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L Band Push Broom Microwave Radiometer—Soil Moisture Verification and Time Series Experiment Delmarva Peninsula: Data Report

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L BAND PUSH BROOM MICROWAVE RADIOMETER - SOIL MOISTURE VERIFICATION AND TIME SERIES EXPERIMENT DELMARVA PENINSULA: DATA REPORT

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ABSTRACT

In May and June, 1983, NASA and USDA cooperated in the verification of a multi-sensor aircraft system developed to study soil moisture applications. This system consisted of a three beam push broom L band microwave radiometer, a thermal infrared scanner, a multispectral scanner, video and photographic cameras and an onboard navigational instrument. Ten flights were made of agricultural sites in Maryland and Delaware with little or no vegetation cover. Comparisons of aircraft and ground measurements showed that the system was reliable and consistent. Time series analysis of microwave and evaporation data showed a strong similarity that indicates a potential direction for future research.

KEYWORDS: Soil Moisture, Remote Sensing, Microwaves, Hydrology

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1. INTRODUCTION

A principal goal of the soil moisture remote sensing research is the evaluation and development of remote sensing technology for measuring and/or monitoring soil moisture. A secondary goal is to improve existing water management procedures through the use of this technology. In some cases, the adaptation of existing procedures is necessary because conventional soil moisture surveys are impractical and, therefore, the current water management procedures have developed under the assumption that this type of data could not be obtained.

Truck and modeling experiments focus on the problems of defining optimal sensor systems and developing soil moisture estimation algorithms based on remotely sensed data. These studies allow evaluation of factors such as vegetation and soil type under well controlled conditions.

Achieving the two primary goals of the project hinges on extrapolating these experiments to airborne systems, which are prototypes of future operational systems. Significant research questions, such as the effects of scene heterogeneity and instrument sensitivity at lower resolutions, can only be addressed using airborne sensors.

Applications related objectives depend upon frequent large area coverage and rapid data turnaround. A dedicated airborne system was crucial to this line of research.

Based on these considerations, NASA and USDA cooperated in the development of an optimal sensor aircraft system that would be available for extended-dedicated periods. It includes a multibeam L band microwave radiometer, a scanning thermal infrared system, and a multispectral scanner. All systems will be time and space registered and ultimately linked to an automatic geographic referencing system.

In 1983, this aircraft sensor system was assembled. The primary purpose of the study described in this report was to verify the performance of the system. Therefore, a fairly intensive ground sampling effort was included. A secondary objective was to evaluate the potential of repetitive observation, i e., time series, in soil moisture and climate studies.

Two agricultural test sites on the Delmarva Peninsula were selected for study due to their proximity to the research team and to the aircraft staging area. One check flight was conducted over the flightlines located in Maryland on March 14, 1983. Ten additional flights were made over the Maryland site from May 12 to June 27, 1983. Eight flights were conducted over the Delaware site during the same period.

2. SITE DESCRIPTIONS

A total of five flightlines were investigated, three near Carmichael, Maryland, and two in Kent County, Delaware. All of the sites are on the Delmarva Peninsula as shown in Figure 1.

Maryland flightlines 1, 2, and 3 were located on or near the facilities of the Wye Research Center operated by the University of Maryland's Agricultural Experiment Station. Figure 2 is a black and white photograph of the area obtained on May 24, 1983, showing the field boundaries and flightlines. With the exception of March 14, 1983, all Maryland flightlines were flown west to east. Flightlines were flown at an altitude of 150 meters (500 feet) and line 2 was also flown at 300 meters (1000 feet).

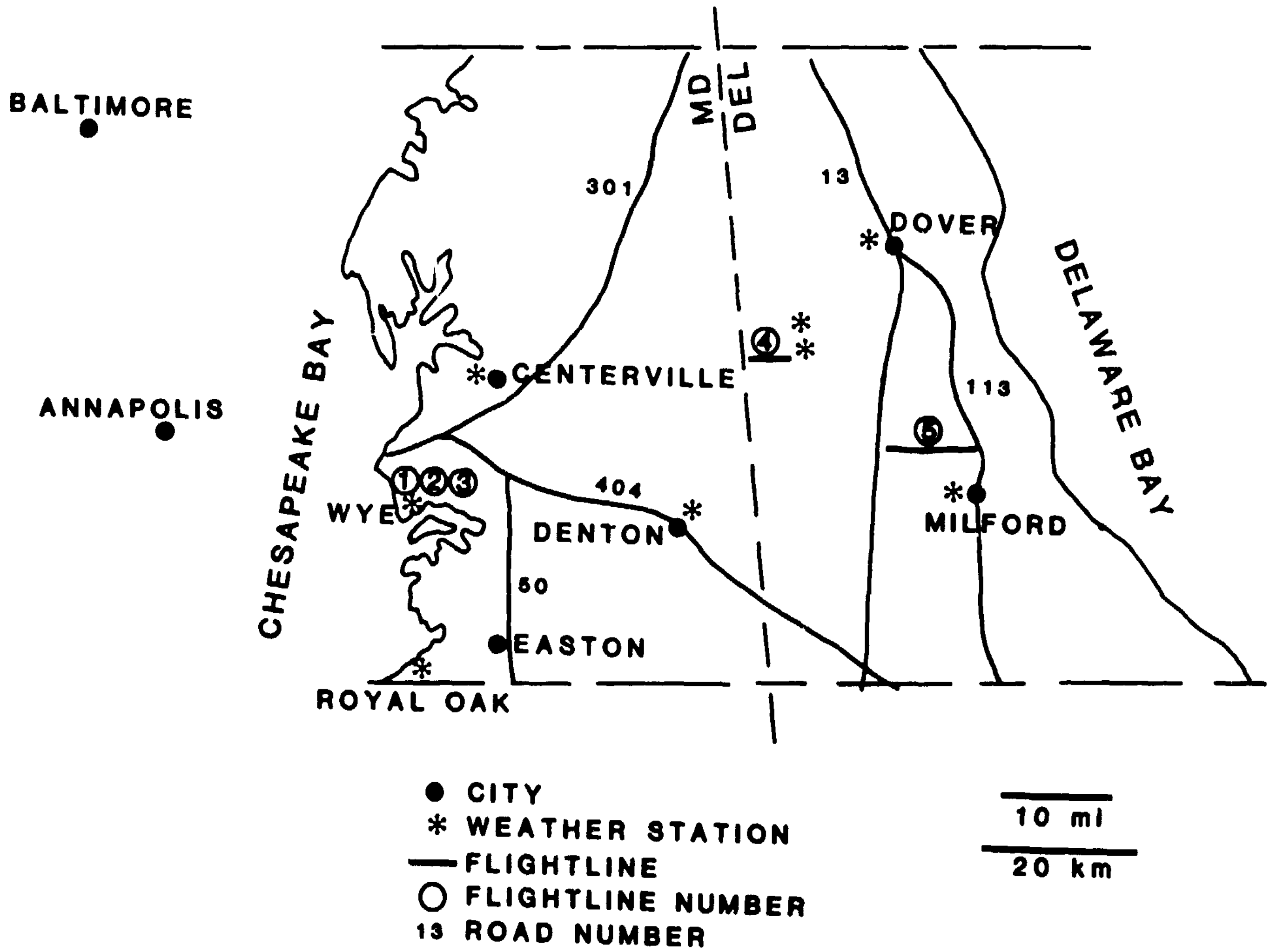

Figure 1. Delmarva stud'' area.

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Figure 2. Maryland flightlines and fields.

In March, all of the fields had corn or soybean stubble and/or weeds. During May and June a variety of bare soil conditions were present. Most of the fields were planted in corn, although, the tillage and mulch cover varied. Soils over this area were mostly silt loams. Additional details are presented in later sections.

Flightline 4 was located near Sandtown, Delaware and was flown in both directions (east to west and west to east) at 500 and 1000 foot altitudes. Field boundaries are shown in Figure 3. These fields included a variety of cover conditions over sandy loam soils. Figure 4 shows the location of flightline 5. Cover conditions at these test sites included corn and soybeans. Surface soil texture ranged from loamy sand to sandy loam. This line was flown in both directions at an altitude of 500 feet.

3. GROUND TRUTH ACQUISITION AND PROCESSING

3.1 Soil Moisture

Ground sampling at the Maryland sites was performed by personnel from USDA and NASA. Data at the Delaware sites were collected by personnel from Delaware State College.

Gravimetric soil samples were collected using a 5 cm deep scoop with a total volume of approximately 85 cm^3. The greatest number of samples were collected for the 0-5 cm soil layer. At the Maryland sites, a fewer number of samples were collected for both the 5-10 and 10-15 cm soil layer. For the Delaware sites the 5-10 cm soil layer was not sampled.

All gravimetric samples were placed in metal cans and sealed with electrical tape. These were weighed at the end of the day to obtain wet weights. Samples were then placed in a drying oven at 104°C for 24 hours and reweighed to obtain dry weights.

