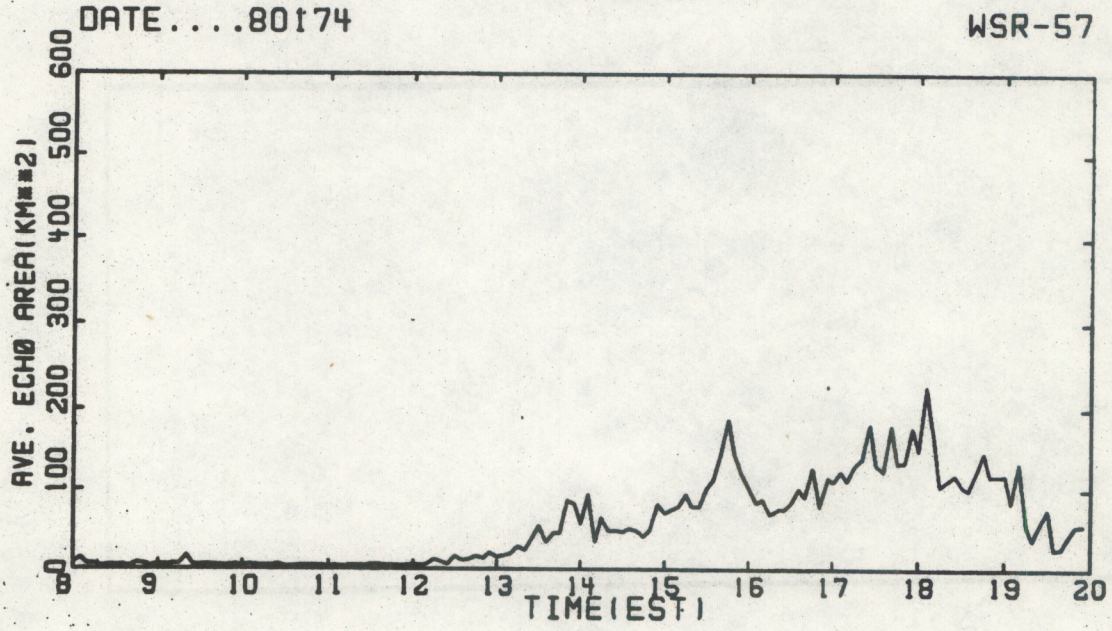

DATE....80174
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
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19
20
TIME(EST)

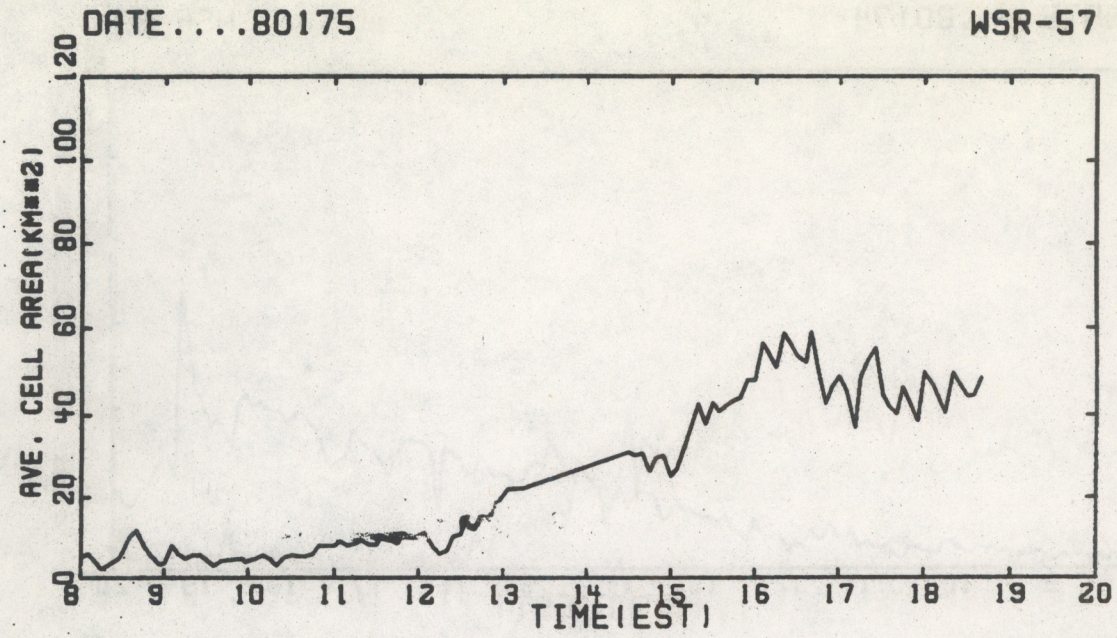

DATE....80174
WSR-57
CELL REFLECTIVITY(DBZ)
AVE.....DASH
MAX.....SOLID
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

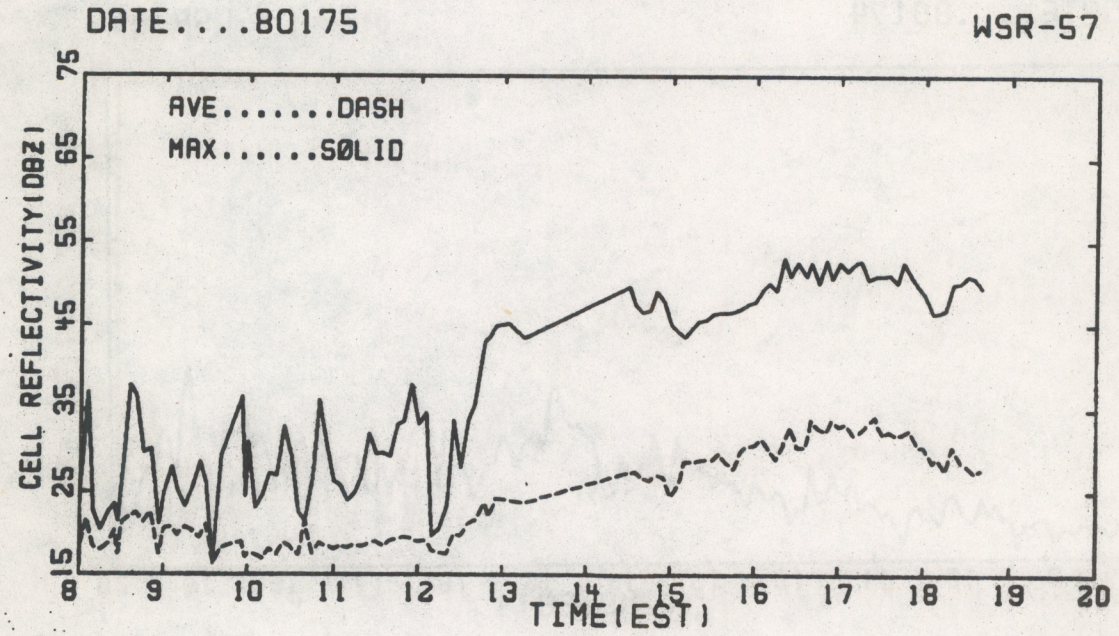


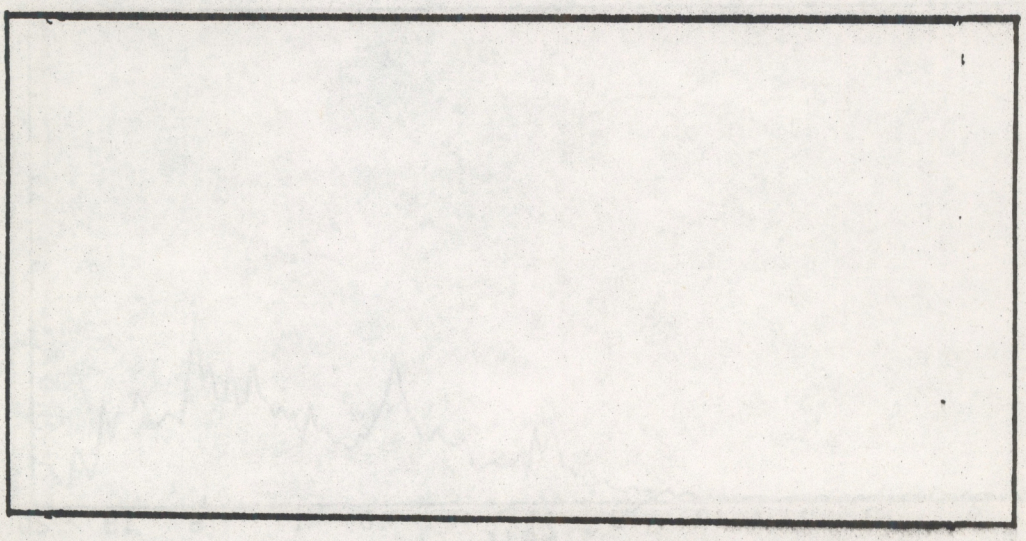

DATE....80174
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
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11
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16
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19
20
TIME(EST)

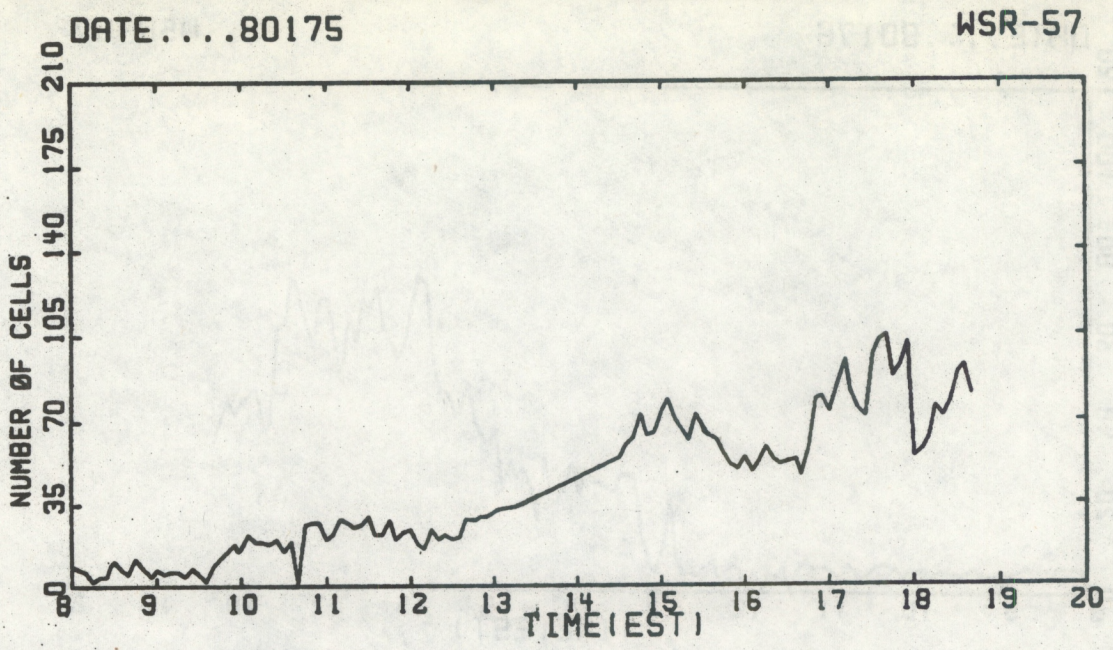

DATE....80174
WSR-57
NUMBER ØF ECHØES
0
15
30
45
60
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TIME(EST)

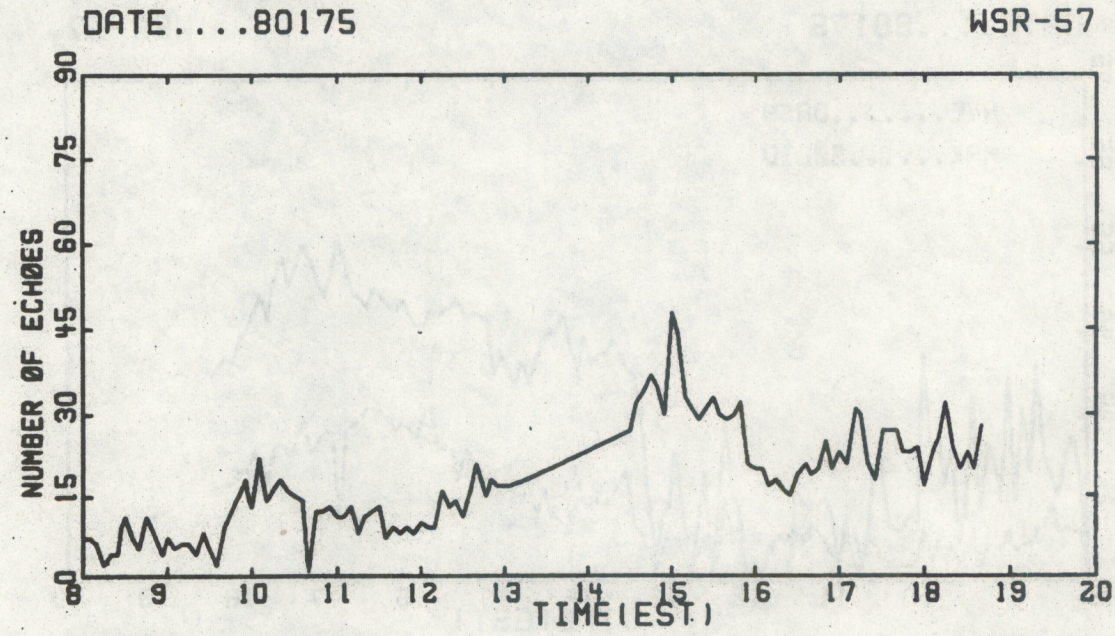

DATE....80174
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
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TIME(EST)

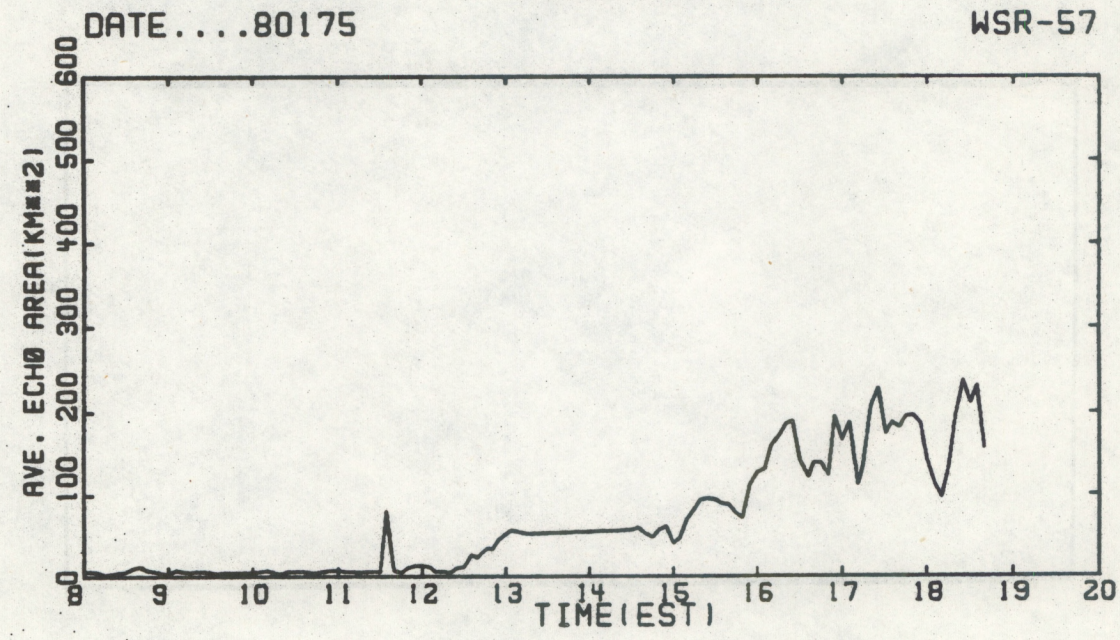

DATE....80175
WSR-57
AVE. CELL AREA(KM**2)
0
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100
120
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TIME(EST)

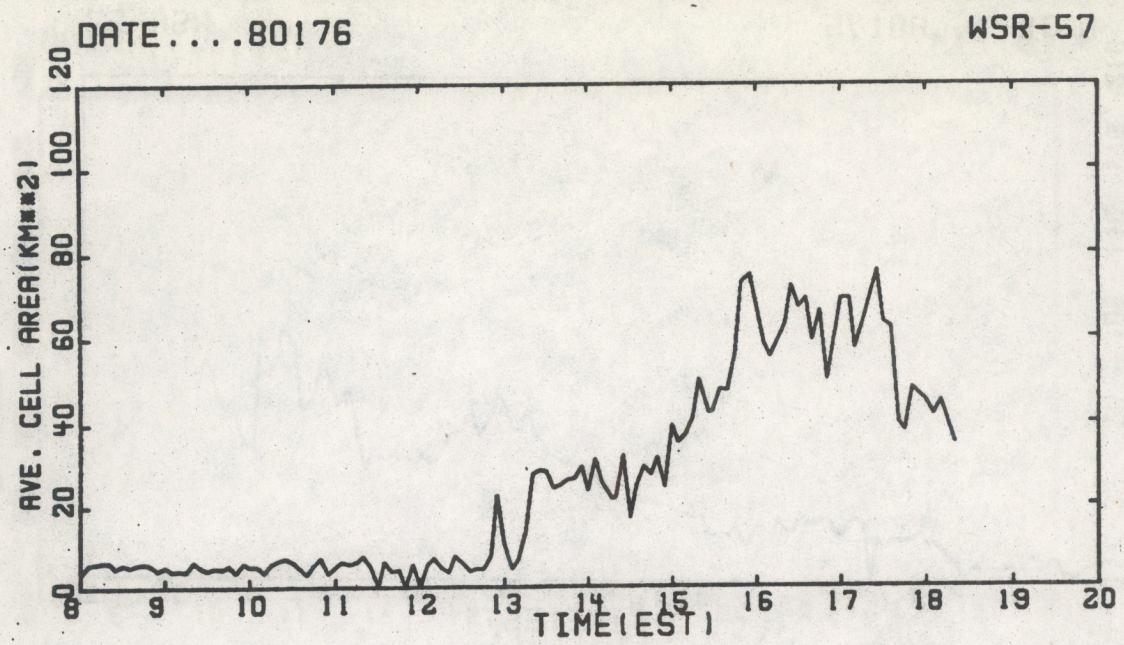

DATE....80175
WSR-57
CELL REFLECTIVITY(DBZ)
AVE.....DASH
MAX.....SOLID
15
25
35
45
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65
75
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TIME(EST)

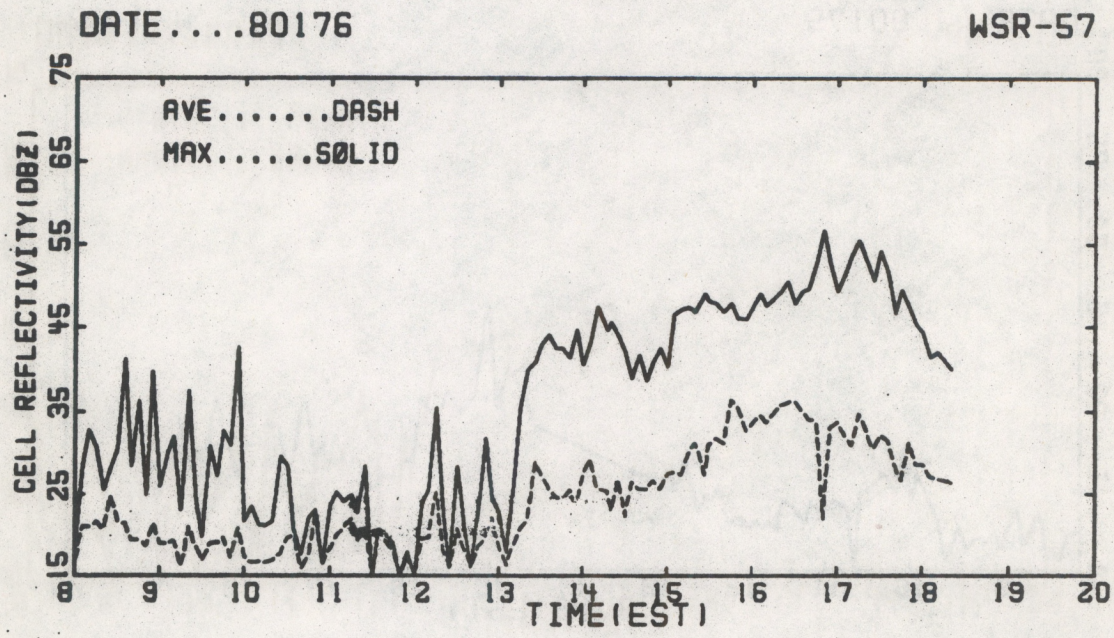


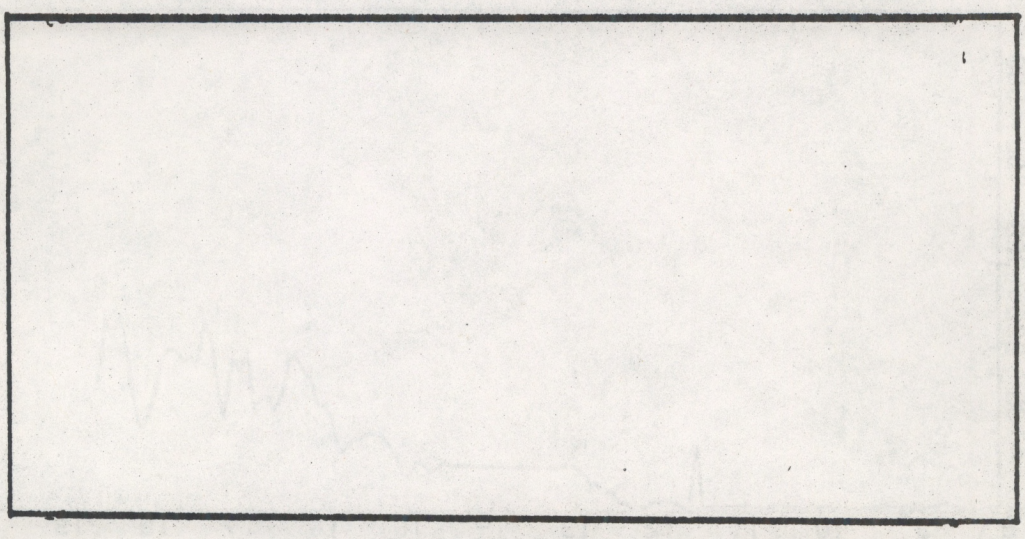

DATE....80175
WSR-57
NUMBER ØF CELLS
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TIME(EST)

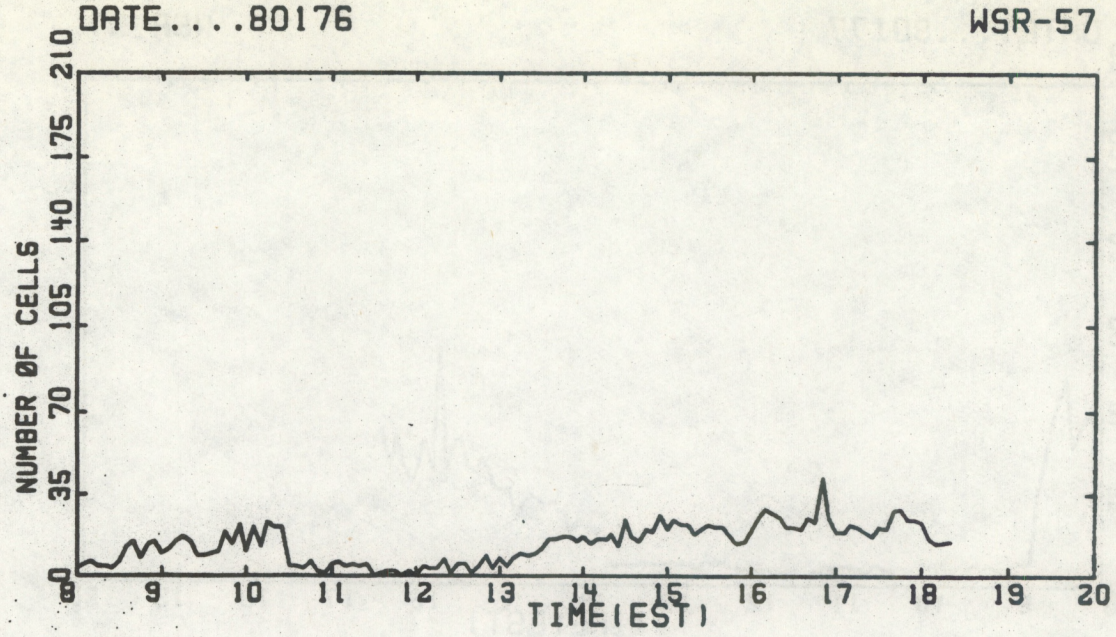

DATE....80175
WSR-57
NUMBER ØF ECHØES
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TIME(EST)

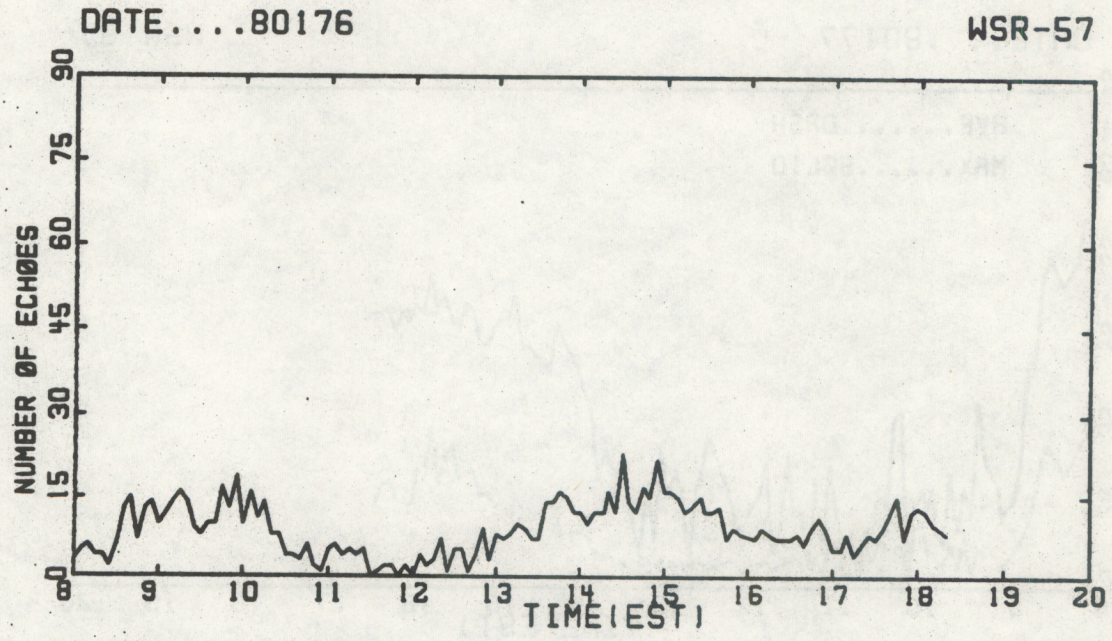

DATE....80175
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
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600
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TIME(EST)

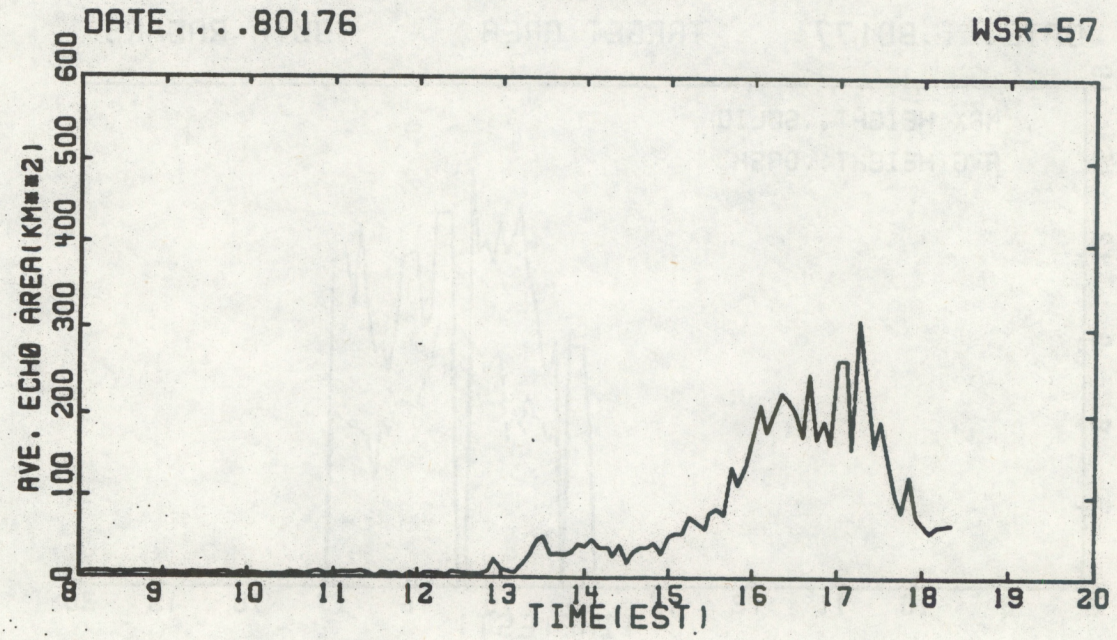

DATE....80176
WSR-57
AVE. CELL AREA(KM**2)
0
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120
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TIME(EST)

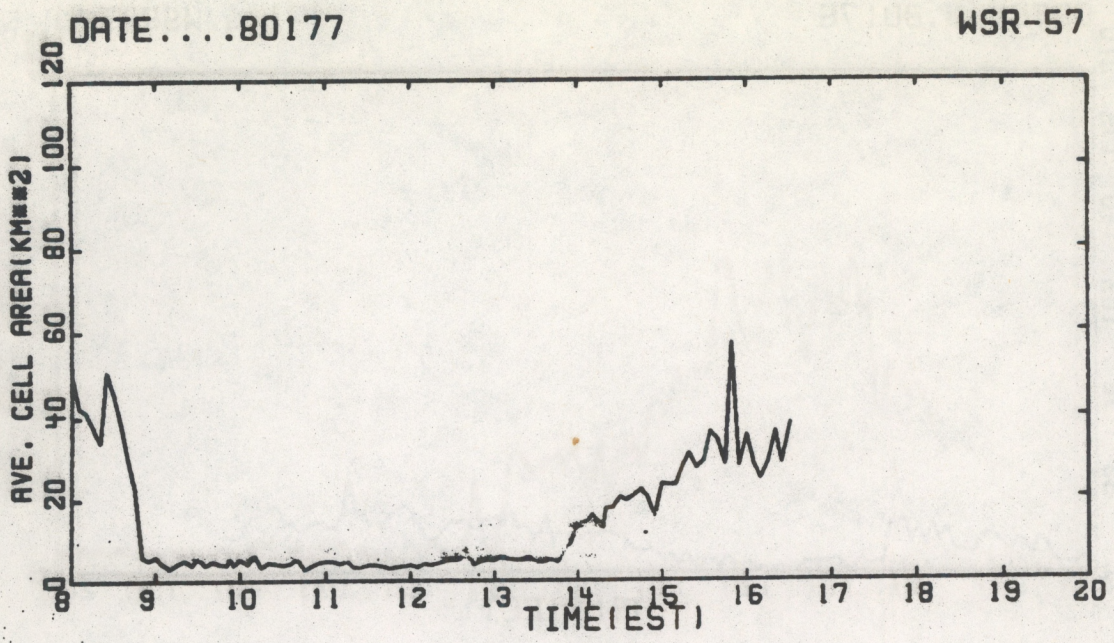

DATE....80176
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
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TIME(EST)

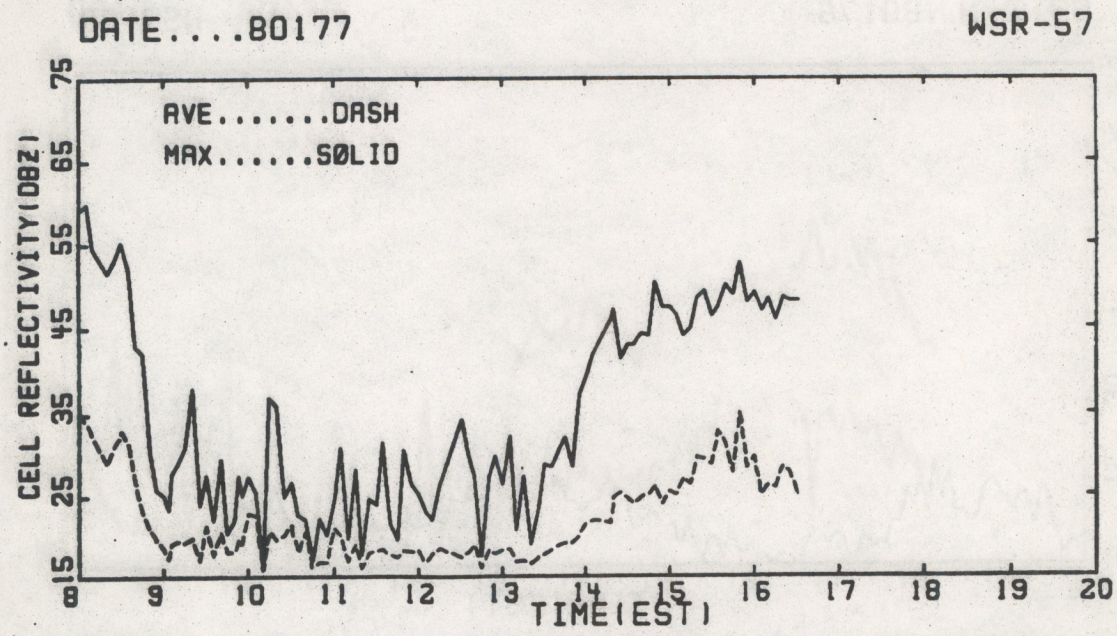


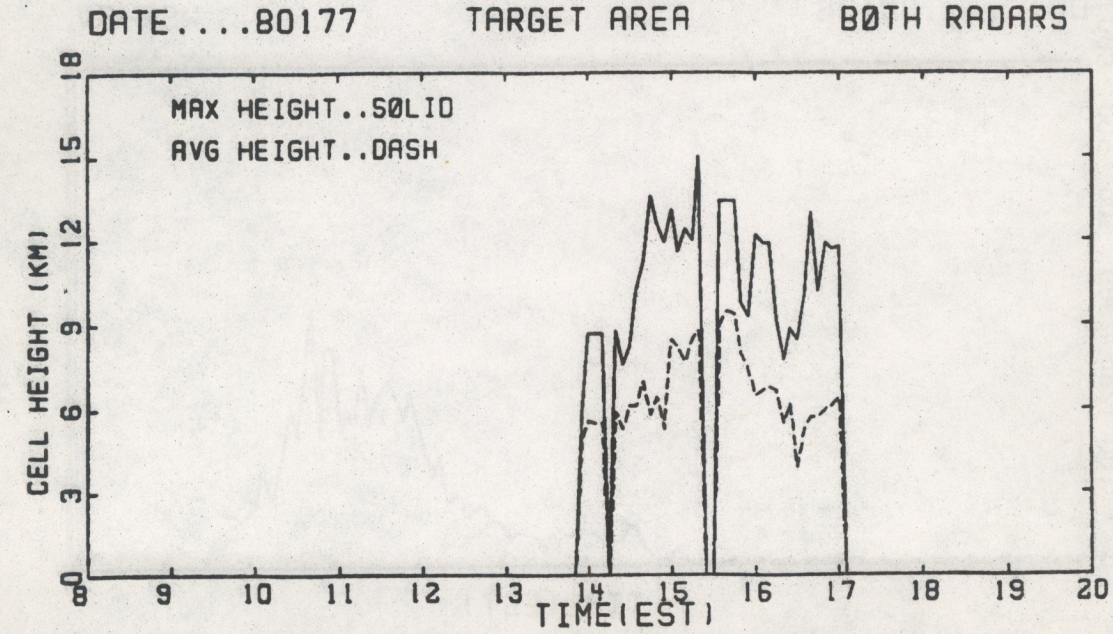

DATE....80176
WSR-57
NUMBER ØF CELLS
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TIME(EST)

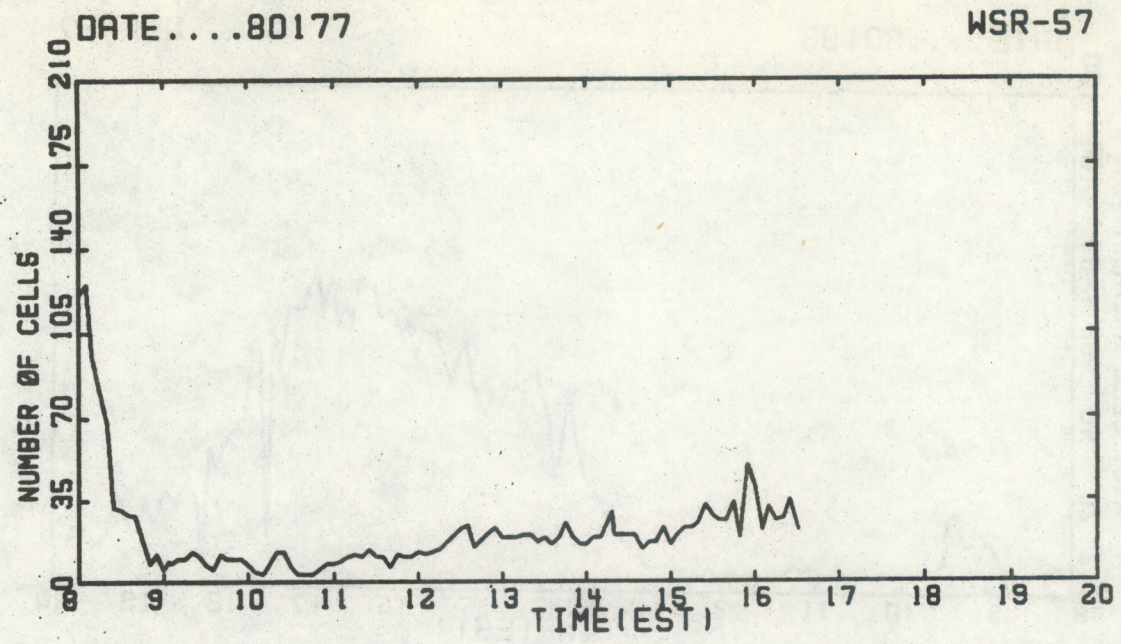

DATE....80176
WSR-57
NUMBER ØF ECHØES
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TIME(EST)

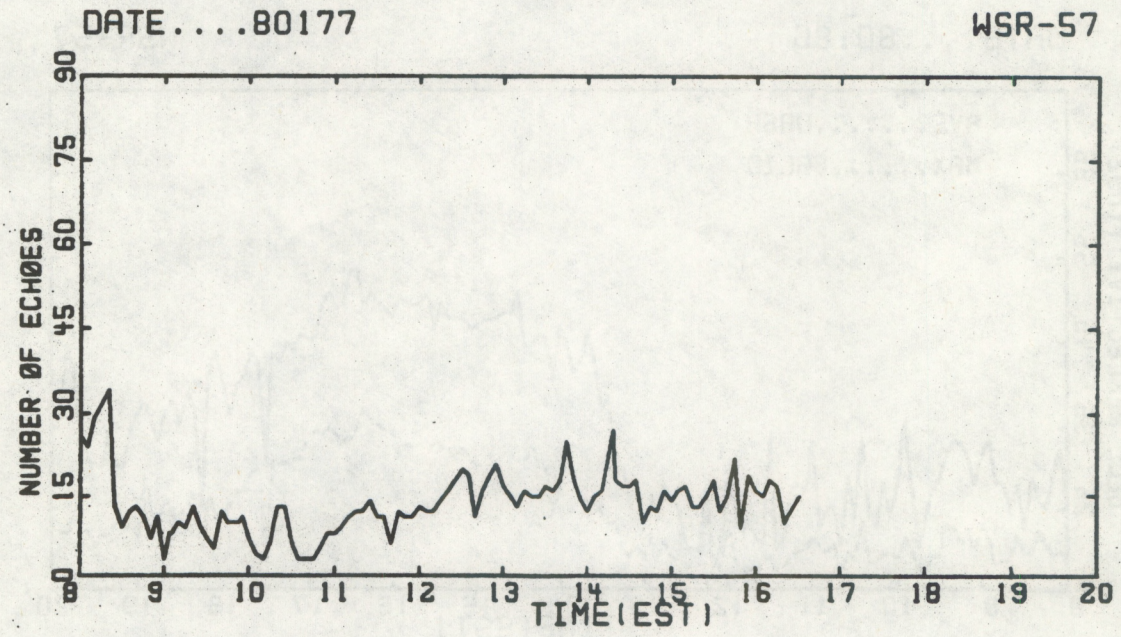

DATE....80176
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
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19
20
TIME(EST)

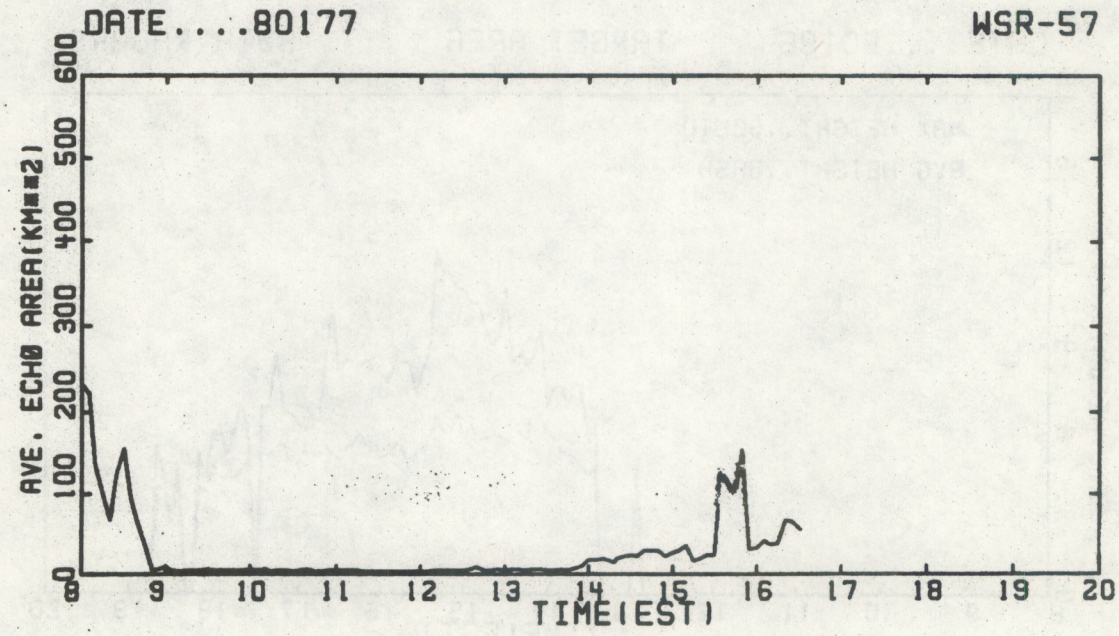

DATE....80177
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
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TIME(EST)

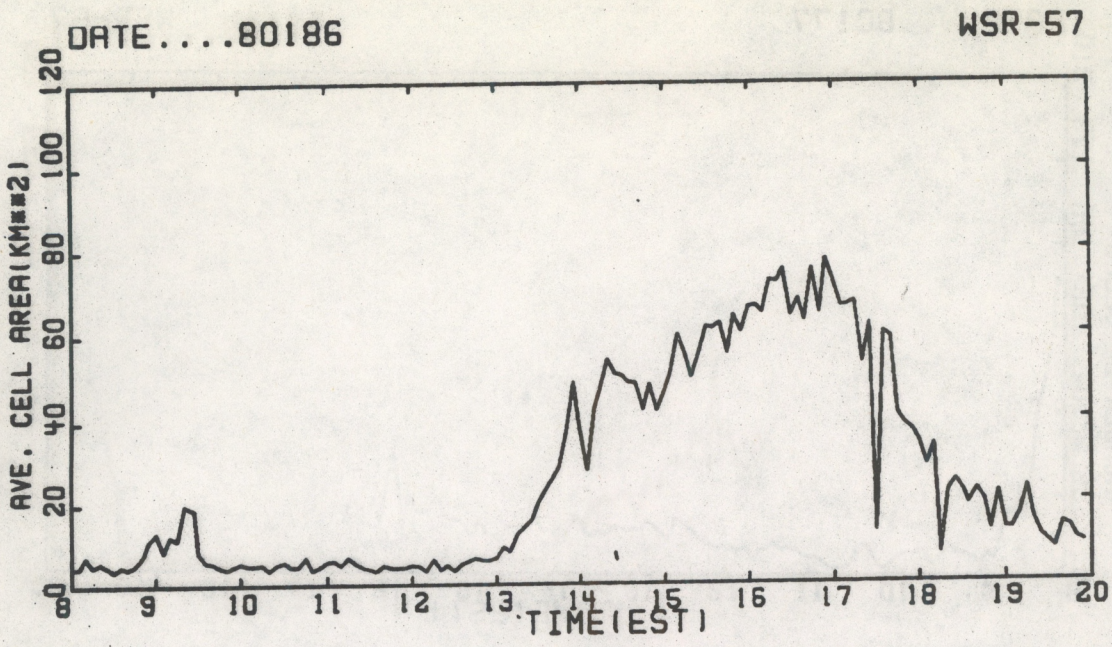

DATE....80177
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
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75
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TIME(EST)

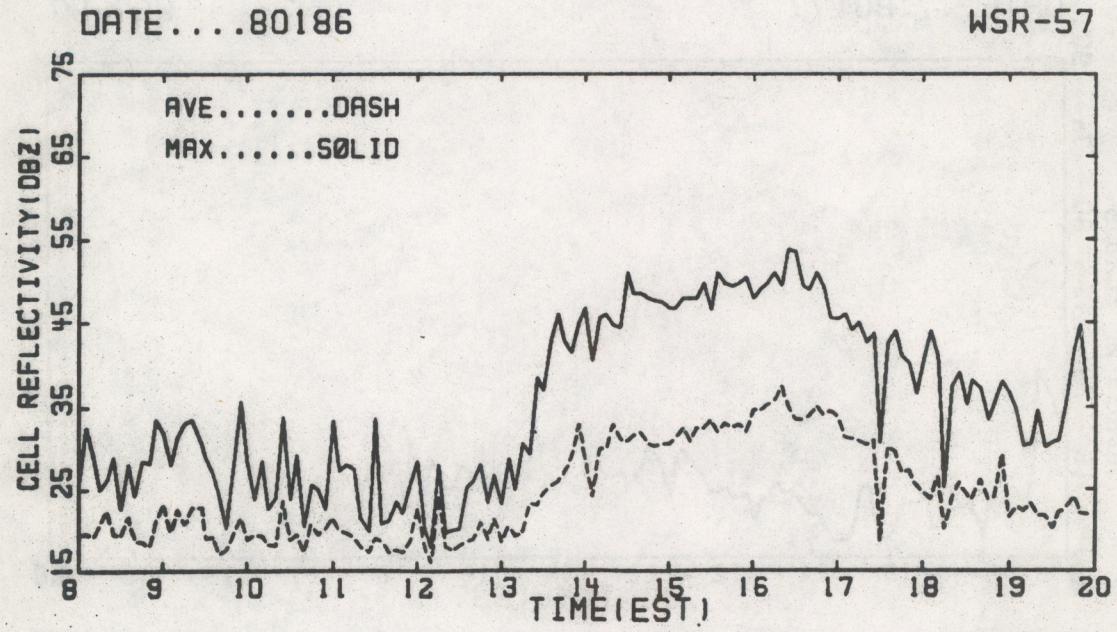

DATE....80177
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

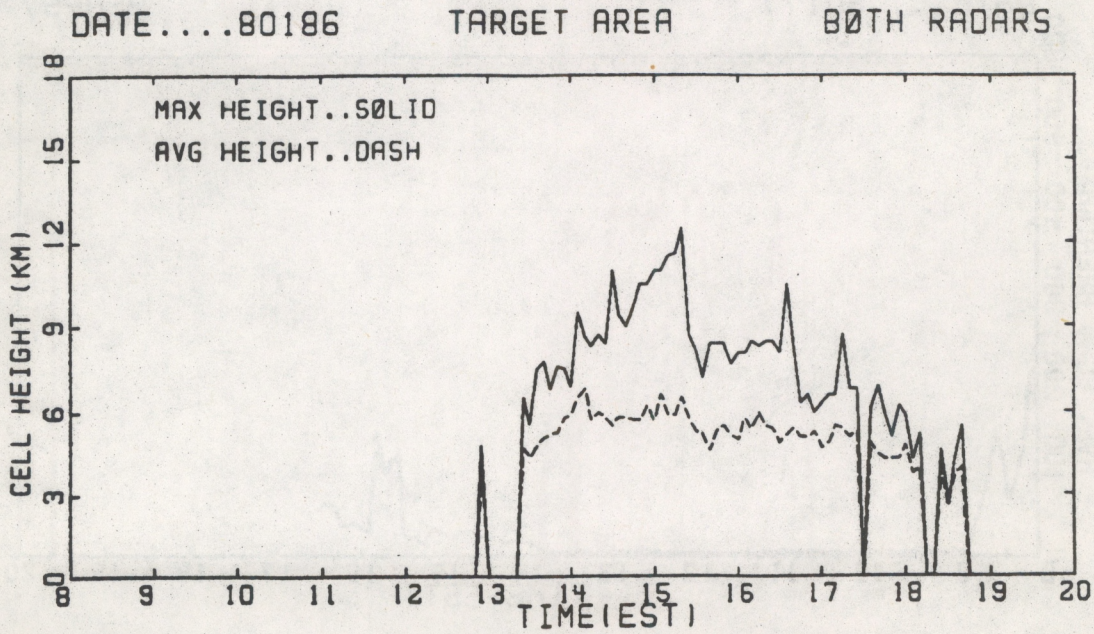

DATE....80177
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
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15
16
17
18
19
20
TIME(EST)