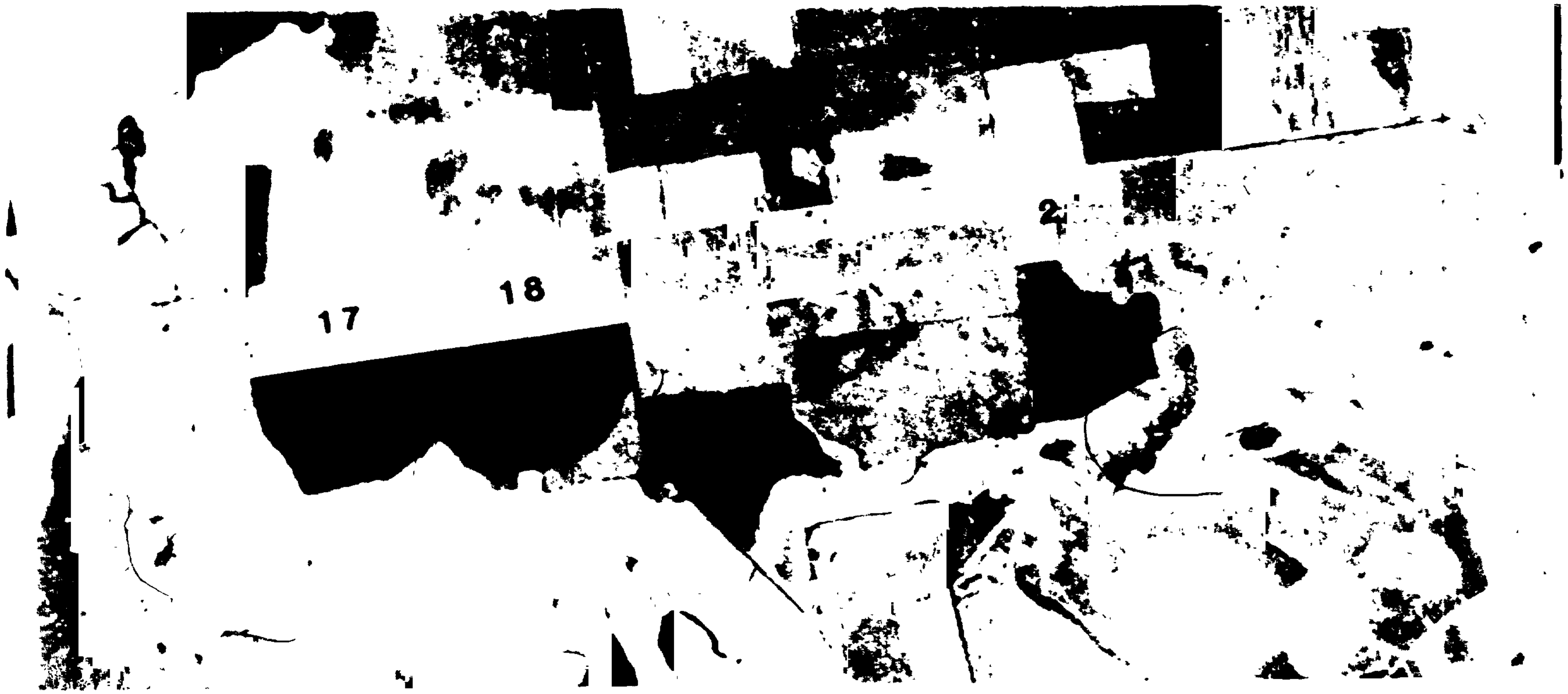

Figure 3. Delaware flightline 4 and fields.

DELAWARE FLIGHTLINE 5

1.0 mi
1.0 km

Figure 4. Delaware flightline 5 and fields.

The number of samples collected in the Maryland fields depended on the field size; however, no fewer than six samples/field were obtained. Data were obtained on a grid centered on the flightline with a surface sample every 150 m (500 feet). In most cases there were 12 points per field. Deeper depth samples were obtained near the field center at 2 or 3 locations.

Several different schemes were used at the Delaware sites. These fields were sampled depending upon access and layout. All fields except number 17 were sampled using a grid with a spacing of about 500 feet (150 m) between samples. Due to access problems, only a border and one path in Field 17 were sampled. The number of samples per field averaged 16 for the 0 to 5 cm soil layer and 4 for the 10-15 cm layer.

Gravimetric soil moisture values were averaged for each field on each date. This average was multiplied by the bulk density, described in the following section, to obtain the field average volumetric soil moisture values listed in Appendix I.

An effort was made to collect the samples within 2 hours of the aircraft flights. In some cases, data from the irrigated Delaware sites had to be deleted because of irrigations that were being performed.

On several sampling dates, especially at the Maryland sites, a significant portion of some fields was covered by standing water. Samplers were instructed that if a grid point happened to fall at a location with standing water, they were to note it as such in the field notebooks. The locations of the standing water followed very distinct patterns which in most cases coincided with local drainage. Comparing field average soil moisture under these conditions to line samples of brightness temperature will require additional analyses beyond the detail presented in this report.

3.2 Bulk Density

Determination of soil bulk density for the 0-5 cm soil layer was based on a volumetric displacement procedure that utilizes a specially designed bulk density ring with a hook gage and three one-foot-long bolts. The bulk density ring is placed on the ground and secured by driving in the three bolts. A sheet of plastic film is used to line the inside of the cylinder. Using a water-filled 500 ml graduated cylinder, the bulk density cylinder is filled to the hook gage and the quantity of water is recorded. This is returned to the graduated cylinder. The soil from the inside of the bulk density ring is then dug out to the desired depth of measurement and placed in a sealed container. The plastic liner is replaced and the ring is filled again. This amount of water is recorded. The soil wet and then dry weights are measured. The volume of soil removed is equal to the difference between the two water volumes used to fill the bulk density ring. The bulk density is computed by dividing the dry weight by this volume.

Samples were collected several times over the study period at the Maryland sites, at least once in each field. Data were collected only once at each Delaware site after the completion of the experiment. Four points were sampled in each field.

All of the bulk density data collected over the experimental period were evaluated in terms of timeliness, tillage, cover, soils, and rainfall to estimate a bulk density value for every gravimetric sampling data.

Values assigned to each observation are included in Appendix I. In general, the following values were used:

Condition	Bulk density	
	Maryland	Delaware
	- g/cm	-
Recently plowed	1.11	1.26
Tilled, not recently plowed	1.34	1.36
No till, idle	1.48	1.34

3.3 Soil Texture

Two sample cans were selected from one of the soil moisture sampling dates for each field. From each of these cans two samples were obtained (four total per field) to estimate the soil texture.

The procedure used is based on a kit (Code 1067) produced by LaMotte Chemical Products Co. It yields the fractions of sand, silt and clay. Based on numerous repetitions using this procedure, we have found that it produces consistent results.

Average texture results for each field based on the samples are listed in Table 1. Also listed in Table 1 are the USDA textural classifications based on sampling and the soils information derived from the soil surveys of the area (Soil Conservation Service, 1966 and 1971). With a few exceptions, the sampled textural classifications and the published soil textures were the same.

Table 1. Field soil properties.

Field	Sand %	Silt %	Clay %	Sample texture	Map soil/texture	Volumetric moisture at specific tensions, Sampled: 15 bar (%)	Sampled: 3 bar (%)	Sampled: 1 bar (%)	Sampled: 1/3 bar (%)	Estimated: 15 bar (%)	Estimated: 1/3 bar (%)	Sample bulk density gm/cm^3
1	27	60	13	Silt loam	Mattapex loam	8	14	19	22	12	27	1.30
2	20	70	10	Silt loam	Othello silt loam	9	16	19	20	12	27	1.47
3	42	56	2	Silt loam	Othello silt loam	5	12	14	17	6	21	1.31
4	32	63	5	Silt loam	Matapecke silt loam	15	17	24	28	8	24	1.57
5	25	72	3	Silt	Sassafras loam	8	[illegible]	19	21	7	26	1.29
6	24	76	0	Silt loam	Mattapex silt loam	8	13	19	23	6	25	1.29
7	37	62	1	Silt loam	Mattapex silt loam	7	16	22	24	6	22	1.24
8	33	54	13	Silt loam	Othello silt loam	8	15	23	33	12	27	1.23
9	33	65	2	Silt loam	Mattapex silt loam	14	21	24	26	7	23	1.27
10	38	50	12	Silt loam	Mixed silt loam	12	18	22	23	11	24	1.31
11	25	68	7	Silt loam	Mattapax silt loam	11	17	27	34	8	27	1.44
12	21	71	8	Silt loam	Matapecke silt loam	8	14	21	24	9	27	1.19
13	31	62	7	Silt loam	Matapecke silt loam	7	15	20	24	9	25	1.02
14	32	57	11	Silt loam	Matapecke silt loam	16	17	25	32	10	26	1.48
15	--	--	--	---	Johnston silt loam	--	--	--	--	--	--	--
16	32	57	11	Silt loam	Othello silt loam	16	25	28	29	10	26	1.56
17	76	20	4	Loamy sand	Rumford loamy sand	2	6	8	11	5	13	1.50
18	54	31	15	Sandy loam	Woodstown sandy loam	7	13	16	19	10	21	1.37
19	--	--	--	---	Woodstown loam	--	--	--	--	--	--	--
20	45	34	21	Loam	Woodstown loam	7	15	18	20	13	25	1.44
21	51	41	8	Sandy loam	Sassafras sandy loam	6	13	17	20	9	20	1.51
22	60	37	3	Sandy loam	Sassafras sandy loam	7	13	15	17	6	17	1.46
23	62	34	4	Sandy loam	Sassafras sandy loam	5	9	11	13	6	17	1.25
24	80	14	6	Loamy sand	Rumford loamy sand	3	4	7	8	6	12	1.42
25	79	20	1	Loamy sand	Sassafras sandy loam	3	7	8	9	3	12	1.41
26	83	15	2	Loamy sand	Sassafras sandy loam	3	7	11	12	4	12	1.45
27	--	--	--	---	---	--	--	--	--	--	--	--

3.4 Moisture-Tension Relationships

The volumetric moisture content of the soils at specific tensions was determined using a pressure plate tensiometer. In such a device, a soil sample in an open ended ring is placed in a container to which pressure, in this case bottled nitrogen gas, is applied at a specific level. The water in the soil which is held by a tension greater than the applied pressure stays while the lower tension water is extracted through a porous plate. These samples are weighed before and after drying to determine the gravimetric moisture content.

Samples were collected using a coring tool to obtain an undisturbed sample. Based on the volume of the ring, a bulk density value can be estimated. Moisture contents were determined for two samples per field at tensions of 1/3, 1, 3 and 15 bars. The 15 bar sample bulk densities must be estimated to obtain a volumetric moisture content because an unconsolidated sample must be used.

The average values for each field are listed in Table 1. Figure 5 shows the results for three of the soils at the test sites plotted in the manner in which they are normally presented in the literature.

An alternative method for estimating moisture-tension values has been developed by Rawls et al. (1983). In this procedure, texture information, estimated from soils maps or sampling, is used with a series of graphs to estimate the volumetric moisture at specific tensions. These graphs were developed using an extensive data base. In this case, the sampled texture data were used with the graphs to estimate the 15 and 1/3 bar moisture contents listed in Table 1. In general, the results are similar to those obtained using the pressure plate tensiometers. The estimated values were higher, except for a few 1/3 bar samples. Considering the difficulties of

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Figure 5. Laboratory moisture-tension relationships for selected Delmarva soils.

pressure plate analyses, the problem of statistical sampling and spatial variations, the graphical procedure appears to yield consistent and reliable results.

3.5 Soil and Surface Temperatures

Soil temperature data were collected using metal-dial type temperature probes at depths of 5 and 15 cm. The 5 cm values were obtained at almost all soil moisture sampling points. Fifteen cm measurements were obtained at all 15 cm soil moisture sampling locations, 3 or 4 near the field center line. Observed within field variations were typically less than 1°C at both depths.

Surface soil/canopy temperatures were obtained using a hand-held thermal infrared radiometer. The sampling procedure involved the person walking from the edge to the center of the field and back and estimating the average response. All temperature data are listed in Appendix I.