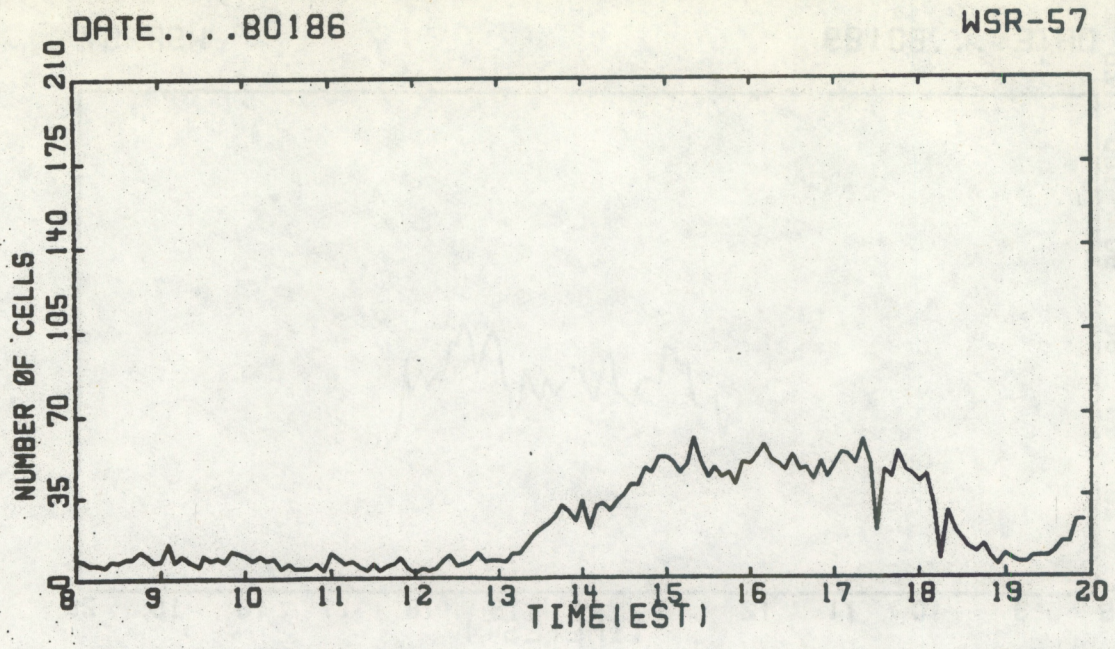

DATE....80177
WSR-57
NUMBER ØF ECHØES
0
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30
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TIME(EST)

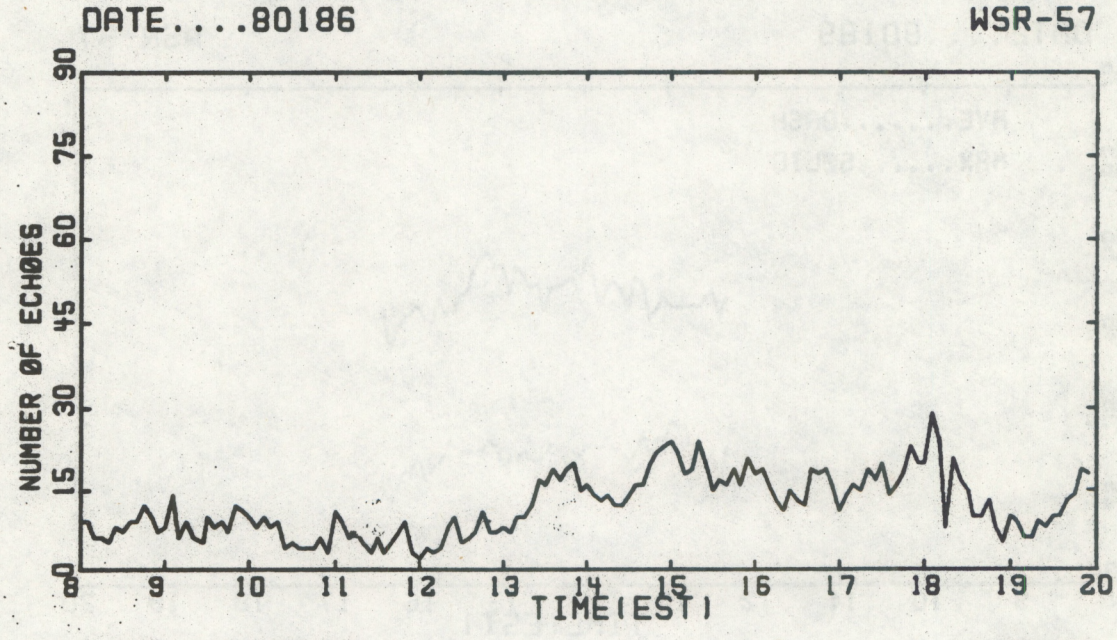

DATE....80177
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
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18
19
20
TIME(EST)

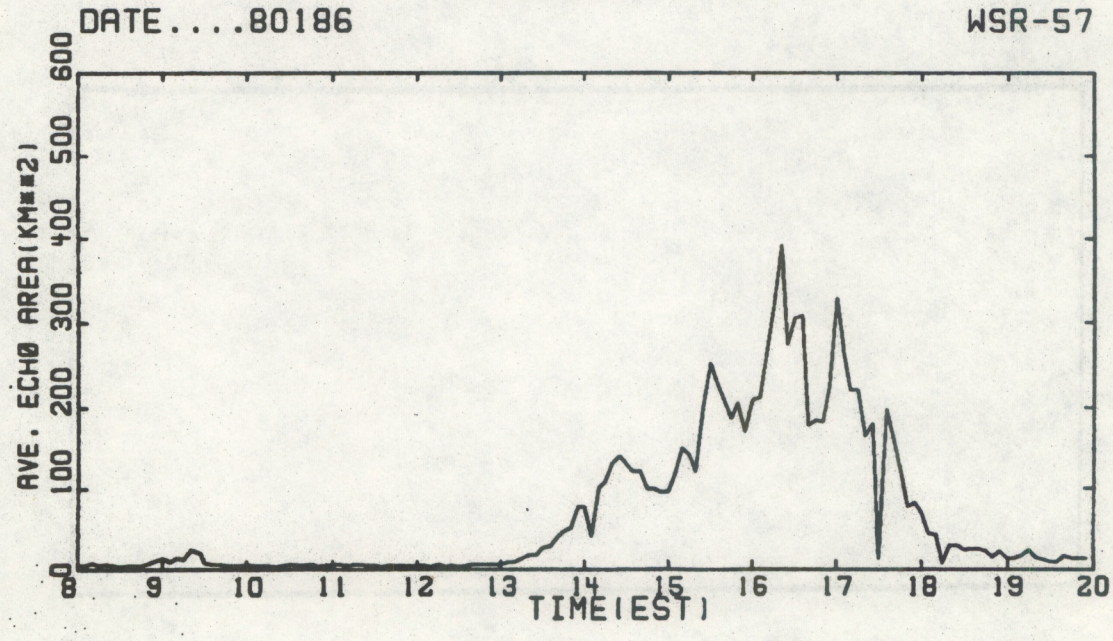

DATE....80186
WSR-57
AVE. CELL AREA(KM**2)
0
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60
80
100
120
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TIME(EST)

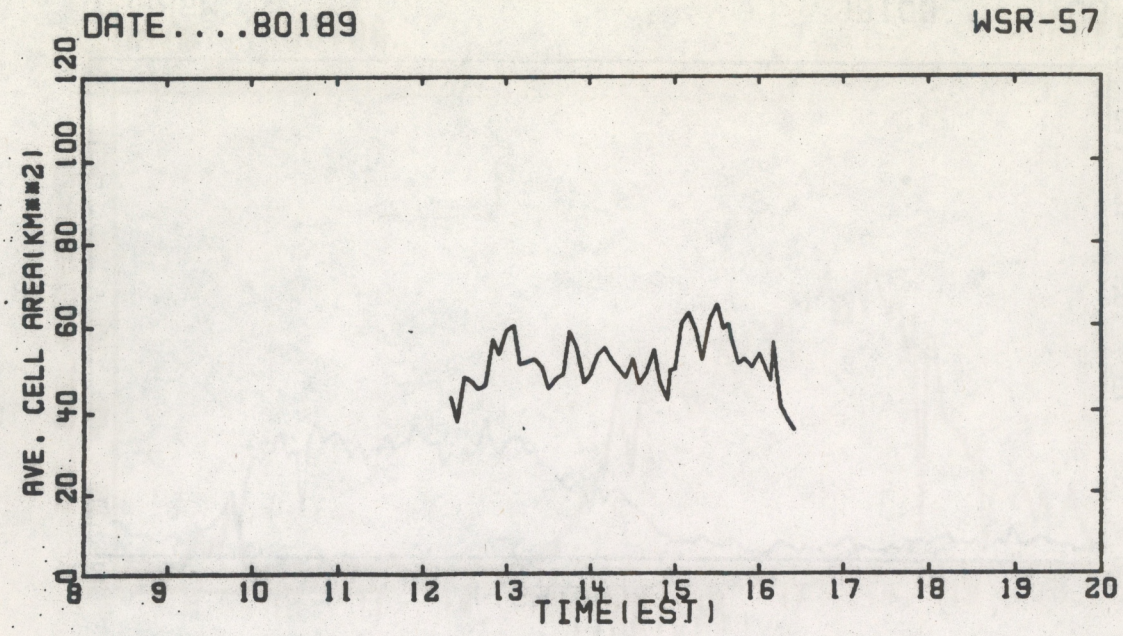

DATE....80186
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
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75
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TIME(EST)

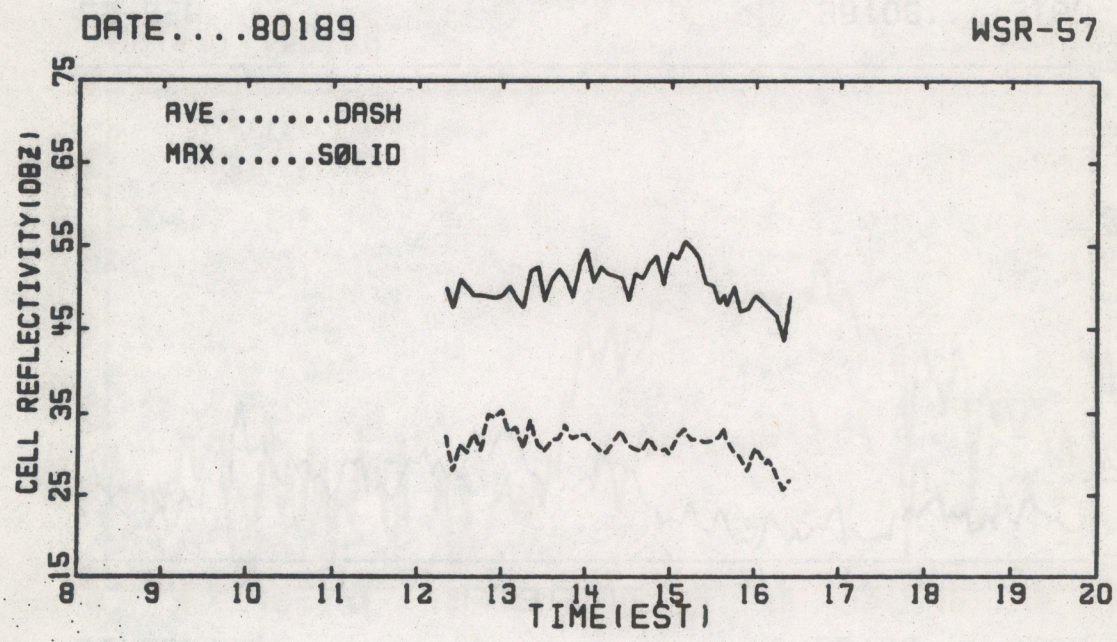

DATE....80186
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
11
12
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15
16
17
18
19
20
TIME(EST)

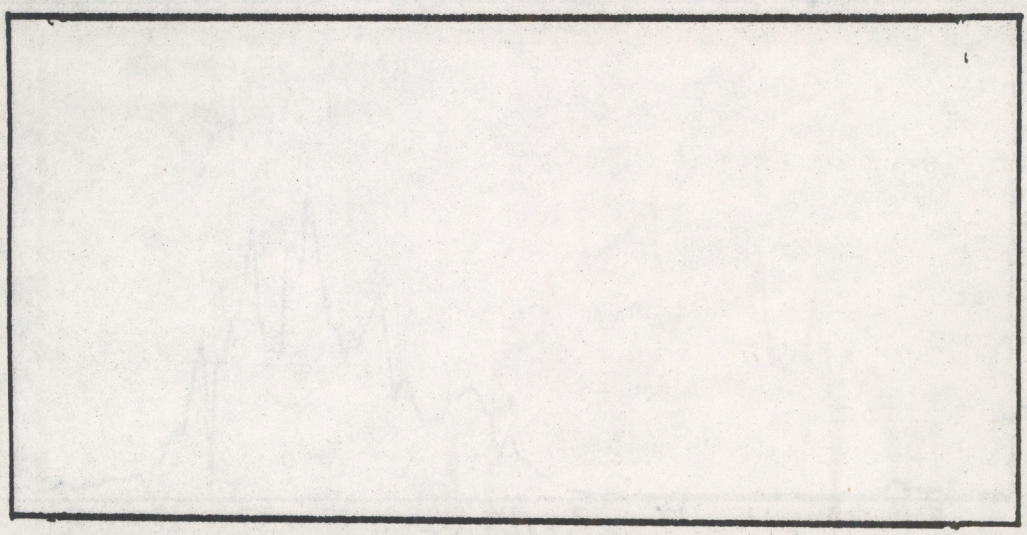

DATE....80186
WSR-57
NUMBER ØF CELLS
0
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140
175
210
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TIME(EST)

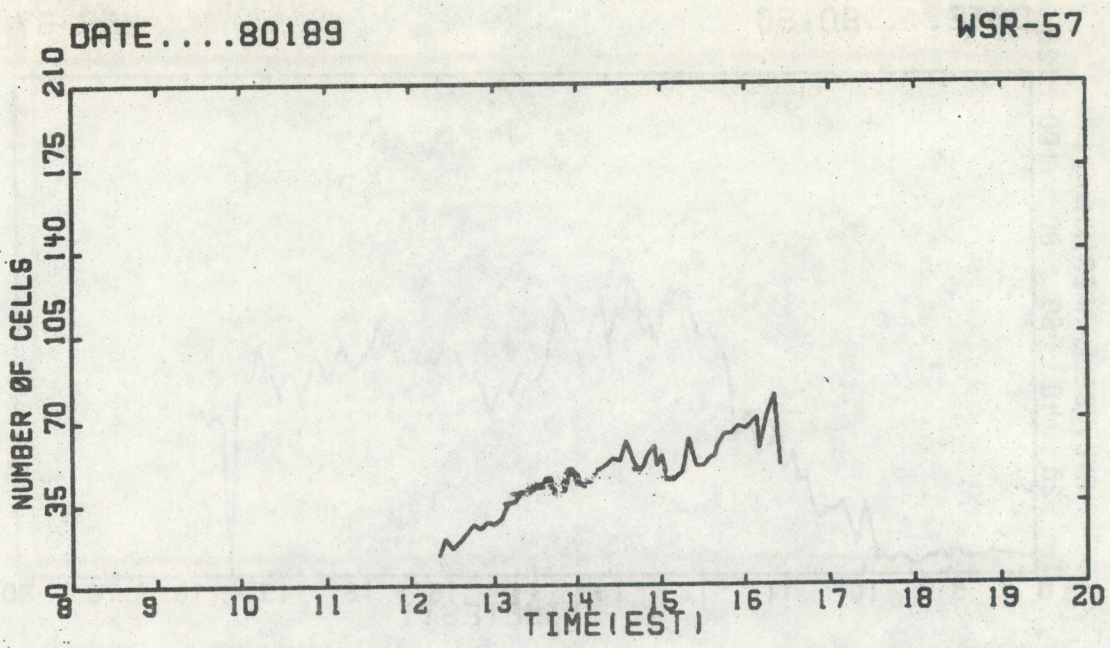

DATE....80186
WSR-57
NUMBER ØF ECHØES
0
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TIME(EST)

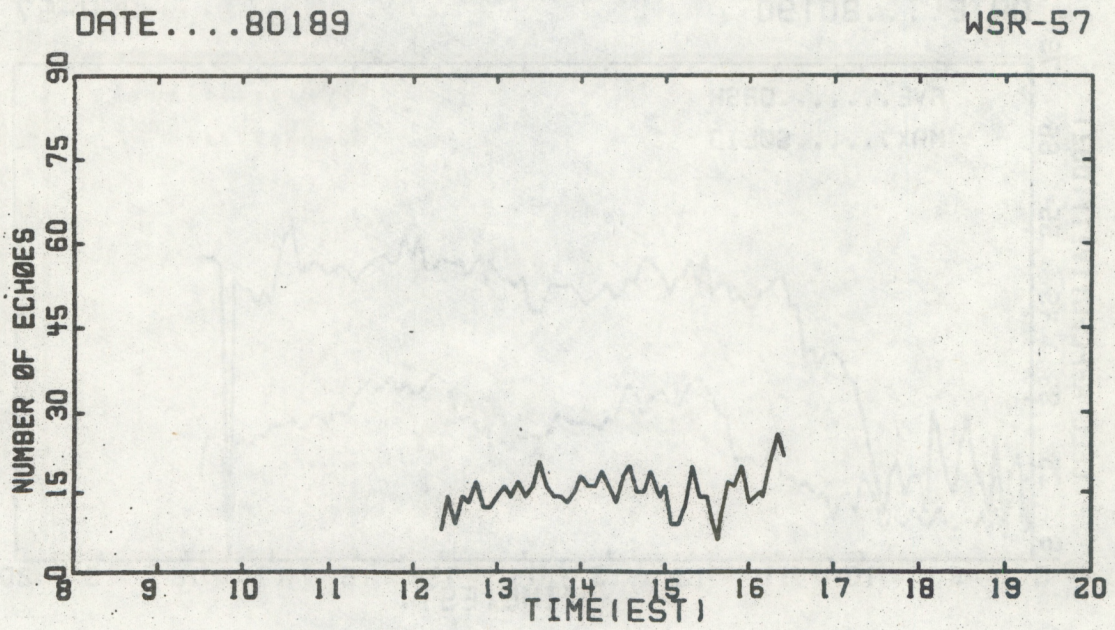

DATE....80186
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
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600
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TIME(EST)

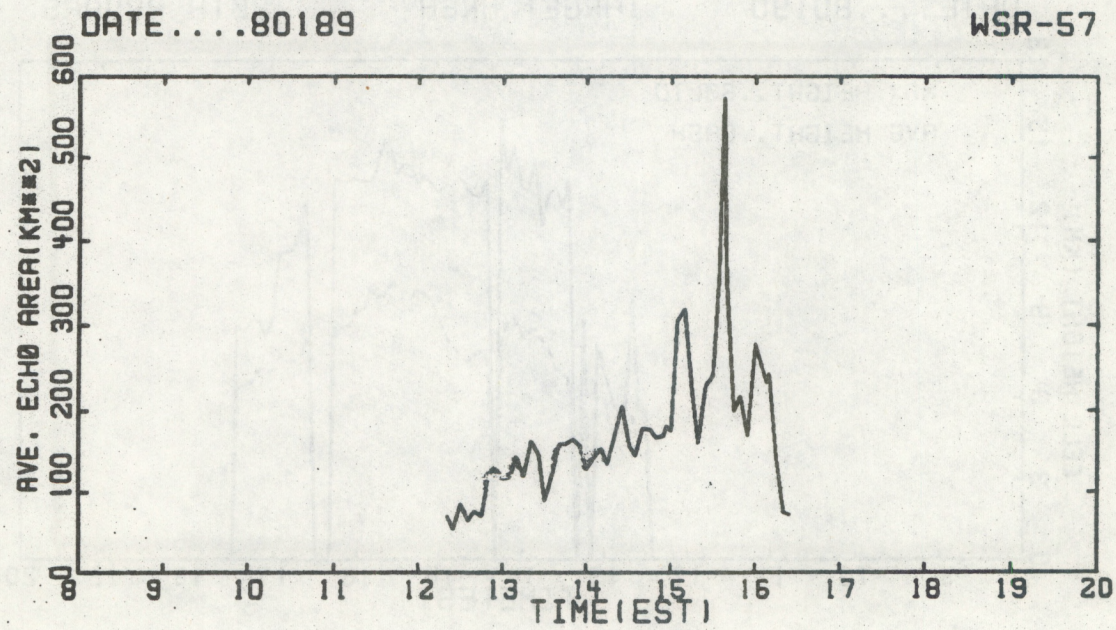

DATE....80189
WSR-57
AVE. CELL AREA(KM**2)
0
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100
120
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TIME(EST)

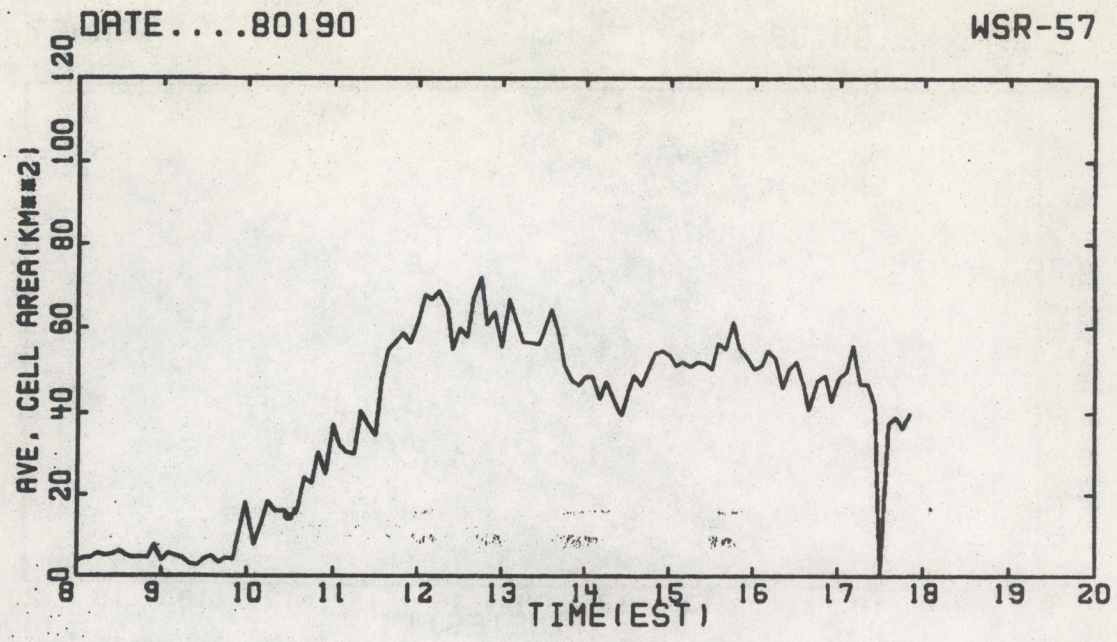

DATE....80189
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
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TIME(EST)

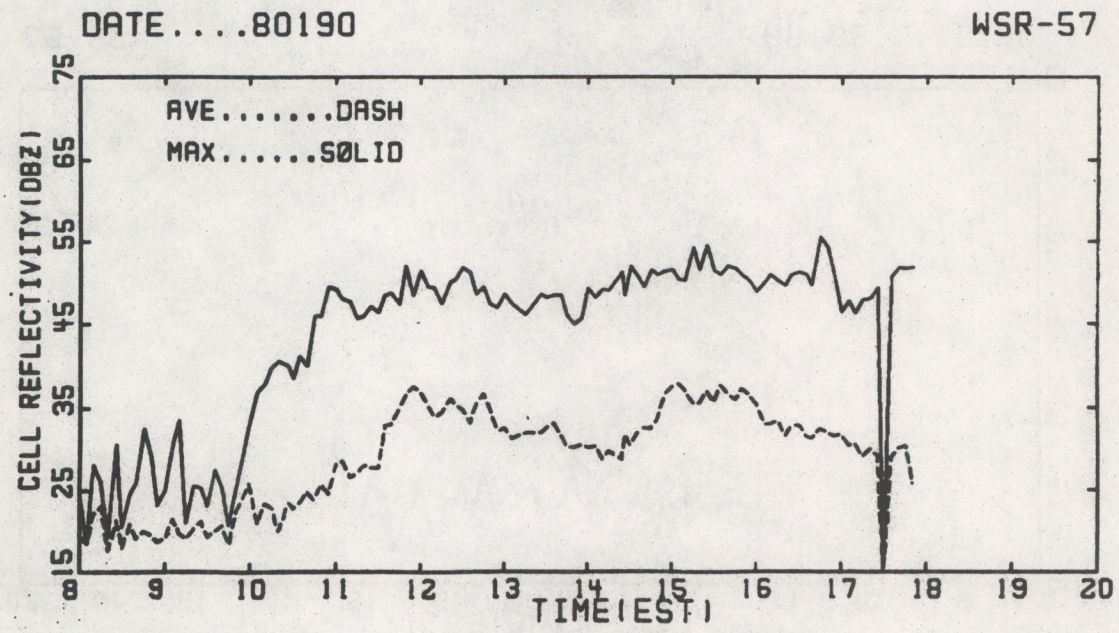


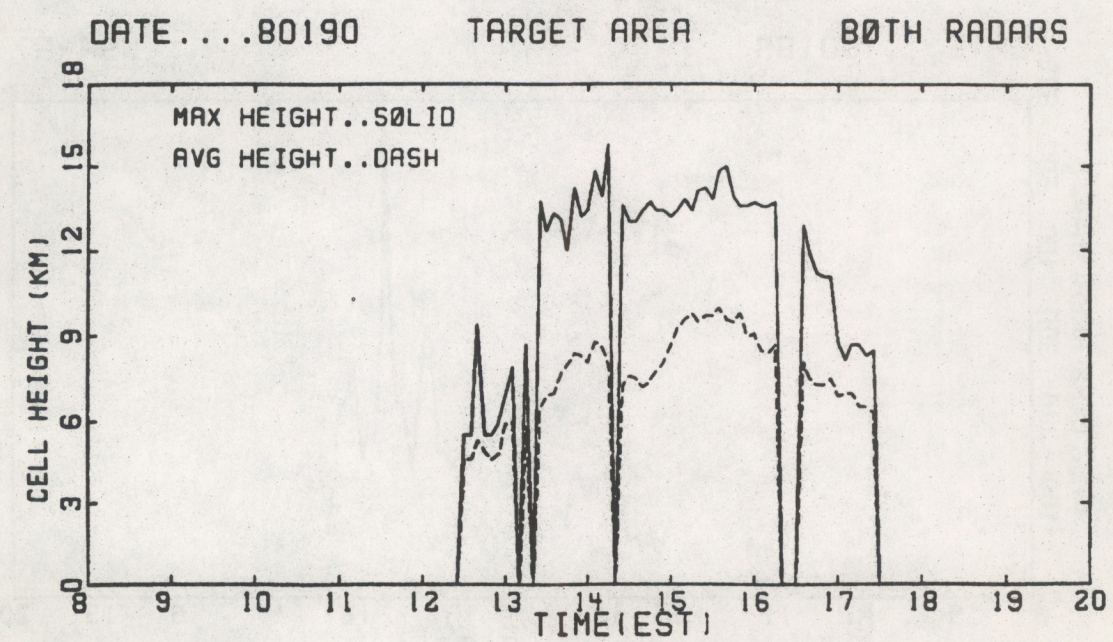

DATE....80189
WSR-57
NUMBER ØF CELLS
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140
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TIME(EST)

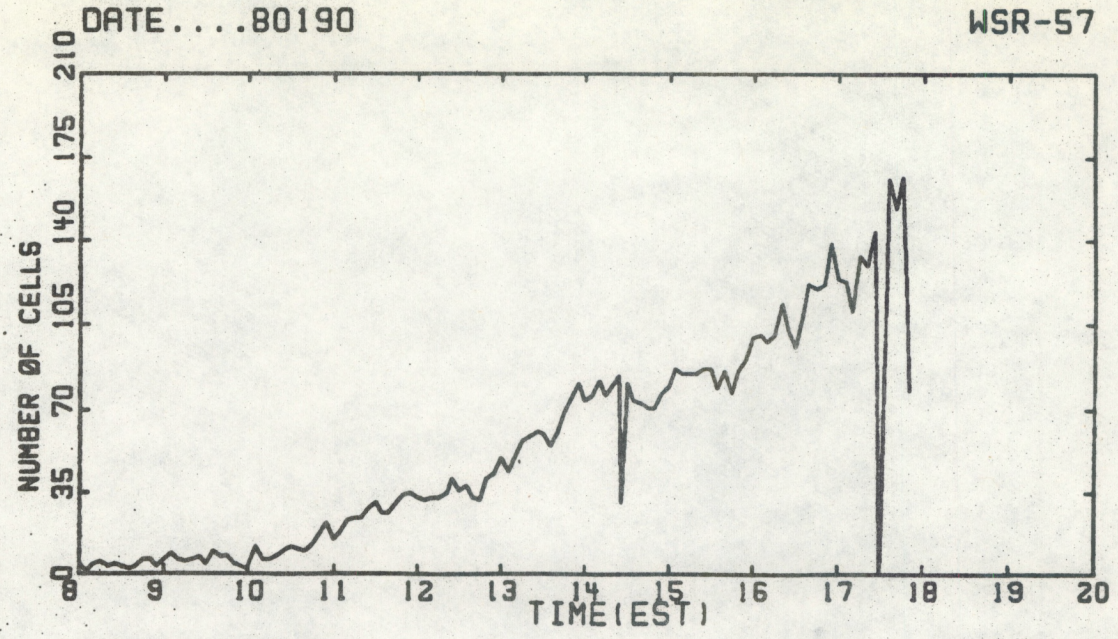

DATE....80189
WSR-57
NUMBER ØF ECHØES
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TIME(EST)

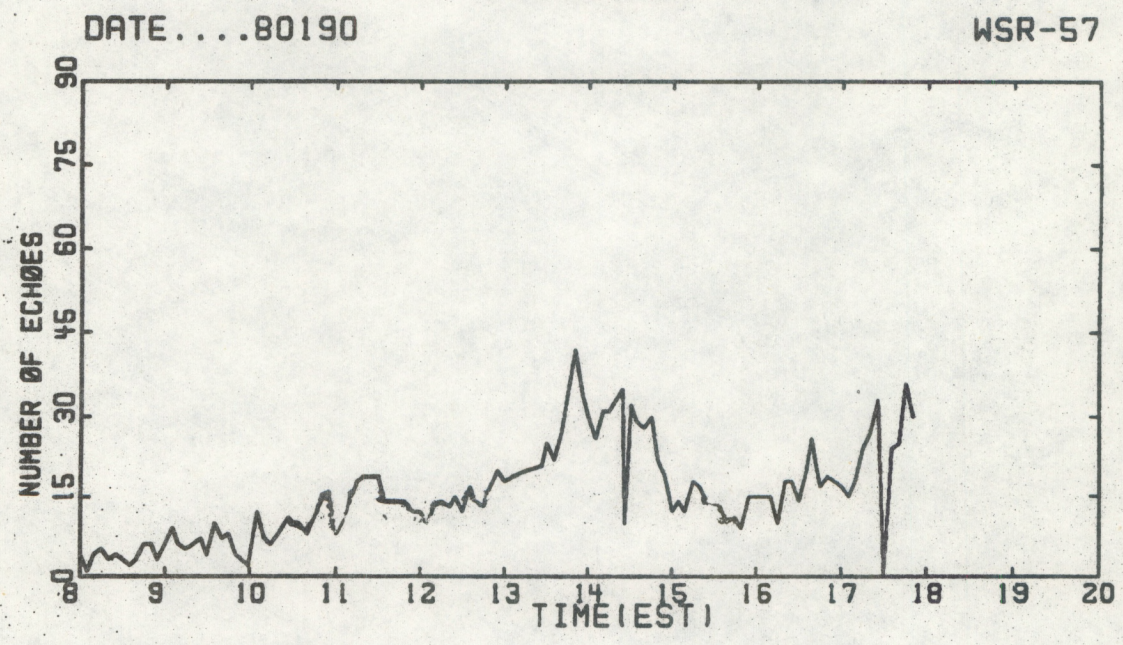

DATE....80189
WSR-57
AVE. ECHØ AREA(KM**2)
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TIME(EST)

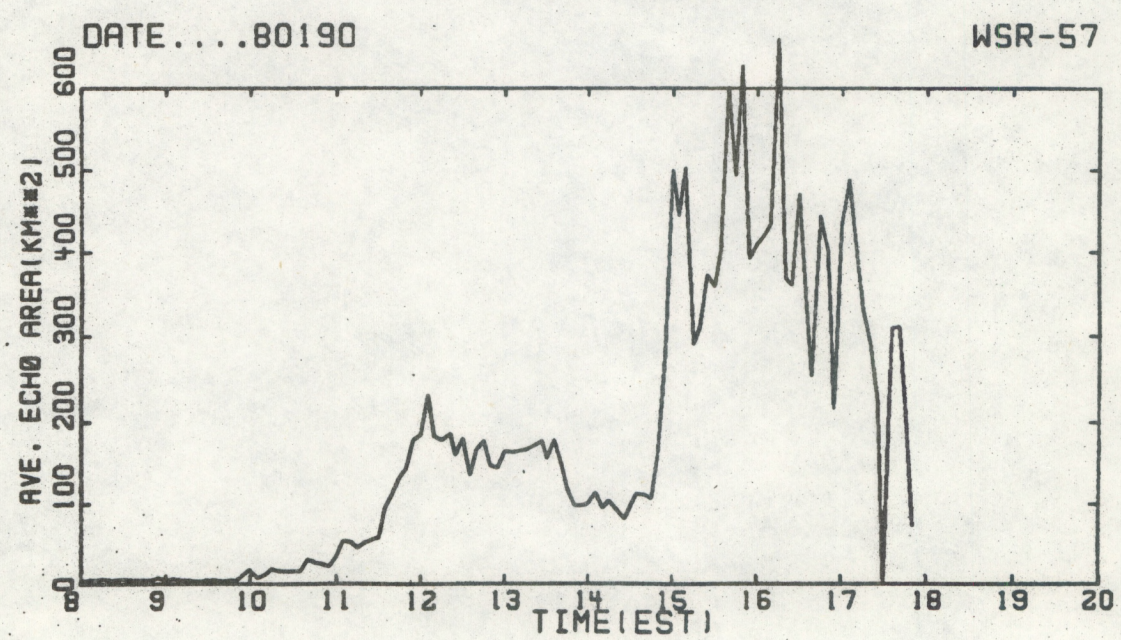

DATE....80190
WSR-57
AVE. CELL AREA(KM**2)
0
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TIME(EST)

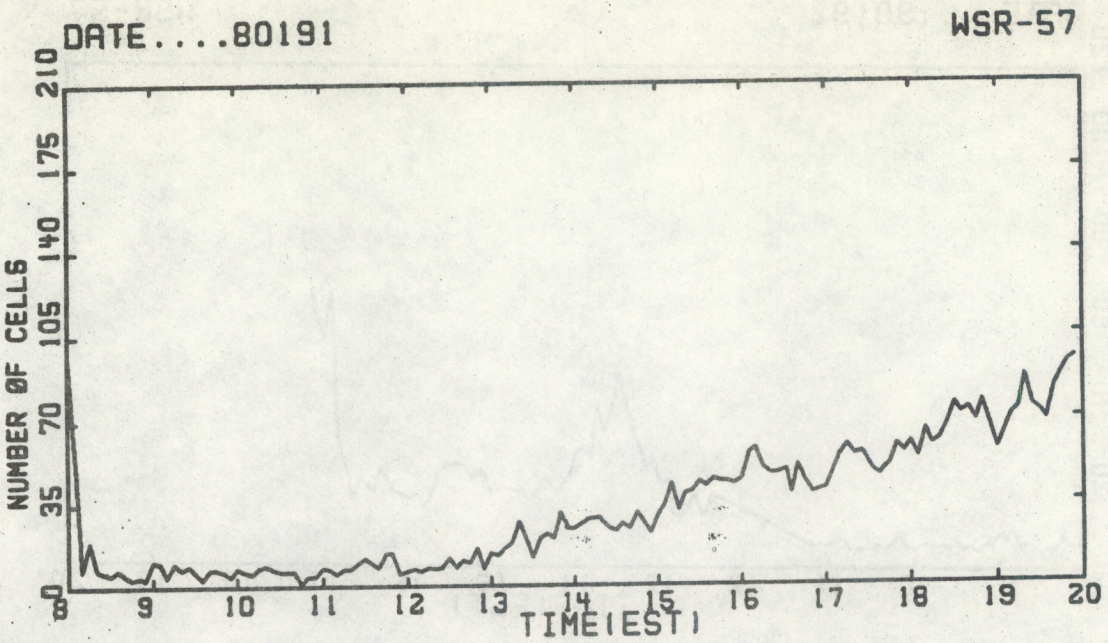

DATE....80190
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
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15
16
17
18
19
20
TIME(EST)

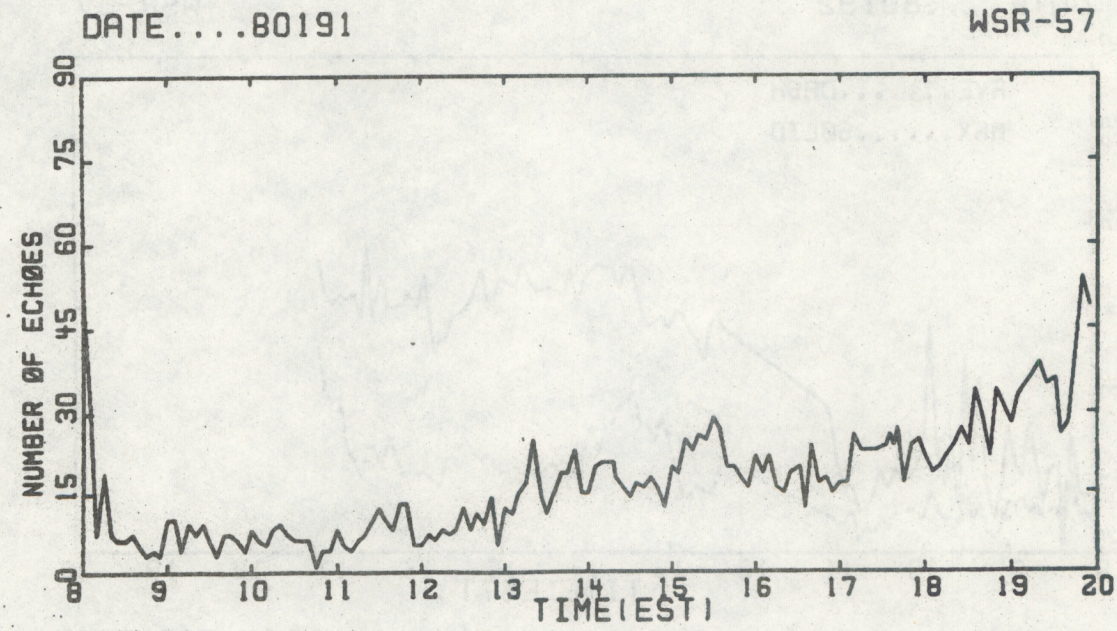

DATE....80190
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

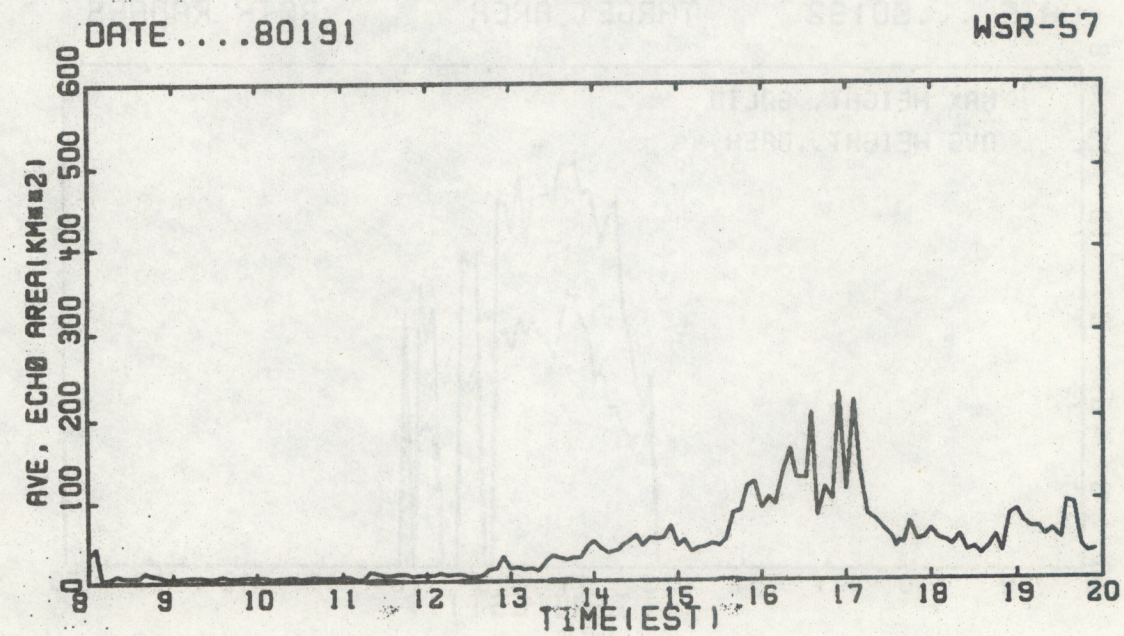

DATE....80190
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

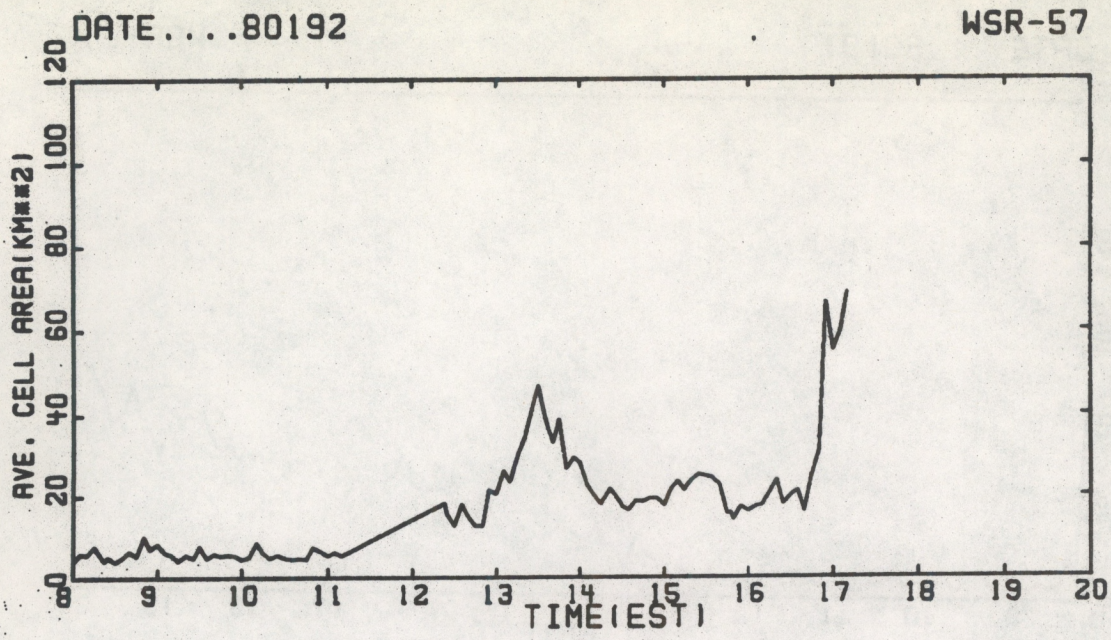

DATE....80190
WSR-57
NUMBER ØF ECHØES
0
15
30
45
60
75
90
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

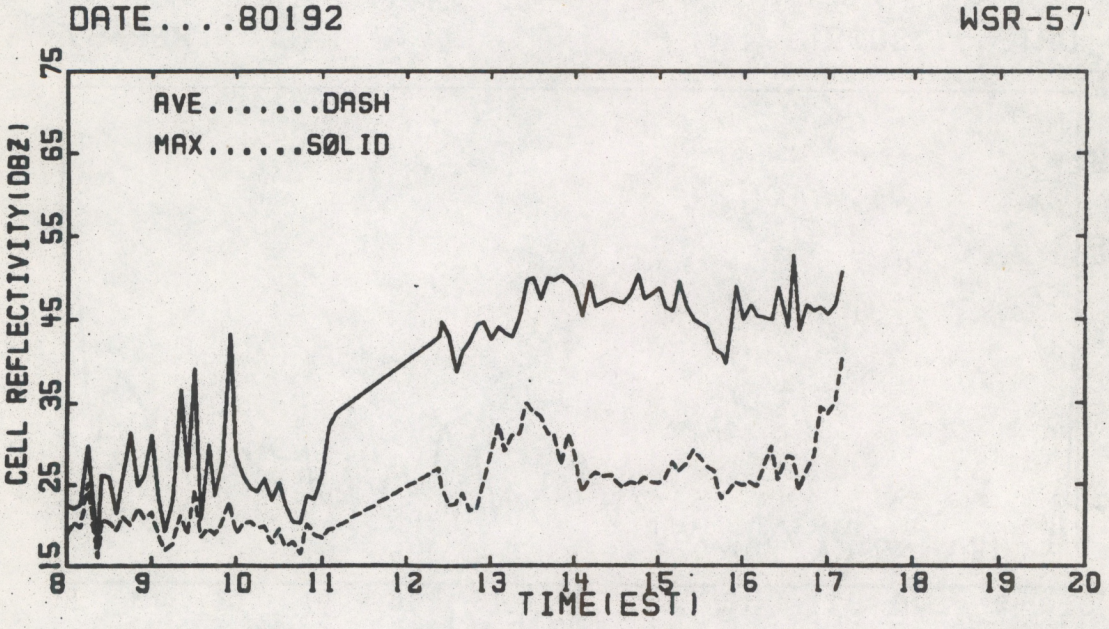

DATE....80190
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

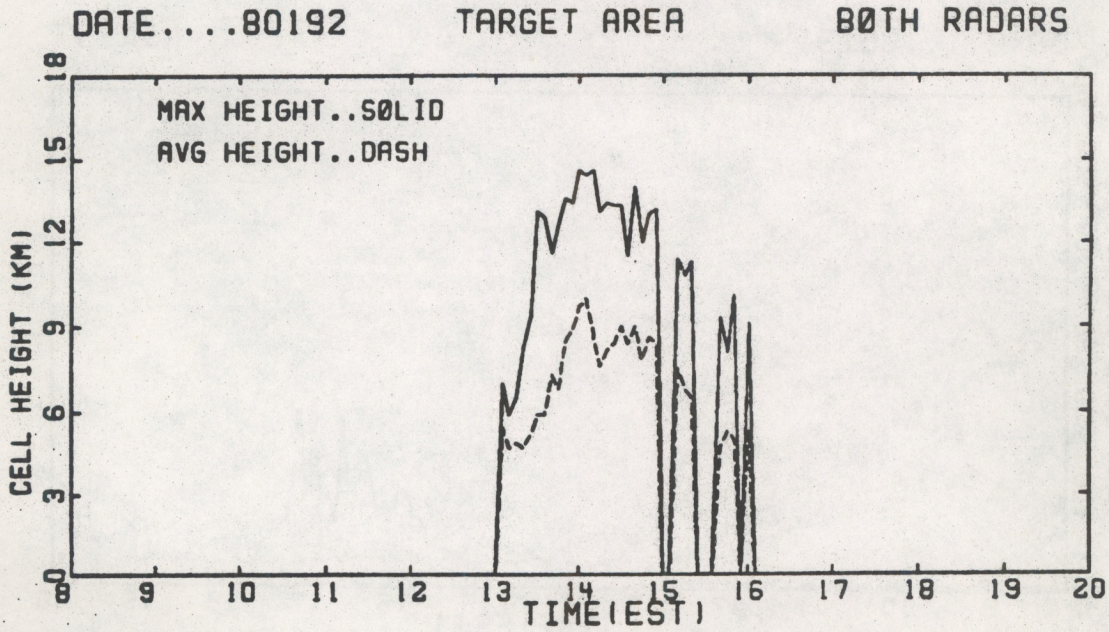

DATE....80191
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
8
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11
12
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15
16
17
18
19
20
TIME(EST)

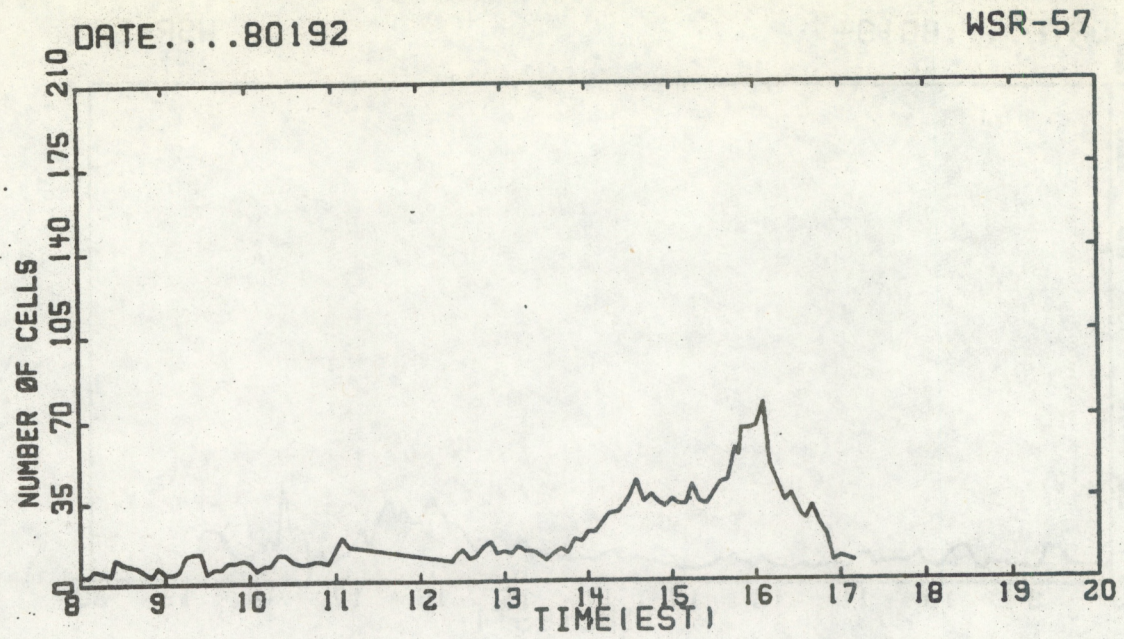

DATE....80191
WSR-57
NUMBER ØF ECHØES
0
15
30
45
60
75
90
8
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11
12
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15
16
17
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19
20
TIME(EST)

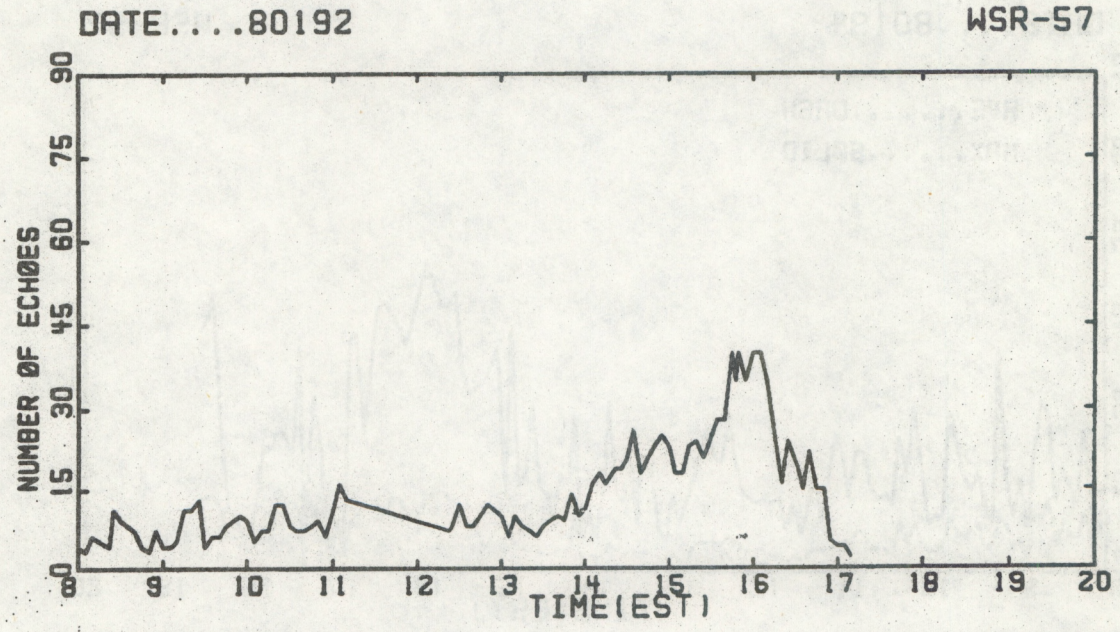

DATE....80191
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
9
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11
12
13
14
15
16
17
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19
20
TIME(EST)

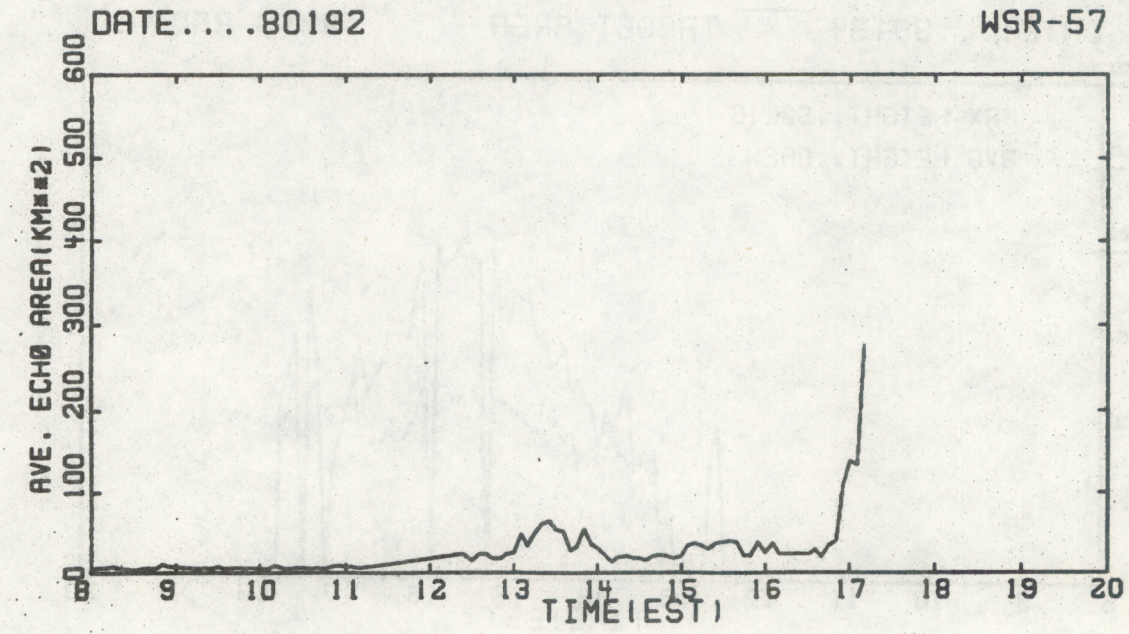

DATE....80192
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

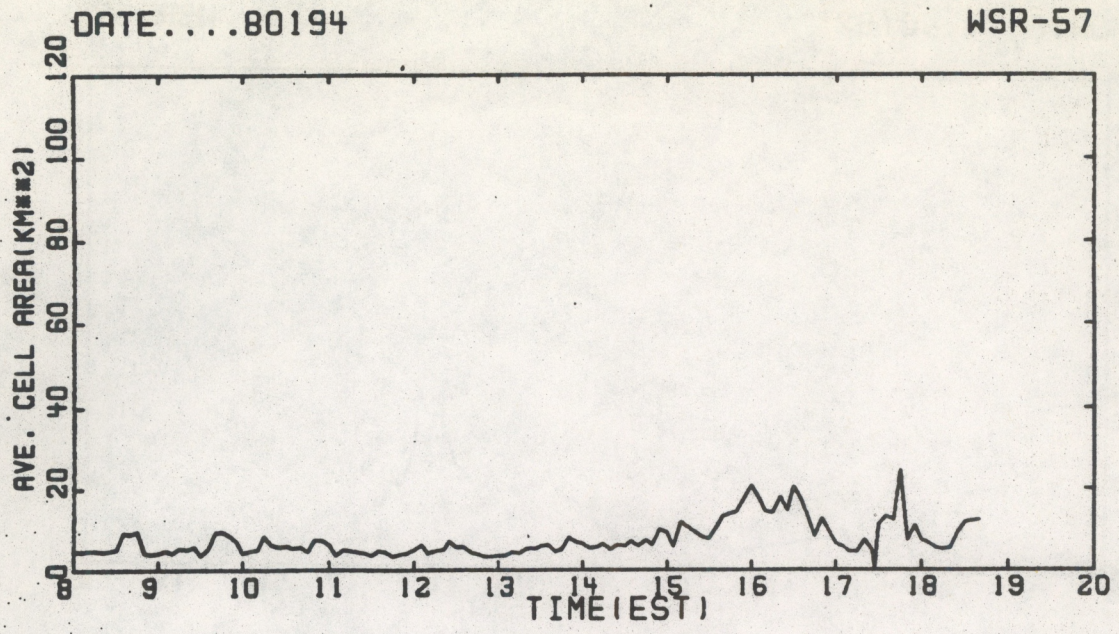

DATE....80192
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
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11
12
13
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15
16
17
18
19
20
TIME(EST)

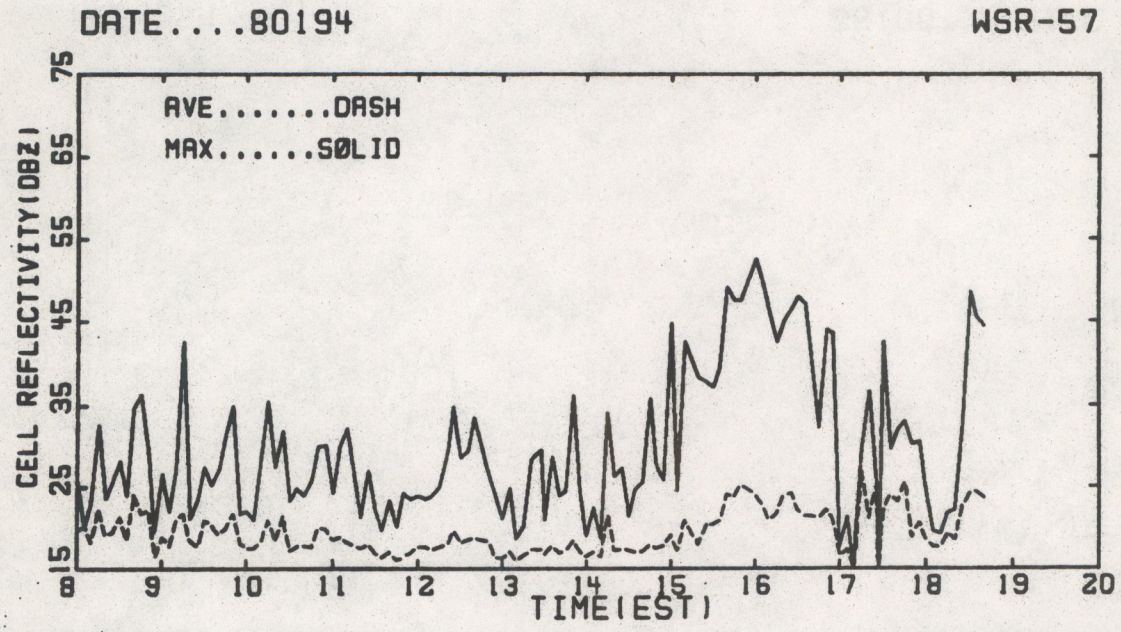

DATE....80192
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

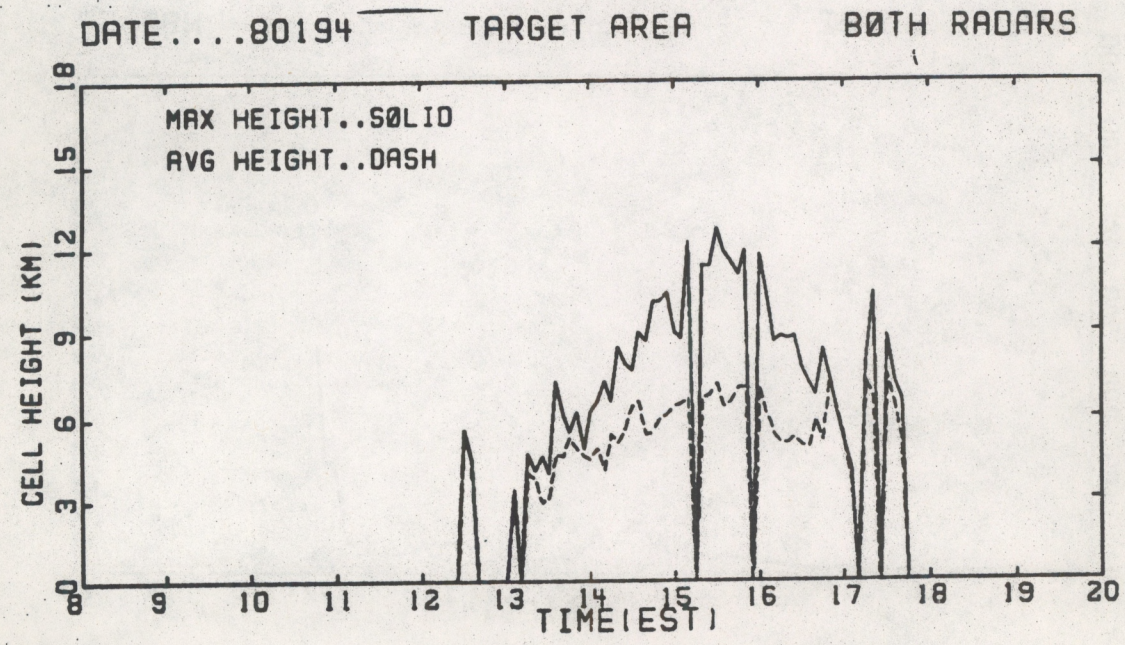

DATE....80192
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
8
9
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11
12
13
14
15
16
17
18
19
20
TIME(EST)

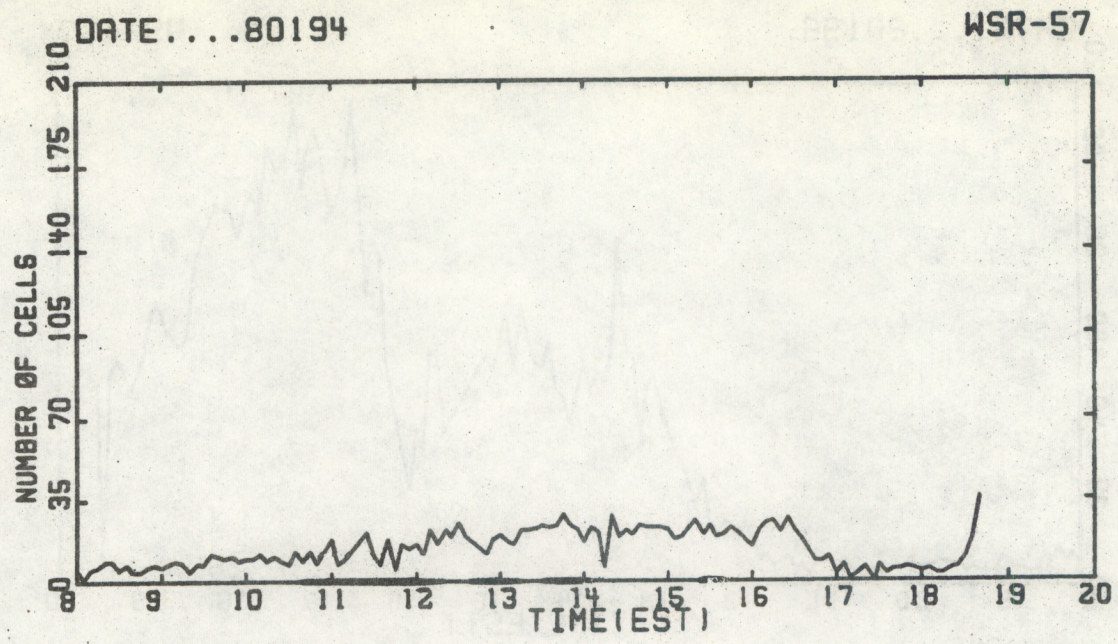

DATE....80192
WSR-57
NUMBER ØF ECHØES
0
15
30
45
60
75
90
8
9
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11
12
13
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15
16
17
18
19
20
TIME(EST)

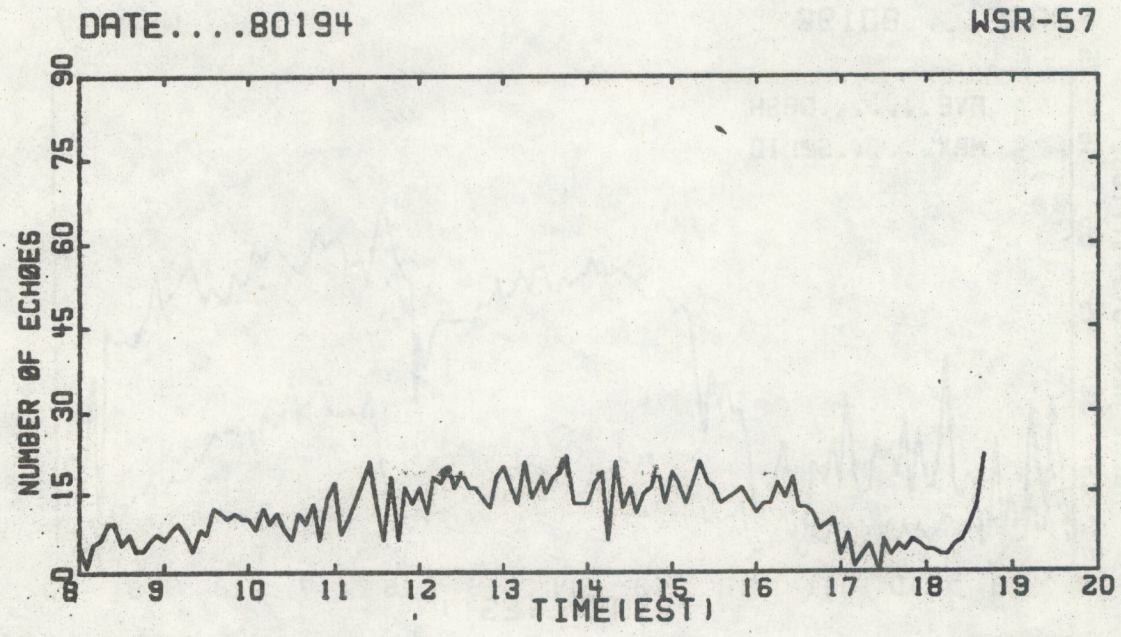

DATE....80192
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
9
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11
12
13
14
15
16
17
18
19
20
TIME(EST)

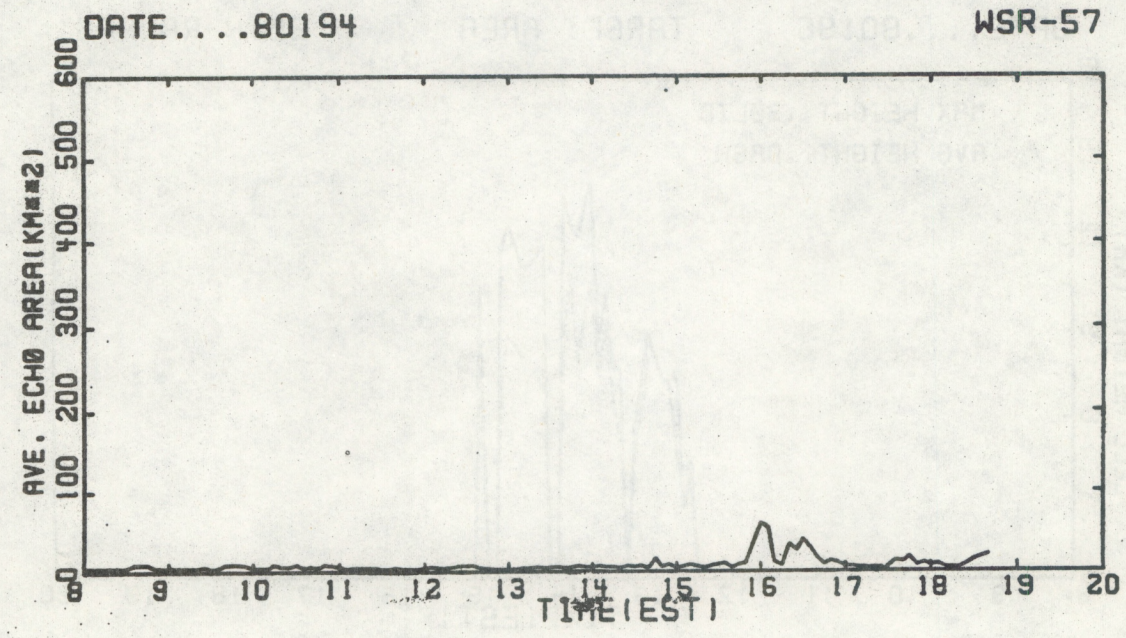

DATE....80194
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

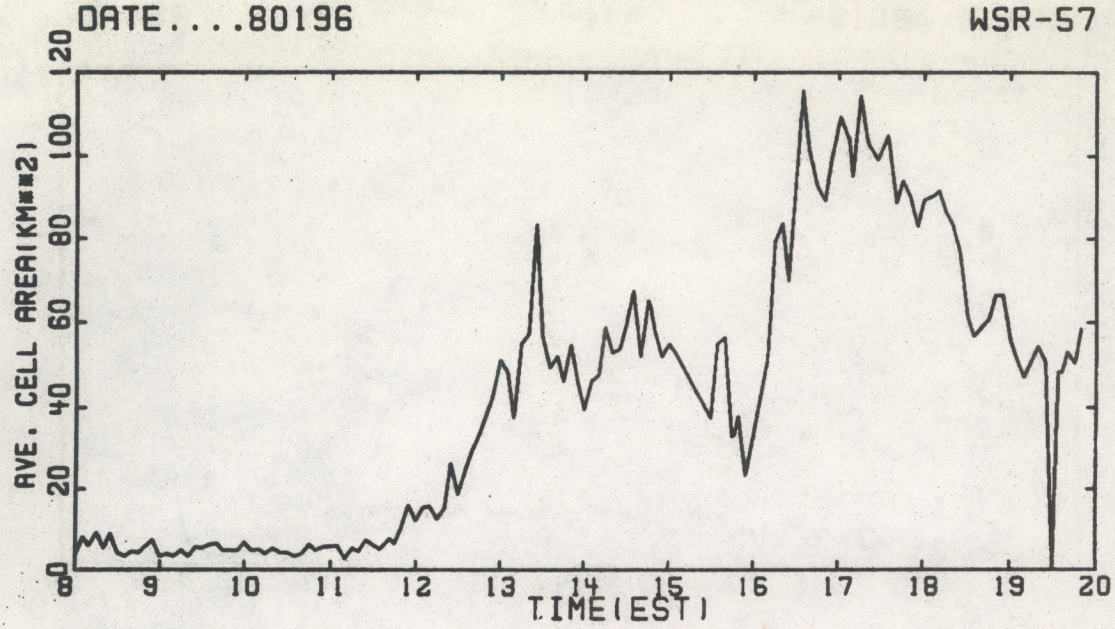

DATE....80194
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

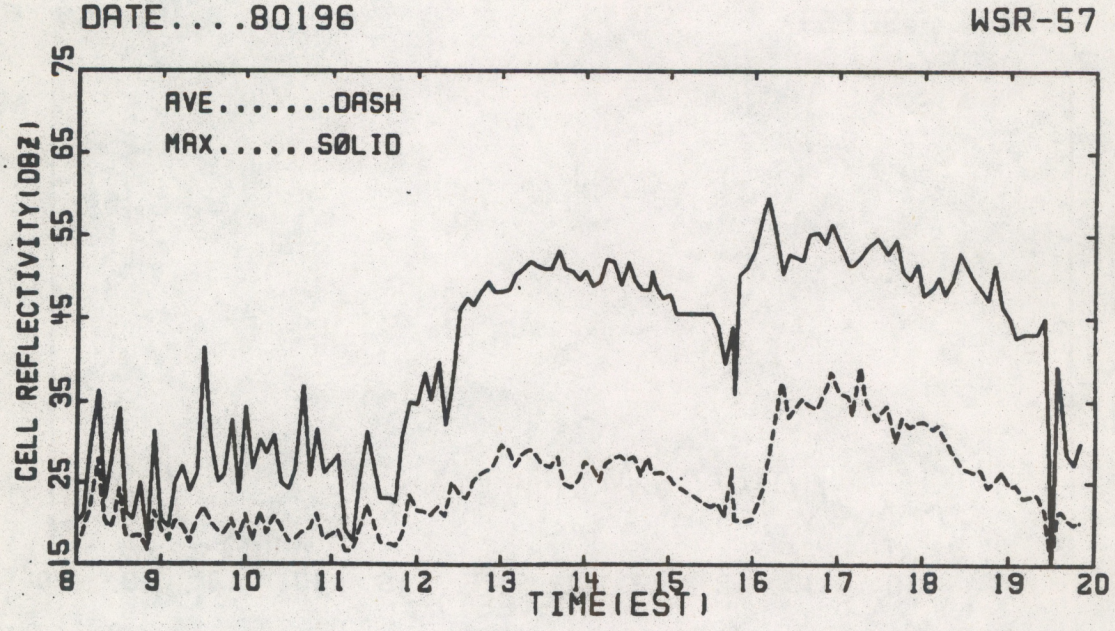

DATE....80194
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

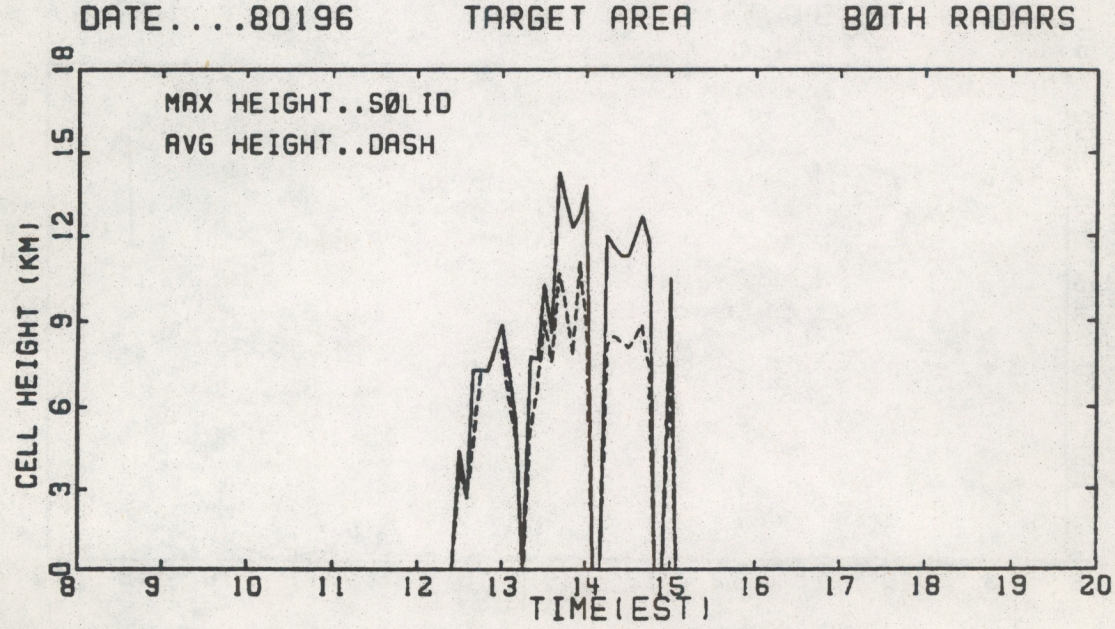

DATE....80194
WSR-57
NUMBER OF CELLS
0
35
70
105
140
175
210
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

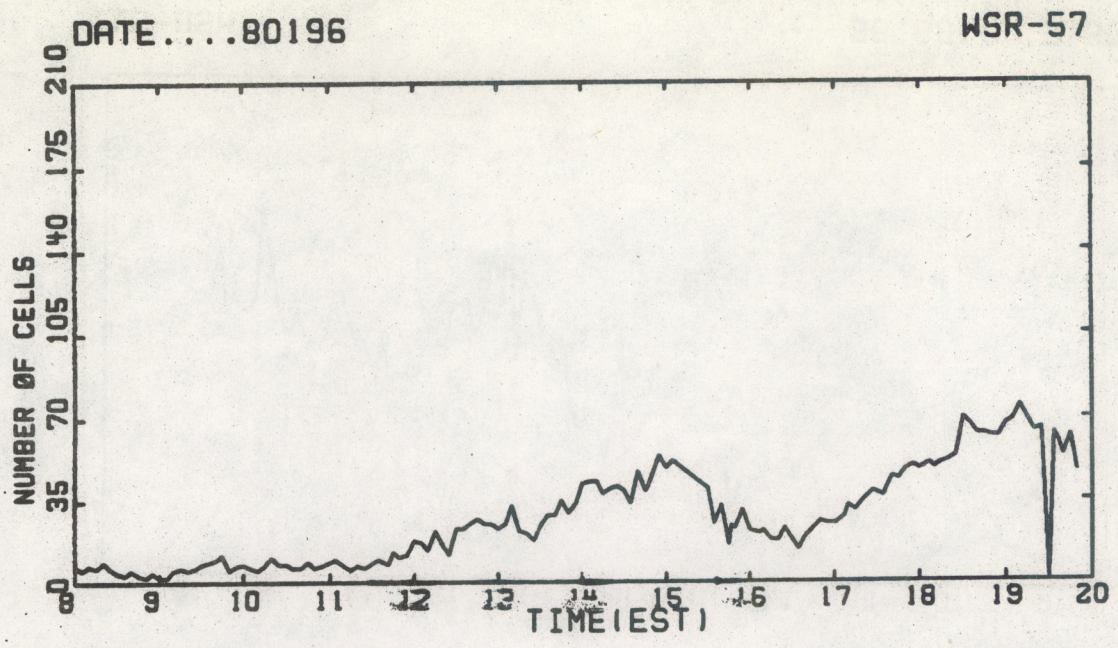

DATE....80194
WSR-57
NUMBER OF ECHOES
0
15
30
45
60
75
90
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

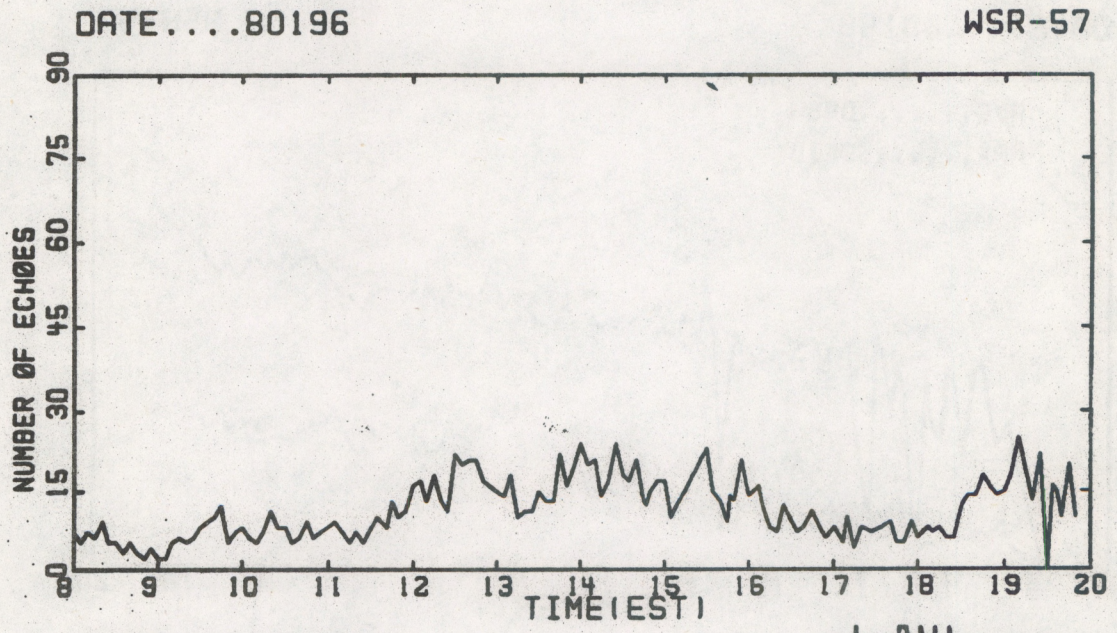

DATE....80194
WSR-57
AVE. ECHO AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

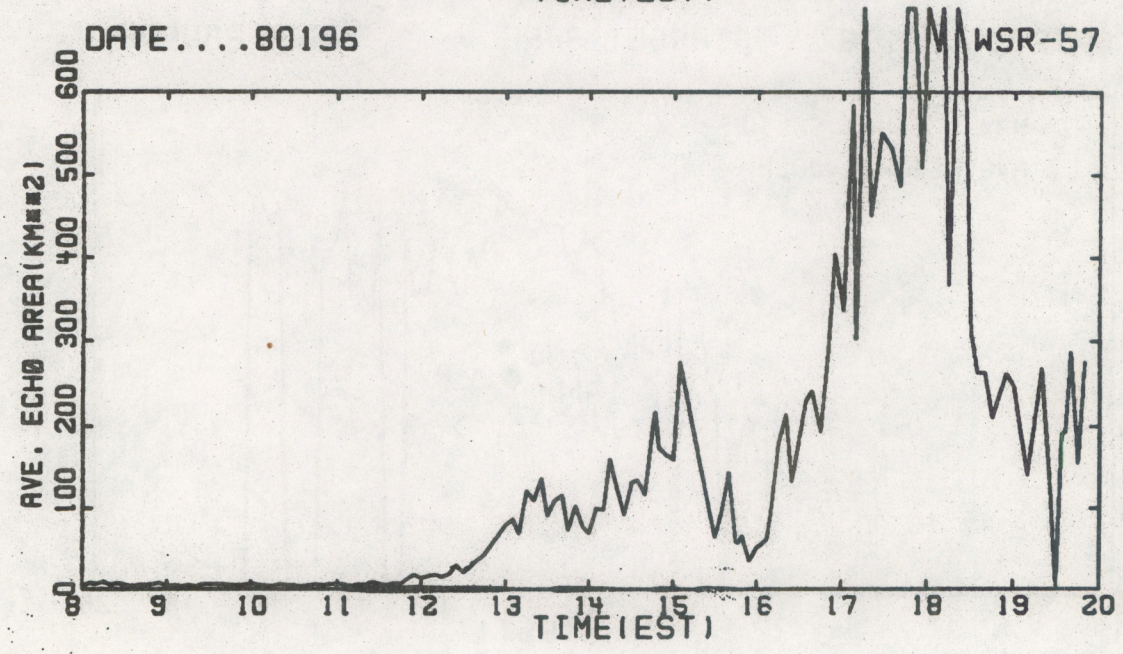

DATE....80196
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

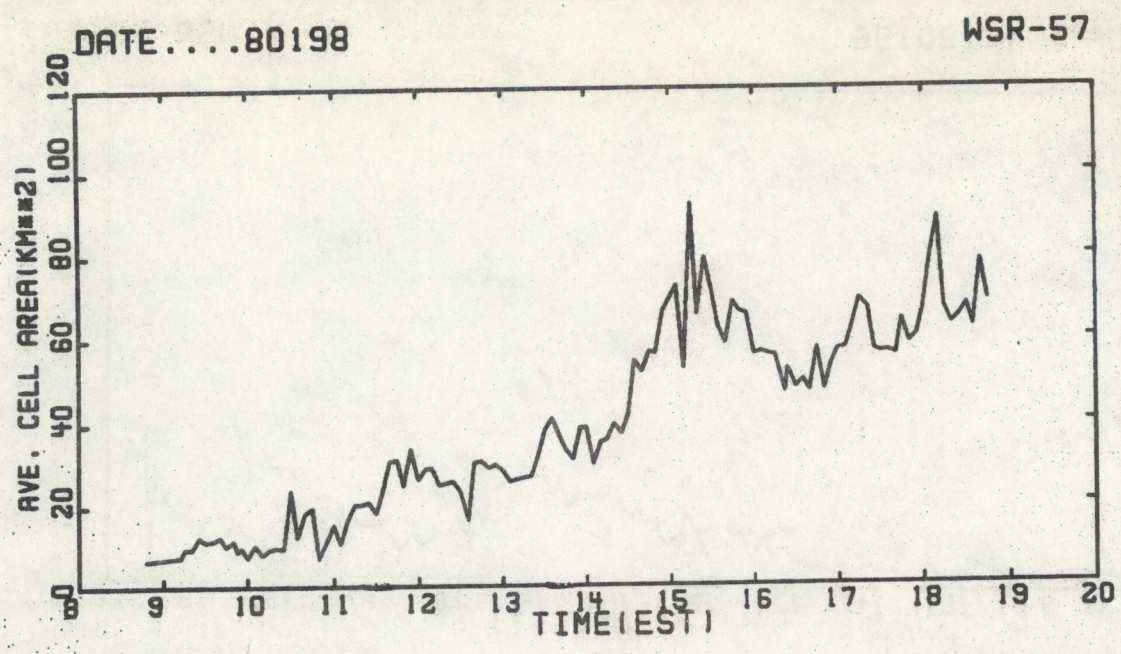

DATE....80196
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
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11
12
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15
16
17
18
19
20
TIME(EST)

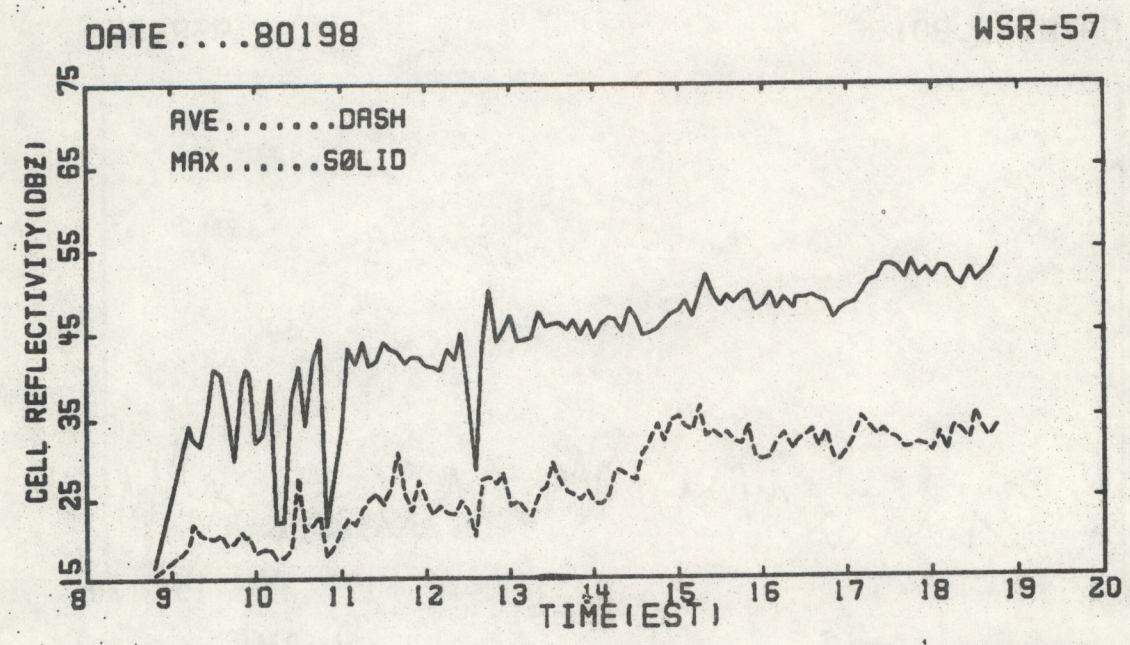

DATE....80196
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
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11
12
13
14
15
16
17
18
19
20
TIME(EST)

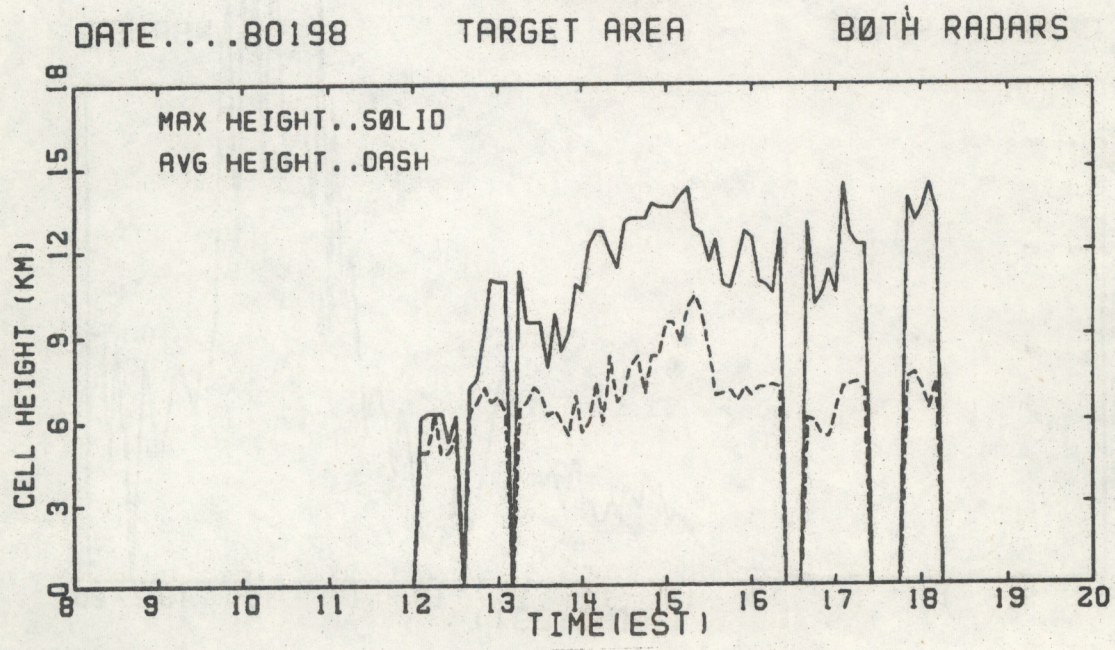

DATE....80196
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
8
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11
12
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15
16
17
18
19
20
TIME(EST)

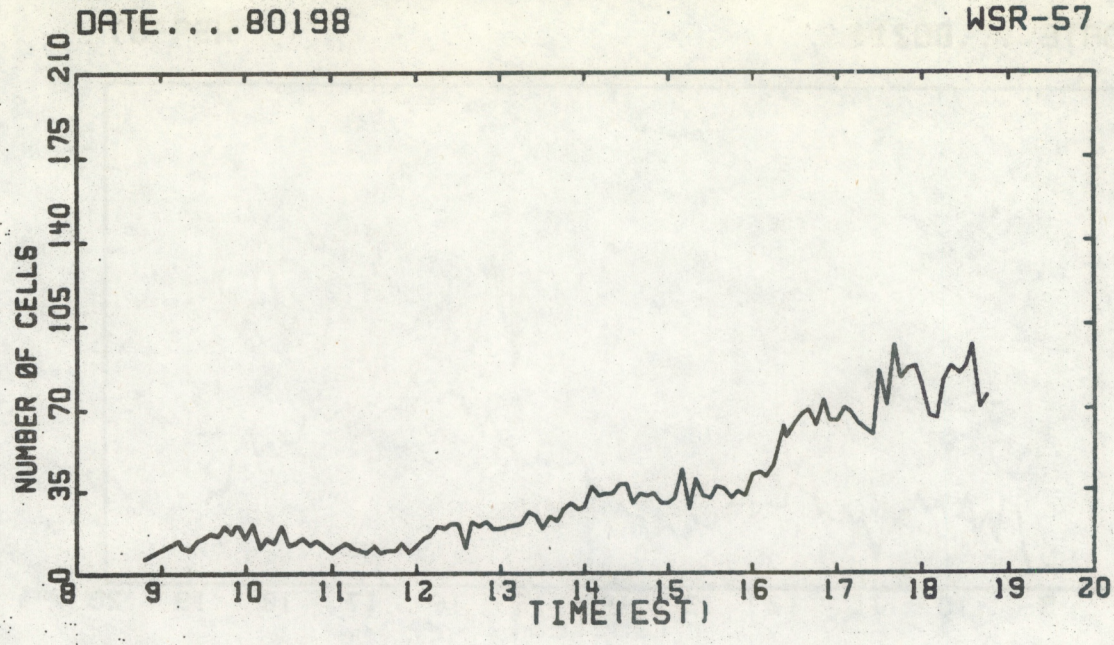

DATE....80196
WSR-57
NUMBER ØF ECHØES
0
15
30
45
60
75
90
8
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11
12
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18
19
20
TIME(EST)

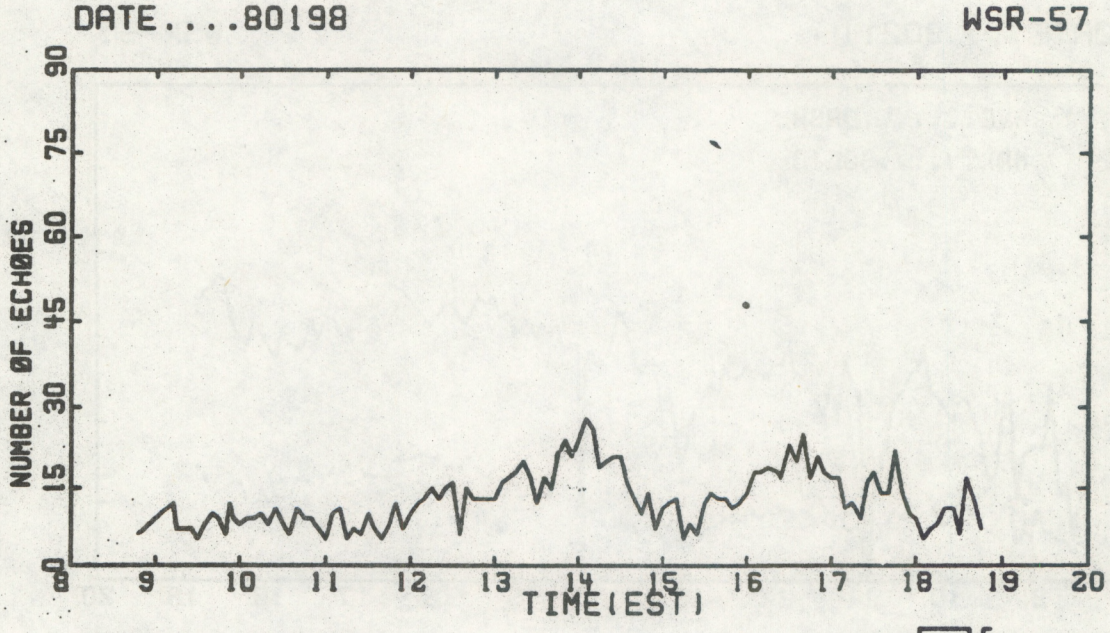

DATE....80196
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
9
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11
12
13
14
15
16
17
18
19
20
TIME(EST)