3.6 Cover Conditions

The predominant crops on Delmarva peninsula are corn and soybeans. Corn is planted in early to mid May and soybeans in late May. Due to wet field conditions the soybean plantings were delayed this year.

On March 14, 1983, all of the Maryland sites had stubble or weed cover. Figure 6a illustrates the density of corn stubble. Soybean stubble results in a higher percentage of cover, as shown in Figure 6b.

In early May, most of the fields were planted in corn with the plants just beginning to emerge. By the beginning of June, the corn was between 10 and 30 cm in height with less than 10% ground cover as shown in Figure 7. Heavy rains during this period made the soil surfaces fairly smooth in the tilled fields. At the end of June, some of the fields had close to 100% ground cover and some were just being planted with soybeans.

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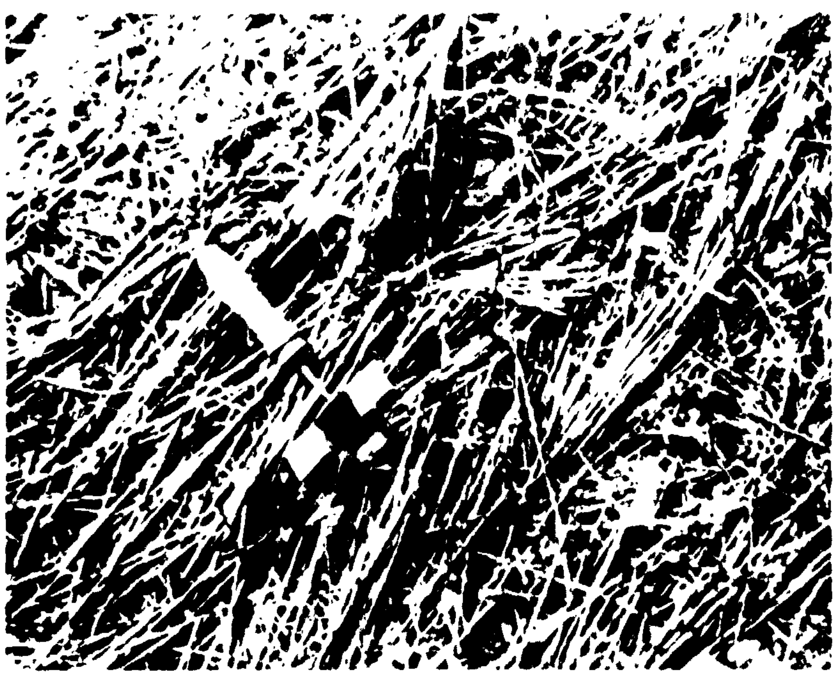
A



B

Figure 6. Ground cover conditions on March 14, 1983 at the Maryland sites - A) corn stubble and B) soybean stubble.

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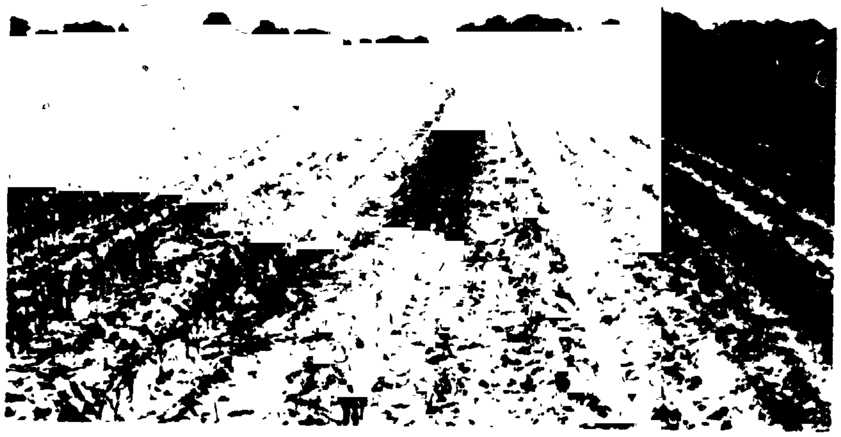

Figure 7. Tilled corn field (field 1) on June 2, 1983.

Figure 8. Corn field with soybean stubble (field 9) on June 2, 1983.

Several of the corn fields were not tilled, as a result, these usually had a ground weed cover and/or a heavy mulch or stubble cover. No till farming usually results in less soil surface evaporation due to the presence of the stubble. Figure 8 illustrates the ground cover in a corn field with a dense soybean stubble cover. Other fields had a weed cover for most of the study. Figure 9 illustrates the typical cover conditions.

The Delaware flightlines included a wider variety of cover conditions. Fields 17 and 18 were vegetable crops and field 19 was mature barley.

Observations during the study period were assembled and coded. For each field the following variables were estimated for each flight:

1. Crop
2. Percent ground cover
3. Height
4. Tillage
5. Surface roughness
6. Row direction

Crop type codings that are used in Appendix I are listed in Table 2. Percent cover was assigned a value between 0 and 100%. Crop height was measured in centimeters. The tillage treatment codes are listed in Table 3 and the visually estimated surface roughness codes are listed in Table 4.

Row direction varied and for certain fields the reference row direction depends upon the flightline that was being considered. Codings used for the row directions are listed in Table 5.

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Figure 9. Condition of a weed covered field (field 10) on June 2, 1983.

Table 2. Crop type codes.

Code	Crop type
1	Bare soil
2	Corn
3	Soybeans
4	Corn stubble
5	Soybean stubble
6	Mixed
7	Barley
8	Deciduous trees

Table 3. Tillage condition codes.

Code	Tillage condition
1	Tilled
2	No till corn stubble
3	No till soybean stubble

Table 4. Surface roughness codes.

Code	Roughness
1	No recent tillage
2	Smooth
3	Moderate
4	Rough

Table 5. Row direction codes.

Code	Direction relative to flightline
1	Parallel
2	Perpendicular
3	Diagonal
4	None

During the course of the study, a limited number of corn biomass samples were collected. On the average, 10 plants were removed, weighed, dried and weighed again to obtain the wet and dry biomass values per plant. Vegetation water content was computed by subtracting the dry weight from the wet weight. The per plant values were then multiplied by the plant density of approximately 6.6 plants per square meter to obtain the values on a square meter basis. Sample data are listed in Table 6. These values for an immature corn crop can be compared to data presented by O'Neill et al. (1983) for a mature canopy which ranged from 5000 to 7000 gm/m^2 for wet biomass. Based on vegetation effects models such as that presented by Jackson et al. (1982), the biomass observed on these fields should not have a significant effect on the sensitivity of the microwave brightness temperature to soil moisture variations.

Table 6. Corn biomass sample data.

			Per plant			Per square meter		
Field	Date	Plant height (cm)	Wet Biomass	Dry Biomass	Water content	Wet Biomass	Dry Biomass	Water Content
			-gm-					
1	6/15/83	90	132	9	123	871	59	812
1	6/22/83	120	336	27	309	2218	178	2040
6	6/15/83	30	46	4	42	304	26	278
13	6/15/83	45	76	5	71	502	33	469
13	6/22/83	60	281	28	253	1855	185	1670
16	6/15/83	15	13	1	12	86	7	79

Two of the fields that are reported in Appendix I were areas covered by deciduous trees. Field 15 was a cross section of the Choptank River which was obscured by trees. Due to the heavy rains during the course of the study, the area covered by water varied. No ground verification of soil or water-covered area was obtained, only video data were used. Field 27 was a forested area that all three Maryland flightlines crossed. At times standing water was observed within this area.

Field 17 was planted in peas in the early period of the study. The 15 cm rows made access difficult. A center pivot irrigation system was present in this field. Field 18 was planted in several vegetable crops, including squash and cucumbers, and was partially bare. This field also had a center pivot system. The only other field with a sprinkler irrigation system was field 23. which was planted in sweet corn.

Field 19 had a mature barley cover over the entire period of study. It can be assumed that the water content of the crop was very low based on other studies involving winter wheat (O'Neill et al. 1983). Field 20 was discarded because the cover conditions were mixed corn and pasture.

4. CLIMATOLOGICAL DATA

Rainfall data were available at several weather station locations near the flightlines as shown in Figure 1. The Centerville, Denton, Royal Oak, Dover, and Milford data were extracted from the "Climatological Data for Maryland and Delaware" published monthly by NOAA. Delaware State College provided the rainfall data at the Darling and Willow Grove sites.

The most complete and detailed record was from the class A station maintained by the Wye Agricultural Experiment Station (Wye Institute). This station included a weighing bucket raingage, evaporation pan, temperature, dew point, solar radiation, and wind speed. Data, excluding the raingage, are recorded in analog form and can be evaluated at 1-min intervals. The Wye Agricultural Experiment Station provided a 1-hour interval listing from which the daily values listed in Appendix II were computed for the period of May and June, 1983. Data for the Wye Institute raingage were obtained from strip charts.

To illustrate the general meteorological conditions, Figure 10 was developed using the daily evaporation pan readings. This is a cumulative plot of evaporation minus rainfall, therefore positive values indicate more evaporation than rainfall. May started off with some very large rainfalls. The first few weeks of June were dry and at the end of June there were a few large storms. As described above, the daily evaporation pan readings reflect