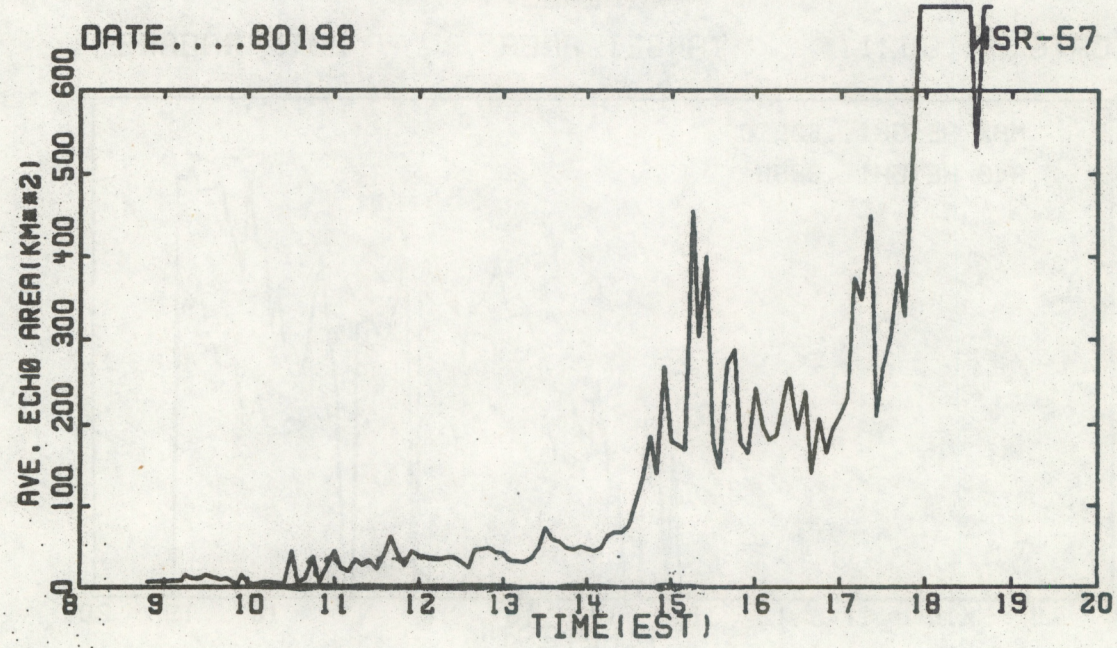

DATE....80198
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

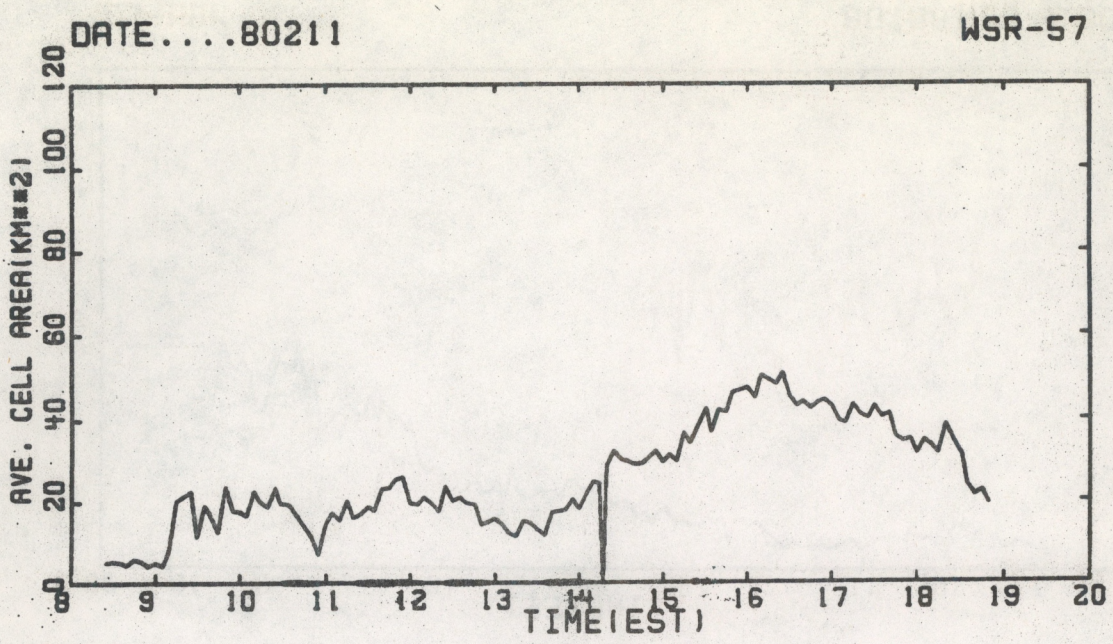

DATE....80198
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
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11
12
13
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15
16
17
18
19
20
TIME(EST)

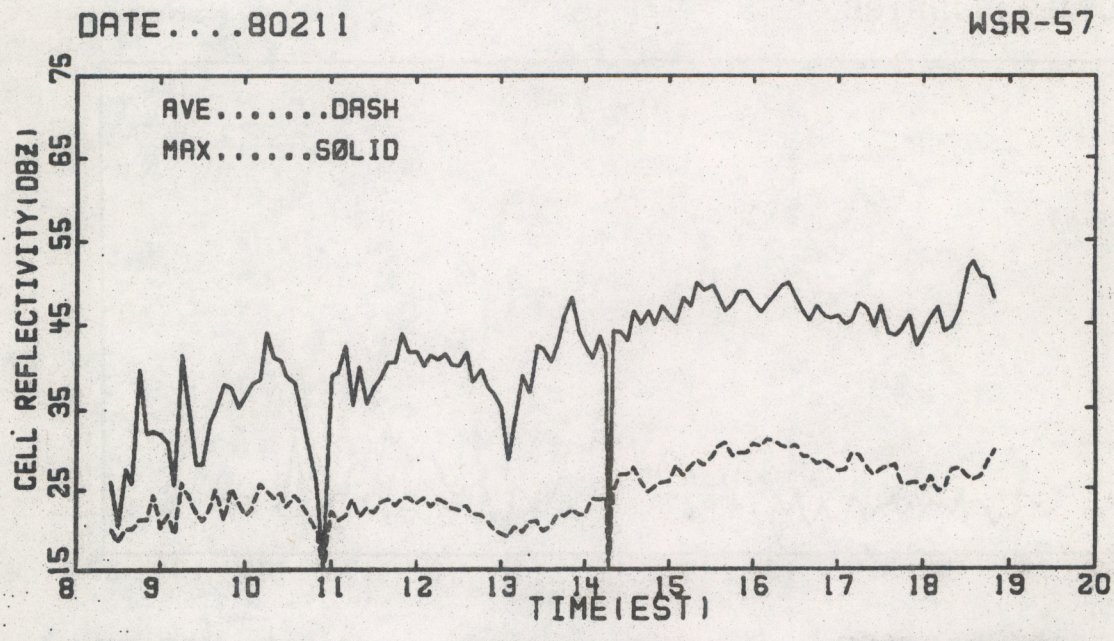

DATE....80198
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
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11
12
13
14
15
16
17
18
19
20
TIME(EST)

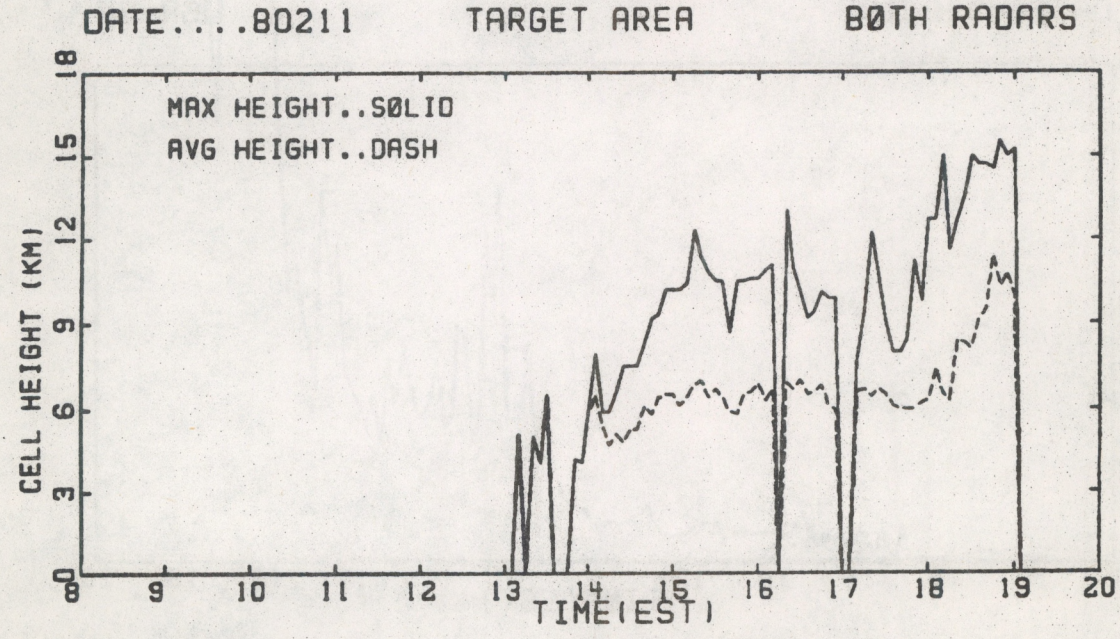

DATE....80198
WSR-57
NUMBER OF CELLS
0
35
70
105
140
175
210
8
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18
19
20
TIME(EST)

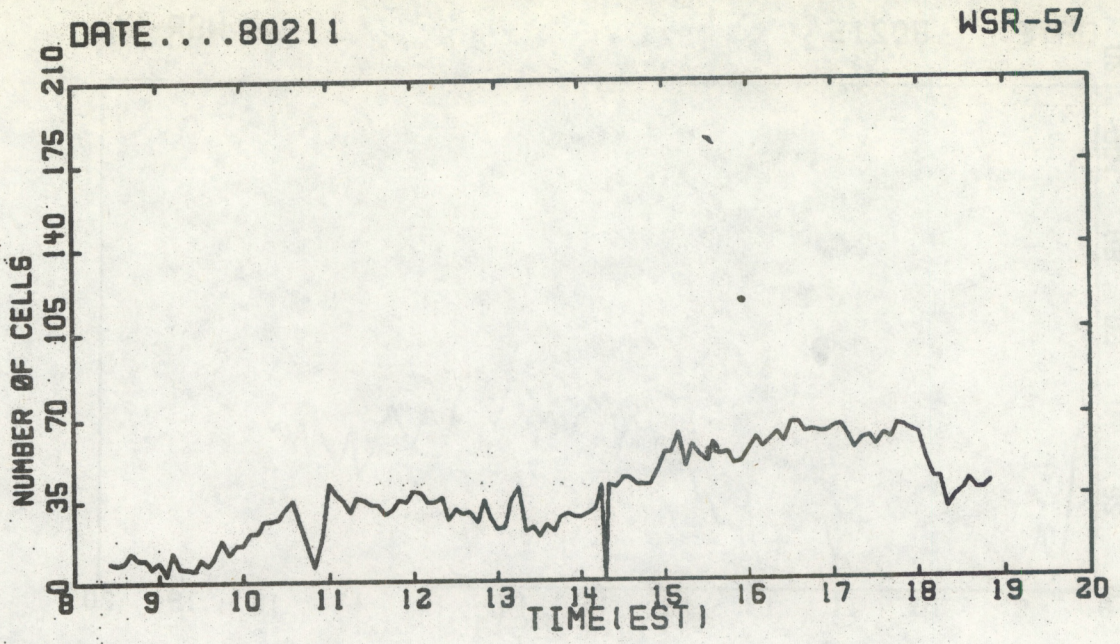

DATE....80198
WSR-57
NUMBER OF ECHOES
0
15
30
45
60
75
90
8
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18
19
20
TIME(EST)

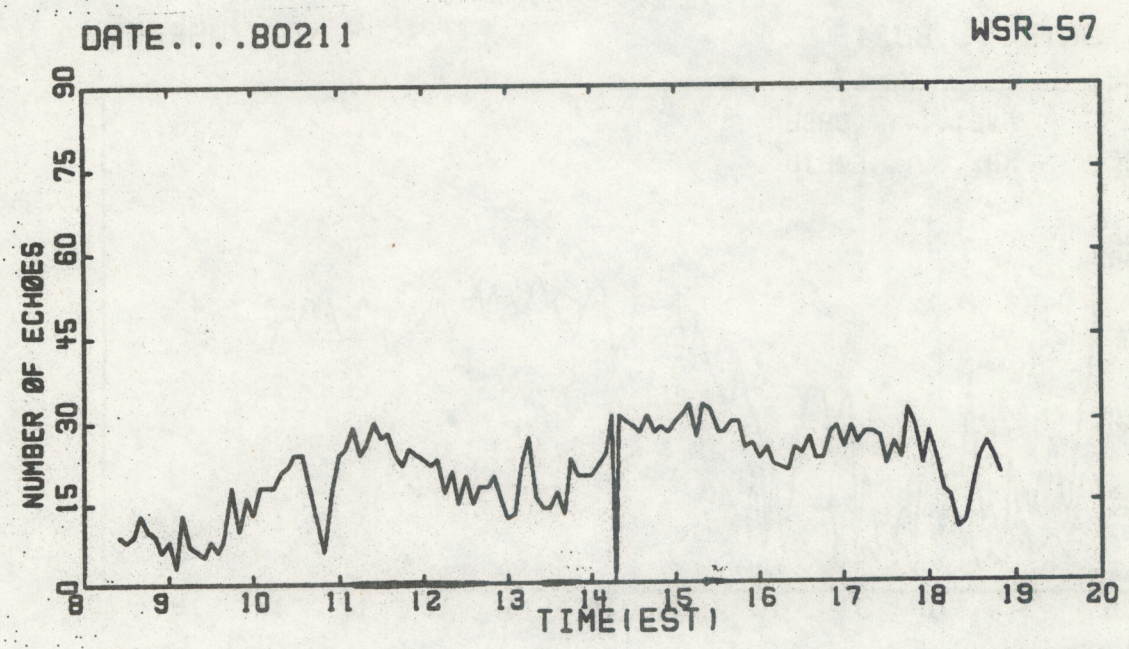

DATE....80198
WSR-57
AVE. ECHO AREA(KM**2)
0
100
200
300
400
500
600
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19
20
TIME(EST)

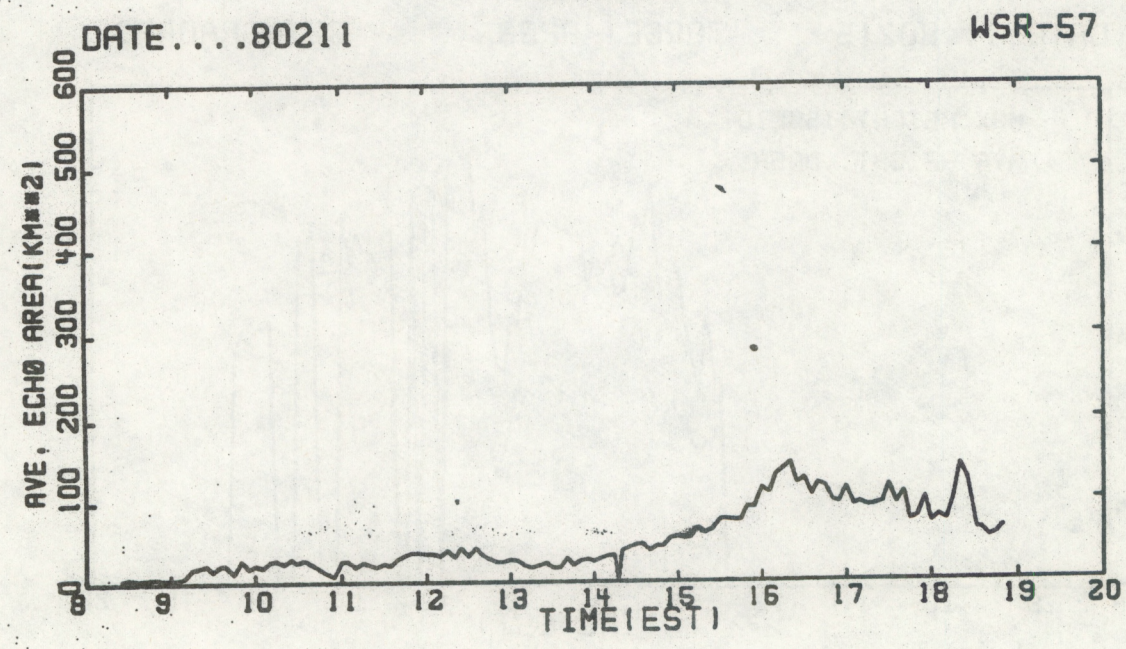

DATE....80211
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

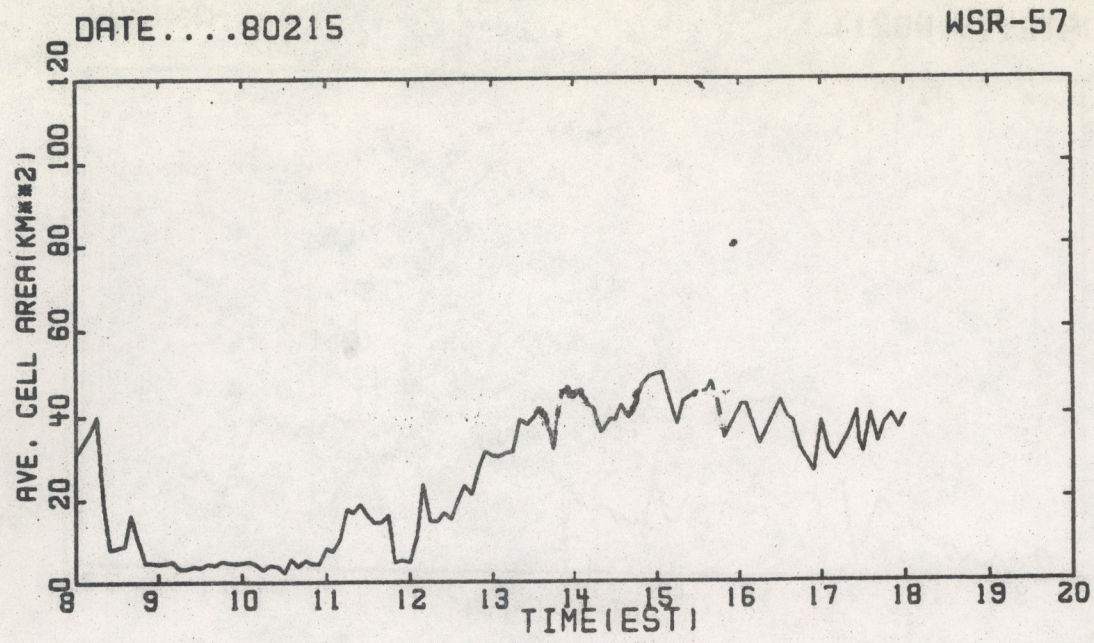

DATE....80211
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
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11
12
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15
16
17
18
19
20
TIME(EST)

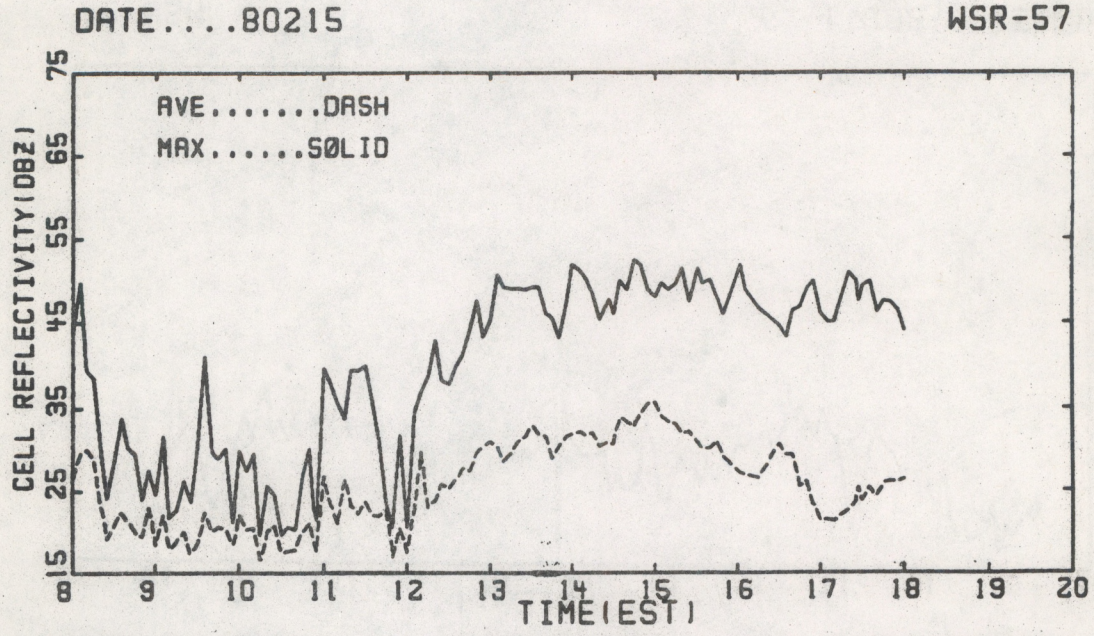

DATE....80211
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
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18
8
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12
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16
17
18
19
20
TIME(EST)

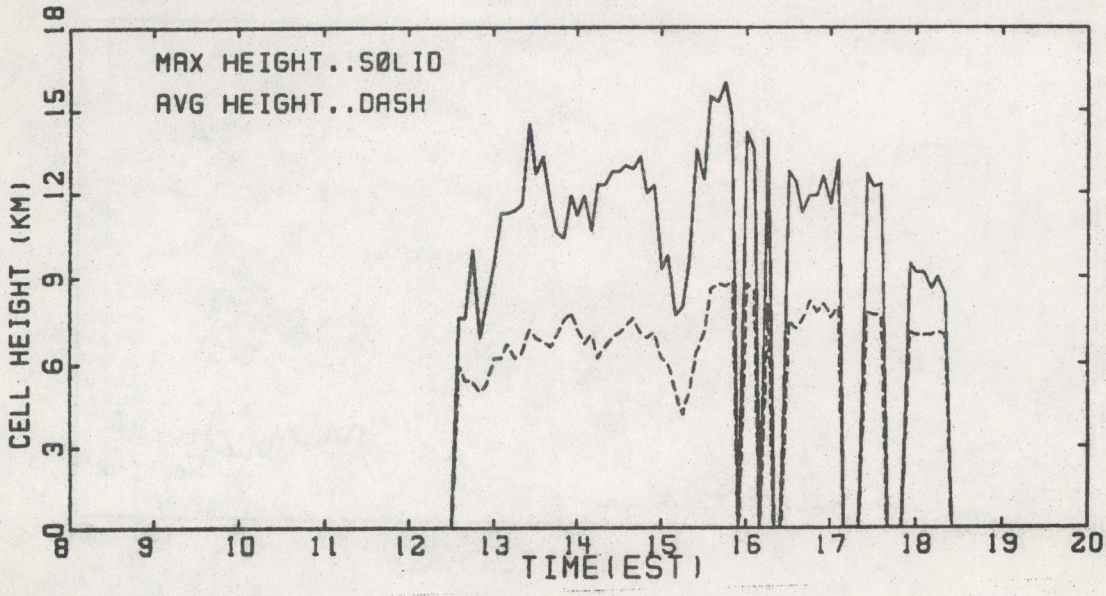

DATE....80211
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
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17
18
19
20
TIME(EST)

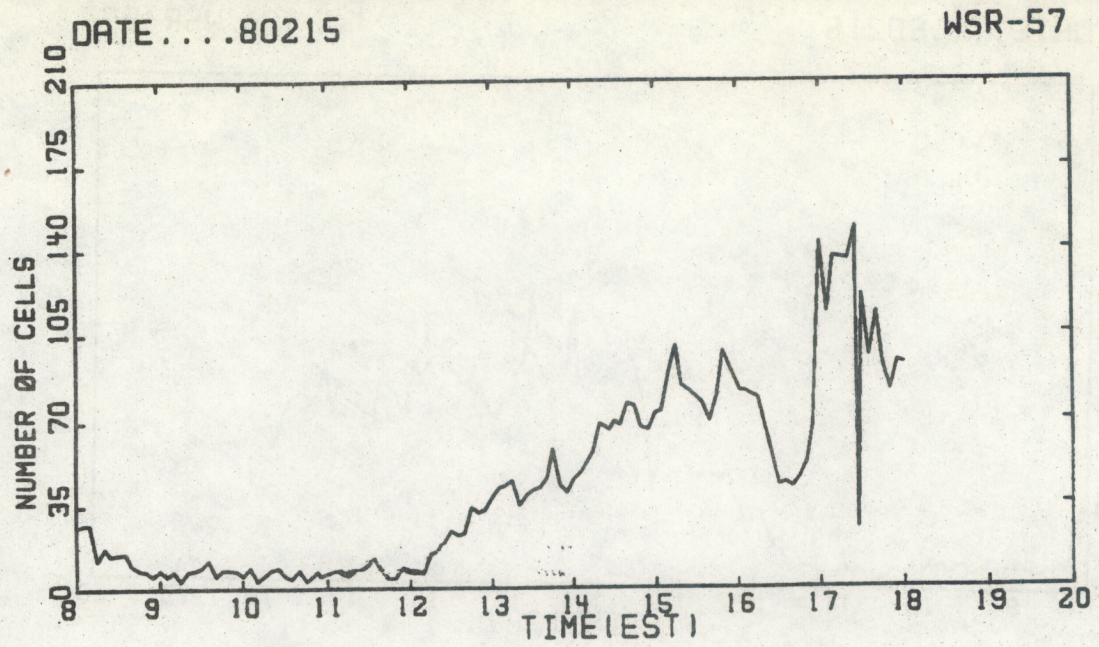

DATE....80211
WSR-57
NUMBER ØF ECHØES
0
15
30
45
60
75
90
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

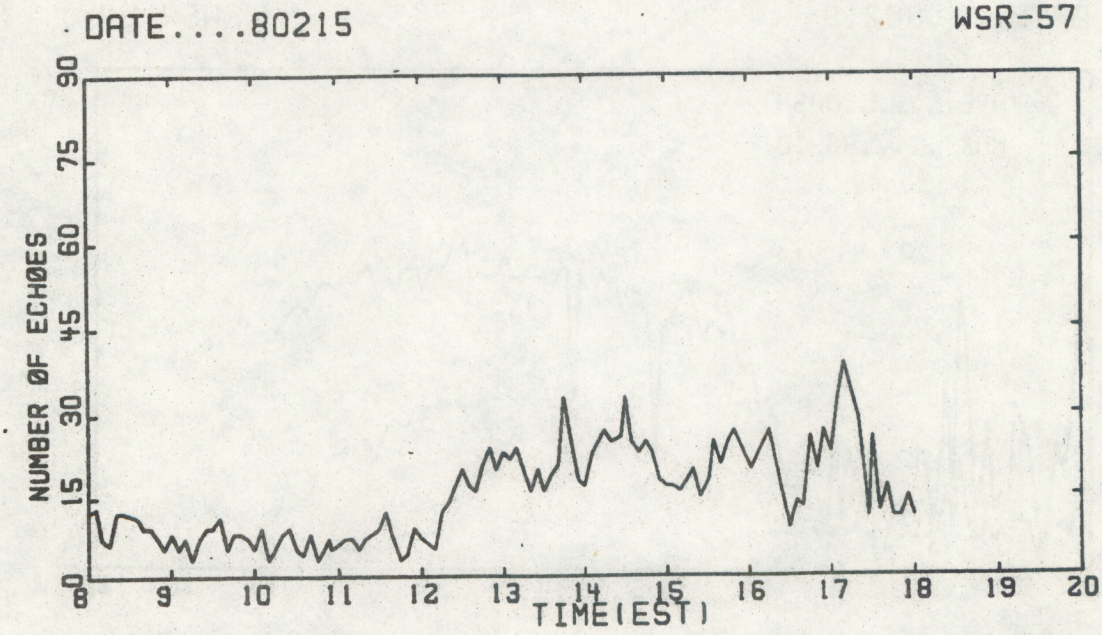

DATE....80211
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

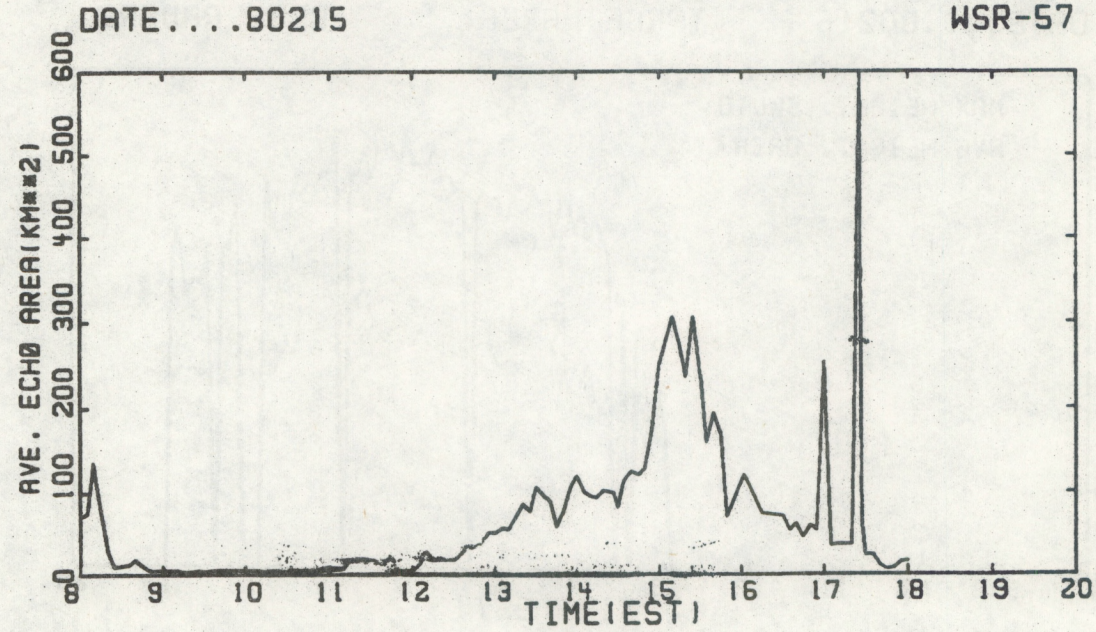

DATE....80215
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

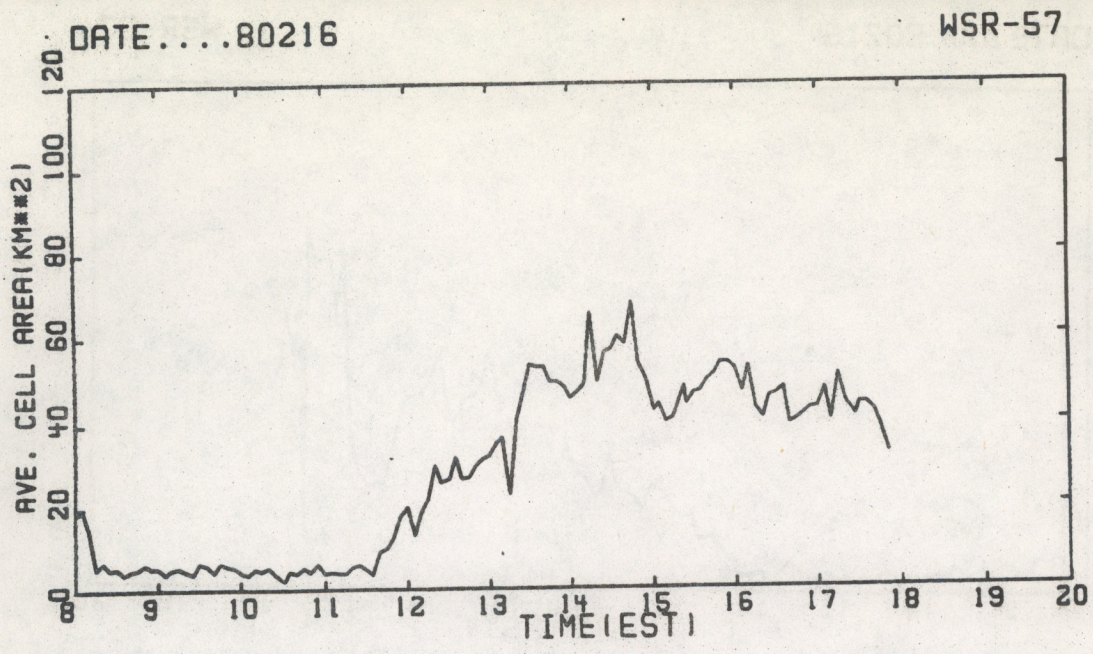

DATE....80215
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
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11
12
13
14
15
16
17
18
19
20
TIME(EST)

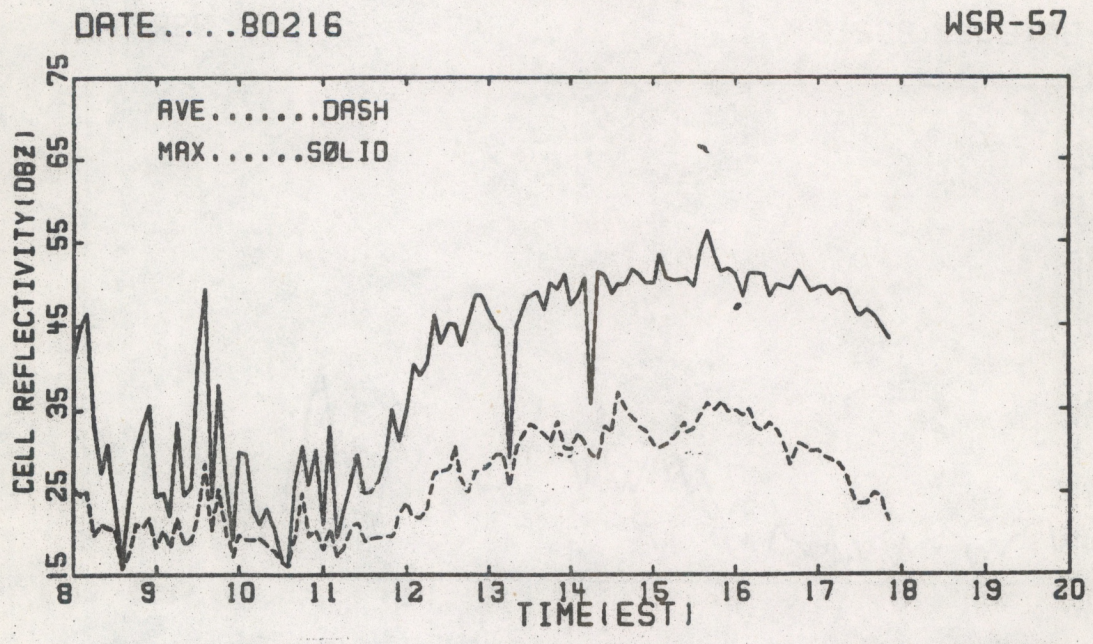

DATE....80215
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

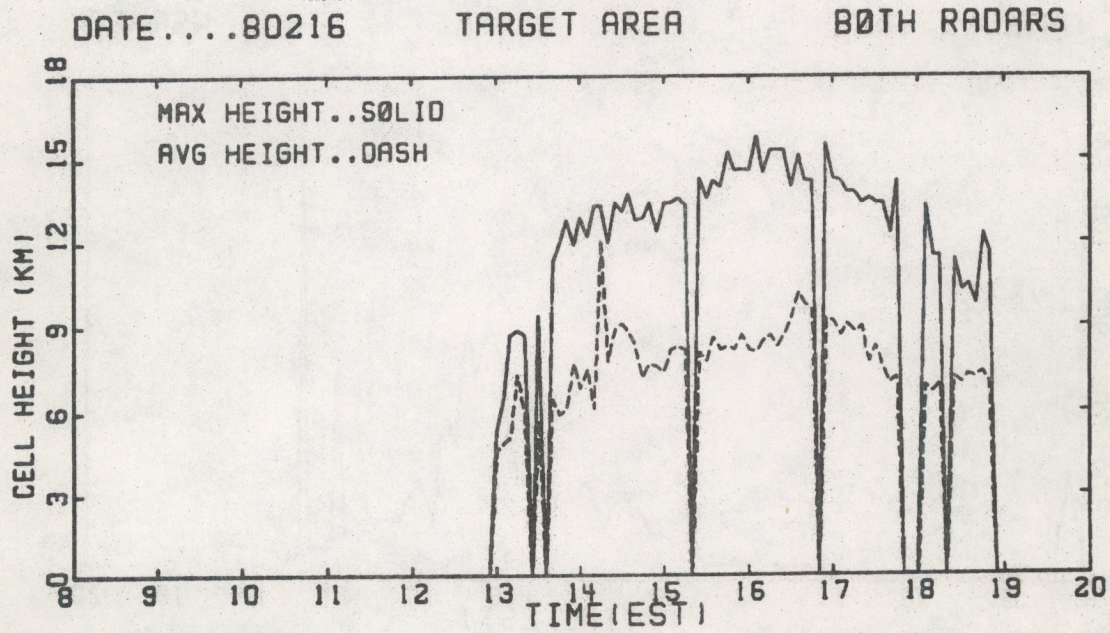

DATE....80215
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
8
9
10
11
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15
16
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18
19
20
TIME(EST)

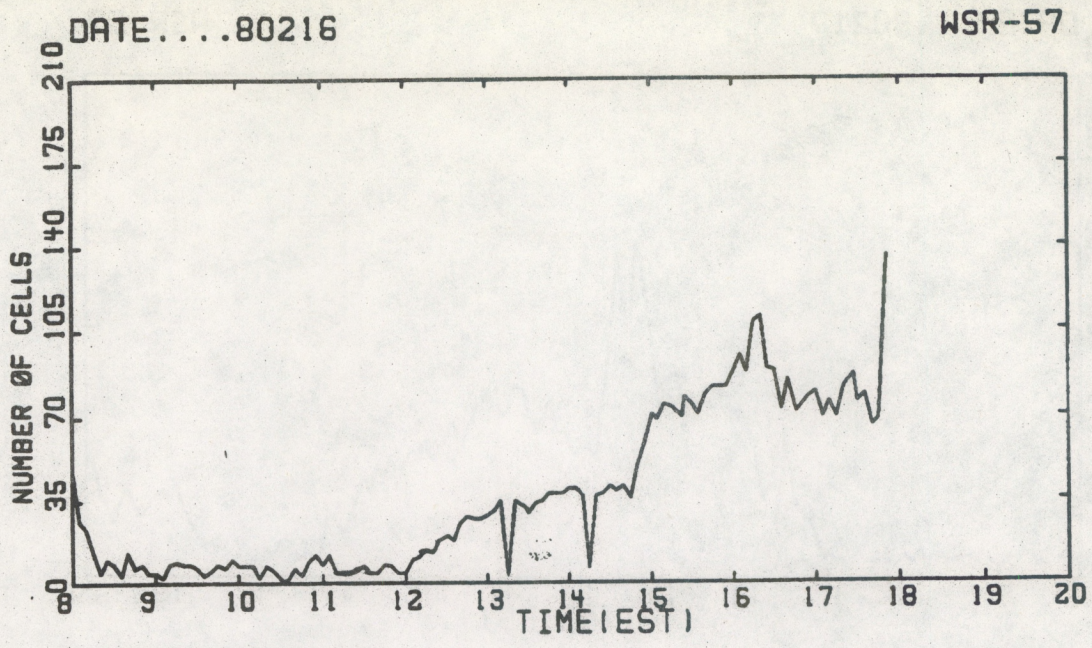

DATE....80215
WSR-57
NUMBER ØF ECHØES
0
15
30
45
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75
90
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TIME(EST)

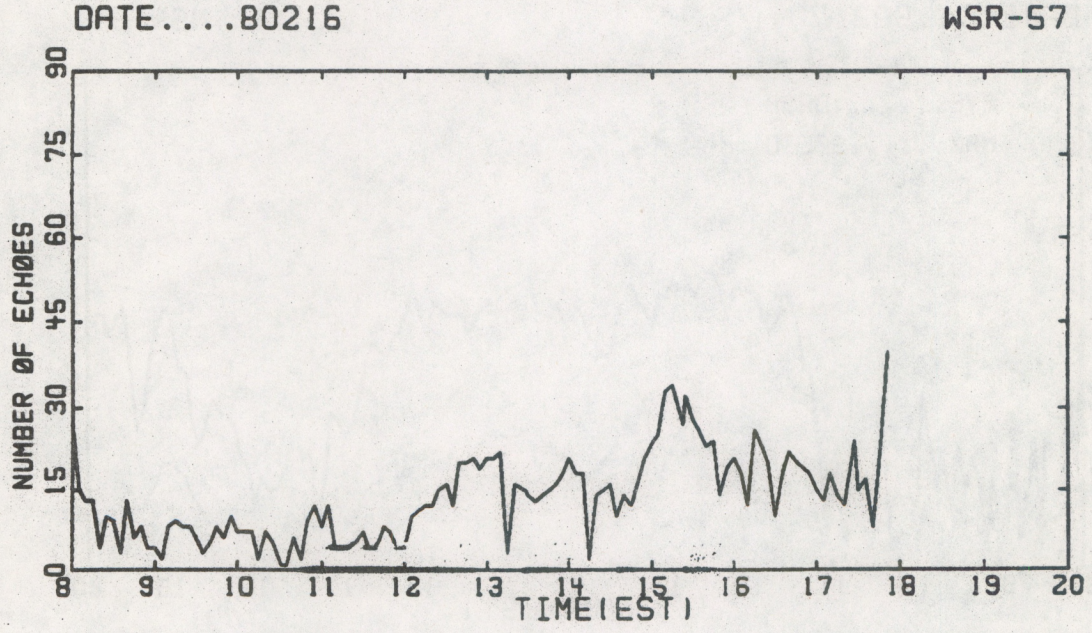

DATE....80215
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
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20
TIME(EST)

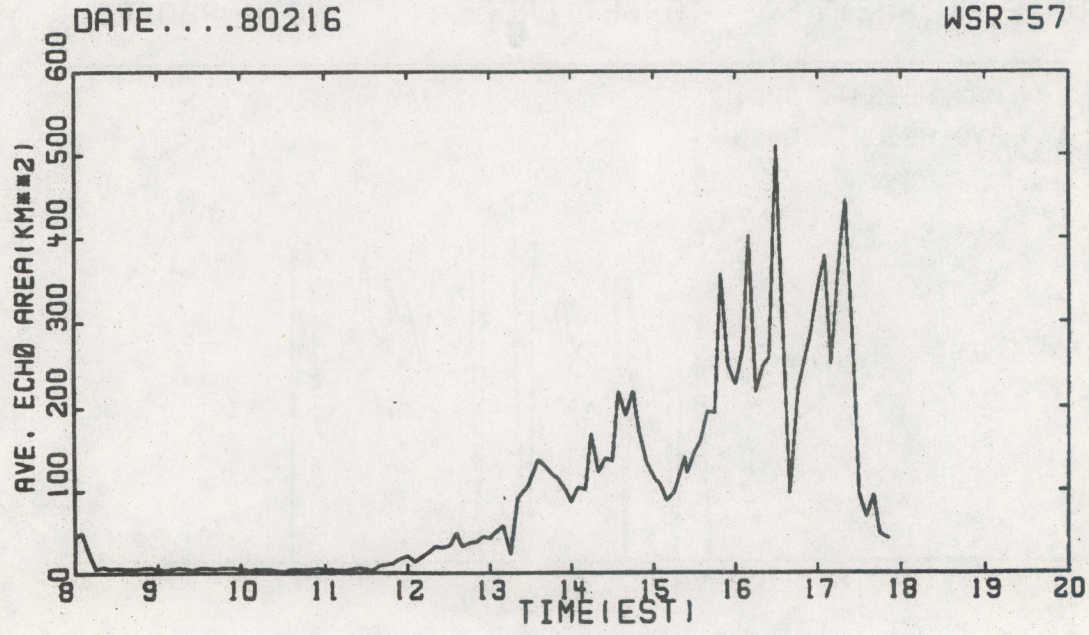

DATE....80216
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
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19
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TIME(EST)

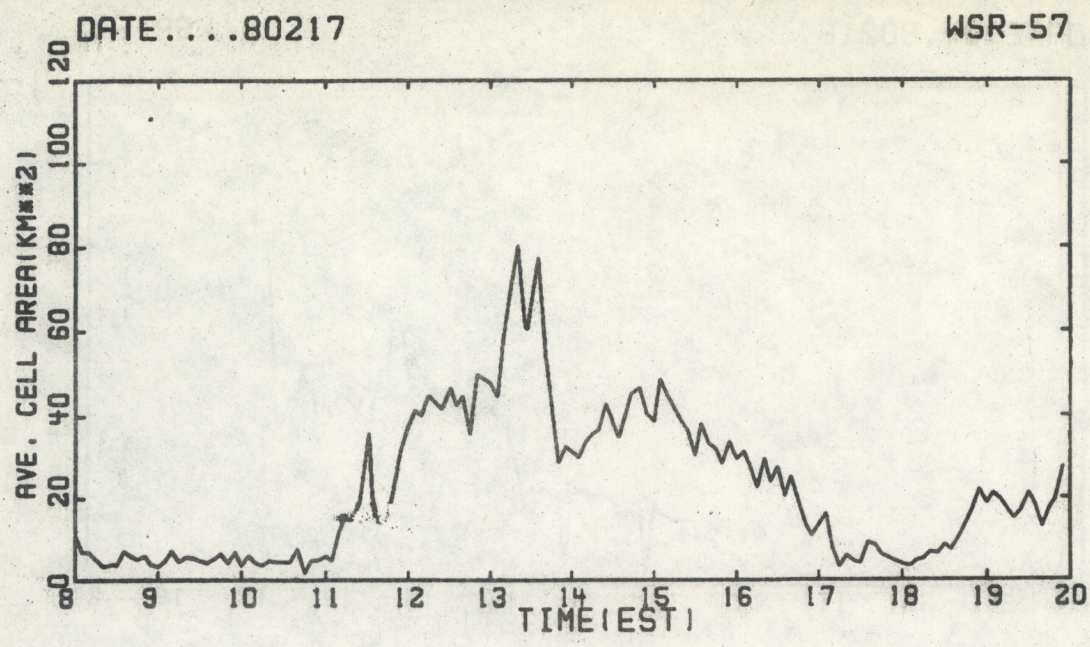

DATE....80216
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
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19
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TIME(EST)

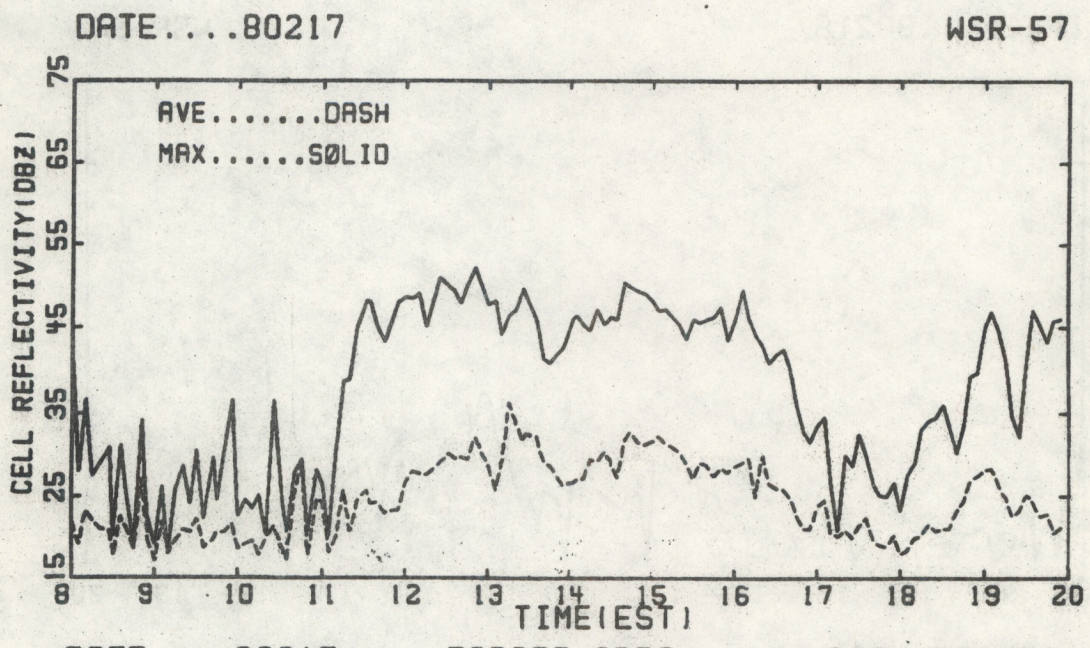

DATE....80216
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
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12
13
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16
17
18
19
20
TIME(EST)

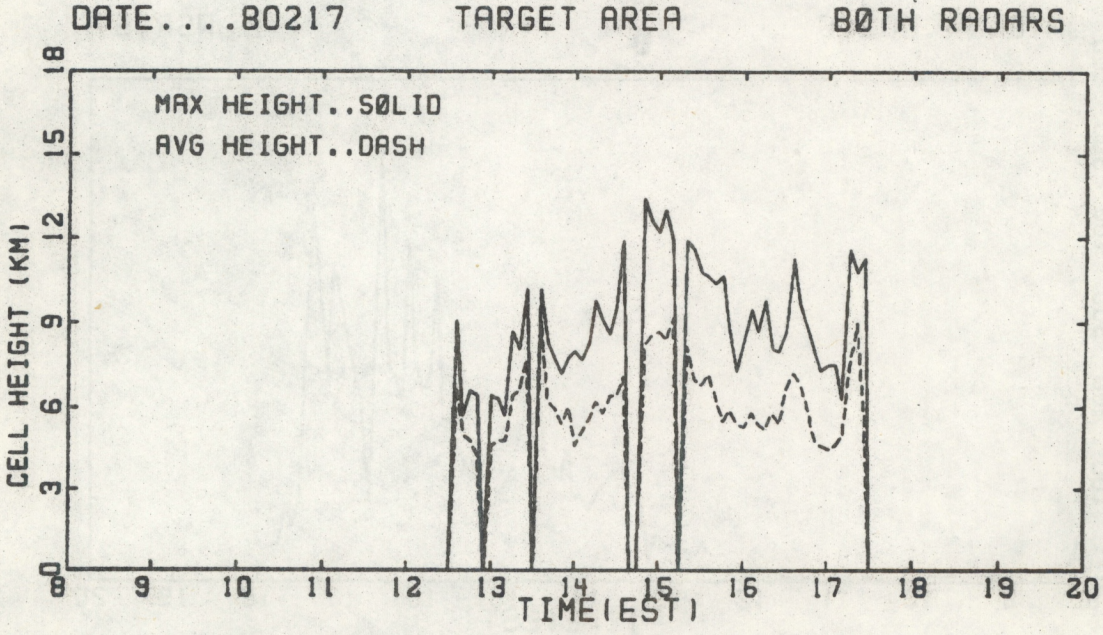

DATE....80216
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
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18
19
20
TIME(EST)

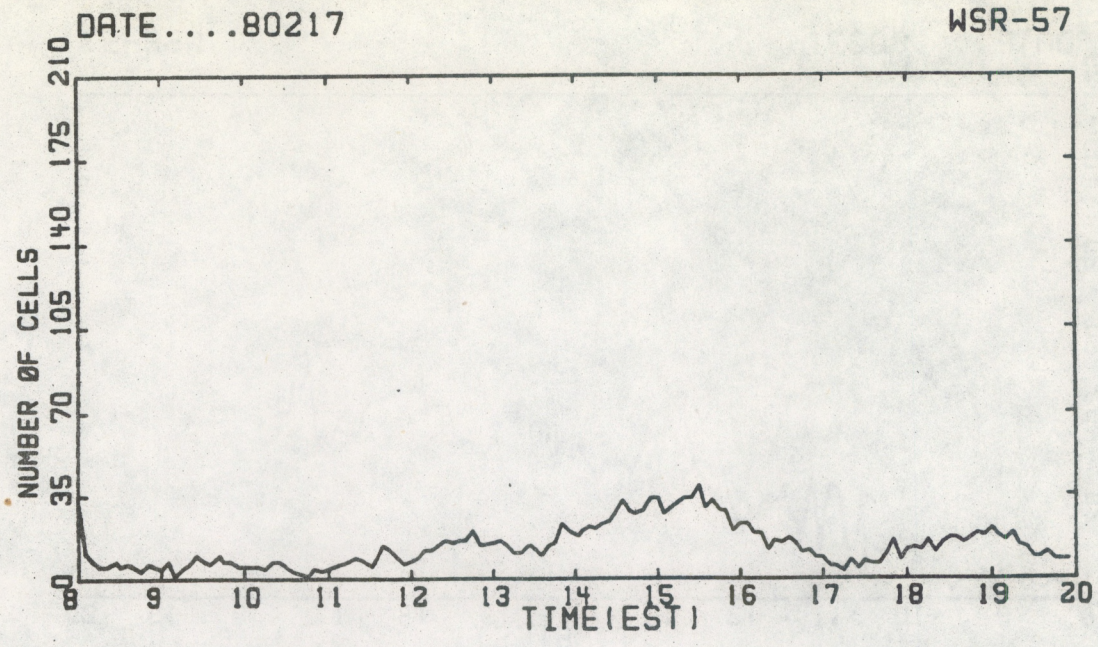

DATE....80216
WSR-57
NUMBER ØF ECHØES
0
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90
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TIME(EST)

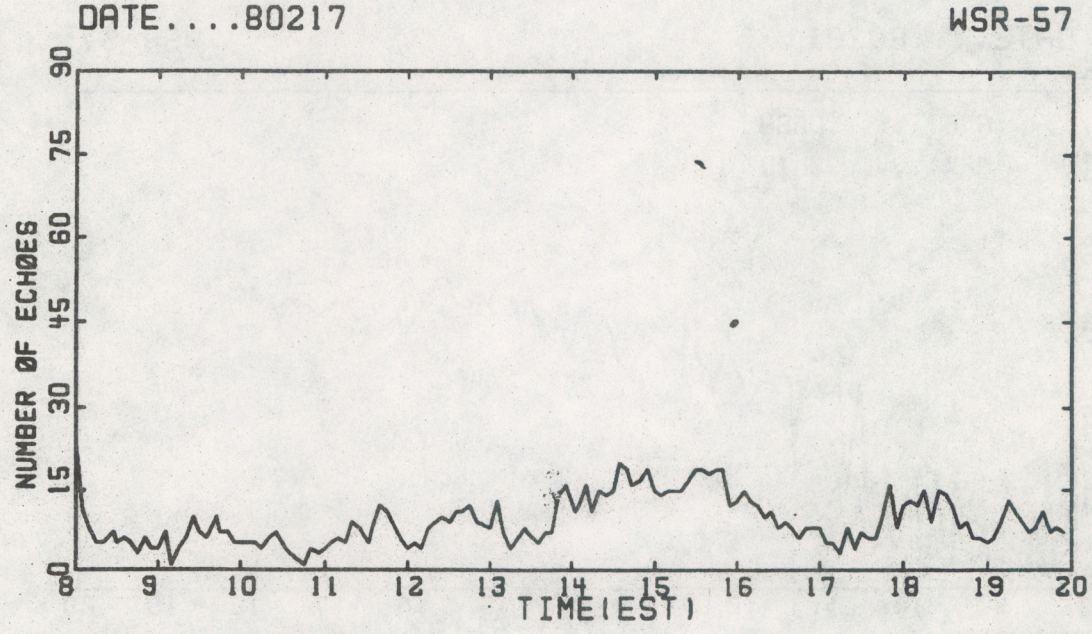

DATE....80216
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
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11
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13
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19
20
TIME(EST)

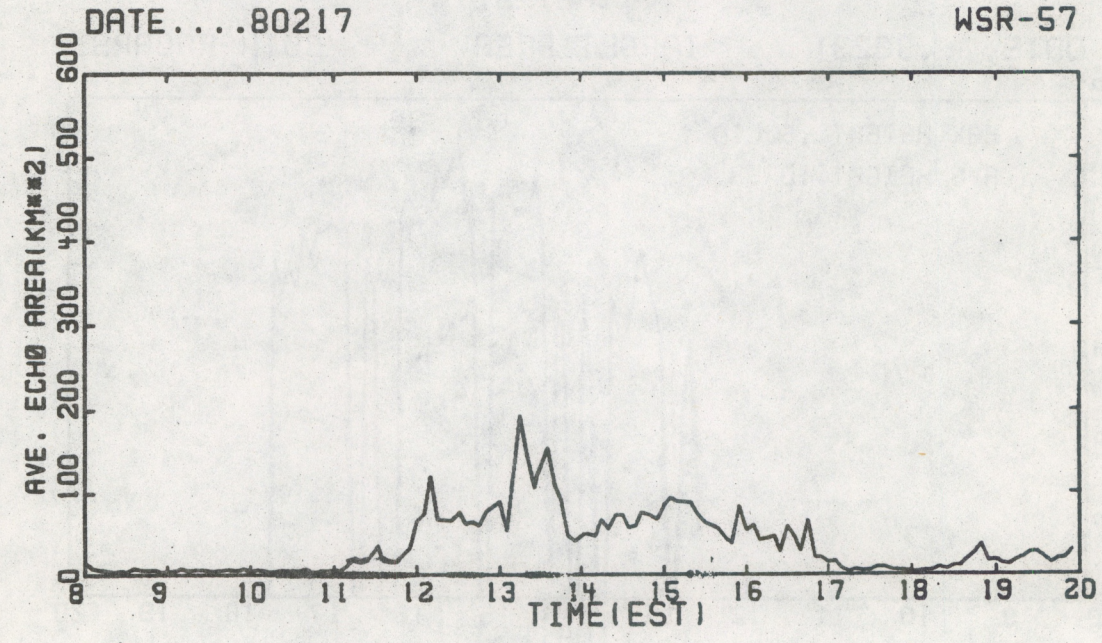

DATE....80217
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
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TIME(EST)

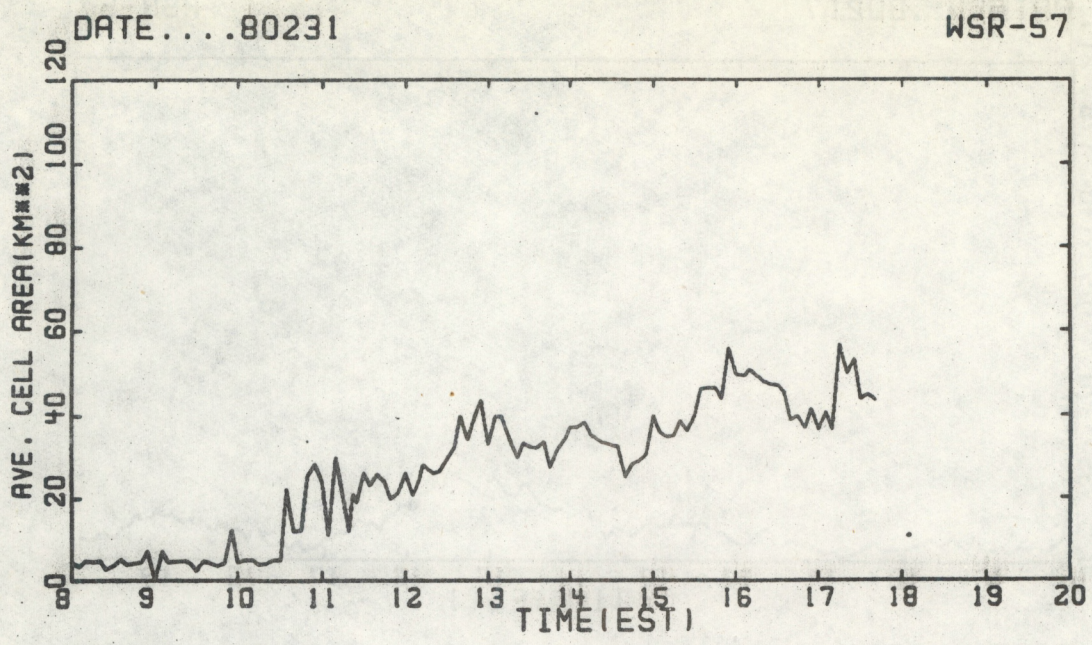

DATE....80217
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
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19
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TIME(EST)

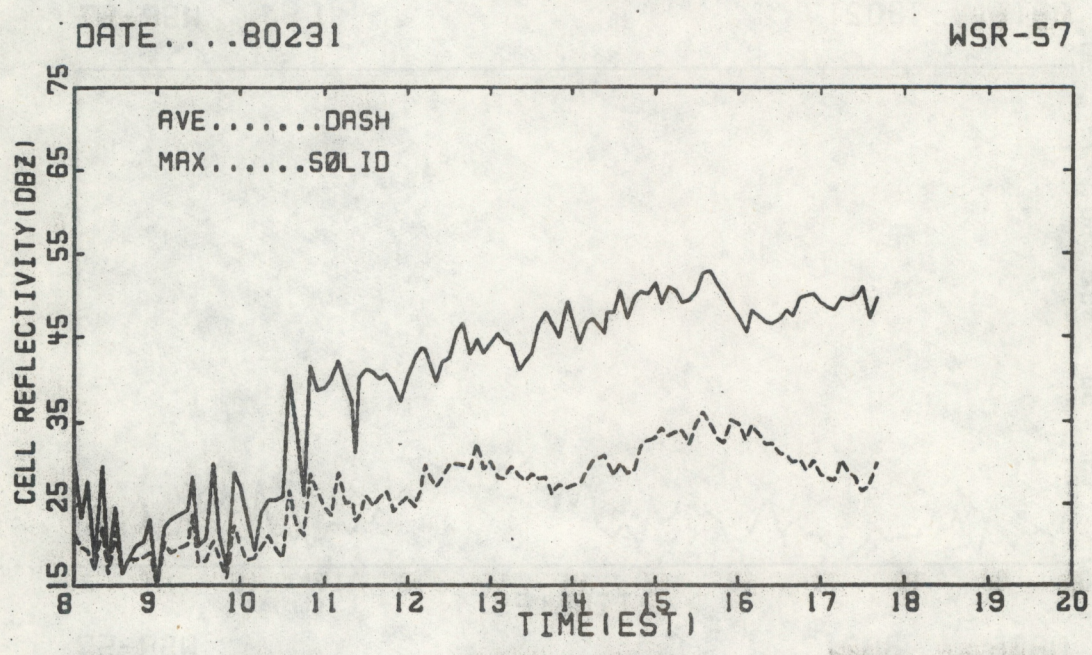

DATE....80217
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
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11
12
13
14
15
16
17
18
19
20
TIME(EST)

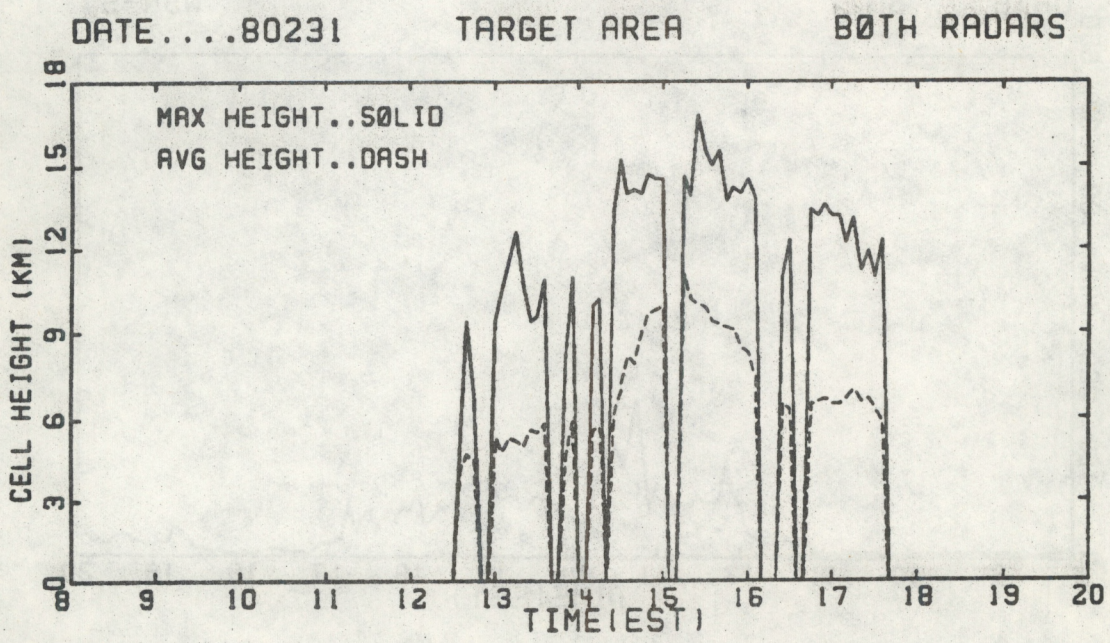

DATE....80217
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
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11
12
13
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15
16
17
18
19
20
TIME(EST)

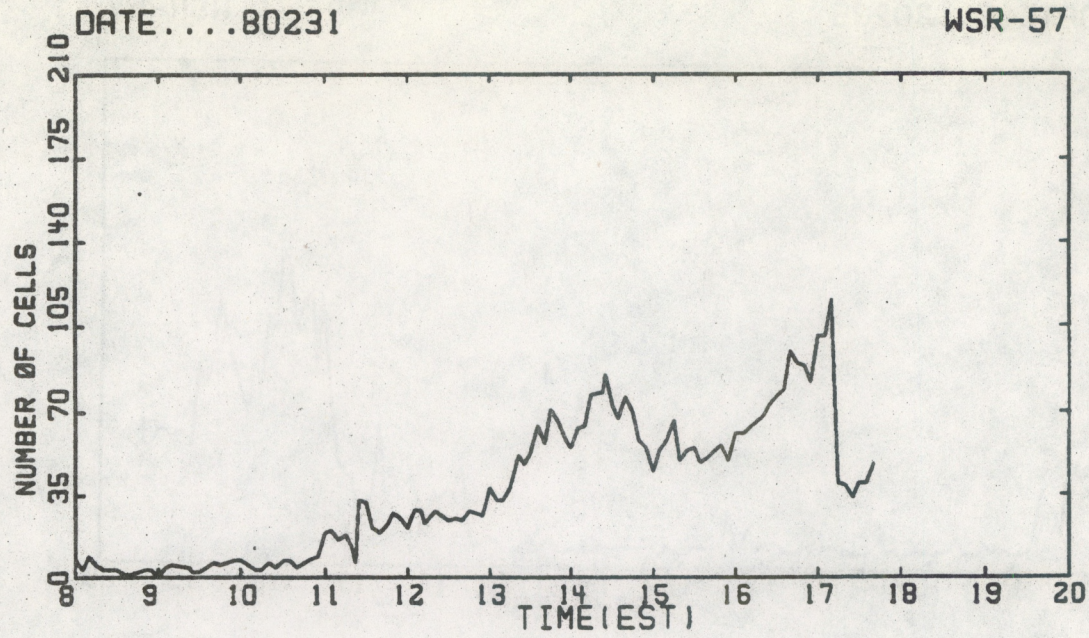

DATE....80217
WSR-57
NUMBER ØF ECHØES
0
15
30
45
60
75
90
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13
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15
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17
18
19
20
TIME(EST)

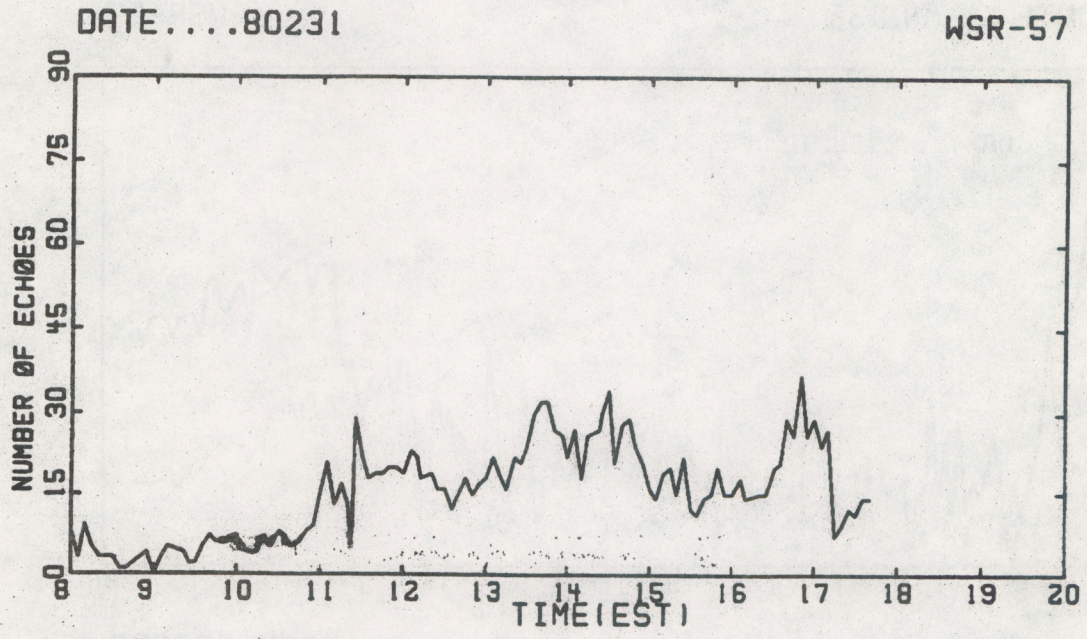

DATE....80217
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

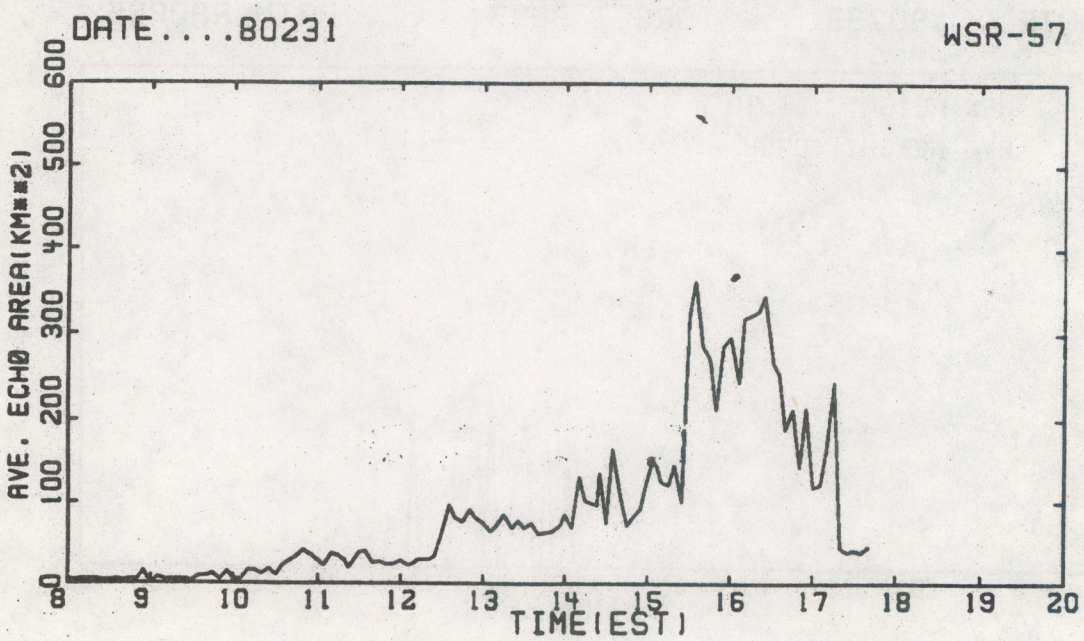

DATE....80231
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

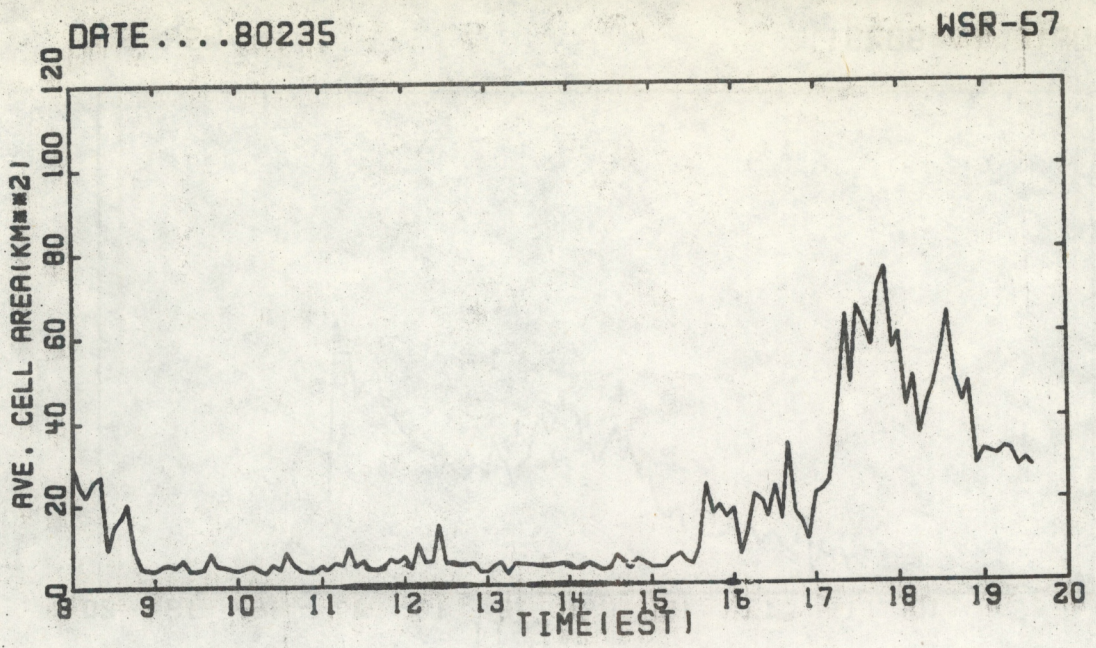

DATE....80231
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
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11
12
13
14
15
16
17
18
19
20
TIME(EST)

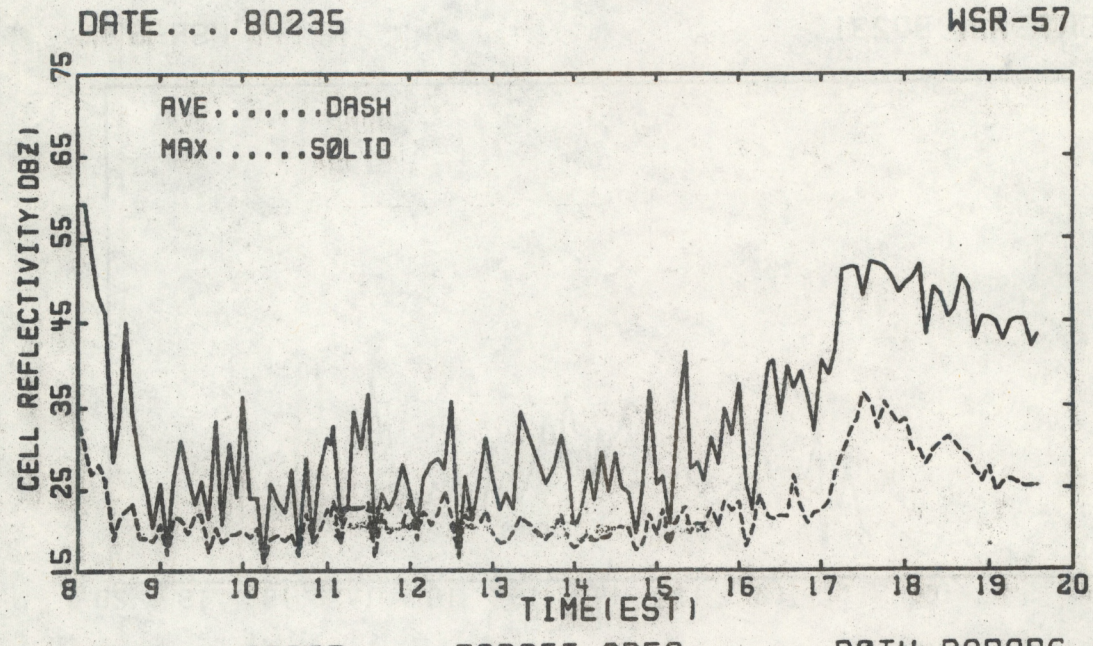

DATE....80231
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

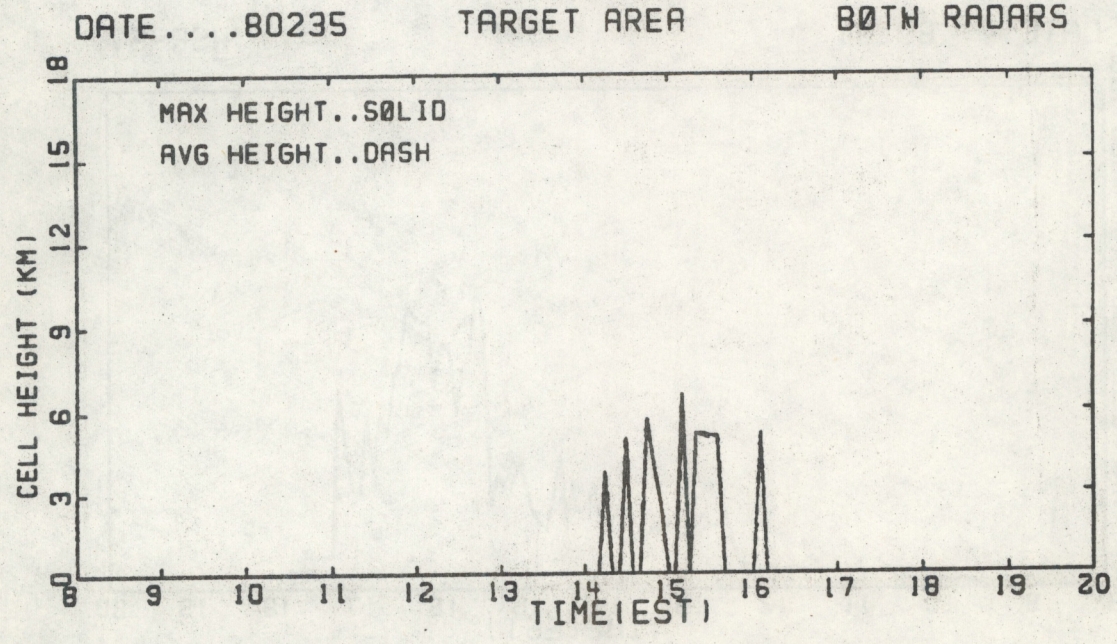

DATE....80231
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
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20
TIME(EST)

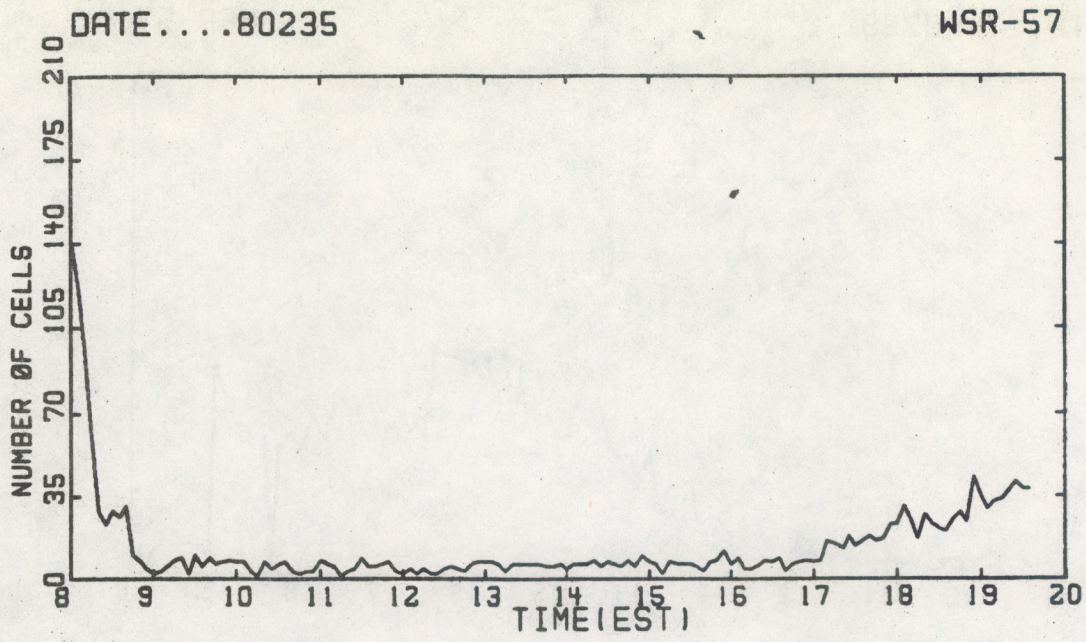

DATE....80231
WSR-57
NUMBER ØF ECHØES
0
15
30
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75
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TIME(EST)

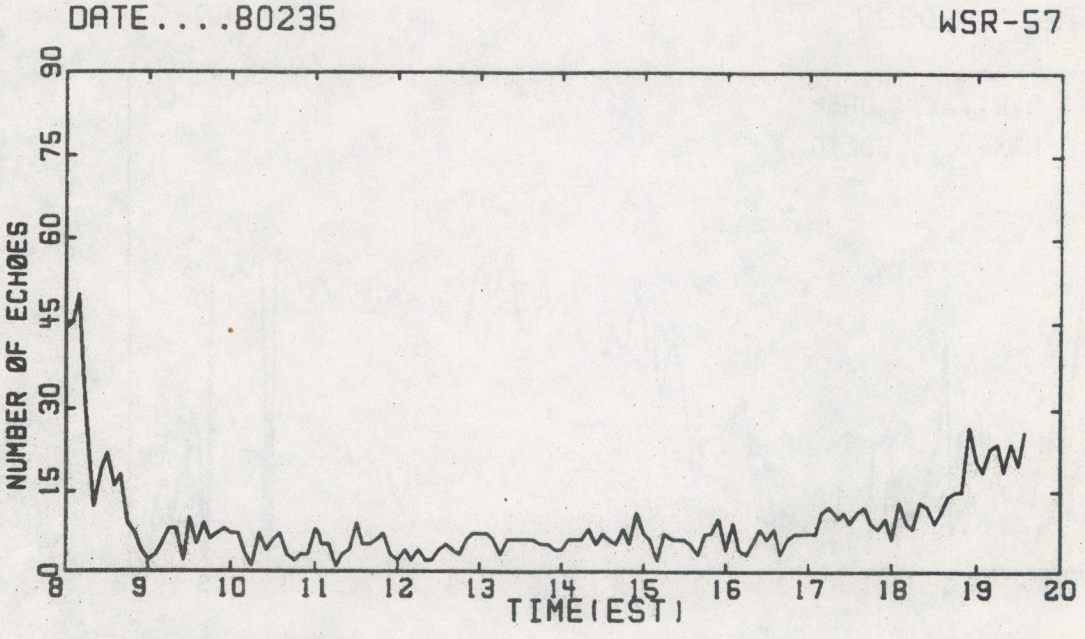

DATE....80231
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
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13
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15
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17
18
19
20
TIME(EST)

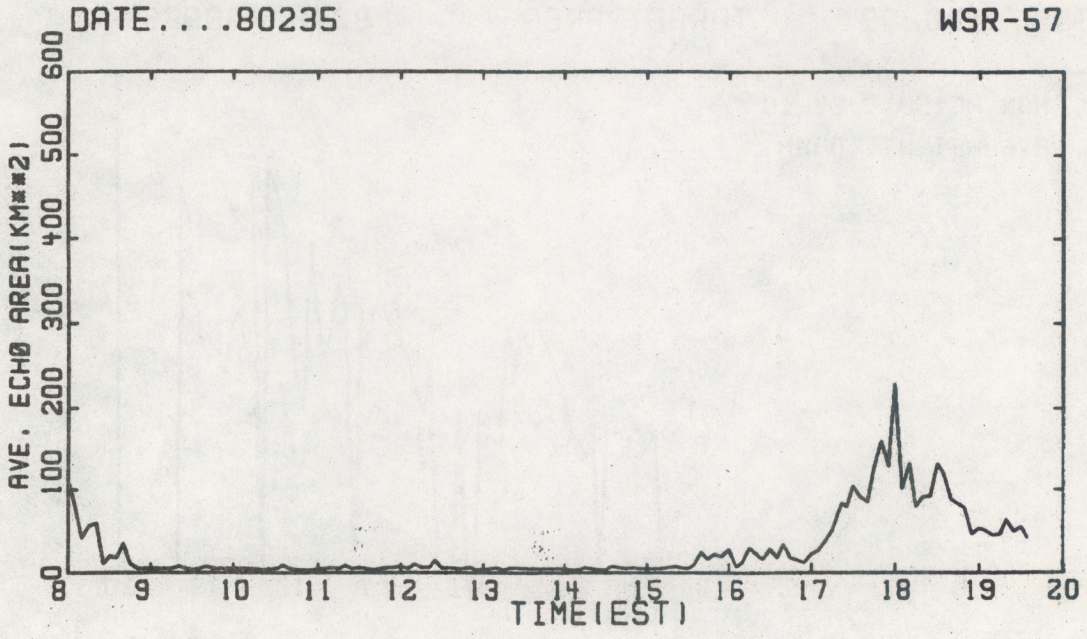

DATE....80235
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
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10
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12
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15
16
17
18
19
20
TIME(EST)

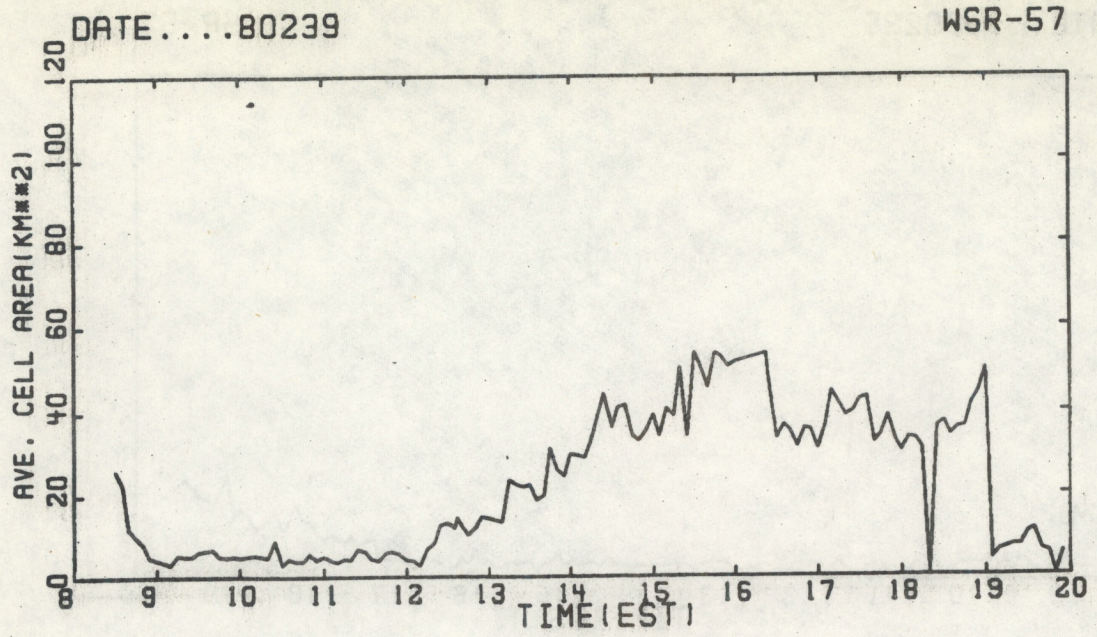

DATE....80235
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
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75
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TIME(EST)

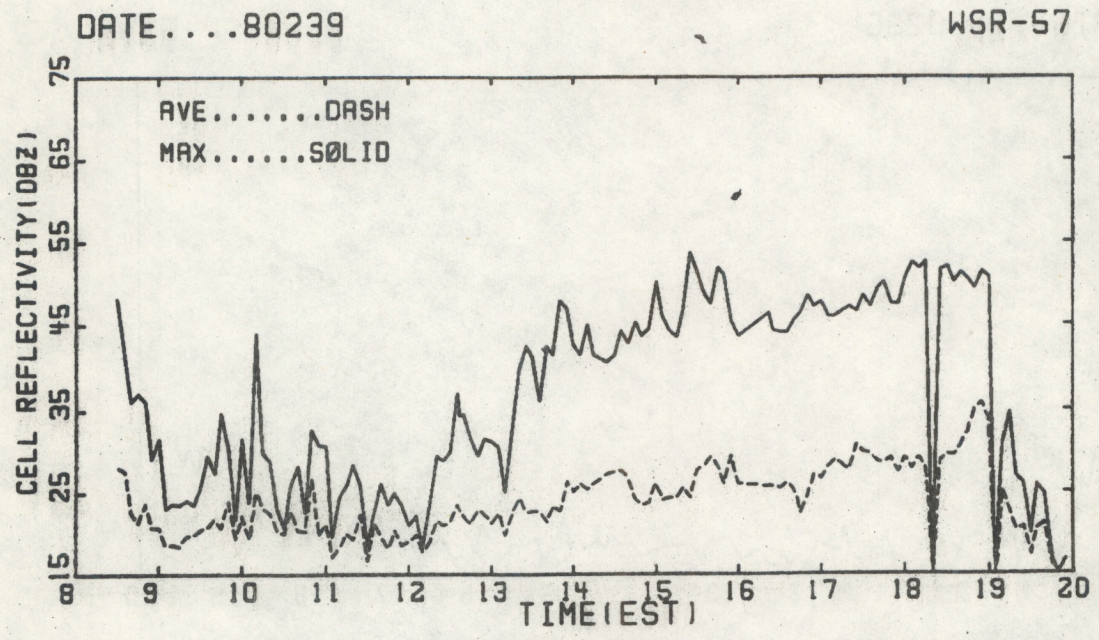

DATE....80235
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
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12
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19
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TIME(EST)

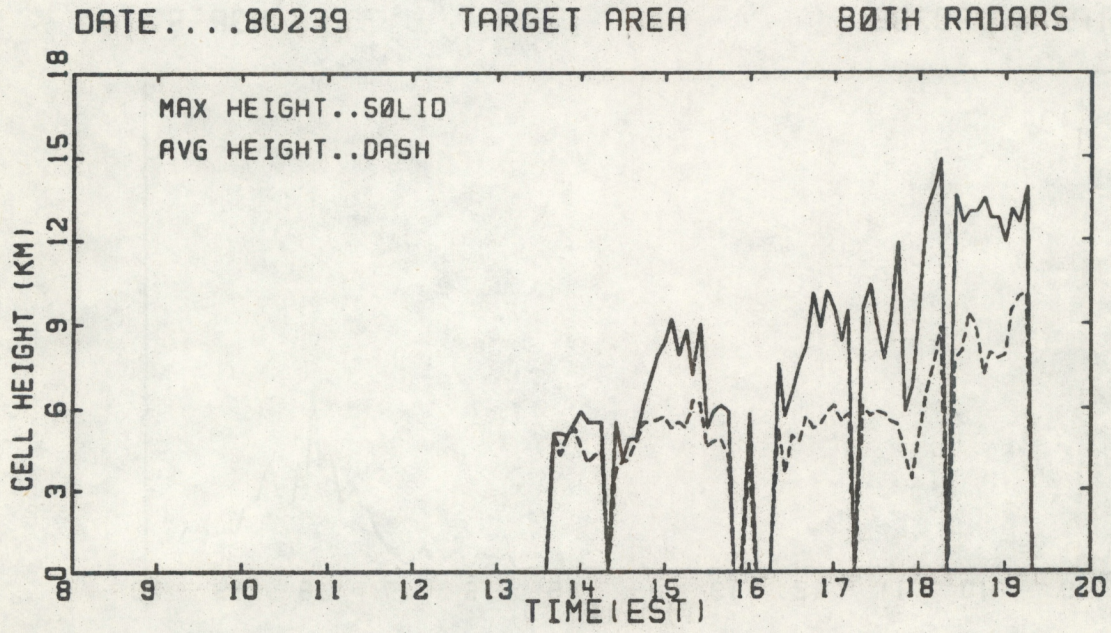

DATE....80235
WSR-57
NUMBER ØF CELLS
0
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70
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TIME(EST)

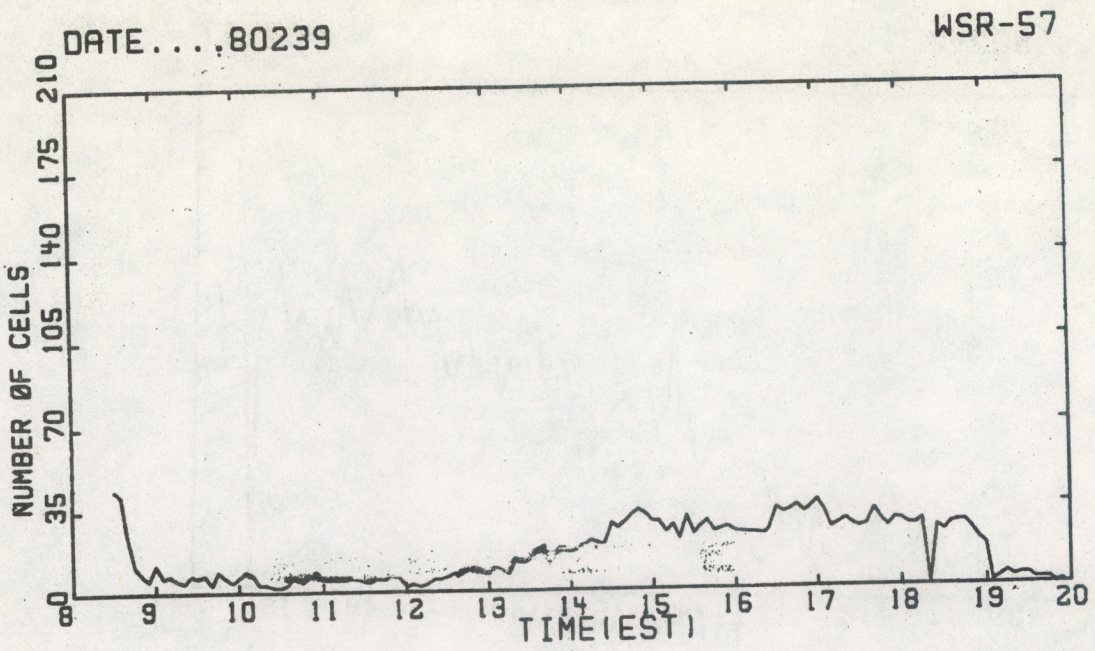

DATE....80235
WSR-57
NUMBER ØF ECHØES
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TIME(EST)

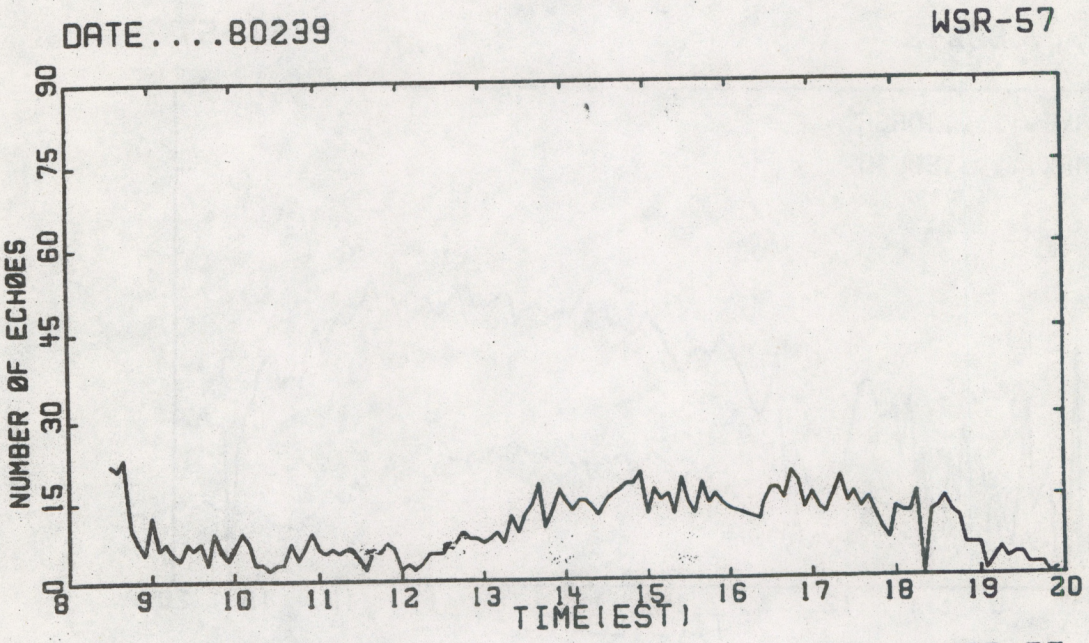

DATE....80235
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
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TIME(EST)