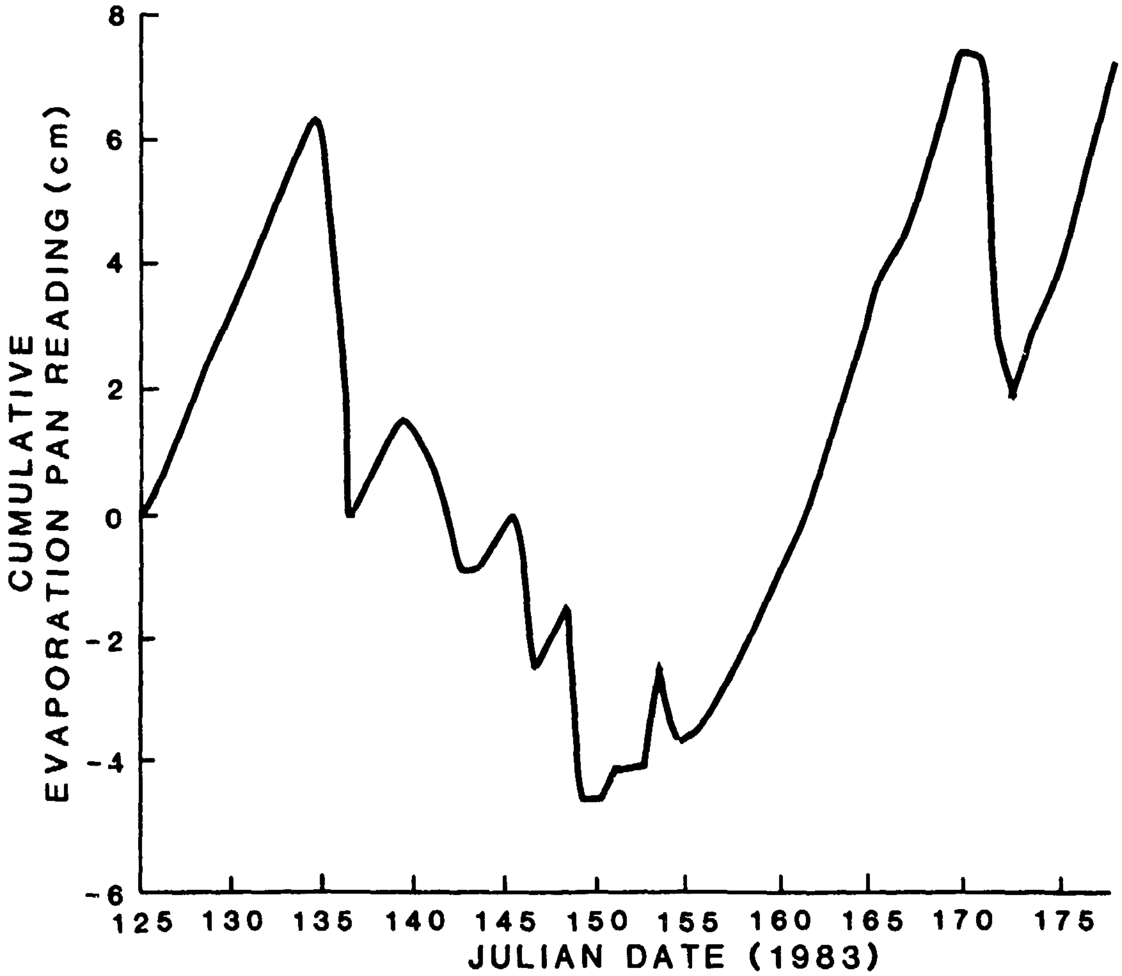

Figure 10. Cumulative evaporation pan readings at the Wye Institute for May and June, 1983.

both evaporation and rainfall. Hourly readings were reviewed to determine the separate rainfall and evaporation components. The estimated pan evaporation valves are listed in Appendix II.

A detailed listing was not provided for the March 14, 1983, flight. Climatological records for the two weeks preceding the flight indicate that there was about 4 cm of rainfall with an event of approximately 1 cm on March 12, 1983. Daily air temperatures ranged from $35^{\circ}F$ to $55^{\circ}F$ on the day of the flight and the few days before. No freezing conditions were present within the preceding two weeks.

Pan evaporation is directly related to the potential evaporation. A pan coefficient is used to relate the pan value to a lake evaporation estimate. This coefficient must be less than one and is usually about 0.7 (Jensen, 1973). Also, it can be related to the potential evapotranspiration of particular crops. As described in Jensen (1973) the coefficient for an area like the Wye Agricultural experiment station, considering the immediate surroundings of the weather station, should range from 0.6 to 0.75.

Potential evapotranspiration from grass can also be computed from the available meteorological data and the combination equation developed by Penman (Jensen, 1973). Using the average air and dew point temperatures, the wind speed and solar radiation listed in Appendix II, a daily potential evapotranspiration value was computed for each day. Results are listed in Appendix II.

Pan evaporation and computed potential evapotranspiration were compared for the period of study. An optimization program was used to determine the value of a coefficient that would minimize the sum of squares of the residuals between the two. This analysis indicated that a pan coefficient of 0.65 was best and had a coefficient of determination of approximately 0.92. These analyses indicate that the pan is performing as expected as an indicator of evaporation.

5. AIRCRAFT AND SENSOR SYSTEMS

The sensor system consists of an L band 3 beam push broom microwave radiometer, a thermal infrared scanner, a multispectral scanner, a photographic camera, a video camera and recorder, and a LORAN-C navigational system.

5.1 Microwave Radiometer

Additional details on the push broom microwave radiometer (PBMR) are presented in Table 7. It is a 3 beam L band system centered at 0° and $\pm 30^{\circ}$. The 3db (half power) points of the beams are located at roughly $\pm 10^{\circ}$ of the beam center position. For the main beam this results in a swath (ground resolution) of 0.35 times the altitude. The two side beams will have swaths about 0.53 times the altitude. Beam centers for the side beams will be ± 0.58 times the altitude. Total coverage for the three beams will be a swath equal to 1.68 x altitude. At 150 m (500 feet) this will be 250 m (840 feet), at 300 m (1,000 feet) it is 500 m (1,680 feet), and 675 m (2,520 feet) at 450 m (1,500 feet). Figure 11 illustrates the geometry of the PBMR system.

Table 7. L Band radiometer specifications.

Antenna:	
Center frequency	1,413.5 MHz
Bandwidth	30 MHz to 100 MHz, variable
Polarization	Horizontal
Beamwidth	20^{o} at 3db points
Beam efficiency	90 percent null to null
Beam directions	0^{o}, $\pm 30^{o}$, left and right of center
Radiometer:	
Type	Dicke
Center frequency	1,413.5 MHz
Bandwidth	12.5 MHz
Temperature sensitivity (short term stability)	T 0.7 ^{o}K, 1 sec integration time
Accuracy (calibration stability)	2^{o}K
Operating temperature range	$+40^{o}$C to -40^{o}C
Integration time (sec)	0.5, sec
Operation environ	unpressurized aircraft to 3,000 m

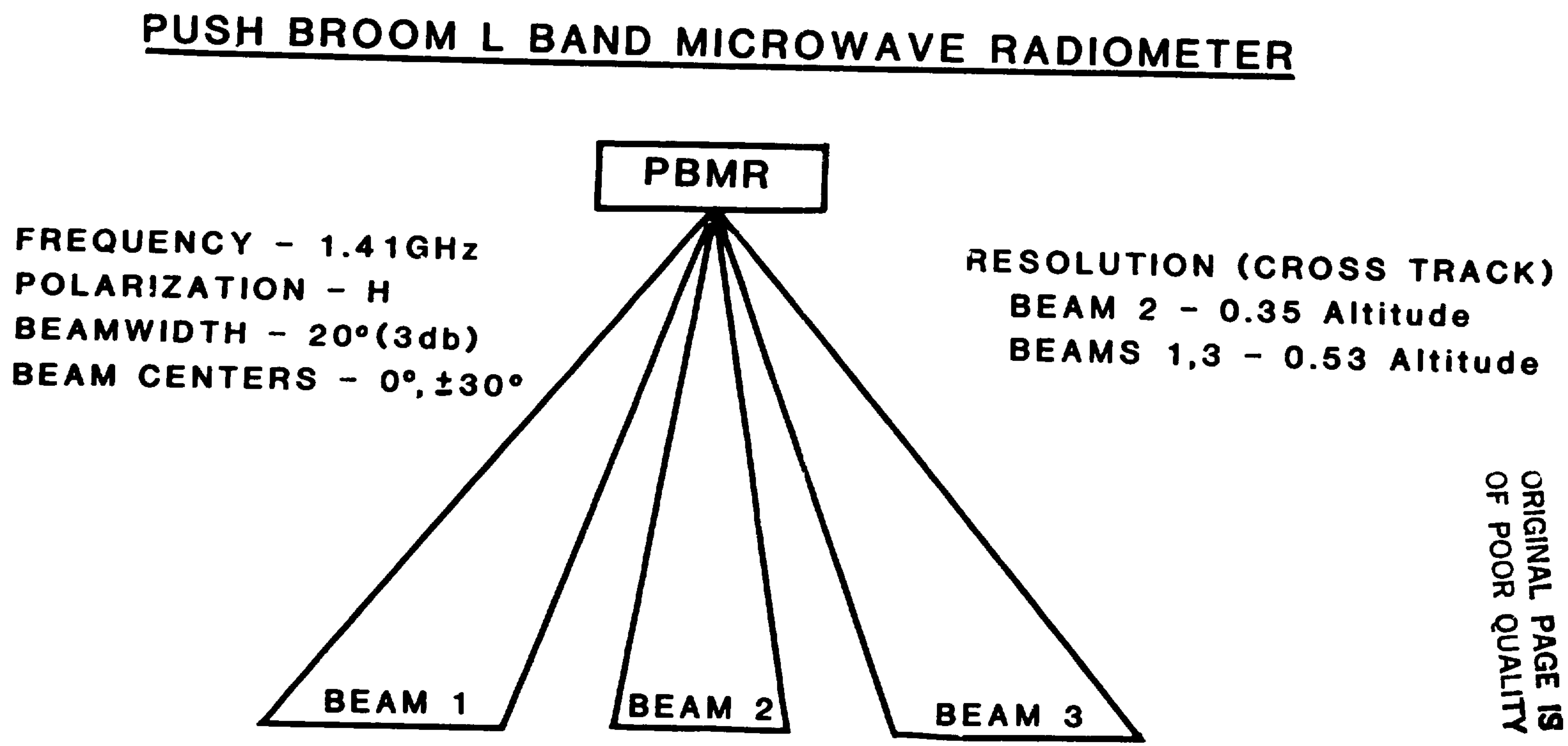

Figure 11. Ground coverage and specifications for the push broom microwave radiometer.

5.2 Heat Capacity Mapping Radiometer (HCMR)

The Heat Capacity Mapping Radiometer is a two channel scanning/imaging radiometer. Channel 1 includes the spectral band from 0.55 - 1.1 microns and can be used to estimate albedo. The second channel provides a thermal infrared measurement over the interval of 10.5 - 12.5 microns. Figures 12 and 13 show the relative response of the two channels as a function of wavelength.

The instantaneous field of view (IFOV) of the sensors can be up to 0.83 milliradian (0.046°) ranging from ± 45° off nadir. At an altitude of 300 m (1000 feet) the nadir beam this would generate a ground resolution of 0.3 m (1 foot) resolution cell. A detailed description of the sensor system can be found in Bohse et al. (1979).

The HCMR was operated at a scan rate that results in a gap of approximately 6 m between scans at an altitude of 300 m (1000 feet). At this rate, there would be approximately 50 scans per field which was considered adequate for this investigation.

5.3 Ocean Color Scanner (OCS)

The Ocean Color Scanner that was used in these studies is called OCS II and is a modification of an earlier system. OCS II has 12 channels as opposed to the 10 of the earlier version.

Center wavelengths of the 12 channels are shown in Table 8. Unfortunately, spectral response curves for this system are not readily available. However, the curves for the 10 channel system are presented in Figure 14 to illustrate typical conditions.

The IFOV of the OCS can be 3.5 milliradians (0.2°) and it scans ± 45° from nadir. At an altitude of 300 m (1000 feet) the footprint would be 1 m (3.5 feet). Additional details on this sensor system can be found in Blaine et al. (1977).

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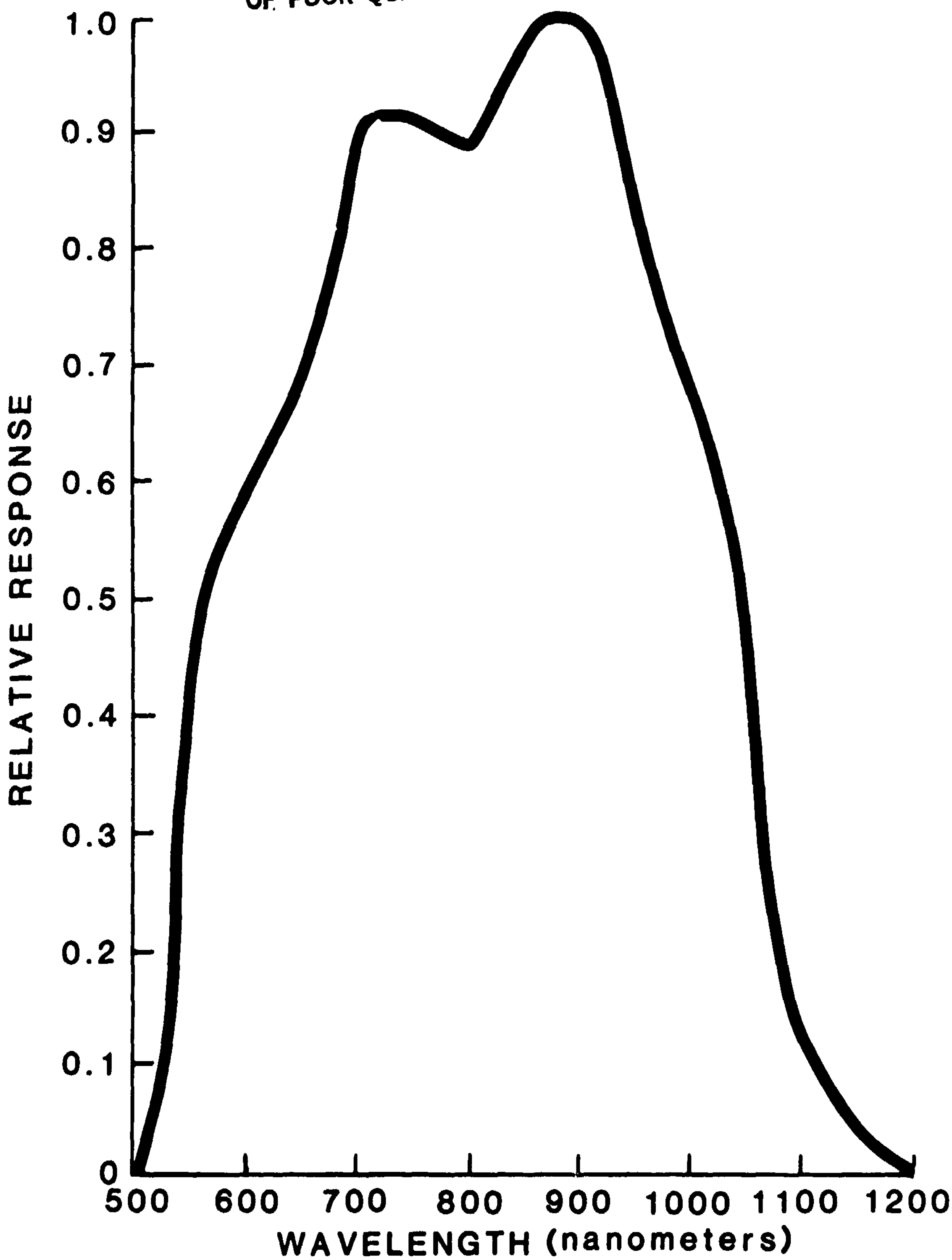

Figure 12 HCMR detector response for channel 1.

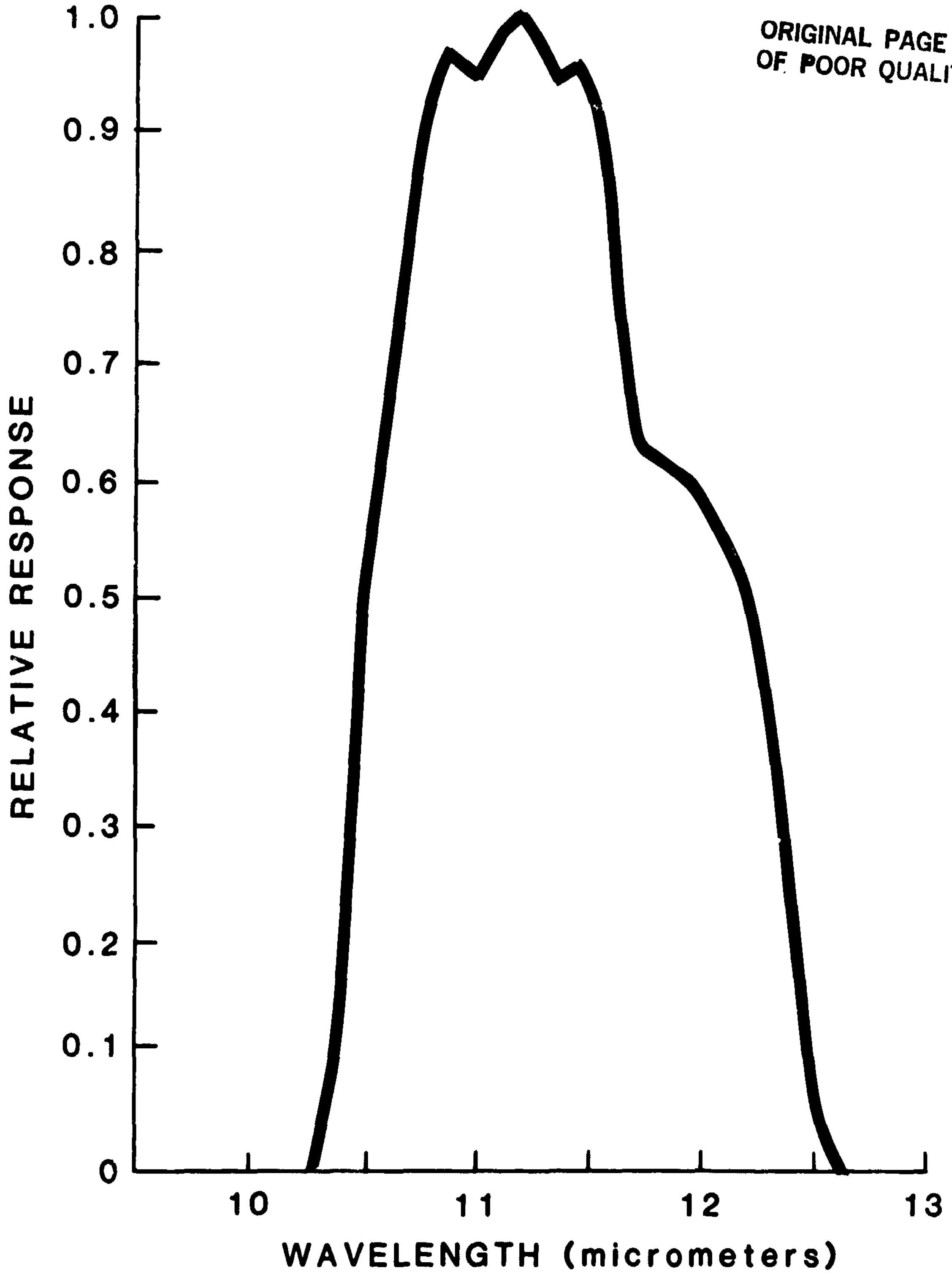

Figure 13. HCMR spectral response for infrared channel.

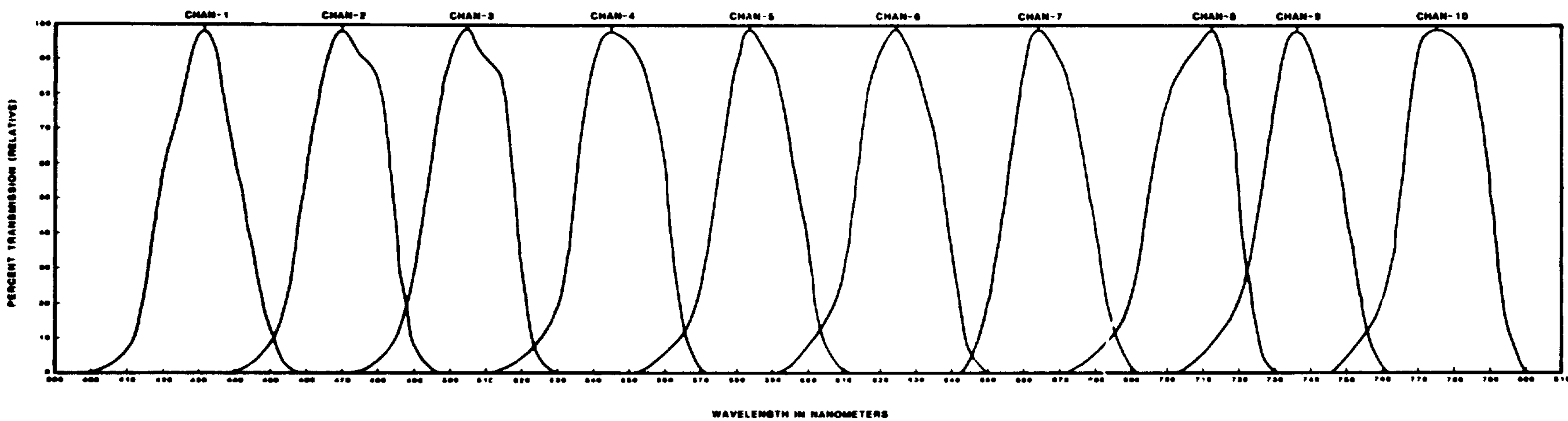

Figure 14. Spectral response of the 10 ocean color scanner channels.