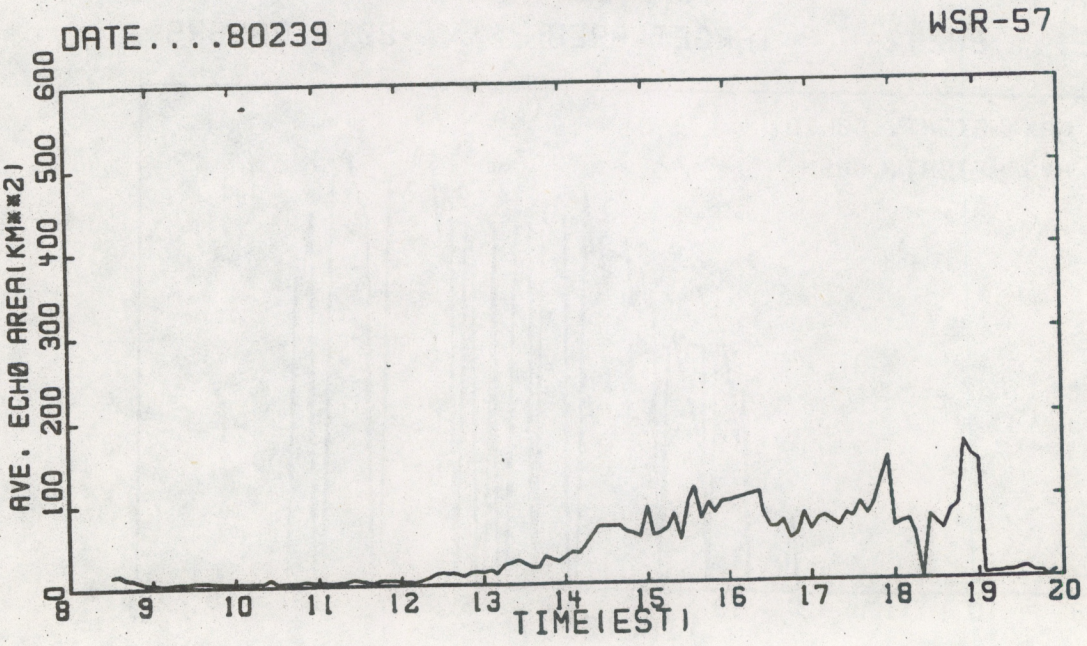

DATE....80239
WSR-57
AVE. CELL AREA(KM**2)
0
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TIME(EST)

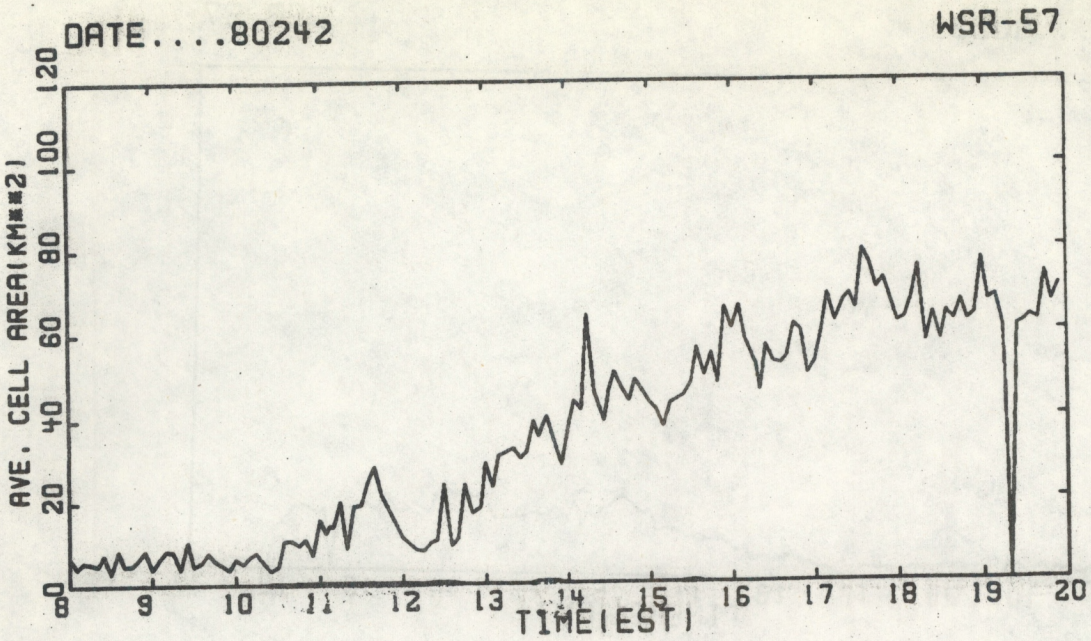

DATE....80239
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
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TIME(EST)

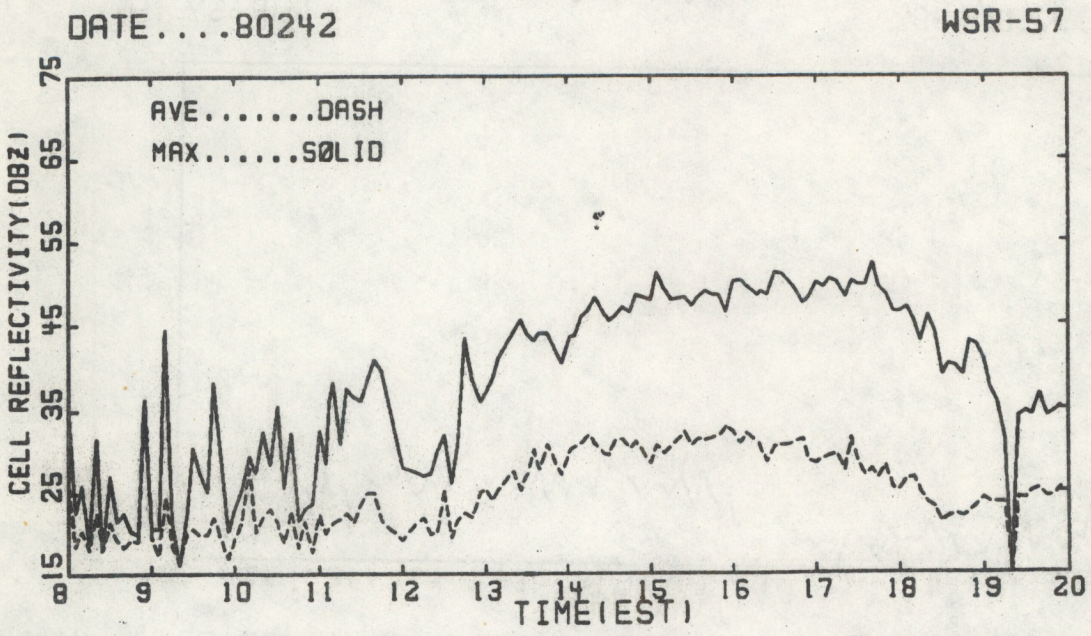

DATE....80239
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
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12
15
18
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17
18
19
20
TIME(EST)

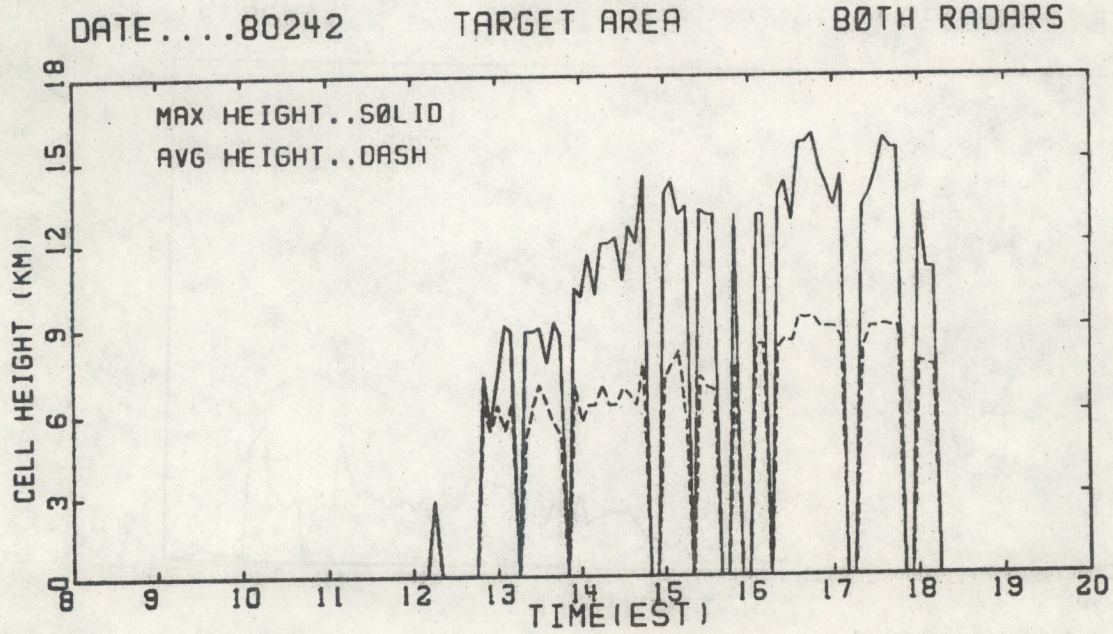

DATE....80239
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

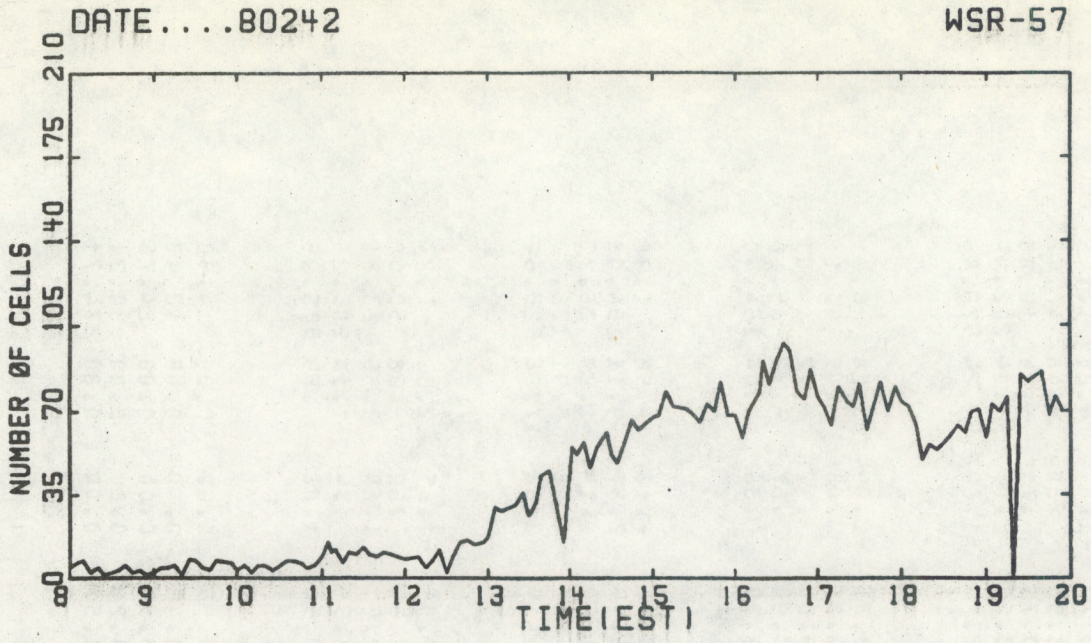

DATE....80239
WSR-57
NUMBER ØF ECHØES
0
15
30
45
60
75
90
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

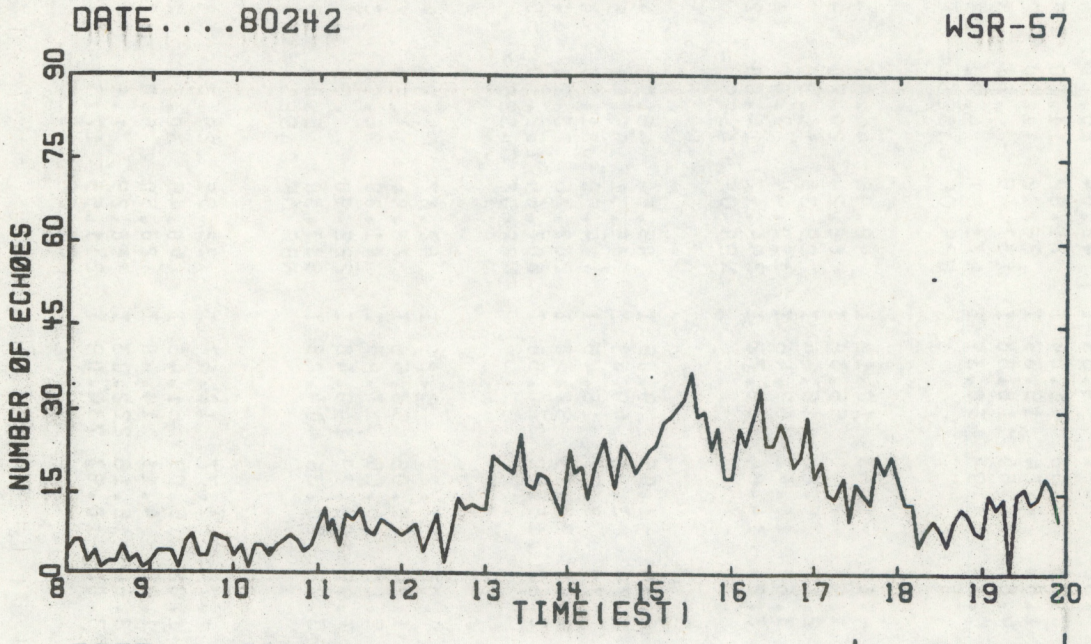

DATE....80239
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE....80242
WSR-57
AVE. CELL AREA(KM**2)
0
20
40
60
80
100
120
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE....80242
WSR-57
AVE.....DASH
MAX.....SØLID
CELL REFLECTIVITY(DBZ)
15
25
35
45
55
65
75
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE....80242
TARGET AREA
BØTH RADARS
MAX HEIGHT..SØLID
AVG HEIGHT..DASH
CELL HEIGHT (KM)
0
3
6
9
12
15
18
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE....80242
WSR-57
NUMBER ØF CELLS
0
35
70
105
140
175
210
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)


DATE....80242
WSR-57
NUMBER ØF ECHØES
0
15
30
45
60
75
90
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

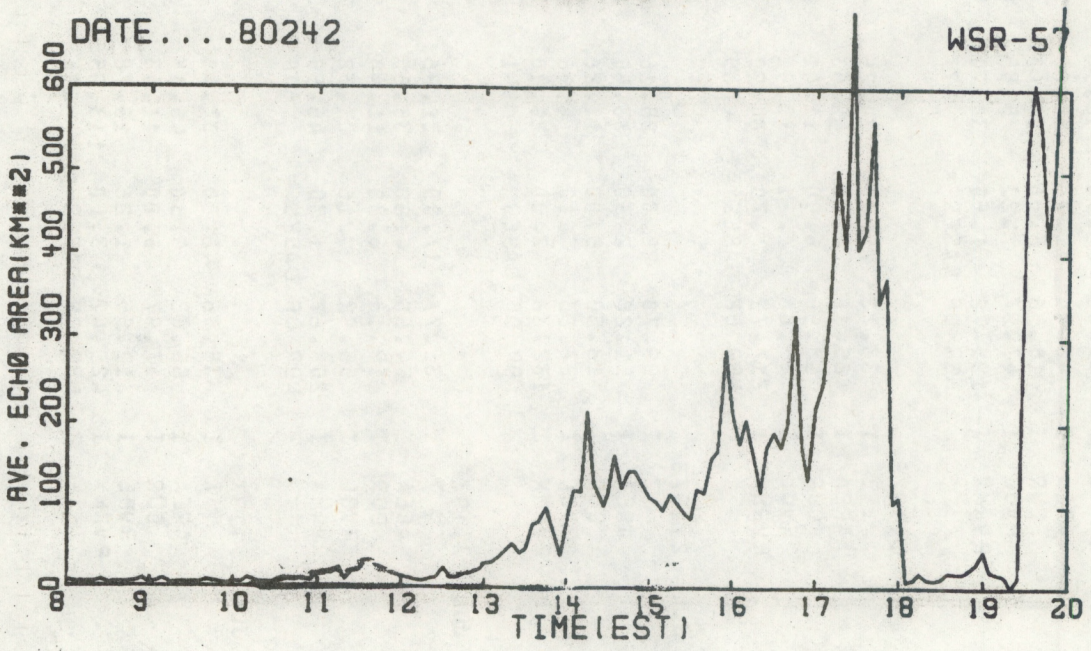

DATE....80242
WSR-57
AVE. ECHØ AREA(KM**2)
0
100
200
300
400
500
600
8
9
10
11
12
13
14
15
16
17
18
19
20
TIME(EST)

*Table 8. Parameters of the frequency distributions of the characteristics of directly treated and non treated cells.*

| | | NON-SEEDED CELLS | | | | | | SEEDED CELLS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MEAN | MODE | MEDIAN | SKEW | KURT | SD | MEAN | MODE | MEDIAN | SKEW | KURT | SD |
| JUN 30,1978 | | | | | | | | | | | | | |
| Z | I | 32.09 | 29.50 | 30.54 | .36 | -.91 | 9.68 | 42.04 | 20.00 | 43.70 | -1.84 | 4.20 | 7.46 |
| AREA | I | 43.94 | 11.70 | 30.60 | 2.06 | 5.68 | 41.04 | 71.62 | 11.20 | 58.00 | .80 | -.48 | 46.47 |
| DUR | I | 18.56 | 6.00 | 11.48 | 1.84 | 4.64 | 15.35 | 26.12 | 11.00 | 20.75 | .71 | -.74 | 19.00 |
| RVOL | I | 47.97 | .20 | 5.56 | 4.81 | 30.64 | 118.88 | 137.45 | .63 | 33.66 | 1.95 | 3.34 | 202.44 |
| RVRMX | I | 195.72 | 1.50 | 30.70 | 5.34 | 41.98 | 450.31 | 471.67 | 4.20 | 252.80 | 1.64 | 2.24 | 529.86 |
| | | NBR OF CASES = | | 677 | | | | NBR OF CASES = | | 17 | | | |
| JUL 1,1978 | | | | | | | | | | | | | |
| Z | I | 33.73 | 21.00 | 34.26 | -.02 | -1.43 | 10.12 | 40.96 | 44.00 | 42.35 | -1.99 | 3.28 | 6.21 |
| AREA | I | 65.18 | 2.20 | 49.53 | 1.43 | 2.40 | 55.36 | 88.24 | 20.70 | 90.85 | .03 | -.45 | 40.18 |
| DUR | I | 18.96 | 6.00 | 11.41 | 2.12 | 5.88 | 16.64 | 29.38 | 16.00 | 29.00 | .42 | .42 | 14.01 |
| RVOL | I | 85.88 | .21 | 13.92 | 3.68 | 18.41 | 169.46 | 110.44 | 2.00 | 113.94 | .67 | -.12 | 85.16 |
| RVRMX | I | 317.72 | .70 | 80.20 | 3.24 | 14.64 | 539.72 | 394.12 | 14.00 | 420.30 | .36 | .04 | 254.40 |
| | | NBR OF CASES = | | 765 | | | | NBR OF CASES = | | 16 | | | |
| JUL 2,1978 | | | | | | | | | | | | | |
| Z | I | 29.70 | 22.00 | 28.16 | .38 | -1.05 | 9.05 | 45.54 | 46.00 | 45.75 | -.13 | -.52 | 1.96 |
| AREA | I | 51.26 | 2.30 | 33.40 | 1.70 | 3.26 | 49.43 | 85.31 | 55.40 | 66.15 | 2.57 | 9.11 | 54.03 |
| DUR | I | 18.50 | 6.00 | 11.26 | 1.79 | 3.27 | 16.45 | 44.50 | 81.00 | 41.50 | .19 | -1.29 | 25.23 |
| RVOL | I | 37.63 | .10 | 4.96 | 4.41 | 23.19 | 92.58 | 202.76 | 22.21 | 145.29 | 2.08 | 5.91 | 176.27 |
| RVRMX | I | 132.38 | 2.00 | 29.10 | 3.62 | 15.40 | 270.56 | 607.64 | 152.50 | 504.30 | 3.83 | 17.28 | 625.69 |
| | | NBR OF CASES = | | 941 | | | | NBR OF CASES = | | 26 | | | |
| JUL 3,1978 | | | | | | | | | | | | | |
| Z | I | 31.77 | 17.00 | 31.96 | .03 | -1.29 | 9.89 | 42.37 | 44.00 | 45.05 | -1.65 | 2.39 | 7.27 |
| AREA | I | 54.60 | 4.60 | 38.60 | 1.94 | 5.06 | 53.56 | 78.84 | 11.50 | 71.65 | .62 | -.28 | 50.00 |
| DUR | I | 19.18 | 6.00 | 11.48 | 2.16 | 6.00 | 17.45 | 41.80 | 26.00 | 32.50 | 1.15 | 2.36 | 23.81 |
| RVOL | I | 56.92 | .16 | 7.52 | 7.99 | 102.29 | 149.48 | 222.90 | .95 | 138.59 | .54 | -1.18 | 205.29 |
| RVRMX | I | 208.67 | 1.30 | 46.55 | 3.82 | 20.36 | 404.25 | 637.30 | 5.80 | 437.50 | 1.02 | .59 | 579.99 |
| | | NBR OF CASES = | | 630 | | | | NBR OF CASES = | | 20 | | | |
| JUL 5,1978 | | | | | | | | | | | | | |
| Z | I | 35.36 | 47.00 | 37.48 | -.28 | -1.37 | 10.67 | 35.55 | 25.30 | 35.55 | 0.00 | 0.00 | 14.50 |
| AREA | I | 66.02 | 9.80 | 48.15 | 1.92 | 5.05 | 61.46 | 40.45 | 30.60 | 40.45 | 0.00 | 0.00 | 13.93 |
| DUR | I | 17.97 | 6.00 | 11.43 | 1.82 | 4.11 | 14.40 | 23.50 | 6.00 | 23.50 | 0.00 | 0.00 | 24.75 |
| RVOL | I | 110.55 | 1.26 | 16.78 | 3.54 | 16.16 | 222.03 | 58.29 | 1.58 | 58.29 | 0.00 | 0.00 | 80.21 |
| RVRMX | I | 429.47 | 3.10 | 113.95 | 3.00 | 10.93 | 734.09 | 211.55 | 17.30 | 211.55 | 0.00 | 0.00 | 274.71 |
| | | NBR OF CASES = | | 658 | | | | NBR OF CASES = | | 2 | | | |

*Table 8. Parameters of the frequency distributions of the characteristics of directly treated and non treated cells. (Continued)*

| | | NON-SEEDED CELLS | | | | | | SEEDED CELLS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MEAN | MODE | MEDIAN | SKEW | KURT | SD | MEAN | MODE | MEDIAN | SKEW | KURT | SD |
| **JUL 10,1978** | | | | | | | | | | | | | |
| Z | I | 36.74 | 47.30 | 37.65 | -.27 | -.95 | 9.16 | 39.71 | 43.70 | 42.55 | -.73 | -.65 | 9.29 |
| AREA | I | 88.40 | 17.80 | 63.75 | 1.56 | 2.68 | 75.11 | 72.03 | 7.10 | 57.95 | 1.95 | 6.02 | 56.22 |
| CUR | I | 20.30 | 6.00 | 15.79 | 1.78 | 3.52 | 16.84 | 27.30 | 11.00 | 21.10 | 1.32 | 2.00 | 20.25 |
| RVOL | I | 124.64 | .61 | 27.38 | 4.85 | 37.29 | 257.64 | 148.96 | .55 | 57.09 | 2.18 | 4.41 | 234.25 |
| RVRMX | I | 507.73 | 5.70 | 155.45 | 3.50 | 15.54 | 900.49 | 577.79 | 3.80 | 248.65 | 1.87 | 2.63 | 813.83 |
| | | NBR OF CASES = | | 478 | | | | NBR OF CASES = | | 30 | | | |
| **JUL 25,1978** | | | | | | | | | | | | | |
| Z | I | 36.31 | 39.00 | 37.04 | -.17 | -1.10 | 10.20 | 43.31 | 45.00 | 43.80 | -.62 | .35 | 8.76 |
| AREA | I | 98.62 | 2.20 | 79.30 | 1.68 | 4.40 | 83.44 | 141.15 | 33.40 | 100.40 | 1.45 | 1.56 | 120.37 |
| CUR | I | 17.34 | 6.00 | 11.24 | 1.86 | 3.93 | 14.68 | 42.27 | 51.00 | 36.00 | 1.85 | 4.36 | 35.94 |
| RVOL | I | 155.47 | 2.01 | 21.17 | 4.13 | 21.09 | 351.10 | 934.30 | 2.20 | 131.41 | 3.12 | 9.97 | 2150.52 |
| RVRMX | I | 630.27 | .90 | 145.60 | 3.88 | 20.18 | 1207.75 | 1906.70 | 21.00 | 308.00 | 2.92 | 8.90 | 3830.81 |
| | | NBR OF CASES = | | 473 | | | | NBR OF CASES = | | 11 | | | |
| **JUL 29,1978** | | | | | | | | | | | | | |
| Z | I | 33.47 | 30.50 | 31.69 | .49 | -.71 | 8.15 | 43.92 | 33.50 | 45.55 | -.68 | .17 | 5.63 |
| AREA | I | 93.17 | 60.80 | 82.80 | 1.10 | 1.80 | 56.83 | 65.19 | 16.70 | 55.30 | 1.65 | 4.00 | 45.58 |
| CUR | I | 18.16 | 6.00 | 12.85 | 1.81 | 3.82 | 14.81 | 30.93 | 21.00 | 26.50 | .31 | -.79 | 18.57 |
| RVOL | I | 80.12 | 1.53 | 23.48 | 4.56 | 32.42 | 160.32 | 197.16 | 4.51 | 131.88 | 2.77 | 8.71 | 272.03 |
| RVRMX | I | 307.19 | 42.90 | 117.60 | 3.86 | 22.88 | 514.59 | 554.10 | 32.20 | 389.90 | 1.58 | 2.65 | 557.03 |
| | | NBR OF CASES = | | 1571 | | | | NBR OF CASES = | | 14 | | | |
| **AUG 4,1978** | | | | | | | | | | | | | |
| Z | I | 33.50 | 24.00 | 33.13 | .10 | -1.26 | 8.96 | 42.00 | 46.00 | 43.05 | -1.38 | 2.95 | 5.47 |
| AREA | I | 63.27 | 25.90 | 48.30 | 1.61 | 2.92 | 53.79 | 75.42 | 24.10 | 62.10 | .78 | -.06 | 34.76 |
| CUR | I | 16.14 | 6.00 | 11.15 | 1.56 | 2.59 | 12.60 | 24.19 | 31.00 | 22.00 | .17 | -1.24 | 10.62 |
| RVOL | I | 63.42 | .26 | 11.21 | 4.17 | 21.55 | 138.74 | 110.20 | 3.61 | 52.86 | 1.43 | .75 | 127.07 |
| RVRMX | I | 252.90 | 5.80 | 59.73 | 3.05 | 11.66 | 438.96 | 404.13 | 18.00 | 256.80 | 1.38 | .97 | 403.52 |
| | | NBR OF CASES = | | 457 | | | | NBR OF CASES = | | 16 | | | |
| **AUG 5,1978** | | | | | | | | | | | | | |
| Z | I | 34.54 | 36.50 | 34.55 | .08 | -.98 | 9.07 | 37.18 | 23.60 | 39.75 | -1.39 | 2.15 | 9.57 |
| AREA | I | 45.17 | 28.50 | 34.25 | 1.57 | 3.46 | 36.47 | 29.65 | 20.20 | 21.70 | .44 | -3.43 | 10.85 |
| CUR | I | 18.43 | 6.00 | 12.82 | 2.33 | 8.49 | 16.14 | 13.50 | 16.00 | 14.33 | -2.00 | 4.00 | 5.00 |
| RVOL | I | 52.93 | .60 | 8.30 | 4.93 | 31.10 | 124.63 | 13.38 | 1.45 | 16.12 | -1.71 | 3.21 | 8.15 |
| RVRMX | I | 215.01 | 2.30 | 54.05 | 4.67 | 28.79 | 442.22 | 107.63 | 9.60 | 90.70 | -.66 | -1.95 | 77.55 |
| | | NBR OF CASES = | | 346 | | | | NBR OF CASES = | | 4 | | | |

*Table 8. Parameters of the frequency distributions of the characteristics of directly treated and non treated cells. (Continued)*

| | | NON-SEEDED CELLS | | | | | | | SEEDED CELLS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MEAN | MODE | MEDIAN | SKEW | KURT | SD | | MEAN | MODE | MEDIAN | SKEW | KURT | SD |
| AUG 10,1978 | | | | | | | | | | | | | | |
| Z | I | 34.36 | 47.00 | 34.47 | .06 | -1.19 | 9.16 | I | 40.33 | 35.50 | 40.63 | -.18 | -.57 | 6.04 |
| AREA | I | 68.28 | 16.70 | 51.56 | 1.93 | 5.32 | 57.10 | I | 74.45 | 12.00 | 61.10 | 1.25 | .83 | 61.05 |
| CUR | I | 16.89 | 6.00 | 11.29 | 2.23 | 6.83 | 14.03 | I | 22.39 | 11.00 | 16.38 | .91 | .04 | 13.73 |
| RVOL | I | 78.36 | 1.11 | 12.67 | 5.25 | 36.20 | 193.04 | I | 107.28 | 1.44 | 37.43 | 1.96 | 3.36 | 160.79 |
| RVRMX | I | 309.98 | 10.30 | 72.30 | 3.54 | 15.01 | 594.81 | I | 360.85 | 10.30 | 190.60 | 1.27 | .17 | 425.79 |
| | | NBR OF CASES = | | 887 | | | | | NBR OF CASES = | | 23 | | | |
| AUG 11,1978 | | | | | | | | | | | | | | |
| Z | I | 33.65 | 24.30 | 32.97 | .30 | -.95 | 9.42 | I | 48.13 | 51.00 | 49.20 | -2.32 | 7.60 | 4.96 |
| AREA | I | 69.03 | 23.50 | 48.85 | 2.03 | 5.82 | 63.96 | I | 127.80 | 43.50 | 127.80 | -.26 | -.44 | 42.32 |
| CUR | I | 15.70 | 6.00 | 11.11 | 2.50 | 9.13 | 13.47 | I | 37.84 | 26.00 | 31.00 | 1.48 | 2.64 | 25.57 |
| RVOL | I | 68.19 | .34 | 10.62 | 4.63 | 28.91 | 158.33 | I | 513.27 | 6.89 | 376.04 | .73 | -.70 | 394.62 |
| RVRMX | I | 290.93 | 5.00 | 64.65 | 3.95 | 22.61 | 571.25 | I | 1518.02 | 49.70 | 1582.30 | 1.21 | 2.85 | 990.92 |
| | | NBR OF CASES = | | 798 | | | | | NBR OF CASES = | | 19 | | | |
| AUG 12,1978 | | | | | | | | | | | | | | |
| Z | I | 34.75 | 23.50 | 35.03 | -.08 | -1.20 | 9.71 | I | 46.60 | 46.00 | 47.60 | -1.55 | 2.60 | 3.53 |
| AREA | I | 78.87 | 13.50 | 59.10 | 2.88 | 18.75 | 70.96 | I | 92.85 | 37.80 | 71.70 | 1.36 | 1.85 | 54.42 |
| CUR | I | 18.70 | 6.00 | 11.85 | 3.38 | 22.09 | 17.27 | I | 36.95 | 11.00 | 36.00 | .45 | -.28 | 22.23 |
| RVOL | I | 97.99 | .48 | 20.22 | 4.86 | 31.09 | 217.34 | I | 355.49 | 10.59 | 234.60 | 1.74 | 2.57 | 425.08 |
| RVRMX | I | 393.92 | 9.70 | 107.00 | 5.51 | 46.89 | 786.71 | I | 1108.63 | 83.50 | 801.00 | 2.21 | 5.89 | 1168.17 |
| | | NBR OF CASES = | | 925 | | | | | NBR OF CASES = | | 19 | | | |
| AUG 13,1978 | | | | | | | | | | | | | | |
| Z | I | 35.23 | 43.20 | 36.05 | -.18 | -1.18 | 9.73 | I | 42.74 | 41.70 | 44.35 | -1.92 | 5.27 | 6.80 |
| AREA | I | 67.29 | 4.40 | 48.85 | 1.49 | 2.75 | 57.53 | I | 77.61 | 9.80 | 58.95 | .75 | -.31 | 53.38 |
| CUR | I | 18.07 | 6.00 | 11.64 | 1.97 | 5.19 | 14.87 | I | 30.00 | 26.00 | 26.25 | .52 | -.57 | 18.09 |
| RVOL | I | 104.01 | .26 | 15.70 | 4.11 | 24.60 | 218.18 | I | 209.15 | .38 | 78.46 | 2.43 | 6.24 | 330.49 |
| RVRMX | I | 369.50 | 3.70 | 90.45 | 2.73 | 8.83 | 612.77 | I | 530.85 | 3.70 | 316.45 | 2.13 | 5.18 | 627.14 |
| | | NBR OF CASES = | | 504 | | | | | NBR OF CASES = | | 24 | | | |
| AUG 14,1978 | | | | | | | | | | | | | | |
| Z | I | 34.75 | 35.50 | 35.50 | -.18 | -1.14 | 8.39 | I | 44.74 | 46.00 | 45.50 | -.60 | -.04 | 4.22 |
| AREA | I | 57.29 | 6.30 | 42.70 | 1.83 | 5.09 | 51.25 | I | 97.02 | 24.30 | 82.10 | 1.33 | 1.56 | 63.69 |
| CUR | I | 17.49 | 6.00 | 11.24 | 2.06 | 5.51 | 15.26 | I | 33.96 | 16.00 | 31.50 | .57 | -.38 | 18.62 |
| RVOL | I | 66.80 | 1.32 | 14.48 | 5.80 | 47.00 | 159.29 | I | 286.20 | 9.11 | 110.68 | 1.95 | 3.52 | 383.95 |
| RVRMX | I | 231.07 | 3.30 | 90.20 | 2.70 | 9.49 | 352.61 | I | 815.49 | 58.80 | 535.90 | 1.60 | 2.08 | 869.77 |
| | | NBR OF CASES = | | 321 | | | | | NBR OF CASES = | | 27 | | | |

*Table 8. Parameters of the frequency distributions of the characteristics of directly treated and non treated cells. (Continued)*

| | | NON-SEEDED CELLS | | | | | | SEEDED CELLS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MEAN | MODE | MEDIAN | SKEW | KURT | SD | MEAN | MODE | MEDIAN | SKEW | KURT | SD |
| AUG 16,1978 | | | | | | | | | | | | | |
| Z | I | 35.17 | 42.50 | 35.78 | -.11 | -1.21 | 9.08 I | 43.35 | 45.00 | 45.05 | -1.81 | 3.28 | 6.24 |
| AREA | I | 67.69 | 8.40 | 50.55 | 2.09 | 7.11 | 57.67 I | 63.49 | 9.30 | 61.15 | 1.13 | 2.51 | 36.05 |
| DUR | I | 16.56 | 6.00 | 11.09 | 2.03 | 4.42 | 14.49 I | 22.12 | 11.00 | 20.70 | 1.01 | .99 | 12.12 |
| RVOL | I | 82.65 | .48 | 15.82 | 4.48 | 28.87 | 174.07 I | 127.81 | .57 | 100.80 | 3.15 | 13.52 | 149.80 |
| RVRMX | I | 325.05 | 3.60 | 96.95 | 3.31 | 14.54 | 547.96 I | 519.29 | 5.90 | 404.85 | 1.18 | 1.15 | 453.32 |
| | | NBR OF CASES = | | 858 | | | | NBR OF CASES = | | 34 | | | |
| AUG 17,1978 | | | | | | | | | | | | | |
| Z | I | 34.37 | 42.50 | 34.78 | -.10 | -1.15 | 8.97 I | 42.19 | 36.50 | 43.50 | -1.49 | 3.11 | 6.28 |
| AREA | I | 68.82 | 12.70 | 51.85 | 1.95 | 5.31 | 60.55 I | 68.27 | 5.80 | 64.70 | 1.22 | 2.74 | 41.05 |
| DUR | I | 19.03 | 6.00 | 12.90 | 1.92 | 4.81 | 15.84 I | 32.28 | 26.00 | 29.00 | .85 | .82 | 19.75 |
| RVOL | I | 83.46 | 1.51 | 15.70 | 4.57 | 25.74 | 189.75 I | 135.13 | .41 | 91.77 | 1.73 | 2.69 | 153.49 |
| RVRMX | I | 294.00 | 9.40 | 81.95 | 3.99 | 20.57 | 554.29 I | 428.31 | 2.60 | 385.30 | .89 | .20 | 357.87 |
| | | NBR OF CASES = | | 666 | | | | NBR OF CASES = | | 29 | | | |
| AUG 18,1978 | | | | | | | | | | | | | |
| Z | I | 37.13 | 41.00 | 38.35 | -.19 | -1.05 | 10.07 I | 36.35 | 23.50 | 36.35 | 0.00 | 0.00 | 18.17 |
| AREA | I | 54.16 | 13.00 | 42.20 | 1.86 | 5.39 | 44.33 I | 47.65 | 44.00 | 47.65 | 0.00 | 0.00 | 5.16 |
| DUR | I | 19.39 | 6.00 | 15.58 | 1.96 | 4.78 | 16.17 I | 18.50 | 6.00 | 18.50 | 0.00 | 0.00 | 17.68 |
| RVOL | I | 92.10 | .64 | 16.95 | 5.18 | 36.25 | 216.44 I | 81.09 | 1.69 | 81.09 | 0.00 | 0.00 | 112.29 |
| RVRMX | I | 349.01 | 2.30 | 102.75 | 5.15 | 44.26 | 661.46 I | 382.25 | 19.20 | 382.25 | 0.00 | 0.00 | 513.43 |
| | | NBR OF CASES = | | 426 | | | | NBR OF CASES = | | 2 | | | |
| AUG 29,1978 | | | | | | | | | | | | | |
| Z | I | 34.89 | 47.00 | 35.13 | -.05 | -1.12 | 9.24 I | 43.89 | 46.00 | 46.00 | -1.70 | 3.46 | 5.73 |
| AREA | I | 67.11 | 58.50 | 51.50 | 2.11 | 8.27 | 57.46 I | 76.15 | 3.70 | 69.25 | .57 | -.10 | 43.43 |
| DUR | I | 17.89 | 6.00 | 11.49 | 1.85 | 4.75 | 14.33 I | 34.35 | 26.00 | 26.30 | 1.18 | 1.14 | 24.14 |
| RVOL | I | 84.03 | 2.31 | 16.35 | 3.67 | 15.79 | 176.98 I | 173.86 | .43 | 97.44 | 1.71 | 2.75 | 195.10 |
| RVRMX | I | 322.06 | 2.70 | 90.60 | 3.35 | 14.14 | 578.48 I | 618.12 | 3.40 | 433.00 | 1.74 | 3.38 | 616.94 |
| | | NBR OF CASES = | | 729 | | | | NBR OF CASES = | | 34 | | | |
| JUL 9,1979 | | | | | | | | | | | | | |
| Z | I | 29.76 | 26.70 | 30.00 | -.14 | -.69 | 4.80 I | 30.80 | 26.30 | 32.10 | -1.31 | 0.00 | 4.01 |
| AREA | I | 35.59 | 29.20 | 27.35 | 1.57 | 1.94 | 26.82 I | 28.63 | 9.80 | 30.50 | -.46 | 0.00 | 17.97 |
| DUR | I | 9.27 | 6.00 | 6.46 | 1.63 | 3.13 | 4.65 I | 9.33 | 6.00 | 8.50 | 1.73 | 0.00 | 5.77 |
| RVOL | I | 5.31 | .35 | 3.19 | 2.30 | 6.58 | 5.84 I | 8.25 | .68 | 8.59 | -.21 | 0.00 | 7.41 |
| RVRMX | I | 36.27 | 3.10 | 23.15 | 1.58 | 2.13 | 33.46 I | 46.70 | 5.70 | 35.60 | .99 | 0.00 | 47.53 |
| | | NBR OF CASES = | | 102 | | | | NBR OF CASES = | | 3 | | | |

*Table 8. Parameters of the frequency distributions of the characteristics of directly treated and non treated cells. (Continued)*

| | | NON-SEEDED CELLS | | | | | | SEEDED CELLS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MEAN | MODE | MEDIAN | SKEW | KURT | SD | MEAN | MODE | MEDIAN | SKEW | KURT | SD |
| **JUL 28,1979** | | | | | | | | | | | | | |
| Z | I | 34.70 | 41.50 | 36.20 | -.34 | -1.01 | 8.91 | I 41.59 | 33.70 | 41.50 | .25 | -.76 | 4.87 |
| AREA | I | 47.88 | 7.50 | 38.90 | 1.03 | .56 | 38.50 | I 52.89 | 12.80 | 46.40 | .80 | -.13 | 29.30 |
| CUR | I | 18.36 | 6.00 | 15.13 | 1.23 | .94 | 13.33 | I 34.33 | 11.00 | 32.25 | .83 | .07 | 21.85 |
| RVOL | I | 58.30 | .18 | 11.45 | 2.81 | 8.57 | 103.93 | I 91.99 | 3.59 | 44.17 | 3.27 | 11.69 | 143.35 |
| RVRMX | I | 216.93 | 1.20 | 72.50 | 3.71 | 19.85 | 364.58 | I 302.39 | 29.70 | 168.90 | 2.30 | 6.02 | 331.98 |
| | | NBR OF CASES = | | 123 | | | | NBR OF CASES = | | 15 | | | |
| **JUL 30,1979** | | | | | | | | | | | | | |
| Z | I | 33.05 | 27.00 | 31.08 | .35 | -1.01 | 10.33 | I 41.98 | 20.00 | 45.40 | -1.11 | .47 | 9.56 |
| AREA | I | 61.39 | 27.00 | 45.48 | 1.79 | 4.25 | 54.99 | I 66.09 | 11.20 | 63.70 | .14 | -1.21 | 38.89 |
| CUR | I | 19.36 | 6.00 | 13.75 | 2.09 | 5.29 | 16.63 | I 26.31 | 31.00 | 26.00 | 1.63 | 4.20 | 18.66 |
| RVOL | I | 86.07 | .33 | 8.12 | 4.90 | 28.02 | 233.42 | I 209.74 | .72 | 77.91 | 1.25 | -.18 | 281.63 |
| RVRMX | I | 318.38 | 3.00 | 47.70 | 4.72 | 27.68 | 744.51 | I 656.08 | 7.00 | 391.15 | 1.06 | -.11 | 715.72 |
| | | NBR OF CASES = | | 519 | | | | NBR OF CASES = | | 16 | | | |
| **JUL 31,1979** | | | | | | | | | | | | | |
| Z | I | 33.24 | 23.00 | 33.05 | .13 | -1.11 | 9.82 | I 43.43 | 51.50 | 44.15 | -1.39 | 3.03 | 7.77 |
| AREA | I | 49.55 | 28.50 | 35.78 | 2.07 | 5.58 | 45.76 | I 62.83 | 8.50 | 50.15 | .64 | .14 | 39.96 |
| CUR | I | 18.22 | 6.00 | 13.50 | 1.59 | 2.40 | 14.52 | I 39.22 | 11.00 | 35.83 | .87 | .66 | 26.76 |
| RVOL | I | 55.26 | .71 | 8.81 | 4.08 | 19.76 | 124.71 | I 159.07 | .58 | 86.13 | 1.70 | 1.83 | 202.41 |
| RVRMX | I | 242.93 | 1.20 | 50.55 | 5.28 | 40.71 | 524.17 | I 466.93 | 4.10 | 271.10 | 1.74 | 3.08 | 492.09 |
| | | NBR OF CASES = | | 358 | | | | NBR OF CASES = | | 18 | | | |
| **AUG 3,1979** | | | | | | | | | | | | | |
| Z | I | 36.83 | 24.70 | 36.98 | .05 | -1.21 | 9.68 | I 49.01 | 51.00 | 50.55 | -1.36 | 2.49 | 5.16 |
| AREA | I | 83.80 | 21.70 | 67.05 | 3.84 | 23.91 | 78.03 | I 87.81 | 23.80 | 81.20 | .16 | -.68 | 34.09 |
| CUR | I | 20.88 | 11.00 | 16.13 | 1.19 | .94 | 15.25 | I 37.23 | 11.00 | 35.17 | 1.07 | 1.59 | 26.29 |
| RVOL | I | 133.68 | .63 | 26.25 | 3.56 | 16.25 | 259.65 | I 380.53 | 4.18 | 317.38 | 1.30 | 1.73 | 327.43 |
| RVRMX | I | 556.98 | 11.60 | 131.65 | 3.84 | 19.21 | 1032.14 | I 1470.26 | 30.80 | 1230.00 | 1.43 | 2.46 | 1197.73 |
| | | NBR OF CASES = | | 222 | | | | NBR OF CASES = | | 22 | | | |
| **AUG 13,1979** | | | | | | | | | | | | | |
| Z | I | 34.81 | 29.50 | 33.70 | .41 | -.90 | 8.85 | I 42.36 | 19.50 | 44.00 | -1.14 | .57 | 10.63 |
| AREA | I | 43.43 | 4.10 | 29.20 | 1.82 | 4.48 | 40.38 | I 49.30 | 17.00 | 51.20 | -.18 | -1.74 | 22.89 |
| CUR | I | 19.25 | 6.00 | 12.00 | 2.72 | 10.49 | 18.28 | I 26.31 | 31.00 | 26.25 | .05 | -.99 | 13.24 |
| RVOL | I | 68.69 | .76 | 6.13 | 4.03 | 17.89 | 168.09 | I 94.97 | .71 | 47.73 | .51 | -1.63 | 91.83 |
| RVRMX | I | 225.42 | 2.70 | 45.20 | 3.94 | 18.91 | 470.86 | I 368.47 | 5.70 | 243.60 | .42 | -1.69 | 340.96 |
| | | NBR OF CASES = | | 91 | | | | NBR OF CASES = | | 13 | | | |