Processing 12 channels of high resolution data is impractical if rapid turnaround is desired. It is also unnecessary for this investigation. Therefore, only two channels will be processed for the biomass estimation procedures; channels 7 and 11. Ground coverage of this sensor is similar to th at of the HCMR.

Table 8. - Center wavelengths of the OCS II.

Channel	Center wavelength (nm)
1	425
2	464
3	509
4	549
5	587
6	631
7	669
8	711
9	756
10	793
11	828
12	863

The photographic camera used was a 35 mm system with color film. Clock time was recorded on the image. 35mm color positive transparencies were generated for each flight. The primary image format used for ground-air time referencing were the color video tapes. These also had clock time on the image and were inexpensive. The aircraft on which the systems were mounted is a Short SC7 Skyvan, which is a twin engine plane.

5.4 Data Processing and Calibration

When the calibrated radiometer data were available for one-half second intervals, coverage for each field and run were extracted to compute an average and standard deviation for the brightness temperature. Start and stop times of field boundaries were determined by reviewing the video tapes or photographs. At least one-half second of data was deleted from the beginning and end of the coverage to avoid minor variations related to aircraft parameters.

In addition, coverage of each field was reviewed to determine if any mixed conditions resulted from flight line drift or changes in aircraft parameters. If these conditions were present, the data for that beam and field were not used.

6.0 RESULTS

Preliminary analyses of the data set focused on the relationship between the center beam (C) brightness temperature (T_B) and the volumetric soil moisture (VSM) in the 0 to 5 cm soil layer. Each field was treated as an individual data set.

Figure 15 illustrates the type of relationship that was observed for a tilled corn field (Field 1) with rows perpendicular to the flightline. The consistency of the response between different runs on the same day is very good. Measurements cover a wide range of soil moisture and brightness temperatures which adds reliability to empirical relationships. Some of the variation observed in Figure 15 can be explained by the increase in canopy. Data from day 173 had nearly 100% corn cover and the brightness temperatures are higher than those we would expect from bare soils.

Field 1 was one of the longer time frames available and had a uniform set of cover and soil moisture conditions on each date. Therefore, this field will be used as a basis of comparison to other fields.

Several other fields at the Maryland site were similar in soils and cover to field 1; these were 4, 8, 13, and 14. Graphical analysis of data from these fields showed that the patterns were very similar, although, the variability

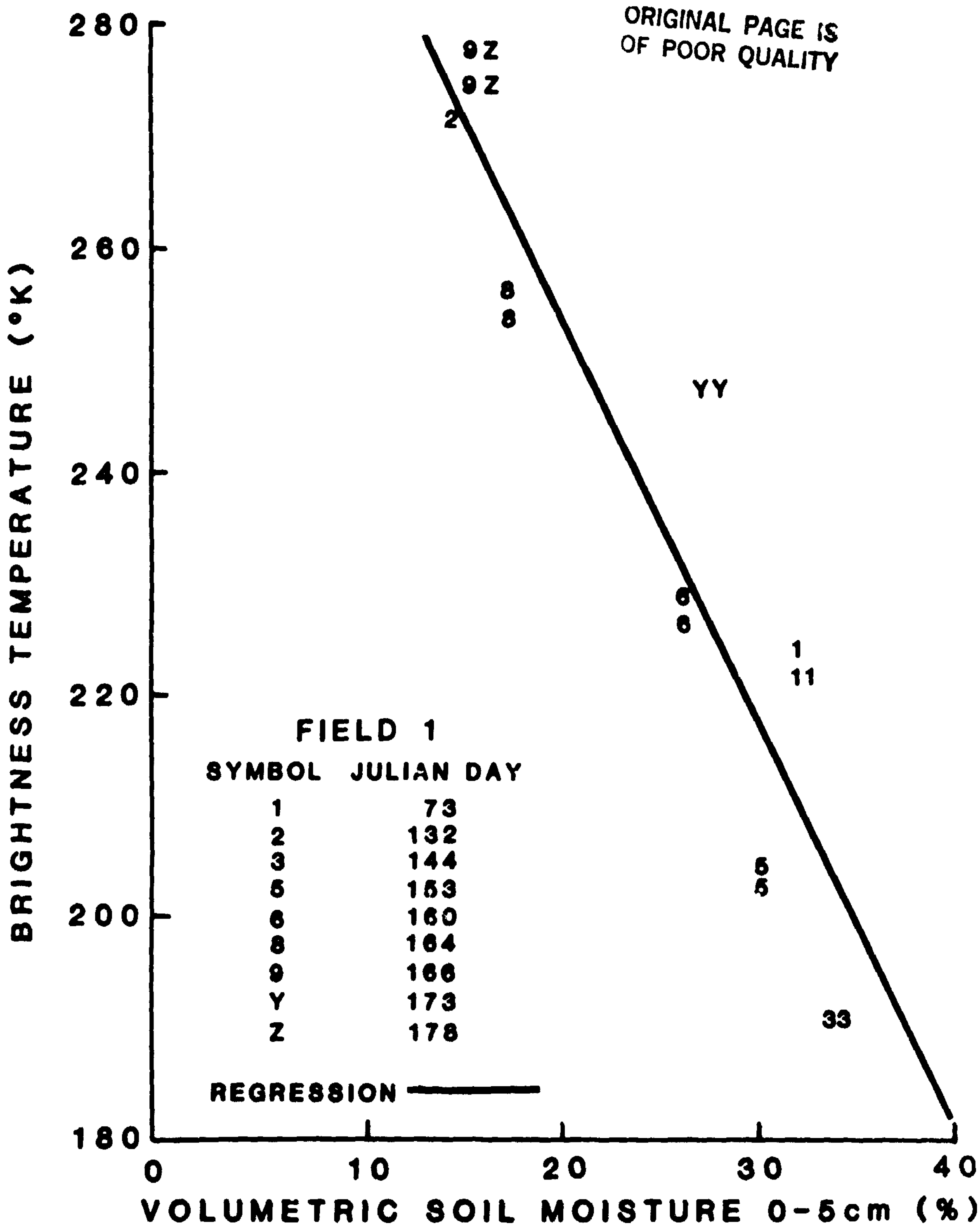

Figure 15. Brightness temperature vs soil moisture, field 1, center beam.

was greater, as shown in Figure 16 for field 13. Regression parameters for brightness temperature and soil moisture listed in Table 9 indicate that these 5 fields have similar intercepts and slopes. The coefficient of determination R^2 is quite a bit smaller in fields 8, 13, and 14, which reflects the variability observed in the graphs. A major portion of the variability in these other fields can probably be attributed to differences between the average soil moisture of the field and the area actually covered by the sensor.

Two of the fields, 2 and 7, remained in a bare soil condition through most of the experiment. However, they were tilled and planted for the last two flights. Regression results shown in Table 9 indicate similar parameters for the two fields. Results were also similar to those obtained for field 1.

Three fields at the Maryland site, 3, 10, and 12, were not planted through most of the study but were covered with stubble and weeds. Qualitatively, field 10 had the densest cover, field 12 the smallest amount, and field 3 was in between. Plots of T_B versus VSM revealed that the dynamic range of observed soil moisture was related to the vegetation cover density, as illustrated by comparing Figure 17 for field 3 with Figure 16 for field 1. As expected from previous research, the observations of B_T on these fields tended to be greater than those observed over the corn field with less cover.

The effect of the denser canopy of field 10 is apparent in Figure 18. These results are particularly interesting because on day 173 the field was plowed and we see that the observation is very close to the field 1 regression. Once the canopy was removed, the field dries out faster and the data from the last flight show this to be true.

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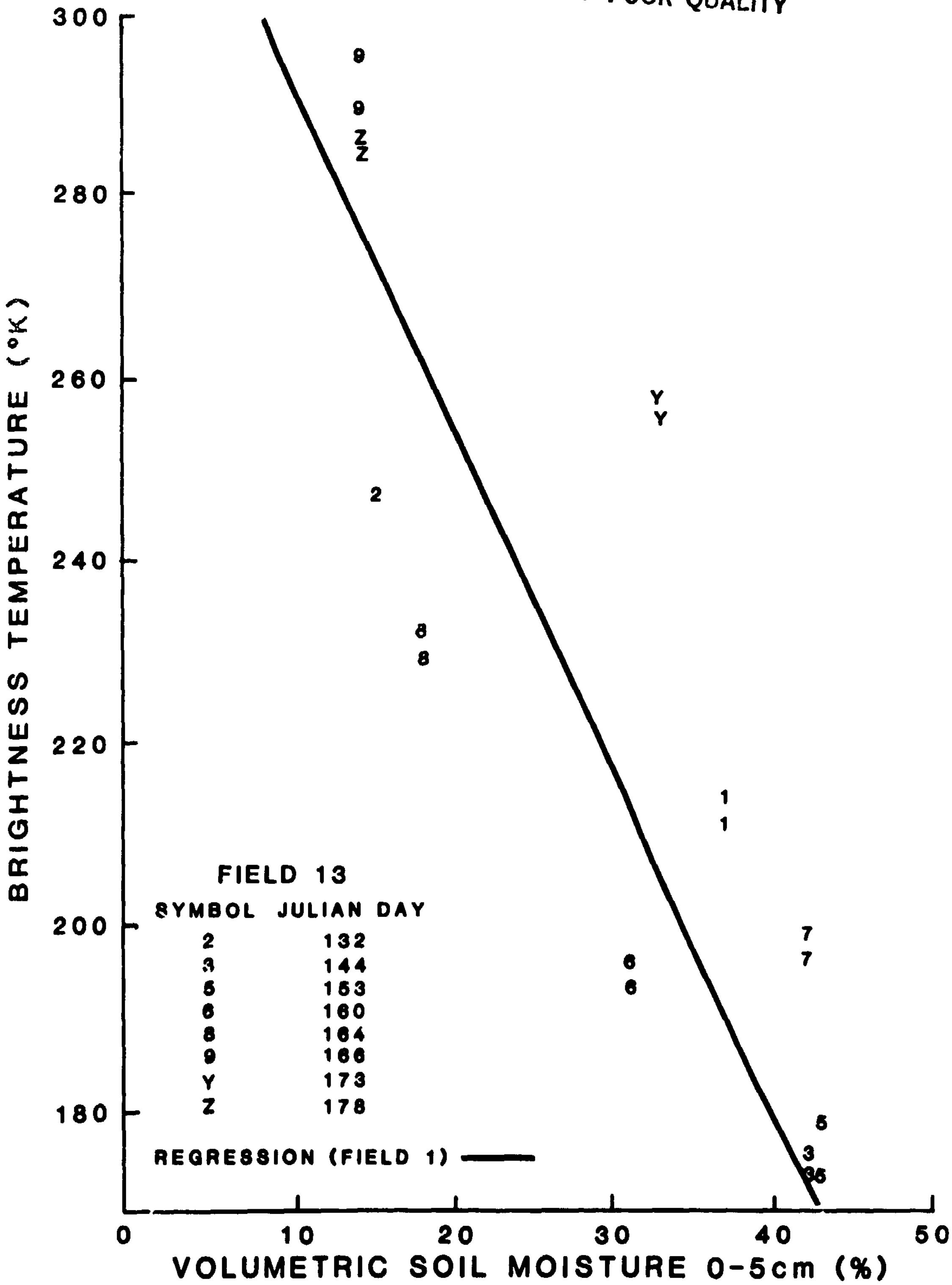

Figure 16. Brightness temperature vs soil moisture, field 13, center beam.

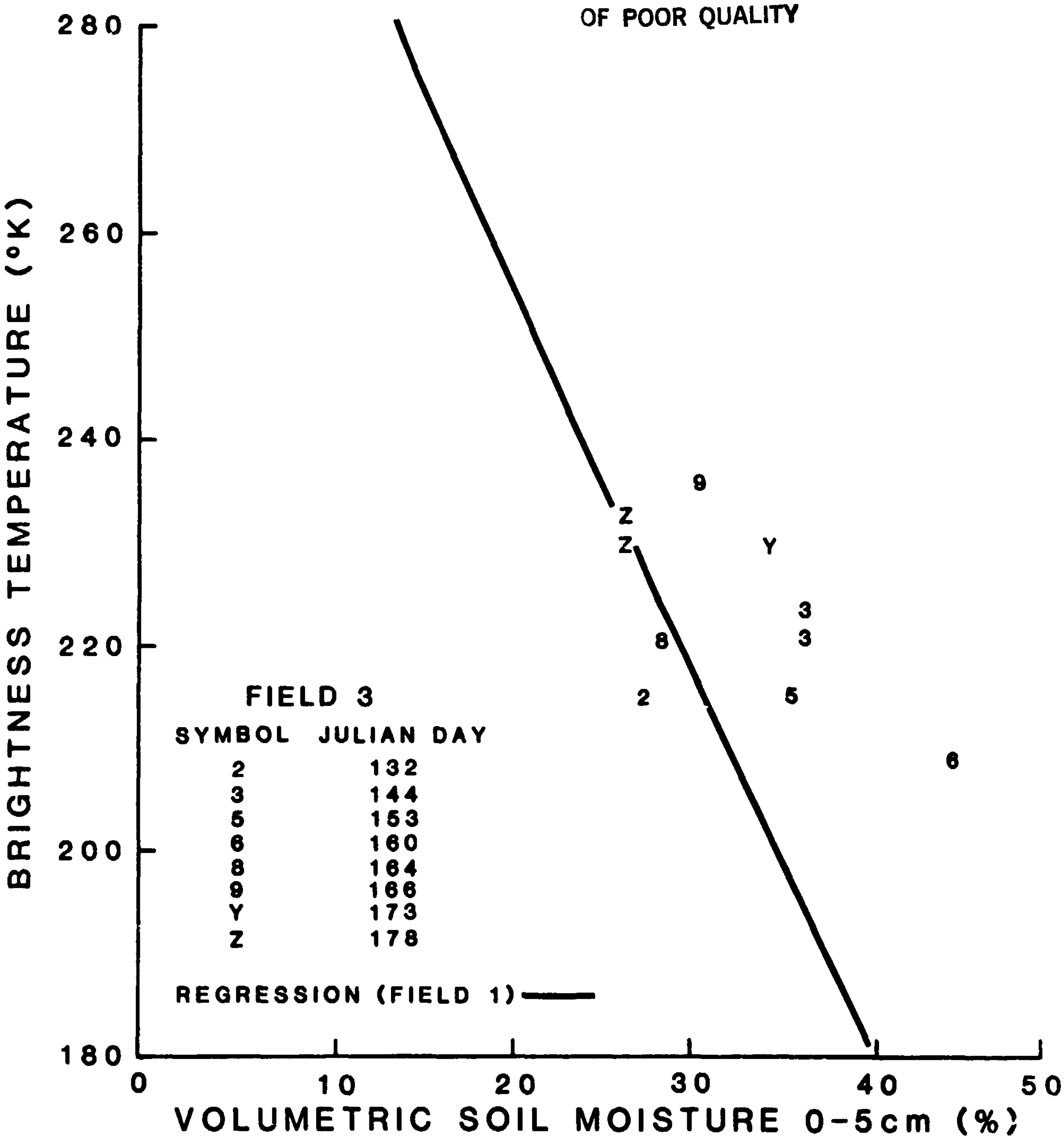

Figure 17. Brightness temperature vs soil moisture, field 3, center beam.

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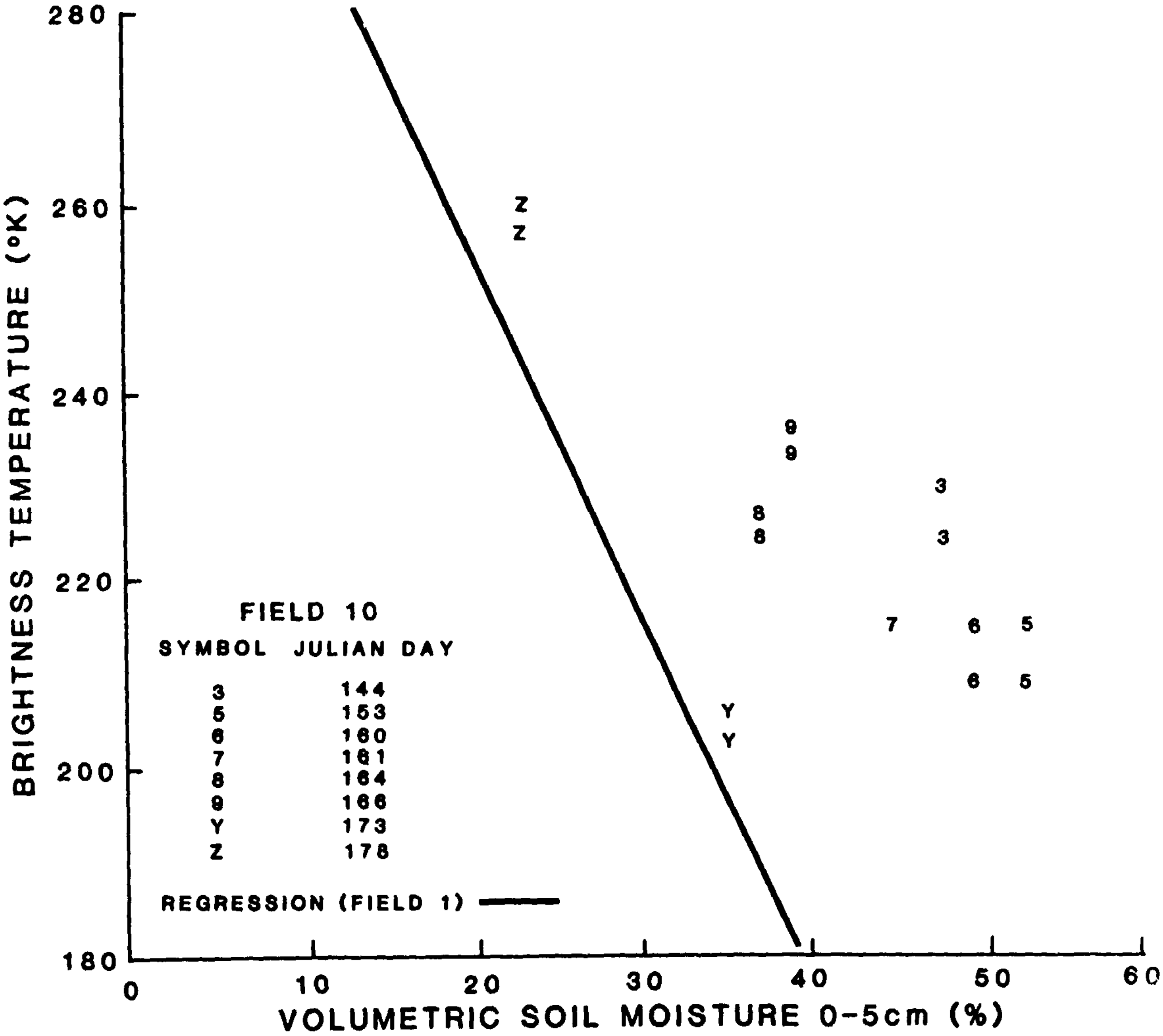

Figure 18. Brightness temperature vs soil moisture, field 10, center beam.

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Table 9. Brightness temperature and 0-5 cm soil moisture linear regression results.

	Linear regression parameters								
	TBC* = a+b(VSM1)			TBL** = a+b(VSM1)			TBR*** = a+b(VSM1)		
Field	Intercept (a)	Slope (b)	R^2	Intercept (a)	Slope (b)	R^2	Intercept (a)	Slope (b)	R^2
1	328	-3.6	.84	334	-4.2	.88	344	-4.7	.92
2	305	-2.6	.85	293	-2.5	.89	298	-2.7	.81
3	259	-1.1	.44	218	.2	.00	219	.2	.02
4	221	-3.4	.76	318	-3.7	.80	262	-1.8	.35
5	317	-2.6	.32	317	-3.0	.31	321	-3.0	.32
6	345	-4.3	.69	320	-4.3	.68	318	-4.2	.61
7	319	-2.9	.64	303	-2.8	.61	296	-1.9	.55
8	323	-3.2	.67	315	-3.4	.68	326	-3.2	.73
9	244	-0.8	.25	255	-1.4	.44	260	-1.0	.18
10	269	-1.1	.43	248	-0.7	.18	263	-1.1	.37
11	322	-[illegible].4	.73	321	-3.6	.78	316	-3.4	.69
12	285	-2.2	.64	283	-2.5	.66	262	-1.7	.46
13	318	-3.1	.71	325	-3.4	.78	299	-2.6	.75
14	320	-3.3	.72	322	-3.7	.85	299	-2.6	.72
15	---	---	---	---	---	---	---	---	---
16	227	-0.6	.11	228	-0.9	.18	204	-0.0	.00
17	343	-6.4	.75	338	-6.8	.73	343	-6.4	.77
18	334	-4.8	.85	322	-5.1	.85	335	-5.2	.83
19	261	-1.4	.75	233	-1.0	.44	265	-1.8	.18
20	---	---	---	---	---	---	---	---	---
21	293	-2.0	.68	284	-1.8	.57	286	-1.5	.38
22	301	-2.8	.32	296	-3.2	.51	293	-3.2	.42
23	334	-5.9	.67	322	-5.8	.65	305	-4.6	.83
24	311	-4.8	.68	309	-6.3	.91	305	-5.5	.79
25	317	-3.6	.85	299	-1.9	.62	318	-4.6	.82
26	308	-2.6	.87	300	-2.9	.78	300	-2.4	.78
27	---	---	---	---	---	---	---	---	---

* TBC = Center beam brightness comparative

** TBL = Left " " "

*** TBR = Right " " "

Regression results from these fields are listed in Table 9, however, the limited range of observed soil moisture values makes them relatively useless on their own.