*Table 8. Parameters of the frequency distributions of the characteristics of directly treated and non treated cells. (Continued)*

| | | NON-SEEDED CELLS | | | | | | SEEDED CELLS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MEAN | MODE | MEDIAN | SKEW | KURT | SD | MEAN | MODE | MEDIAN | SKEW | KURT | SD |
| **AUG 14,1979** | | | | | | | | | | | | | |
| Z | I | 34.27 | 36.00 | 34.63 | .02 | -1.17 | 9.78 | I 48.02 | 48.80 | 48.78 | -.69 | -.21 | 4.23 |
| AREA | I | 61.89 | 44.70 | 46.00 | 2.67 | 11.01 | 56.99 | I 85.22 | 17.20 | 58.90 | .92 | .44 | 47.35 |
| DUR | I | 18.18 | 6.00 | 11.35 | 2.84 | 14.93 | 16.35 | I 32.19 | 16.00 | 30.00 | .94 | -.02 | 22.84 |
| RVOL | I | 79.44 | .77 | 11.09 | 5.87 | 45.79 | 208.80 | I 324.53 | 10.25 | 215.17 | 1.66 | 2.35 | 372.69 |
| RVRMX | I | 277.76 | 7.70 | 67.10 | 3.35 | 14.97 | 512.23 | I 1030.75 | 75.00 | 764.20 | 1.43 | 1.74 | 918.02 |
| | | NBR OF CASES = | | 697 | | | | NBR OF CASES = | | 27 | | | |
| **AUG 16,1979** | | | | | | | | | | | | | |
| Z | I | 33.83 | 31.00 | 34.78 | -.14 | -.97 | 8.61 | I 41.08 | 38.30 | 41.35 | -.56 | .25 | 5.27 |
| AREA | I | 62.43 | 40.10 | 46.38 | 2.39 | 8.05 | 55.64 | I 57.89 | 22.50 | 58.05 | .41 | -.92 | 26.51 |
| DUR | I | 18.62 | 6.00 | 12.68 | 2.22 | 6.70 | 16.26 | I 26.50 | 11.00 | 23.50 | 1.45 | 1.94 | 16.21 |
| RVOL | I | 70.19 | .71 | 10.66 | 5.59 | 38.88 | 181.79 | I 87.74 | 2.97 | 43.61 | 2.39 | 6.87 | 112.08 |
| RVRMX | I | 238.01 | 6.00 | 69.90 | 4.16 | 21.45 | 454.73 | I 285.14 | 19.60 | 192.15 | 1.15 | .55 | 253.55 |
| | | NBR OF CASES = | | 321 | | | | NBR OF CASES = | | 20 | | | |
| **AUG 18,1979** | | | | | | | | | | | | | |
| Z | I | 32.90 | 22.00 | 32.75 | .11 | -1.09 | 8.73 | I 43.57 | 43.00 | 43.55 | -.73 | 1.99 | 7.26 |
| AREA | I | 54.72 | 5.10 | 36.75 | 1.66 | 3.41 | 52.78 | I 84.73 | 38.60 | 71.80 | .87 | .18 | 48.74 |
| DUR | I | 18.51 | 6.00 | 11.42 | 2.17 | 5.84 | 16.47 | I 34.31 | 16.00 | 31.17 | .79 | .07 | 22.36 |
| RVOL | I | 59.91 | .42 | 7.81 | 5.25 | 37.35 | 144.99 | I 253.94 | .68 | 95.25 | 1.89 | 2.20 | 363.77 |
| RVRMX | I | 211.36 | 1.30 | 46.60 | 7.68 | 96.22 | 477.23 | I 771.11 | 5.90 | 423.65 | 2.82 | 9.34 | 1056.37 |
| | | NBR OF CASES = | | 618 | | | | NBR OF CASES = | | 26 | | | |
| **AUG 20,1979** | | | | | | | | | | | | | |
| Z | I | 38.19 | 44.80 | 39.60 | -.41 | -.96 | 8.83 | I 43.78 | 39.60 | 42.05 | -.33 | .44 | 5.54 |
| AREA | I | 69.10 | 29.60 | 58.50 | 1.24 | 1.87 | 50.16 | I 66.87 | 17.30 | 53.65 | 1.79 | 4.48 | 39.92 |
| DUR | I | 20.08 | 6.00 | 15.67 | 1.73 | 3.08 | 16.96 | I 29.94 | 16.00 | 27.00 | .32 | -1.20 | 11.95 |
| RVOL | I | 121.12 | 15.21 | 34.88 | 4.39 | 26.91 | 224.87 | I 130.39 | 6.30 | 77.38 | 3.02 | 10.12 | 189.47 |
| RVRMX | I | 434.45 | 9.40 | 186.60 | 2.47 | 8.23 | 594.00 | I 442.61 | 42.20 | 315.90 | 1.91 | 3.90 | 453.29 |
| | | NBR OF CASES = | | 599 | | | | NBR OF CASES = | | 16 | | | |
| **AUG 25,1979** | | | | | | | | | | | | | |
| Z | I | 31.28 | 21.00 | 31.73 | .08 | -.96 | 8.90 | I 39.25 | 42.50 | 40.75 | -1.12 | .84 | 6.51 |
| AREA | I | 47.79 | 16.90 | 36.40 | 2.05 | 7.26 | 40.24 | I 52.34 | 20.90 | 50.05 | .49 | 1.29 | 20.20 |
| DUR | I | 14.59 | 6.00 | 11.18 | 2.43 | 8.04 | 11.56 | I 34.75 | 11.00 | 36.00 | .59 | 1.27 | 19.04 |
| RVOL | I | 31.79 | .50 | 5.68 | 8.18 | 92.13 | 88.92 | I 52.54 | 1.90 | 37.56 | 1.23 | 1.72 | 49.28 |
| RVRMX | I | 136.11 | 6.70 | 34.10 | 3.98 | 19.72 | 272.08 | I 176.65 | 13.80 | 191.15 | .55 | -.12 | 133.29 |
| | | NBR OF CASES = | | 271 | | | | NBR OF CASES = | | 8 | | | |

*Table 8. Parameters of the frequency distributions of the characteristics of directly treated and non treated cells. (Continued)*

| | | NON-SEEDED CELLS | | | | | | SEEDED CELLS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MEAN | MODE | MEDIAN | SKEW | KURT | SD | MEAN | MODE | MEDIAN | SKEW | KURT | SD |
| AUG 28,1979 | | | | | | | | | | | | | |
| Z | I | 34.21 | 36.00 | 34.67 | -.04 | -.94 | 8.10 I | 44.23 | 45.00 | 44.80 | -.45 | -.94 | 4.24 |
| AREA | I | 47.33 | 12.10 | 38.55 | 1.43 | 2.91 | 35.09 I | 68.82 | 25.40 | 59.70 | .91 | .37 | 34.13 |
| DUR | I | 16.29 | 6.00 | 11.13 | 2.10 | 5.79 | 13.61 I | 24.77 | 26.00 | 21.67 | 1.67 | 3.37 | 16.57 |
| RVOL | I | 42.57 | .44 | 10.95 | 4.08 | 22.39 | 83.30 I | 131.59 | 6.86 | 70.62 | 2.19 | 4.78 | 157.63 |
| RVRMX | I | 166.17 | 4.80 | 67.15 | 2.76 | 9.35 | 246.80 I | 449.22 | 40.00 | 337.50 | 1.14 | .96 | 354.05 |
| | | NBR OF CASES = | | 778 | | | | NBR OF CASES = | | 31 | | | |
| AUG 29,1979 | | | | | | | | | | | | | |
| Z | I | 34.51 | 30.00 | 34.99 | -.01 | -.96 | 8.48 I | 46.60 | 46.80 | 46.85 | -.46 | -.71 | 4.65 |
| AREA | I | 61.30 | 18.80 | 51.40 | 1.29 | 1.91 | 45.45 I | 99.25 | 51.50 | 85.00 | .70 | -.28 | 56.76 |
| DUR | I | 19.43 | 6.00 | 15.78 | 1.56 | 2.60 | 15.07 I | 40.10 | 21.00 | 36.33 | .82 | .03 | 23.54 |
| RVOL | I | 70.10 | 1.10 | 14.92 | 4.48 | 27.04 | 147.51 I | 403.55 | 25.17 | 225.78 | 1.49 | 1.66 | 457.54 |
| RVRMX | I | 257.87 | 3.70 | 79.10 | 3.51 | 16.57 | 446.79 I | 1092.37 | 121.90 | 799.55 | 1.34 | 1.25 | 1027.35 |
| | | NBR OF CASES = | | 955 | | | | NBR OF CASES = | | 30 | | | |
| JUN 23,1980 | | | | | | | | | | | | | |
| Z | I | 33.86 | 23.50 | 34.05 | -.04 | -1.02 | 9.42 I | 44.47 | 36.00 | 44.20 | -.39 | -.10 | 5.13 |
| AREA | I | 61.76 | 16.30 | 42.95 | 1.71 | 3.28 | 58.62 I | 74.74 | 26.70 | 59.80 | 1.98 | 4.50 | 56.09 |
| DUR | I | 18.34 | 6.00 | 11.37 | 2.29 | 6.74 | 16.85 I | 39.00 | 36.00 | 35.50 | .75 | -1.22 | 32.49 |
| RVOL | I | 89.00 | .21 | 10.68 | 5.22 | 35.36 | 223.31 I | 145.56 | 10.68 | 65.28 | 1.74 | 3.12 | 177.97 |
| RVRMX | I | 321.07 | 1.50 | 63.75 | 3.69 | 18.56 | 624.28 I | 543.14 | 93.30 | 218.60 | 1.03 | -.07 | 507.10 |
| | | NBR OF CASES = | | 536 | | | | NBR OF CASES = | | 7 | | | |
| JUN 24,1980 | | | | | | | | | | | | | |
| Z | I | 33.57 | 38.00 | 34.28 | -.02 | -.95 | 9.98 I | 40.69 | 43.00 | 43.05 | -.91 | -.18 | 8.59 |
| AREA | I | 67.26 | 5.00 | 50.53 | 2.13 | 5.50 | 65.33 I | 86.10 | 9.00 | 82.20 | .42 | -.86 | 56.77 |
| DUR | I | 17.50 | 6.00 | 11.13 | 2.11 | 6.75 | 15.37 I | 41.77 | 31.00 | 31.67 | 2.10 | 5.88 | 36.07 |
| RVOL | I | 83.58 | .08 | 12.12 | 4.30 | 20.41 | 203.40 I | 188.33 | .52 | 67.61 | .68 | -1.04 | 201.00 |
| RVRMX | I | 353.03 | .50 | 67.90 | 4.76 | 26.35 | 826.15 I | 523.75 | 4.90 | 251.90 | .75 | -.77 | 517.40 |
| | | NBR OF CASES = | | 177 | | | | NBR OF CASES = | | 17 | | | |
| JUN 25,1980 | | | | | | | | | | | | | |
| Z | I | 31.13 | 21.00 | 30.08 | .25 | -.69 | 8.40 I | 43.95 | 50.60 | 43.55 | -1.41 | 1.74 | 8.15 |
| AREA | I | 36.88 | 13.50 | 27.05 | 1.71 | 3.54 | 32.30 I | 78.93 | 16.90 | 54.20 | .64 | -.87 | 48.64 |
| DUR | I | 12.53 | 6.00 | 10.07 | 2.13 | 5.35 | 9.69 I | 37.19 | 51.00 | 27.00 | 1.40 | 2.44 | 29.38 |
| RVOL | I | 26.33 | .51 | 3.35 | 6.31 | 46.27 | 78.56 I | 238.61 | 1.53 | 69.43 | 1.60 | 2.63 | 297.48 |
| RVRMX | I | 109.33 | 4.20 | 27.25 | 4.01 | 18.07 | 225.34 I | 659.82 | 8.60 | 277.25 | .94 | -.34 | 652.48 |
| | | NBR OF CASES = | | 206 | | | | NBR OF CASES = | | 16 | | | |

*Table 8. Parameters of the frequency distributions of the characteristics of directly treated and non treated cells. (Continued)*

| | | NON-SEEDED CELLS | | | | | | SEEDED CELLS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MEAN | MODE | MEDIAN | SKEW | KURT | SD | MEAN | MODE | MEDIAN | SKEW | KURT | SD |
| JUL 4,1980 | | | | | | | | | | | | | |
| Z | I | 35.69 | 34.50 | 36.61 | -.29 | -.58 | 7.98 | I 42.54 | 41.20 | 42.55 | -1.10 | 2.79 | 4.06 |
| AREA | I | 78.35 | 13.00 | 64.68 | 1.71 | 5.04 | 58.51 | I 91.20 | 20.60 | 81.70 | .69 | .61 | 43.07 |
| DUR | I | 13.31 | 6.00 | 10.71 | 2.90 | 14.49 | 10.92 | I 22.04 | 16.00 | 16.36 | 1.71 | 2.81 | 15.95 |
| RVOL | I | 77.11 | 2.57 | 18.56 | 4.82 | 29.74 | 174.79 | I 123.49 | 2.41 | 63.03 | 2.85 | 8.90 | 172.24 |
| RVRMX | I | 339.31 | 2.70 | 122.50 | 3.91 | 20.86 | 604.75 | I 431.75 | 19.90 | 350.55 | .98 | .25 | 303.43 |
| | | NBR OF CASES = | | 583 | | | | NBR OF CASES = | | 24 | | | |
| JUL 7,1980 | | | | | | | | | | | | | |
| Z | I | 34.26 | 35.00 | 34.27 | .07 | -.76 | 9.00 | I 44.62 | 29.80 | 46.25 | -1.13 | .63 | 6.77 |
| AREA | I | 76.66 | 40.10 | 64.93 | 1.63 | 4.00 | 54.82 | I 76.79 | 10.80 | 65.40 | .74 | -.05 | 46.15 |
| DUR | I | 14.35 | 6.00 | 10.76 | 2.39 | 7.31 | 12.21 | I 22.06 | 6.00 | 26.00 | -.25 | -1.66 | 12.17 |
| RVOL | I | 68.06 | .39 | 17.58 | 5.06 | 33.96 | 145.22 | I 178.70 | 1.48 | 113.32 | 1.93 | 3.02 | 212.57 |
| RVRMX | I | 321.59 | 1.90 | 104.70 | 3.40 | 15.43 | 552.71 | I 762.56 | 15.50 | 484.25 | 1.83 | 3.71 | 838.61 |
| | | NBR OF CASES = | | 397 | | | | NBR OF CASES = | | 16 | | | |
| JUL 8,1980 | | | | | | | | | | | | | |
| Z | I | 34.58 | 24.00 | 34.27 | .01 | -1.00 | 9.46 | I 44.84 | 49.00 | 45.00 | -.20 | -1.38 | 4.82 |
| AREA | I | 67.39 | 15.00 | 52.60 | 1.80 | 4.40 | 55.12 | I 87.63 | 32.90 | 85.90 | .93 | -.26 | 49.18 |
| DUR | I | 19.72 | 6.00 | 15.61 | 1.91 | 4.37 | 16.97 | I 33.22 | 21.00 | 27.00 | 1.36 | 2.69 | 18.78 |
| RVOL | I | 82.96 | 1.18 | 15.06 | 4.48 | 26.75 | 184.14 | I 271.76 | 12.42 | 115.25 | 1.98 | 4.51 | 344.49 |
| RVRMX | I | 314.97 | 6.90 | 90.20 | 3.43 | 15.61 | 565.51 | I 942.87 | 102.60 | 550.60 | .81 | -.62 | 887.22 |
| | | NBR OF CASES = | | 725 | | | | NBR OF CASES = | | 23 | | | |
| JUL 9,1980 | | | | | | | | | | | | | |
| Z | I | 33.26 | 25.50 | 33.48 | .05 | -1.02 | 9.17 | I 44.07 | 25.80 | 45.55 | -2.04 | 4.11 | 6.10 |
| AREA | I | 51.97 | 8.10 | 37.60 | 2.76 | 15.08 | 48.33 | I 70.88 | 15.40 | 65.30 | .94 | .91 | 39.35 |
| DUR | I | 17.18 | 6.00 | 11.24 | 1.47 | 1.82 | 13.61 | I 33.16 | 6.00 | 26.25 | 2.28 | 8.85 | 24.66 |
| RVOL | I | 58.30 | .33 | 8.62 | 5.83 | 43.81 | 149.70 | I 168.73 | 1.22 | 93.54 | 1.86 | 4.22 | 188.45 |
| RVRMX | I | 218.05 | 1.50 | 50.40 | 4.82 | 33.50 | 438.33 | I 495.96 | 11.90 | 384.90 | 1.56 | 3.15 | 429.14 |
| | | NBR OF CASES = | | 374 | | | | NBR OF CASES = | | 38 | | | |
| JUL 10,1980 | | | | | | | | | | | | | |
| Z | I | 30.90 | 21.00 | 29.98 | .34 | -.85 | 8.96 | I 40.73 | 19.50 | 44.50 | -1.39 | 2.21 | 10.82 |
| AREA | I | 32.57 | 10.40 | 24.48 | 2.43 | 8.13 | 31.28 | I 68.01 | 4.70 | 63.40 | -.16 | -1.07 | 41.81 |
| DUR | I | 16.89 | 6.00 | 11.02 | 3.60 | 19.19 | 17.68 | I 37.29 | 16.00 | 29.00 | 1.90 | 3.89 | 30.45 |
| RVOL | I | 29.12 | .23 | 3.67 | 7.44 | 75.97 | 90.99 | I 179.31 | .28 | 96.99 | 1.63 | 2.67 | 225.51 |
| RVRMX | I | 111.61 | 2.10 | 22.00 | 4.71 | 29.98 | 252.83 | I 595.10 | 1.50 | 555.30 | .77 | -1.01 | 601.92 |
| | | NBR OF CASES = | | 375 | | | | NBR OF CASES = | | 7 | | | |

*Table 8. Parameters of the frequency distributions of the characteristics of directly treated and non treated cells. (Continued)*

| | | NON-SEEDED CELLS | | | | | | SEEDED CELLS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MEAN | MODE | MEDIAN | SKEW | KURT | SD | MEAN | MODE | MEDIAN | SKEW | KURT | SD |
| JUL 12,1980 | | | | | | | | | | | | | |
| Z | I | 24.64 | 16.50 | 20.15 | .98 | -.37 | 9.67 I | 41.22 | 16.30 | 41.10 | -1.22 | 1.81 | 9.06 |
| AREA | I | 20.55 | 6.60 | 10.65 | 2.23 | 5.93 | 23.41 I | 62.67 | 33.80 | 48.30 | 1.18 | .75 | 46.45 |
| DUR | I | 13.78 | 6.00 | 10.50 | 2.83 | 8.99 | 13.37 I | 32.50 | 12.00 | 26.50 | 1.07 | .27 | 21.72 |
| RVOL | I | 13.38 | .12 | .50 | 6.42 | 48.08 | 46.96 I | 153.11 | .20 | 34.44 | 2.80 | 8.89 | 263.12 |
| RVRMX | I | 49.53 | 1.00 | 3.35 | 4.75 | 28.18 | 129.54 I | 421.47 | 2.00 | 196.85 | 1.98 | 3.83 | 537.46 |
| | | NBR OF CASES = | | 134 | | | | NBR OF CASES = | | 20 | | | |
| JUL 14,1980 | | | | | | | | | | | | | |
| Z | I | 27.71 | 17.00 | 23.35 | .80 | -.61 | 11.12 I | 41.76 | 31.00 | 44.70 | -.29 | -2.63 | 9.26 |
| AREA | I | 79.72 | 1.90 | 51.95 | 1.84 | 3.31 | 77.19 I | 107.84 | 45.40 | 95.20 | 1.36 | 1.85 | 73.80 |
| DUR | I | 15.60 | 6.00 | 10.91 | 3.96 | 26.26 | 15.50 I | 38.00 | 11.00 | 41.00 | .35 | -1.30 | 27.75 |
| RVOL | I | 79.03 | 1.43 | 3.48 | 6.12 | 46.79 | 254.61 I | 307.74 | 9.67 | 159.45 | 1.80 | 3.34 | 432.68 |
| RVRMX | I | 302.03 | 10.50 | 23.10 | 5.70 | 45.47 | 800.11 I | 529.54 | 59.90 | 321.30 | .78 | -1.39 | 554.09 |
| | | NBR OF CASES = | | 178 | | | | NBR OF CASES = | | 5 | | | |
| JUL 16,1980 | | | | | | | | | | | | | |
| Z | I | 33.91 | 24.50 | 34.60 | -.06 | -1.19 | 10.26 I | 44.22 | 41.70 | 44.60 | -1.55 | 3.50 | 7.25 |
| AREA | I | 77.63 | 3.80 | 61.00 | 1.59 | 3.41 | 66.95 I | 79.55 | 6.20 | 78.80 | .32 | -.33 | 42.31 |
| DUR | I | 14.53 | 6.00 | 10.94 | 2.44 | 7.83 | 11.87 I | 27.95 | 16.00 | 25.88 | .95 | 1.15 | 14.16 |
| RVOL | I | 95.56 | .19 | 14.21 | 5.58 | 47.74 | 224.92 I | 228.75 | .30 | 105.51 | 1.86 | 3.78 | 281.68 |
| RVRMX | I | 397.32 | 1.40 | 86.80 | 3.52 | 16.75 | 746.61 I | 805.04 | 2.70 | 474.60 | 1.02 | -.27 | 821.15 |
| | | NBR OF CASES = | | 661 | | | | NBR OF CASES = | | 21 | | | |
| JUL 29,1980 | | | | | | | | | | | | | |
| Z | I | 31.40 | 38.50 | 31.53 | .01 | -1.04 | 8.95 I | 43.33 | 44.80 | 43.50 | -1.69 | 5.33 | 6.13 |
| AREA | I | 55.01 | 32.30 | 43.75 | 1.44 | 2.69 | 45.25 I | 63.00 | 27.80 | 52.30 | .92 | .42 | 26.01 |
| DUR | I | 17.83 | 6.00 | 11.46 | 2.03 | 5.10 | 15.29 I | 41.32 | 21.00 | 35.75 | 1.06 | .30 | 26.64 |
| RVOL | I | 48.82 | .34 | 7.41 | 6.10 | 49.92 | 126.22 I | 149.56 | 2.03 | 91.42 | 1.19 | -.12 | 150.58 |
| RVRMX | I | 176.15 | .90 | 48.25 | 3.58 | 15.44 | 329.87 I | 429.07 | 11.90 | 274.90 | 1.68 | 2.43 | 408.39 |
| | | NBR OF CASES = | | 372 | | | | NBR OF CASES = | | 19 | | | |
| AUG 2,1980 | | | | | | | | | | | | | |
| Z | I | 34.25 | 37.70 | 34.70 | -.17 | -.99 | 8.81 I | 40.50 | 36.80 | 40.85 | -.27 | -.61 | 6.40 |
| AREA | I | 54.25 | 5.60 | 44.55 | 1.14 | 1.16 | 42.81 I | 61.47 | 5.90 | 40.55 | .97 | -.46 | 50.45 |
| DUR | I | 20.50 | 6.00 | 15.86 | 1.41 | 1.62 | 16.42 I | 29.56 | 16.00 | 21.17 | 1.75 | 3.74 | 23.50 |
| RVOL | I | 55.60 | .19 | 10.85 | 3.47 | 14.76 | 106.30 I | 114.87 | .51 | 23.98 | 1.76 | 2.23 | 170.76 |
| RVRMX | I | 202.71 | 5.80 | 61.25 | 3.07 | 12.09 | 319.22 I | 356.39 | 5.90 | 127.55 | 1.66 | 1.80 | 467.19 |
| | | NBR OF CASES = | | 342 | | | | NBR OF CASES = | | 32 | | | |

*Table 8. Parameters of the frequency distributions of the characteristics of directly treated and non treated cells. (Continued)*

| | | NON-SEEDED CELLS | | | | | | SEEDED CELLS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MEAN | MODE | MEDIAN | SKEW | KURT | SD | MEAN | MODE | MEDIAN | SKEW | KURT | SD |
| AUG 3,1980 | | | | | | | | | | | | | |
| Z | I | 32.88 | 17.00 | 32.35 | .07 | -1.32 | 11.18 | 41.15 | 50.00 | 42.65 | -1.12 | 1.34 | 7.65 |
| AREA | I | 60.45 | 1.90 | 47.35 | 1.80 | 4.38 | 50.50 | 62.87 | 82.20 | 54.15 | .70 | -.62 | 41.76 |
| DUR | I | 16.85 | 6.00 | 11.23 | 2.07 | 5.76 | 14.33 | 27.36 | 36.00 | 26.50 | .12 | -.44 | 12.85 |
| RVOL | I | 81.95 | .07 | 10.08 | 5.92 | 51.61 | 200.49 | 125.30 | .36 | 43.39 | 1.33 | .85 | 150.72 |
| RVRMX | I | 331.62 | 4.80 | 61.75 | 3.73 | 19.19 | 632.62 | 509.57 | 1.90 | 152.25 | 1.31 | 1.22 | 599.02 |
| | | NBR OF CASES = | | 694 | | | | NBR OF CASES = | | 22 | | | |
| AUG 4,1980 | | | | | | | | | | | | | |
| Z | I | 32.74 | 20.50 | 33.00 | -.01 | -1.08 | 9.25 | 39.92 | 42.00 | 41.97 | -.40 | -1.22 | 6.45 |
| AREA | I | 52.87 | 6.50 | 37.20 | 2.51 | 10.87 | 48.06 | 49.62 | 10.30 | 43.10 | 1.03 | .58 | 31.80 |
| DUR | I | 19.44 | 6.00 | 14.00 | 2.01 | 3.53 | 18.39 | 27.09 | 21.00 | 21.00 | 1.95 | 4.67 | 22.05 |
| RVOL | I | 60.14 | .93 | 6.92 | 4.15 | 19.87 | 146.70 | 66.35 | 1.06 | 26.78 | 1.89 | 2.76 | 89.21 |
| RVRMX | I | 180.86 | 8.50 | 48.10 | 2.83 | 9.27 | 308.59 | 228.16 | 8.40 | 130.00 | 1.32 | .63 | 246.10 |
| | | NBR OF CASES = | | 177 | | | | NBR OF CASES = | | 23 | | | |
| AUG 18,1980 | | | | | | | | | | | | | |
| Z | I | 32.67 | 38.50 | 32.20 | .12 | -1.04 | 8.92 | 43.36 | 47.30 | 45.03 | -.90 | -.05 | 5.90 |
| AREA | I | 51.62 | 3.90 | 40.63 | 1.88 | 5.46 | 42.83 | 75.06 | 23.30 | 75.80 | .42 | -.51 | 32.28 |
| DUR | I | 17.89 | 6.00 | 14.94 | 2.05 | 5.31 | 14.55 | 30.69 | 41.00 | 26.33 | 1.35 | 2.41 | 20.62 |
| RVOL | I | 51.07 | .47 | 7.88 | 4.45 | 24.77 | 117.19 | 206.59 | 1.47 | 113.74 | 1.94 | 3.88 | 252.41 |
| RVRMX | I | 180.97 | 3.90 | 45.20 | 3.10 | 11.24 | 323.16 | 587.87 | 16.60 | 523.70 | 1.34 | 1.93 | 542.95 |
| | | NBR OF CASES = | | 513 | | | | NBR OF CASES = | | 29 | | | |
| AUG 22,1980 | | | | | | | | | | | | | |
| Z | I | 28.99 | 34.20 | 28.70 | .15 | -1.26 | 10.25 | 42.35 | 38.80 | 40.95 | -.04 | -4.33 | 3.33 |
| AREA | I | 29.15 | 2.00 | 20.70 | .71 | -.20 | 24.63 | 74.38 | 55.00 | 67.65 | 1.57 | 2.94 | 22.69 |
| DUR | I | 18.42 | 6.00 | 11.08 | 1.97 | 4.15 | 17.09 | 32.50 | 31.00 | 31.00 | 1.24 | 2.39 | 6.76 |
| RVOL | I | 17.66 | .10 | 2.43 | 3.59 | 15.79 | 33.36 | 92.97 | 35.75 | 73.73 | 1.32 | 1.76 | 64.83 |
| RVRMX | I | 78.82 | .50 | 18.10 | 1.99 | 4.15 | 114.97 | 278.78 | 120.30 | 195.45 | .15 | -4.22 | 159.17 |
| | | NBR OF CASES = | | 33 | | | | NBR OF CASES = | | 4 | | | |
| AUG 26,1980 | | | | | | | | | | | | | |
| Z | I | 28.04 | 17.00 | 25.35 | .82 | -.12 | 9.10 | 39.12 | 40.00 | 41.10 | -.55 | -.96 | 7.32 |
| AREA | I | 46.87 | 3.80 | 30.05 | 2.11 | 4.64 | 49.82 | 62.57 | 6.30 | 61.80 | 1.11 | 2.07 | 39.49 |
| DUR | I | 16.25 | 6.00 | 10.83 | 2.76 | 9.85 | 16.62 | 27.94 | 31.00 | 26.25 | .59 | -.55 | 18.80 |
| RVOL | I | 41.24 | .32 | 2.79 | 5.05 | 28.00 | 135.86 | 89.72 | .64 | 58.23 | 2.09 | 5.04 | 112.78 |
| RVRMX | I | 144.97 | 2.00 | 18.45 | 5.00 | 28.10 | 421.45 | 291.95 | 5.80 | 192.60 | 1.09 | .10 | 298.80 |
| | | NBR OF CASES = | | 250 | | | | NBR OF CASES = | | 17 | | | |

*Table 8. Parameters of the frequency distributions of the characteristics of directly treated and non treated cells. (Continued)*

| | NON-SEEDED CELLS | | | | | | SEEDED CELLS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUG 29,1980 | MEAN | MODE | MEDIAN | SKEW | KURT | SD | MEAN | MODE | MEDIAN | SKEW | KURT | SD |
| Z I | 32.59 | 42.00 | 32.58 | .00 | -1.29 | 10.04 I | 41.18 | 44.00 | 42.55 | -1.33 | 1.69 | 6.66 |
| AREA I | 76.60 | 2.00 | 55.65 | 1.97 | 6.36 | 73.63 I | 68.15 | 61.10 | 64.45 | .46 | .55 | 32.07 |
| DUR I | 17.15 | 6.00 | 11.22 | 3.37 | 23.05 | 15.39 I | 25.81 | 31.00 | 24.50 | .47 | -.10 | 13.60 |
| RVOL I | 85.42 | .17 | 9.03 | 5.65 | 46.02 | 217.93 I | 78.14 | .47 | 54.30 | 1.53 | 2.14 | 77.67 |
| RVRMX I | 318.24 | 1.60 | 54.65 | 3.69 | 18.29 | 623.06 I | 316.19 | 4.40 | 307.35 | .68 | -.30 | 233.38 |
| | NBR OF CASES = | | 830 | | | | NBR OF CASES = | | 26 | | | |

*Table 8. Parameters of the frequency distributions of the characteristics of directly treated and non treated cells. (Continued)*

| | NON-SEEDED CELL HEIGHTS | | | | | | SEEDED CELL HEIGHTS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MEAN | MODE | MEDIAN | SKEW | KURT | SD | MEAN | MODE | MEDIAN | SKEW | KURT | SD |
| AUG 20,1979 I | 7.51 | 6.25 | 6.65 | .58 | -.72 | 2.84 I | 8.53 | 4.91 | 7.77 | .55 | -.95 | 16.47 |
| | NBR OF CASES = | | 855 | | | | NBR OF CASES = | | 19 | | | |
| AUG 25,1979 I | 5.89 | 5.18 | 5.35 | .98 | .67 | 1.93 I | 5.87 | 5.06 | 5.73 | -.29 | -1.09 | 16.29 |
| | NBR OF CASES = | | 151 | | | | NBR OF CASES = | | 7 | | | |
| AUG 28,1979 I | 5.69 | 5.06 | 5.25 | 1.09 | 1.18 | 2.11 I | 6.30 | 5.67 | 6.10 | 1.25 | 1.92 | 16.32 |
| | NBR OF CASES = | | 483 | | | | NBR OF CASES = | | 26 | | | |
| AUG 29,1979 I | 6.30 | 5.10 | 5.52 | 1.17 | .62 | 2.47 I | 8.05 | 5.18 | 7.42 | .49 | -.85 | 18.42 |
| | NBR OF CASES = | | 533 | | | | NBR OF CASES = | | 30 | | | |
| JUN 25,1980 I | 7.02 | 7.47 | 7.24 | .49 | -.05 | 1.99 I | 9.51 | 6.74 | 8.08 | .58 | -1.64 | 18.60 |
| | NBR OF CASES = | | 76 | | | | NBR OF CASES = | | 9 | | | |
| JUL 4,1980 I | 6.86 | 6.25 | 6.51 | .56 | .02 | 2.21 I | 7.03 | 7.32 | 7.09 | -.83 | 2.14 | 17.03 |
| | NBR OF CASES = | | 546 | | | | NBR OF CASES = | | 26 | | | |
| JUL 7,1980 I | 7.81 | 5.34 | 7.54 | .43 | -.27 | 2.32 I | 8.48 | 7.47 | 7.82 | .76 | .06 | 18.62 |
| | NBR OF CASES = | | 336 | | | | NBR OF CASES = | | 18 | | | |
| JUL 8,1980 I | 8.49 | 7.77 | 8.28 | .30 | -.09 | 2.49 I | 9.91 | 7.16 | 9.91 | .06 | -1.57 | 19.43 |
| | NBR OF CASES = | | 694 | | | | NBR OF CASES = | | 23 | | | |
| JUL 9,1980 I | 7.13 | 6.25 | 6.86 | .47 | -.26 | 2.57 I | 8.10 | 7.10 | 7.48 | .31 | -.24 | 23.33 |
| | NBR OF CASES = | | 286 | | | | NBR OF CASES = | | 38 | | | |
| JUL 10,1980 I | 6.81 | 3.81 | 6.13 | .74 | -.27 | 2.92 I | 9.24 | 11.43 | 8.69 | .06 | -1.25 | 30.45 |
| | NBR OF CASES = | | 145 | | | | NBR OF CASES = | | 7 | | | |
| JUL 12,1980 I | 6.05 | 4.48 | 6.33 | .02 | -.87 | 2.14 I | 8.10 | 6.61 | 7.77 | .56 | -.43 | 18.39 |
| | NBR OF CASES = | | 82 | | | | NBR OF CASES = | | 23 | | | |
| JUL 14,1980 I | 8.37 | 7.62 | 8.18 | .21 | .03 | 2.35 I | 9.67 | 6.13 | 9.95 | -.56 | .62 | 24.96 |
| | NBR OF CASES = | | 140 | | | | NBR OF CASES = | | 4 | | | |
| JUL 16,1980 I | 8.04 | 5.94 | 7.79 | .32 | -.71 | 2.70 I | 8.97 | 6.92 | 8.43 | -.31 | -1.17 | 12.68 |
| | NBR OF CASES = | | 465 | | | | NBR OF CASES = | | 20 | | | |
| JUL 29,1980 I | 6.92 | 5.94 | 6.66 | .61 | .30 | 2.08 I | 8.26 | 5.64 | 6.58 | .80 | -.39 | 27.11 |
| | NBR OF CASES = | | 370 | | | | NBR OF CASES = | | 18 | | | |
| AUG 2,1980 I | 7.59 | 7.47 | 7.52 | .23 | .22 | 2.18 I | 8.31 | 4.05 | 8.70 | 0.00 | -.93 | 20.14 |
| | NBR OF CASES = | | 493 | | | | NBR OF CASES = | | 26 | | | |
| AUG 3,1980 I | 8.07 | 7.47 | 7.63 | .39 | -.45 | 2.70 I | 7.24 | 2.47 | 6.74 | 1.06 | .43 | 14.25 |
| | NBR OF CASES = | | 829 | | | | NBR OF CASES = | | 23 | | | |
| AUG 4,1980 I | 7.49 | 8.32 | 7.35 | .30 | -.69 | 2.74 I | 7.21 | 3.81 | 7.10 | -.06 | -.80 | 19.54 |
| | NBR OF CASES = | | 171 | | | | NBR OF CASES = | | 20 | | | |
| AUG 18,1980 I | 6.96 | 4.42 | 6.44 | .96 | .50 | 2.70 I | 9.60 | 11.49 | 11.28 | -.48 | -1.30 | 20.39 |
| | NBR OF CASES = | | 541 | | | | NBR OF CASES = | | 27 | | | |
| AUG 22,1980 I | 5.61 | 2.77 | 5.50 | .70 | 2.66 | 1.40 I | 6.18 | 6.58 | 6.58 | -1.93 | 3.80 | 10.81 |
| | NBR OF CASES = | | 20 | | | | NBR OF CASES = | | 4 | | | |
| AUG 26,1980 I | 6.54 | 5.09 | 5.87 | 1.11 | .77 | 2.58 I | 6.71 | 3.66 | 6.25 | .51 | -.67 | 19.30 |
| | NBR OF CASES = | | 192 | | | | NBR OF CASES = | | 17 | | | |
| AUG 29,1980 I | 8.51 | 7.47 | 8.07 | .13 | -.77 | 2.83 I | 9.27 | 5.49 | 8.87 | .31 | -.78 | 11.83 |
| | NBR OF CASES = | | 645 | | | | NBR OF CASES = | | 23 | | | |

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Appendix A.

# CHAPTER I INTRODUCTION TO CELLS ANALYSIS SOFTWARE PACKAGE

## ABSTRACT

The CASP (Cells Analysis Software Package) is a group of computer programs that analyze digital volume scan and PPI radar data. CASP breaks the digital radar echo data into cells and clusters of cells. Every cell and cluster is tracked through all of its lifetime, and physical and dynamical parameters are assigned to it (for instance, water yield, max height, max rain intensity, number of cells in the cluster).

CASP runs on the CDC Boulder computer. CASP has been adjusted to process the special format of the MPS-4 and WSR-57 radars in Miami.

The basic programs, which produce the reflectivities and cloud top maps, were written by Raul Lopez and David Blanchard.

## THE INPUT DATA

CASP uses the MPS-4 volume scans to obtain the cloud top heights. Because of the large horizontal beamwidth ($4^{o}$), the reflectivity values of the MPS-4 radar are not accurate enough. The base scan reflectivities are taken from the WSR-57 radar, which is located near the MPS-4 radar. The use of both radars simultaneously gives rise to the following problems:

1) The radars are not synchronized.
2) The frequency of the PPI base scans is one scan every 5 minutes: the frequency of the volume scans varies from 7 to 12 minutes, and sometimes there are gaps of 15 minutes.
3) The range delay, the distance between the range bins, and the azimuth of the $360^{o}$ ray vary slightly from day to day, and are not

identical for both radars. A careful adjustment of the radar coordinates should be done before this stage of the analysis.

There are procedures in CASP that, with the interaction of the operator, take care of those problems.

It is possible to operate CASP with WSR-57 PPI scans only. That mode of operation avoids going into the problems that are mentioned above, but all height parameters are missing in the end product.

## THE DATA PROCESSING

In this chapter there is only a brief description of the process. It will be more detailed in the operator manual.

Fig. A1 will be helpful for the understanding of the following description

There are five phases in the data processing:

I. The basic phase of obtaining the data from the raw magnetic tapes.

The program WSRMAT does this for the WSR-57 radar, and MPSMAT for the MPS-4 radar. These two programs need calibration data as input. Two other programs, WSRMAP and MPSMAP, can be used for the display of the raw data in polar matrices in an expanded cartesian form. These two last programs are the original programs that Raul Lopez and David Blanchard wrote before CASP was developed.

II. The matching and merging of the data from both radars.

The first thing to do is to look at the reflectivity maps from the WSR-57 radar and the cloud top height maps from the MPS-4 radar. This is done by using the program MAPS. The program MAPS uses as input the product of the first phase programs. If the operator

wants to print the WSR-57 data matrices he should use the product of the WSRMAT program. If he wants to print the MPS-4 data he should use the product of MPSMAT and he can choose the printing of the echo top heights or the base scan reflectivities. At this point the operator can decide what part of the data is good (no AP, for instance) and what is the maximum range that is contaminated with ground clutter.

The second step is to match the coordinates of the two radars. This is done by operating the program BREAKZ on each radar. Program BREAKZ breaks the reflectivity polar matrix of the MPS-4 or WSR-57 radar into cells and clusters, gives them ID numbers and assigns to them certain physical parameters. The parameters that are most relevant at the matching step are the polar coordinates of the peaks of the cells. The operator should operate BREAKZ with the options of printing the cell and cluster's parameters and polar DBZ matrices and cell for the desired time span. Now it is possible to identify the same cells in both radars and to find the difference in the coordinates for different ranges. The MPS-4 radar coordinates are chosen to be the reference, and the correction should be computed for the WSR-57 radar. Three coefficients are to be computed:

1) The difference in azimuth.
2) The difference in range delay.
3) The number which when multiplied by the WSR-57 range (in range bins units) produces the range correction for that range.

Those three coefficients should be fed to WSRMAT program, rerun WSRMAT

and then rerun BREAKZ on the last WSRMAT run product. Then compare the last run of BREAKZ on WSR-57 data with the BREAKZ run on MPS-4 data, and verify that there is a complete match of the addresses. If not, correct the coefficients and repeat the procedure. It is very important to get the best possible fit. A one-grid-point difference in the coordinates can cause loss of height information of many cells, or relating one cell's height data to its neighbor. When the operator is sure that he has the best match of the WSR-57 to the MPS-4, he can merge both data files to one file which includes all the reflectivity and height information of both radars. The merging is done by operating the program RADARS. Since the frequency of the MPS-4 scans is lower than that of the WSR-57 radar, some WSR-57 DBZ scans remain without height data. The heights for those maps should be interpolated from the neighboring maps, using program INTERH on the product file of program RADARS.

III. Break down the data matrix into cells and clusters of cells.

The program BREAKR gets as input the product of RADARS or INTERH. BREAKR breaks the polar matrix into cells and clusters and computes physical parameters for them. BREAKR provides an option for elimination of the ground clutter. If there are no MPS-4 data for a certain day, it is possible to operate the program BREAKZ on the product of WSRMAT, and to get the same analysis as that done by BREAKR, except for the parameters that concern the echo tops height. In that case the operator can skip the matching step in phase II. If the operator wishes to look at the cellular structure of the

cloud tops surface, he can operate program BREAKH on the product of MPSMAT, and get the same kind of analysis BREAKZ does.

IV. Tracking cells and clusters from map to map.

Program LIFE does the tracking. It gets as input the product of BREAKR or BREAKZ. LIFE gives to each cell and cluster identity numbers which are common from scan to scan through the whole life history of the cell or cluster. Each cell and cluster in every map also gets a status code which marks it as a merger, split, simple continuation, new birth or other possibilities. LIFE produces two data files; one is for the cells and one for the clusters. A by-product of the run of LIFE is a list of mean vector of cell motion for every PPI scan.

The program REWRIT gets as input the product of LIFE. REWRIT sorts the clouds according to their identity, and finds whole life-time parameters like duration, maximum reflectivity attained, etc. REWRIT handles the cells or clusters data files separately according to the choice of the operator.

V. The statistics and final results phase.

The SPSS statistical package can handle the product of REWRIT. The operator can select or reject cells according to specified limits on the values of the 62 parameters or combinations thereof of the cells or clusters that are produced by REWRIT.

The program TABLE selects and prints parameter tables according to the operator's instructions. TABLE gets as input the product of REWRIT.

If the operator wants to have the cloud parameters along its life history, he can operate program GRAF on the product of REWRIT. GRAF prints the reflectivity, height, and status of the cloud along its lifetime. Additional parameters are printed according to the operator's choice. The operator can eliminate the printing of clouds that lived less than a desired length of time.

CHAPTER II PROGRAM WSRMAT

TASK

WSRMAT reads the magnetic tape with the raw data of the WSR-57 radar and produces a file with polar matrices of reflectivity in dBz units for the NW quadrant of the radar.

STRUCTURE AND LOGIC

The program is a modification of the original WSR-57 Lopez/Blanchard program. It reads a calibration curve and coordinates correction coefficients, noise level, and some other optional parameters.

INPUT FILES

TAPE 1: Magnetic tape of raw data as recorded at the WSR-57 radar site.

TAPE 15 or INPUT cards:

1: Calibration curve coefficients. FORMAT (4E15.5)

2: Noise level in DVIP units. FORMAT (I5)

3: Azimuth correction. The number of degrees that is to be added to the WSR-57 azimuths, to make the coordinates fit to the MPS-4 radar. FORMAT (F5.1)

4: Range correction coefficient. The number which when multiplied by the WSR-57 range (in range-bin units) produces the number which has to be added to the WSR-57 range coordinate to make it fit the MPS-4 range. FORMAT (F7.5)

5: Range delay difference between the two radars in units of

nautical miles. This is the MPS-4 range delay minus the WSR-57 corrected range delay. FORMAT (F5.1)

6: Symbol string: not in use at this version of the program, but the card has to be there. FORMAT (41A1)

7: Beginning day; beginning hour; beginning minute; ending day; ending hour; ending minute. FORMAT (2(I3, 2I2))

OUTPUT FILES

OUTPUT or TAPE 6: Prints all the input coefficients and the labels of the scans that the program encountered.

TAPE 15: The resultant polar dBz matrix. It is saved under the name DBWyddd, where

DB: units

W: WSR-57

yddd: year and julian date.

DBWyddd is written in a condensed format that is impossible to read in a straightforward manner.

CHAPTER III PROGRAM MPSMAT

TASK

MPSMAT reads the magnetic tape with the raw data of the MPS-4 radar, and produces polar matrices of base scan reflectivities in dBz units and echo top heights in hundreds of feet.

STRUCTURE AND LOGIC

The program is a modification of the original MPS-4 Lopez/Blanchard program. It reads a calibration curve, and has the option to include a range bias reflectivity threshold correction. The sensitivity of the MPS-4 radar is small, especially at high antenna elevations, because of a higher noise level. Therefore it is unable to resolve the weak sections of echoes and so loses their upper parts and underestimates their height. To make up for that problem the noise threshold for the upper scans was lowered to that of the base scan. To avoid the noise problem in the higher elevation angles of the antenna the following logic has been applied:

> A data point will not be considered noise if there is a continuous column (different heights for the same surface location) of data points having values above the base scan noise threshold and the lowermost data point is above the high antenna elevation noise level, unless the lowermost point belongs to the base scan. This logic adds a few thousand feet to the measured height, and makes is possible to discover weak clouds top heights.

The option of supressing the range bias reflectivity threshold correction was added for the sake of gaining sensitivity at close ranges.

INPUT FILES

TAPE 1: Magnetic tape of raw data as recorded at the MPS-4 radar site.

TAPE 15 or INPUT cards:

1: Calibration curve coefficients. FORMAT (4E15.5)

2: Noise level of the base scan in DVIP units. FORMAT (I5)

3: Tilt to be used for the base scan; tilt correction. FORMAT (2F5.1)

4: Range delay in nautical miles units; year. FORMAT (F5.1, I5)

5: Intensities symbols (not in use in this version). FORMAT (41A1)

6: Number of the sounding; Mode: 1 is for mixing ratio values, 2 for relative humidity; Number of levels. FORMAT (3I5)

N levels

Mode 1: Temperature $C^{o}$, Mix ratio ($g/m^{3}$), pressure in mb.

Mode 2: Temperature $C^{o}$, relative humidity (%), pressure in mb.

FORMAT (F8.2, E10.2, F8.0) for both modes.

6+N+1: Beginning day; beginning hour; beginning minute; ending day; ending hour; ending minute. FORMAT (2(I3, 2I2))

OUTPUT FILES

OUTPUT or TAPE 6: Prints all the input coefficients and the labels of the radar scans that the program encountered.

TAPE 15: The resultant polar dBz and cloud top height matrices. It is saved under the name DBMyddd. The letters of the name stand for dBz and height data of MPS-4 radar, year and julian date.

CHAPTER IV PROGRAM MAPS

TASK

Print out a cartesian map of reflectivities or echo top heights. The maximum reflectivity or height value within each cartesian grid (2 x 2 nmi) is coded and printed in the maps.

STRUCTURE AND LOGIC

The program can use the product of the WSRMAT or MPSMAT program. The user can specify the time interval for which he wants printed maps. If the input data file is the product of the MPSMAT program the user must specify whether he wants the base scan reflectivity maps or the echo top height maps.

INPUT FILES

TAPE 1: The product of program MPSMAT: file DBMyddd or
the product of program WSRMAT: file DBWyddd.

INPUT CARDS:

1: Time interval: hour, minute. FORMAT (4(I2, 1x))

2: First range-bin to be used. FORMAT (I3)

3: The additional noise level threshold in dBz units. FORMAT (F4.1)

4: Mode: Z for base scan reflectivity maps or H for cloud top height maps. FORMAT (A1)

OUTPUT FILES

OUTPUT: A printout of the maps.

CHAPTER V PROGRAM RADARS

TASK

Merging the MPS-4 and WSR-57 radar data into a common data file.

STRUCTURE AND LOGIC

The main program calls subroutines that read the data files produced by WSRMAT and MPSMAT (DBWyddd and DBMyddd). The subroutine that reads the DDBZWn file corrects unevenly spaced azimuths and interpolates for missing azimuths, if the gap is not too big.

The frequency of the scans of the WSR-57 radar is one per 5 minutes, and that of the MPS-4 radar is one per 7-12 minutes. Every MPS-4 scan is attached to the closest WSR-57 scan, after 2 minutes have been added to the WSR-57 scan time (to match the time of the WSR-57 PPI scan to the time by which most of the cloud tops are discovered by the volume scan). Every merged radar scan has two times. The first one is of the WSR-57 and the second time is of the MPS-4 radar. If there is no MPS-4 scan to be merged with a WSR-57 scan, the MPS-4 time will be set to zero. The program stops at the last common time.

INPUT FILES

TAPE 1: The product of the program MPSMAT: file DBMyddd.

TAPE 2: The product of the program WSRMAT: file DBWyddd.

INPUT cards:

1: Time of beginning of the merging in the format of hours, minutes. FORMAT (F5.2)

OUTPUT FILES

TAPE 2: The merged data file. The file name is DRADARn, for Data, RADARS, file number.

OUTPUT: A list of the labels of the input maps and the output merged maps. The time when the operator chose to begin is printed also.

## CHAPTER V I PROGRAM INTERH

### TASK

Program INTERH interpolates heights for WSR-57 map times that have no corresponding MPS-4 maps.

### STRUCTURE AND LOGIC

INTERH reads the product of program RADARS. The program scans the maps; if it finds a WSR-57 map that has an assigned MPS-4 time as zero (meaning that no height data are available for this map) and the two neighboring WSR-57 maps have height data, interpolation will be done.

The interpolation will be done only for grid points that have height data in both MPS-4 neighboring maps. The MPS-4 time is interpolated too, and is the mean of the times of the two neighboring maps.

### INPUT FILES

TAPE 1: DRADARn, the product of RADARS program. No input cards required.

### OUTPUT FILES

TAPE 2: The data file of the merged and interpolated radar data. The file name is DRADARn (Data, Radar, file Number). The name of the output file of program INTERH is identical to the name of the input file because the output file is supposed to replace the input file.

OUTPUT: Prints a list of all the maps.

CHAPTER VII PROGRAM BREAKZ

TASK

Program BREAKZ analyzes the polar base-scan reflectivity matrix of any of the two radars. The program breaks down the data array into cells and clusters of cells, and computes physical statistics for them. BREAKZ is capable of dealing with a maximum of 400 cells and 200 clusters per map.

STRUCTURE AND LOGIC

The main program does nothing but call the different subroutines.

Subroutine SDATA (for Set DATA to initial values) sets the variables' initial values and reads the operator instructions.

Subroutine READWSR reads the raw reflectivities matrix.

Subroutine MARK identifies the echoes. An echo is defined as the group of neighboring data points which it is possible to enclose with a contour line that does not go between neighboring data points (including neighbors on a diagonal).

Subroutine CELPEAK identifies the cells. A cell is defined by its peak value data point. The peak of a cell is defined as the data point having a higher value than any of its eight neighbors. A cluster is an echo with two or more cells (or peaks) in it.

Subroutine CELLFIL relates the rest of the data points to one of the cells (which are defined by their peak). The division line between two cells that are in the same echo goes in the valley line of the minimum values. If there is a field of equal values the decision is made according to the shortest distance to the possible peaks.

Subroutine STATIST finds 23 parameters for the cells and 24 parameters for the echoes, as listed below:

FOR THE CELLS:

1: Cell ID

2: The ID of the echo that contains the cell

3: Cell's peak I address--range in range bin units

4: Cell's peak J address--azimuth in (360-270)/2 degrees

5: Cell's area in $km^2$

6: The length of the outline of the cell, which is not common to other cells

7: Rain volume rate in thousands of cubic meters per hour

8: Rain center of gravity I address

9: Rain center of gravity J address

10: Mean reflectivity

11: Max reflectivity

12: Number of grid points that make up the cell

13: Max rain intensity

14: Mean rain intensity

15: Cartesian X address of the rain center of gravity
(Origin located at 100+ range delay nmi west of the radar position)

16: Cartesian Y address of the rain center of gravity

17: Cartesian X address of the peak

18: Cartesian Y address of the peak

19: Distance between the peak and the rain center of gravity in km

20: Equivalent round cell diameter in km

21: The number of cells in the echo that the cell belongs to. In the printout this parameter is replaced by the fraction of the area with reflectivity greater than 50% of peak reflectivity.

22: Length of map edge within the cell in km

23: Azimuth from peak to rain center of gravity

FOR THE ECHOES:

1: Echo ID number

2: Mean rain intensity

3: Number of cells

4: Area of the holes in the cloud

5: Area of the echo

6: Length of the outline of the echo

7: Rain volume rate in thousands of cubic meters per hour

8: Cartesian X coordinate of the rain center of gravity

9: Cartesian Y coordinate of the rain center of gravity

10: Mean reflectivity

11: Maximum reflectivity

12: Number of grid points that make up the echo

13: Maximum rain intensity in mm/hr

14: Interiorness of the echo (area/perimeter)

15: Distance between the rain center of gravity and the peak

16: Cartesian X coordinate of the peak

17: Cartesian Y coordinate of the peak

18: Circle equivalent diameter

19: Mean area of the cells in the echo

20: Percentage of area with dBz greater than 50% of peak reflectivity

21: Length of map edge within the echo

22: Echoes peak I address

23: Echoes peak J address

24: Azimuth from peak to rain center of gravity

INPUT FILES

TAPE 1: The reflectivity polar matrix. Can be DMPSZHn or DDBZWn.

INPUT: The operator instructions on card images.

1: Initial and final analysis times. Hours.Minutes. FORMAT (4(I2, 1X))

2: Last 2 digits of the year of the data. FORMAT (I2)

3: Additional noise level threshold in dBz units. FORMAT (F4.1)

4: Printout mode. 0 for maps labels only. 1 for statistics tables. 2 for statistics, raw polar matrices, and cells identification matrices. FORMAT (I1)

5: The first range bin to be analyzed (in order to eliminate ground clutter) and its time interval. (Beginning hour, minute; ending hour, minute, range-bin) FORMAT (4(I2,1x), I3) This card can be repeated as many times as required for different ranges during the day. The time intervals should be contiguous and cover the entire time period that was defined in card #1. If the times are erroneous the program will stop with a proper message.

OUTPUT FILES

TAPE 2: The product of BREAKZ, which includes all the statistics, the identification matrix, and raw data matrix (in DBZX10). The file name is BRZyddd. (BReakZ: year, julian day).

OUTPUT: Three different options of printouts. The options are described in input card number 4.

CHAPTER VIII PROGRAM BREAKH

TASK

Program BREAKH analyzes the polar cloud top height matrix of the MPS-4 radar. The program breaks down the data points array into cells and clusters, and computes physical statistics for them. BREAKH does the same thing as BREAKZ, but with height data (units of hundreds of feet) instead of dBz units.

STRUCTURE AND LOGIC

Identical to the structure and logic of BREAKZ.

BREAKH finds these parameters:

FOR THE CELLS:

1: Cell ID

2: The ID of the echo that contains the cell

3: Cell's peak I address

4: Cell's peak J address

5: Cell's area in $km^2$

6. The length of the outline of the cell, which is not common to other cells

7: Rain volume in cubic kilometers

8: Cloud volume center of gravity I address

9: Cloud volume center of gravity J address

10: Mean height in thousands of feet

11: Max height in thousands of feet

12: Number of grid points that make up the cell

15: Cartesian X address of the cloud volume center of gravity

16: Cartesian Y address of the cloud volume center of gravity

17: Cartesian X address of the peak

18: Cartesian Y address of the peak

19: Distance between the peak and the rain center of gravity in km

20: Equivalent round cell diameter in km

21: The fraction of the area with height greater than 75% of peak height

22: Length of map edge within the cell, in km

FOR THE CLUSTERS

1: Echo ID number

2: Not used

3: Number of cells

4: Area of the holes in the echo

5: Area of the echo

6: Length of the outline of the echo

7: Echo rain volume in cubic kilometers

8: Cartesian X coordinate of the rain center of gravity

9: Cartesian Y coordinate of the rain center of gravity

10: Mean height

11: Maximum height

12: Number of grid points that make up the echo

14: Interiorness of the echo (area/perimeter)

15: Distance between the rain center of gravity and the peak

16: Cartesian X coordinate of the peak

17: Cartesian Y coordinate of the peak

18: Circle equivalent diameter

19: Mean area of the cells in the echo

20: Percentage of area with height greater than 75% of peak height

21: Length of map edge within the echo

22: Echoes peak I address

23: Echoes peak J address

INPUT FILES

TAPE 1: The MPS-4 data file - DMPSZHn.

INPUT: The operator instructions on card images.

1: Initial and final analysis times. Hours.Minutes.

FORMAT (4(I2, 1X))

OUTPUT FILES

OUTPUT: Printout of the raw height polar matrix, the cell identity matrix and all parameters.

The program BREAKH does not produce a data file.

CHAPTER IX PROGRAM BREAKR

TASK

Program BREAKR analyzes the merged height and reflectivity data from both the WSR-57 and MPS-4 radars. The program breaks down the data points of the polar array into cells and clusters of cells, and computes physical statistics for them. BREAKR is capable of dealing with 400 cells and 200 clusters per map, the same as BREAKZ and BREAKH.

STRUCTURE AND LOGIC

Identical to the structure and logic of BREAKZ. A few options were added to this version, which will be explained in the description of the input operator instructions. These options are found in the subroutine READWSR.

BREAKR finds these parameters:

FOR THE CELLS:

1: Cell ID

2: The ID of the echo that contains the cell

3: Cell's peak I address

4: Cell's peak J address

5: Cell's area in $km^2$

6: The length of the outline of the cell, which is not common to other cells

7: Rain volume rate in thousands of cubic meters per hour

8: Rain center of gravity I address

9: Rain center of gravity J address

10: Mean reflectivity

11: Max reflectivity

12: Number of grid points that make up the cell

13: Max rain intensity

14: Mean rain intensity

15: Cartesian X address of the rain center of gravity

16: Cartesian Y address of the rain center of gravity

17: Cartesian X address of the peak

18: Cartesian Y address of the peak

19: Distance between the peak and the rain center of gravity in km

20: Equivalent round cell diameter in km

21: The number of cells in the echo that the cell belongs to. This parameter is replaced by the fraction of the area with reflectivity greater than 50% of peak reflectivity in the printout

22: Length of map edge within the cell

23: Volume of cell

24: Max height in thousands of feet

25: Mean height

26: Percentage of cell area in which the rain does not reach the ground

27: Percentage of cell area for which cloud top data are missing

28: Number of grid points with cloud top data

29: Cell's summit I address

30: Cell's summit J address

31: Cartesian X address of the summit

32: Cartesian Y address of the summit

33: Cartesian X address of the height center of gravity

34: Cartesian Y address of the height center of gravity

35: Azimuth from peak to rain center of gravity

36: Distance from peak to summit

37: Azimuth from peak to summit

38: Cell's height center of gravity I address

39: Cell's height center of gravity J address

40: Number of grid points with reflectivity value. (Substitutes for variable 38 in the ECHO file)

FOR THE ECHOES

1: Echo ID number

2: Mean rain intensity

3: Number of cells

4: Area of the holes in the cloud

5: Area of the echo

6: Length of the outline of the echo

7: Rain volume rate in thousands of cubic meters per hour

8: Cartesian X coordinate of the rain center of gravity

9: Cartesian Y coordinate of the rain center of gravity

10: Mean reflectivity

11: Maximum reflectivity

12: Number of grid points that make up the echo

13: Maximum rain intensity in mm/hr

14: Interiorness of the echo (area/perimeter)

15: Distance between the rain center of gravity and the peak

16: Cartesian X coordinate of the peak

17: Cartesian Y coordinate of the peak

18: Circle equivalent diameter

19: Mean area of cells in the echo

20: Percentage of area with dBz greater than 50% of the peak

21: Length of map edge within the echo

22: Echo's peak I address

23: Echo's peak J address

24 - 39: The same as for the cells

INPUT FILES

TAPE 1: The merged radars data file - DRADARn.

The file can be a product of program RADARS or of program INTERH.

INPUT: The operator instructions on card images:

1: Initial and final analysis time. Hour.Minutes.
FORMAT (4(I2, 1X))

2: Last two digits of the year of the data. FORMAT (I2)

3: Additional noise level threshold in dBz units. FORMAT (F4.1)

4: Printout mode. 0 for maps labels only. 1 for statistics tables. 2 for statistics tables, raw polar matrices, and cells identification matrices. FORMAT (I1)

Four cards are used to eliminate ground clutter and AP in various ways. The maximum range bin up to which the following criteria will be applied:

5: Reflectivity data points will be rejected if they do not

appear in that same grid point in both radars. FORMAT (I3)

6: Echo top in hundreds of feet, below which the echo is considered ground clutter. FORMAT (I3)

7: Range bin up to which reflectivity is used only if there are height data for the same grid point. FORMAT (I3)

8: Range bin up to which MPS-4 reflectivity data is used instead of the WSR-57 reflectivity. FORMAT (I3)

9: Mode of cloud top height analysis. 1 to include the grid points that have height without base scan reflectivity data. 0 for excluding them. The use of option "1" is recommended in order not to lose the heights of tilted clouds and in order to correct any imperfect matching of the two radars. The WSR-57 cells' areas can be later extracted by AREA* RAINUP/100. FORMAT (I1)

10: The same as card #5 in BREAKZ.

OUTPUT FILES

TAPE 2: The product of BREAKR, which includes all the statistics, the cells identification matrices, and the raw data matrices. The file name is BRRyddd. (BReakR, year, julian day).

OUTPUT: Three different options of printouts. The options are described in input card number 4.

CHAPTER X PROGRAM LIFE

TASK

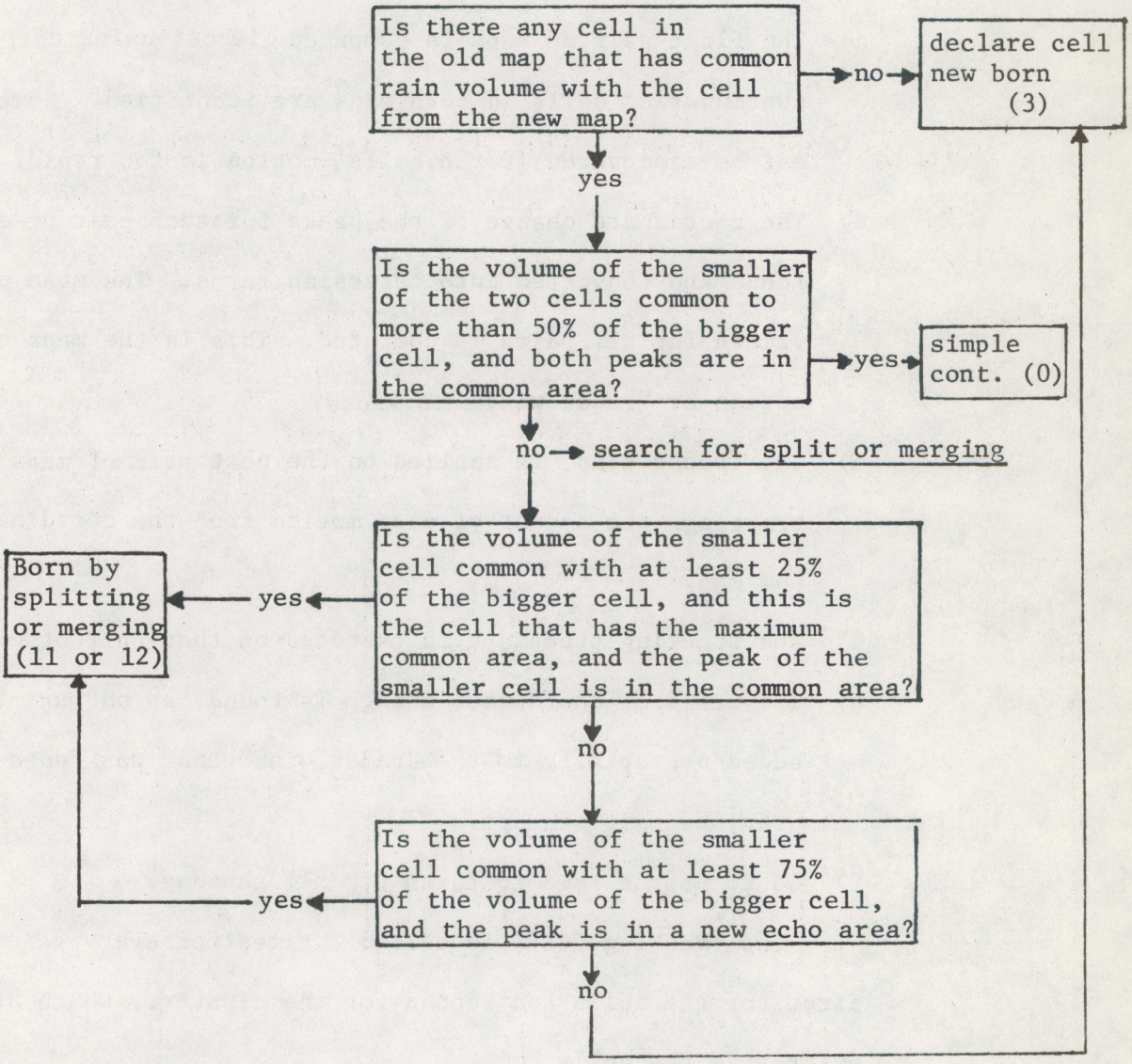
Program LIFE tracks the cells and clusters of cells throughout their life history; it also finds the status of the cells (mergers, splits, etc.). LIFE can use the data of either one or both radars. It is capable of dealing with up to 200 cells per radar scan. In case of scans with more than 200 cells and up to 400 cells, an extended mamory version named LIFE400 should be used.

STRUCTURE AND LOGIC

The program has a main program that does all the input-output and controls the operation of the CELLS subroutine. The CELLS subroutine does the tracking. The logic of the tracking procedure is as follows:

1) A pair of sequential maps are compared, and for every possible pair of cells (one from each map) the following parameters are found:
   a) Common rain volume rate.
   b) Number of cells from the first map that have any common area with each cell of the second map and vice versa.
   c) Identity of the cell from the first map that has the largest common rain volume rate with each cell in the second and vice versa.
2) In general, for every cell of the later map a source cell (a cell is a source for the cells in the next map that overlap significantly with it) is searched for in the previous map. If only one source cell is found, and this cell is the source cell for only one cell

in the later map, the later map cell will get a status of simple continuation. If there are 2 or more daughter cells to a source cell, they will get a status of split. If there are 2 or more source cells to a common daughter cell it will get a status of merger. If a cell in the later map has no source cell it will get a status of a simple new birth. The procedure is explained in more detail in the following flow chart:



If in the area of a continuing cell (status 0), there were 2 or more peaks of cells in the previous map it is declared as a merger (1). If in the area of a cell there are 2 or more peaks of cells in the next map, and one of them is declared already as a continuation (0) of the first cell, that cell's status will be changed to a split (2).

If the cells move too fast, the tracking logic can fail. To make up for that problem the following procedure has been applied:

a) The first pair of maps is compared without using corrections, and pairs continuation cells in both maps are identified. Some pairs will not be discovered if the cells' motion is too rapid.

b) The coordinate change of the peaks for each pair of cells is found and converted into cartesian terms. The mean of those values for all pairs is computed. This is the mean cells' motion or "radar wind" in knots.

c) The "radar wind" is applied on the next pair of maps by subtracting the amount of mean motion from the coordinates of the new map.

d) The tracking procedure is executed on that pair of maps.

e) The residual coordinate change is found, as on part 2, and added vectorially to the "radar wind" that was found in the previous pair of maps.

f) Go to part c and so forth for all the day.

The tracking CELLS is called 2 times for every pair of maps: first for the cells and second for the clusters, which are treated exactly as the cells.

The "radar wind" is found from the cells data only.

The "radar wind" velocity is underestimated by a small value because the change in coordinates can be an integer only, and the additional movement on the fraction of a grid point cannot be detected.

INPUT FILES

TAPE 1: The input data file. This is the resultant data file of the programs BREAKZ or BREAKR, and its name is BRZyddd or BRRyddd.

INPUT: Operator instructions on a card image: PRINTOUT mode: 0--no print-out. 1--only motion vectors. 2--all tracking data. Free format.

OUTPUT FILES

TAPE 2: The output data of the cells. The name of the file can be DLIFCZn or DLIFCRn: Data LIFe Cells from breakZ or breakR programs. The parameters of the cells are identical to those from the input file, with 10 additional parameters that are used for the tracking, namely:

1) NMAP - serial number of the scan.
2) RJULDT - Count data.
3) IRTIME - WSR-57 time.
4) IRMTIME - MPS-4 time.
5-10) ID, NOLD, IDOLD, STATUS, RVOL, TBIRTH. Those parameters are explained later in the printout section.

TAPE 3: The same as tape 2, but for the clusters. Hence, the name of this file should be DLIFEZn or DLIFERn (Data LIFe Echoes from BreakZ or from BreakR). TAPE 2 and TAPE 3 are only intermediate data files for the next program.

OUTPUT: Printout of the tracking data and of the "radar wind" for every map.

The following parameters are printed:

NO - Serial number of the echo/cell.

ID - Identity of the echo/cell.

NOLD - Number of old echoes/cells which have common area with the new one.

IDOLD - The identity of the old echo/cell which has the largest common volume with the new one.

Status -

Key to the status code:

0 - Simple continuation.

1 - Merger.

2 - Split.

3 - Simple birth.

11 - Birth by merging.

12 - Birth by splitting.

FORSTAT - Forward status.

Key to the code:

0 - Simple continuation.

1 - A source for merging.

2 - A source for splitting.

3 - Simple death.

RVOL - The volume which is common to the new echo/cell and to the same echo/cell in the previous map.

TBIRTH - The time (hour*60 + minutes) of the echo/cell birth in minutes.

These parameters are printed for the cells and the clusters separately.

The radar wind is in units of azimuth and knots.

CHAPTER XI PROGRAM REWRIT

TASK

Program REWRIT reads the tracking data of cells and clusters as produced by program LIFE. REWRIT finds lifetime parameters for the cells and the clusters, and writes a data file that can be read by any statistical package. The program has to be executed separately on the cells and the clusters data.

STRUCTURE AND LOGIC

The input file contains one record of data for each cell/cluster for every map. If one wants to get the life history of a certain cell, he should read the whole input data file and so on for every cell.

To solve this problem, REWRIT sorts the records of the cells and clusters data according to their identity numbers. This is done by using the CDC utilities READMS and WRITMS which read and write records on a random access file.

When the file is sorted, the program scans it sequentially and finds the lifetime parameters of the cells and clusters, and rewrites the data file with the additional parameters. That's the reason for the program's name: REWRITe.

Program REWRIT can recognize what is the input file and find the suitable parameters.

The lifetime parameters are written in two groups. One group has the parameter for the entire time that the cell was tracked. The other group refers only to the life history of the cell before it was merged after having split. The logic of this is the following:

The purpose of the procedure is to obtain the tracking of a precipitating cloud unit which can be physically called a cell through its entire life cycle, and to try to separate off any apparent continuation of its lifetime which could be caused by other cells forming so close together that they are confused with the original cell. In order to do the above the following assumptions are made:

1) In the growing stage, a cell can be merged with a smaller neighboring cell, and yet keep its identity as an individual cell.
2) In the decaying stage small pieces can be split from the cell, and yet the original cell can keep its identity.
3) If the cell has decayed to such an extent that pieces are split from it and it further merges with a smaller cell, then the tracking of the original cell is discontinued. The reason for this is that the new merged cell could be beginning its life cycle and it could now dominate the characteristics of the merged system, which was before the principal reflection of the original cell.

INPUT FILE

TAPE 1: There are four optional input files that result from program LIFE.

1) DLIFCZn - single radar cells data file.
2) DLIFEZn - single radar clusters data file.
3) DLIFCRn - merged radars cells data file.
4) DLIFERn - merged radars clusters data file.

Only one of the four can be run at one time.

LOCAL FILE

TAPE 2: A random access file which is used by the program as additional

virtual memory. TAPE 2 should be nonexistent before the program runs; otherwise a fatal error will occur. TAPE 2 has no use after the run, and can be returned.

OUTPUT FILES

TAPE 3: The final data file of the cells or the clusters, which includes the lifetime parameters also.

The seeding data will be appended to the file without changing its existing contents.

There are four possibilities according to the four different optional input files:

1) RCRyddd - cells from two radars.

Variable List: NMAP, RJULDT, RTIME, RMTIME, IDCEL, NOLD, TMZMAX1, STATUS, COMRVOL, TBIRTH,CELNUM, ECHONUM, IPEAK, JPEAK, AREA, OUTLINE, RVOLR, NCLM1, TNCLM1, ZMEAN, ZMAX, NPCELL, RMAX, RMEAN, NMAPZ, NMAPH,NCLM, FORSTAT, LASTAT1, LASTAT, NCELLS,EDGE, HVOL, HMAX, HMEAN, RAINUP, HMIS, NMAPZ1, AMAX, TAMAX, MAXAGE1, MAXAGE, RVOL1, RVOLALL, TNCLM, DISPH, AZPH, RVMAX, TRVMAX, NMAPH1, ZMAX1, TZMAX1, HMAX1, THMAX1, AMAX1, TAMAX1, RVMAX1, TRVMAX1, ZMAXALL, TZMAX HMAXALL, THMAX

Input Format: Fixed (1X, F5.0, F4.0, 3F5.0, F3.0, F5.0, F3.0, F7.0, F5.0, 4F4.0, 3F7.1, 2F6.1, 2F4.1/1X, F6.0, 2F5.1, 8F5.1, F8.1, 2F4.1, 2F5.1, F5.0, F8.1, 3F5.0/1X, 2F8.1, 3F6.1, F8.1, F5.0, F3.0, F4.1, F5.0, F4.1, F5.0, F8.1, F5.0, F8.1, F5.0. F4.1, F5.0, F5.1, F5.0)

2) RCZyddd - cells from one radar.

Variable List: NMAP, RJULDT, RTIME, RMTIME, IDCEL, NOLD, IDOLD, STATUS, COMRVOL, TBIRTH,CELNUM, ECHONUM, IPEAK, JPEAK, AREA, OUTLINE, RVOLR, NCLM1, TNCLM1, ZMEAN, ZMAX, NPCELL, RMAX, RMEAN, NMAPZ, NMAPH, NCLM, FORSTAT, LASTAT1, LASTAT, NCELLS, EDGE, TNCLM, NMAPZ1, AMAX, TAMAX, MAXAGE1, MAXAGE, RVOL1, RVOLALL, RVMAX, TRVMAX, NMAPH1, ZMAX1, TZMAX1, AMAX1, TAMAX1, RVMAX1, TRVMAX1, ZMAXALL, TZMAX

Input Format: Fixed (1X, F5.0, F4.0, 3F5.0, F3.0, F5.0, F3.0, F7.0, F5.0, 4F4.0, 3F7.1, 2F6.1, 2F4.1, F6.0/1X, 10F5.1, F6.9, F5.0, F8.1, 3F5.0, 3F8.1, F5.0, F3.0, F4.1/1X, F5.0, F8.1, F5.0, F8.1, F5.0, F4.1, F5.0)

3) RERyddd - clusters from two radars.

Variable List: NMAP, RJULDT, RTIME, RMTIME, IDCEL, NOLD, TMZMAX1, STATUS, LASTAT1, TBIRTH, ECHONUM, RMEAN, NCELLS, HOLE, AREA, OUTLINE, RVOLR, NMAPZ, NMAPH, ZMEAN, ZMAX, NPECHO, RMAX, NCELMAX1, TNCMAX1, NCELMAX, TNCMAX, FORSTAT, MCELLA, DBZ50, EDGE, IPEAK, JPEAK, HMAX, HMEAN, RAINUP, HMIS, NMAPZ1, AMAX, TAMAX, MAXAGE1, MAXAGE, RVOL1, RVOLRALL, LASTAT, DISPH, AZPH, RVMAX, TRVMAX, NMAPH1, ZMAX1, TZMAX1, HMAX1, THMAX1, AMAX1, TAMAX1, RVMAX1, TRVMAX1, ZMAXALL, TZMAX, HMAXALL, THMAX

Input Format: Fixed (1X, F5.0, F4.0, 3F5.0, F3.0, F5.0, F3.0, F7.0, F5.0, F4.0, F5.1, F4.0, F7.1, F8.1, F5.1, F7.1, 2F5.1, 2F4.1, F6.0, F5.1/1X, F4.0, F5.0, F4.0, F5.0, F5.1, F6.1, 3F5.1, F8.1, 2F4.1, 2F5.1, F5.0, F8.1, 3F5.0, 2F8.1/1X, 3F5.1, F8.1, F5.0, F3.0, F4.1, F5.0, F4.1, F5.0, F8.1, F5.0, F8.1, F5.0, F4.1, F5.0, F5.1, F5.0)

4) REZyddd - clusters from one radar.

Variable List: NMAP, RJULDT, RTIME, RMTIME, IDCEL, NOLD, IDOLD, STATUS, LASTAT1, TBIRTH, ECHONUM, RMEAN, NCELLS, HOLE, AREA, OUTLINE, RVOLR, NMAPZ, NMAPH, ZMEAN, ZMAX, NPECHO, RMAX, NCELMAX1, TNCMAX1, NCELMAX, TNCMAX, FORSTAT, MCELLA, DBZ50, EDGE, IPEAK, JPEAK, AZPV, NMAPZ1, AMAX, TAMAX, MAXAGE1, MAXAGE, RVOL1, RVOLALL, RVMAX, TRVMAX, LASTAT, ZMAX1, TZMAX1, AMAX1, TAMAX1, RVMAX1, TRVMAX1, ZMAXALL, TZMAX

Input Format: Fixed (1X, F5.0, F4.0, 3F5.0, F3.0, F5.0, F3.0, F7.0, F5.0, F4.0, F5.1, F4.0, F7.1, F8.1, F5.1, F7.1, 2F5.1, 2F4.1, F6.0/1X, F5.1, F4.0, F5.0, F4.0, F5.0, F5.1, F6.1, 3F5.1, F8.1, F5.1, F5.0, F8.1, 3F5.0, 3F8.1/1X, F5.0, F3.0, F4.1, F5.0, F8.1, F5.0, F8.1, F5.0, F4.1, F5.0)

VARIABLES LIST

AMAX - maximum base scan area during the whole life.

AMAX1 - maximum base scan area during the first life cycle.

AREA - area (inst).

AZPH - azimuth from peak to summit.

CELNUM - local serial number of the cell in the map.

COMRVOL - common rain volume of the cell with itself in the previous map.

DBZSO - percentage of area with reflectivity greater than 50% of the peak's reflectivity.

DISPH - distance from the peak to the summit in km.

ECHONUM - local serial number of the echo (cluster) in the map.

EDGE - the length of contact with edge of the map.

FORSTAT - forward status: 0) simple continuation, 1) a source for a merger, 2) a source for a split, 8) simple death, 9) ending due to the end of the data collection.

HMAX - maximum height (inst).

HMAX1 - maximum height during the first life cycle.

HMAXALL - maximum height during the whole life.

HMEAN - mean height (inst).

HMIS - percentage of area that has no height data.

HOLE - area of holes in the cluster, $km^2$.

HVOL - volume in $km^3$.

IDCEL - identity number.

IPEAK - range of the reflectivity peak in range bin units.

JPEAK - azimuth of the reflectivity peak in (360-270)/2 degrees.

LASTAT - forward status of the last tracking.

LASTAT1 - forward status of the last tracking in the first life cycle.

MAXAGE - time of last tracking.

MAXAGE1 - time of last tracking in the first life cycle.

MCELLA - mean cells area in the cluster in $km^2$.

NCELLS - number of cells in the cluster.

NCLM - the maximum number of cells in the cell's cluster that was reached during the whole life of the cell.

NCLM1 - the maximum number of cells in the cell's cluster that was reached during the first life cycle of the cell.

NCELMAX - the maximum number of cells in the cluster during the whole life history of the cluster.

NCELMAX1 - the maximum number of cells in the cluster during the first life cycle of the cluster.

NMAP - the serial number of the map.

NMAPH - number of scans with height data during the whole life.

NMAPH1 - number of scans with height data during the first life cycle.

NMAPZ - number of maps with reflectivity data during the whole life.

NMAPZ1 - number of maps with reflectivity data during the first life cycle.

NOLD - number of units (cells or clusters) in the previous map that have common area with the current cloud unit.

NPCELL - number of polar grid points that build the cell.

NPECHO - number of polar grid points that build the clusters.

OUTLINE - the length of the contact with clear air.

RAINUP - percentage of area without base scan reflectivity data.

RJULDT - count date.

RMAX - maximum rain intensity in mm/hr (inst).

RMEAN - mean rain intensity in mm/hr (inst).

RMTIME - MPS-4 time to the maximum reflectivity in the first life cycle.

RVMAX - maximum rain volume rate during the whole life in $m^3 x10^3 hr^{-1}$.

RVMAX1 - maximum rain volume rate during the first life cycle in $m^3 x10^3 hr^{-1}$.

RVOL1 - total rain volume in the first life cycle in $m^3 x10^3$.

RVOLALL - total rain volume in the whole life in $m^3 x10^3$.

RVOLR - rain volume rate in $m^3 x10^3 hr^{-1}$.

STATUS - status of the cloud unit: 0) simple continuation, 1) merger, 2) split, 3) simple birth, 11) birth by merging, 12) birth by splitting.

TAMAX - time of AMAX.

TAMAX1 - time of AMAX1.

TBIRTH - time of the birth.

THMAX - time of HMAXALL.

THMAX1 - time of HMAX1.

TMZMAX1 - MPS-4 time for the TZMAX1.

TNCLM - time of NCLM.

TNCLM1 - time of NCLM1.

TNCMAX - time of NCELMAX.

TNCMAX1 - time of NCELMAX1.

TRUMAX - time of RVMAX.

TRUMAX1 - time of RVMAX1.

TZMAX - time of ZMAXALL.

TZMAX1 - time of ZMAX1.

XPEAX - x coordinate of the reflectivity peak.

ZMAX - maximum reflectivity in dBz units (inst).

ZMAX1 - maximum reflectivity during the first life cycle.

ZMAXALL - maximum reflectivity during the whole lifetime.

ZMEAN - mean reflectivity (inst).

CHAPTER XII PROGRAM GRAF

TASK

Program GRAF prints the parameters that cells or clusters had during their lifetime. The operator can choose the parameters and the minimum life lengths. GRAF is compatible with all of the four forms of final data files. It is recommended to operate GRAF interactively.

STRUCTURE AND LOGIC

GRAF reads the data file with the same format of the statistic programs. It prints automatically the WSR-57 times, the status, the peak reflectivity, the height and the area of the cloud unit. GRAF asks next the minimum lifetime, in minutes, that a cloud must have for the information to be printed. GRAF asks the operator to insert the serial number of the optional variables, as it appears in the statistical program.

INPUT FILES

TAPE 1: One of the four options: RCRyddd; RCZyddd; RERyddd, REZyddd.

INPUT: Free format cards.

1: Input file code: 50 for RLIFCR; 48 for RLIFER; 23 for RLIFCZ; 24 for RLIFEZ.

2: The minimum lifetime that will be processed, in minutes.

3: The additional optional variable's serial number.

OUTPUT FILES

OUTPUT: The printout. A sample of the life history of a tracked cell, based on the GRAF output, is shown in figure A2.

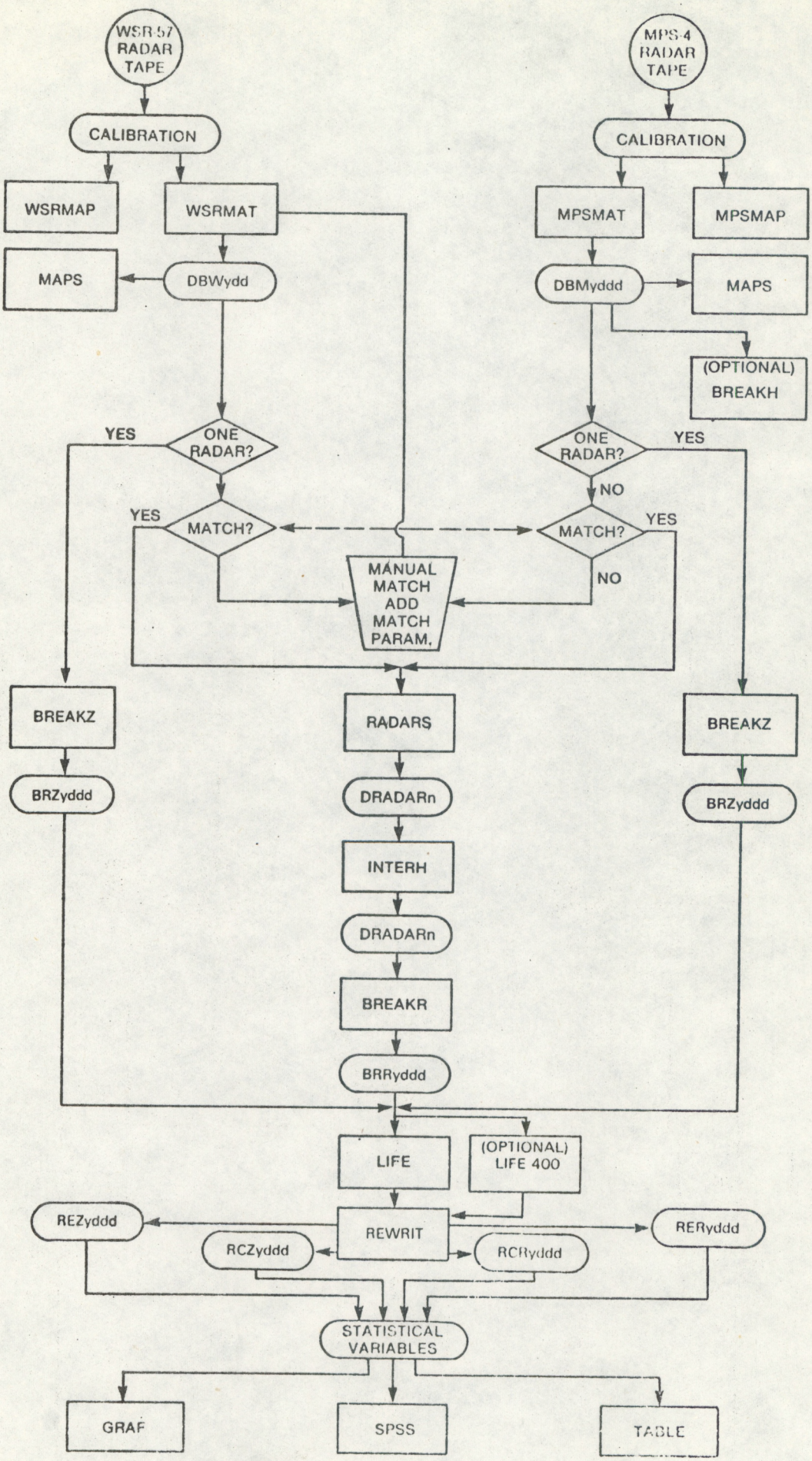



*Fig. A1. Flow chart of CASPS procedures.*

Appendix B.

## RADAR ANALYSIS OF CELLS TREATMENT

### INTRODUCTION

The main goal of the FACE experiment was to find out the influence of seeding on convective cells and cell clusters. The information required for that purpose consists of the following data sets:

1) A broad data base with statistics that describe the radar characteristics of the cells and the clusters for every day with digital radar observations. This set is produced by CASP--the Cells Analysis Software Package.

2) For every GO day there is the seeding data base, which includes the time of each cloud seeding pass, the coordinates, and the number of flares expended for each particular pass.

These two data bases have to be merged into one comprehensive data base, in a form suitable for computerized statistical analysis. SEED performs that task. It is described in the following sections. The seeding influence should be found by comparing the cell's and cluster's representative characteristics, according to the different kinds of treatment.

# PROGRAM SEED

## TASK

Program SEED reads the cells' data base which is produced by REWRIT , and the seeding coordinates data base. The matching of the coordinates of the cells and the seeding is done by running the program interactively. SEED produces 15 extra seeding parameters for each cell that it considers.

## STRUCTURE AND LOGIC

During FACE-2 the WSR-57 radar system had problems in locating correctly the observed echoes. The recorded range and azimuth of the different echoes are usually both in error. When the coordinates of the seeding passes are compared with the echo pattern a considerable part of the seeding runs appears to have been done in clear air. For that reason the first part of the SEED program is devoted to the matching of the cloud seeding coordinates to the radar cell coordinates. The matching is done by modifying the seeding coordinates according to the following formulas:

(1) $R1 = K \cdot R \cdot 1.853248 + B$

(2) $AZ1 = AZ + C$

where

R - seeding range from the radar in nautical miles.

K - range factor correction.

B - range delay correction in km.

R1 - the corrected seeding range in km.

AZ - the seeding azimuth from the radar in degrees.

C - seeding azimuth correction in degrees.

AZ1 - the corrected seeding azimuth.

The program asks for estimates of the three correction parameters (K, B, C), and produces a score for the resulting match. That score has two elements: 1) The number of seeding passes that were related to cells. 2) The number of direct hits - which is the number of seeding coordinates that fell inside the boundaries of a cell. A new set of correction parameters can then be supplied and its matching score compared with the previous one. The process should be done separately for the range and for the azimuth. A preferable way is to change one correction factor at a time in a binary seek that will bring the score to a maximum. It is not recommended to change the range factor correction (K) from the value of 1.0 unless the score does not peak significantly with the various range delay corrections.

The logic and the decisions employed in the matching procedure are described in the flow chart shown in Fig. B1. The main conditions that are used to ascertain if a seeding pass is related to a cell are these:

1) The cell was scanned at most 3 minutes before or 6 minutes after the seeding time. This assymetry in time is for the sake of those cells that are seeded while they are still too weak to be identified by the radar.

2) The distance between the seeding position and the cell's peak is less than two cell radii provided that that distance does not exceed 8 km (a 2.5-km minimum radius was assumed only for this purpose).

After the matching is done the program finds the seeding lifetime characteristics for every cell. The values of some of those characteristics (Numbers 1-9) for unmatched cells are set to zero. Their contents and format are brought out in detail later in the section "Output Files".

INPUT FILES

1) TAPE1 - The cells and cluster tracking data that were produced by REWRIT , which belongs to the CASP package. It can be one of the four possible forms of files:

   a) RCZyddd - single radar cell's data file.

   b) RCRyddd - merged radars cell's data file.

   c) REZyddd - single radar cluster's data file.

   d) RERyddd - merged radars cluster's data file.

2) TAPE2 - Seeding coordinates data file.

   The format of the seeding data is the following:

   First line includes the date in format: yymmddd, where yy stands for the last two digits of the year, mm - the month, and ddd - julian date.

   The next lines include one seeding pass data per line.

   The parameters are time, azimuth from the radar in degrees, range from the radar in nautical miles, number of flares.

   The time is four digits. The first two are the hour and the second two are the minutes.

3) INPUT - The operator's commands:

   1: The input radar data form (one out of four possibilities - RCZyddd, RCRyddd, REZyddd, RERyddd). FORMAT (I2)

   2: Range factor correction (K). Free format.

   3: Range delay correction (B). Free format.

   4: Azimuth correction (C). Free format.

   5: After computing the matching score and printing it, the program asks for the continuation mode. Answering "1" will cause another try of matching, and the operator will return to input card #2.

"2" will cause the program to take the last matching factors that were inserted and finish all the computations according to them. Free format.

OUTPUT FILES

TAPE 3 - The merged output cells and seeding data file.

There are four possibilities for the output file according to the input file. The output file name is the input file name with the first initial "R" replaced by "S" (for Seed). Hence the possible four names respectively are SCZyddd, SCRyddd, SEZyddd, SERyddd.

This file is a copy of the input file (that was produced by the REWRIT program), plus an additional line after each cell entry (there is one cell entry for each radar scan during which the cell was observed). That line includes the following 15 seeding parameters:

1) NFLARES - Number of flares that were shot into the cell at the radar scan time.
2) TBSEED - Time of first seed of the cell (in minutes).
3) TBSEED1 - Time of first seed of the cell during its first life cycle.
4) TLSEED - Time of last seed of the cell.
5) TLSEED1 - Time of last seed of the cell during its first life cycle.
6) SUMSID - Total number of flares that were shot into the cell during its whole lifetime.
7) SUMSID1 - Total number of flares that were shot into the cell during its first life cycle.
8) NPASS - Total number of seeding passes that were done during the whole lifetime of the cell.

9) NPASS1 - Total number of seeding passes that were done during the first life cycle of the cell.

10) SRB - The distance in km from the peak of the cell to the closest past seeding location.

11) SAZB - The azimuth in degrees from the peak of the cell to the closest past seeding location.

12) TSB - The time in minutes that has passed since the closest past seeding.

13) SRF - The distance in km from the peak of the cell to the closest future seeding location.

14) SAZF - The azimuth in degrees from the peak of the cell to the closest future seeding location.

15) TSF - The time in minutes that will pass until the closest future seeding.

FORMAT (1x, 15F5.0)

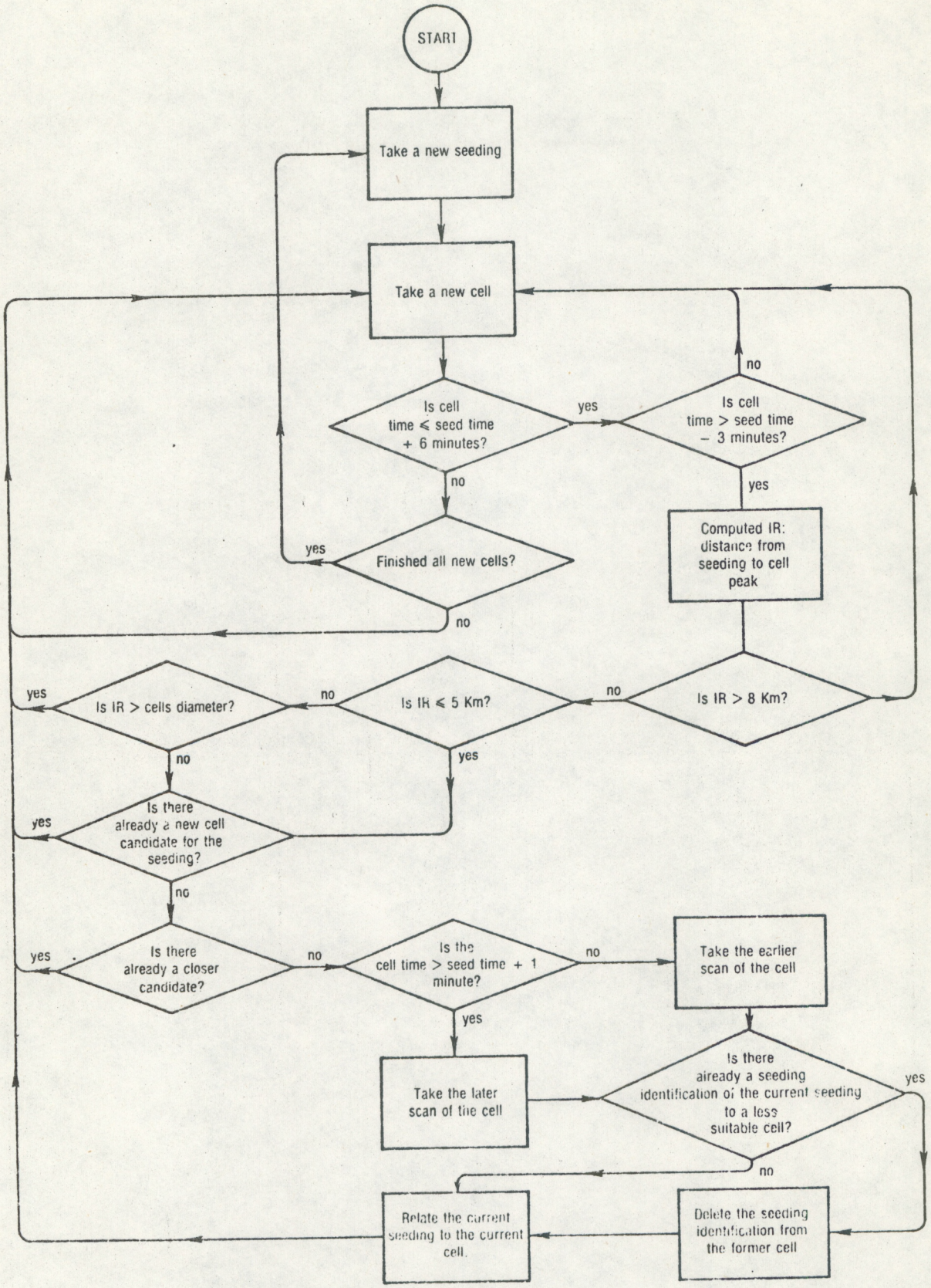



*Figure B1. Flow chart of seeding pass/cell matching procedures.*