One set of conditions that was observed in this study that had not been previously analyzed was mulched no till fields. Four fields, 5, 9, 16, and 22,

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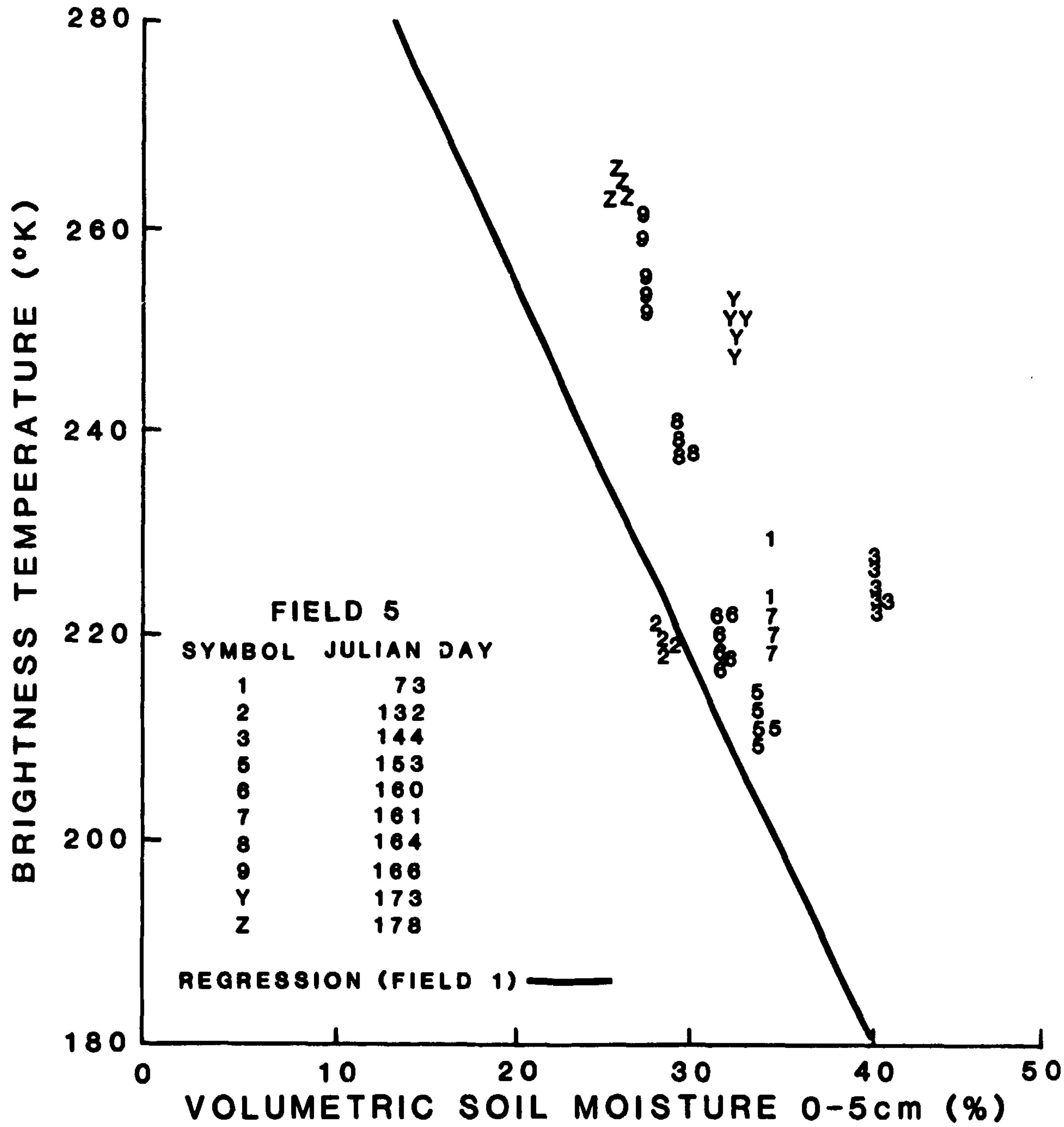

Figure 19. Brightness temperature vs soil moisture, field 5, center beam.

were no till corn with relatively dense ground covers of soybean mulch/stubble. As a result of the mulch cover, there was less surface evaporation than on a tilled field; this resulted in a small range of observed soil moisture values. Figure 19 illustrates the typical relationship for field 5. A general interpretation of these results is that since the T_B exhibits a large dynamic range and the soil moisture does not, the soil moisture we are using is not indicative. Since there is a mulch layer present the moisture is fairly uniform with depth at the surface. This might suggest that the changes in T_B are the result of something related to the mulch. Perhaps there is a build-up of moisture just under the mulch that affects the response. This aspect needs further study.

Data collected over fields with lighter vegetation cover at the Delaware sites, such as field 23 shown in Figure 20, indicate a greater sensitivity of T_B to VSM. This result is typical of the change we expect between silt loams such as those at the Maryland sites, and the sandy loams at the Delaware sites.

Field 19 had a mature barley cover through the series of flights. For all practical purposes, we can assume it to be the same cover on each day. Under these conditions, the effect of soil moisture changes under the canopy on the observed T_B can be evaluated. Figure 21 shows the plot of the data. There appears to be a distinct trend, although, the absolute level is not consistent with results from Field 1.

Analysis of the data collected by the two side beams was performed through plots and regressions. Figure 22 shows the left and right beam measurements and the center beam regression for field 1. In this case there is no obvious difference between the two beams. Also, the regression from the center beam

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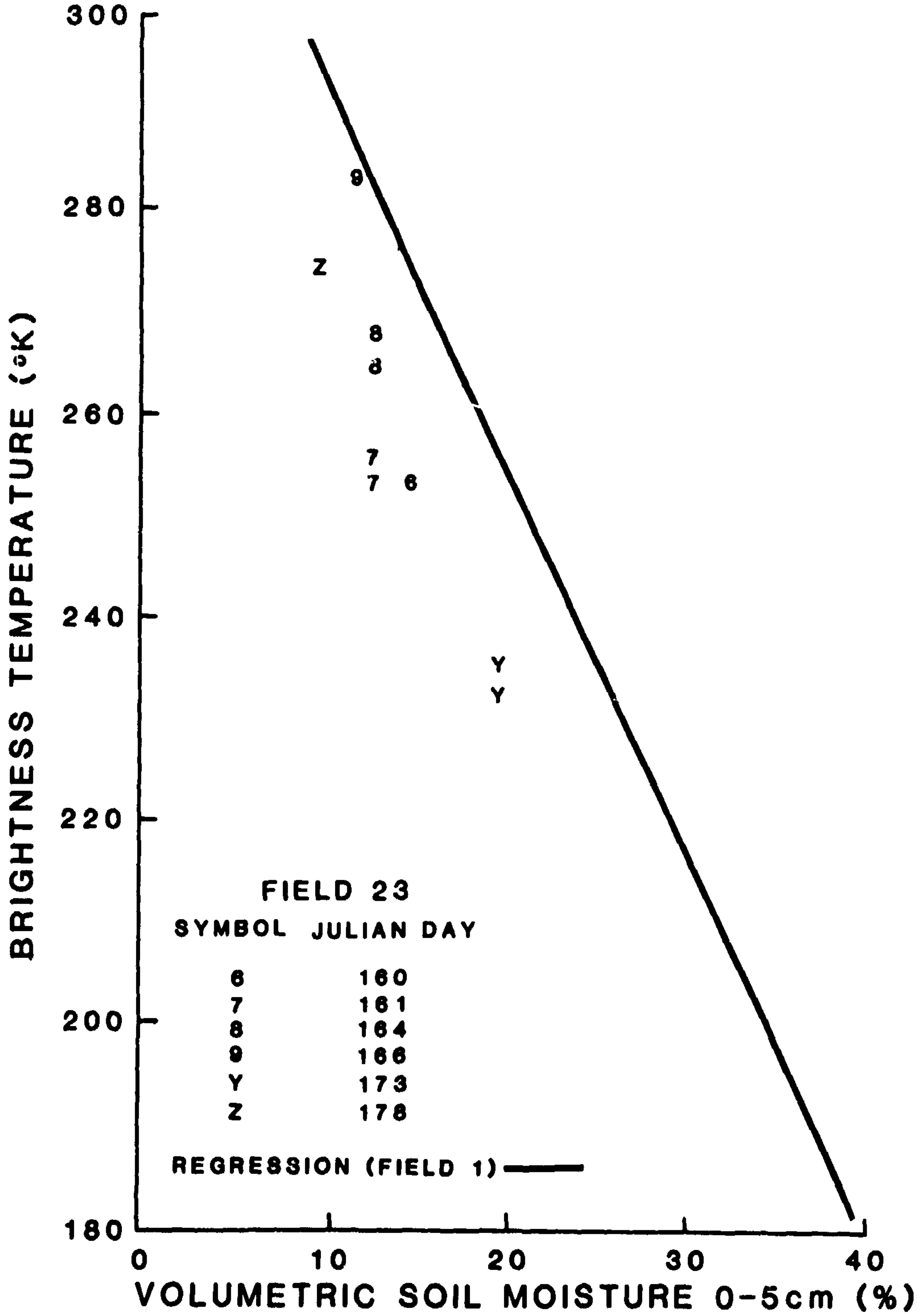

Figure 20. Brightness temperature vs soil moisture, field 23, center beam.

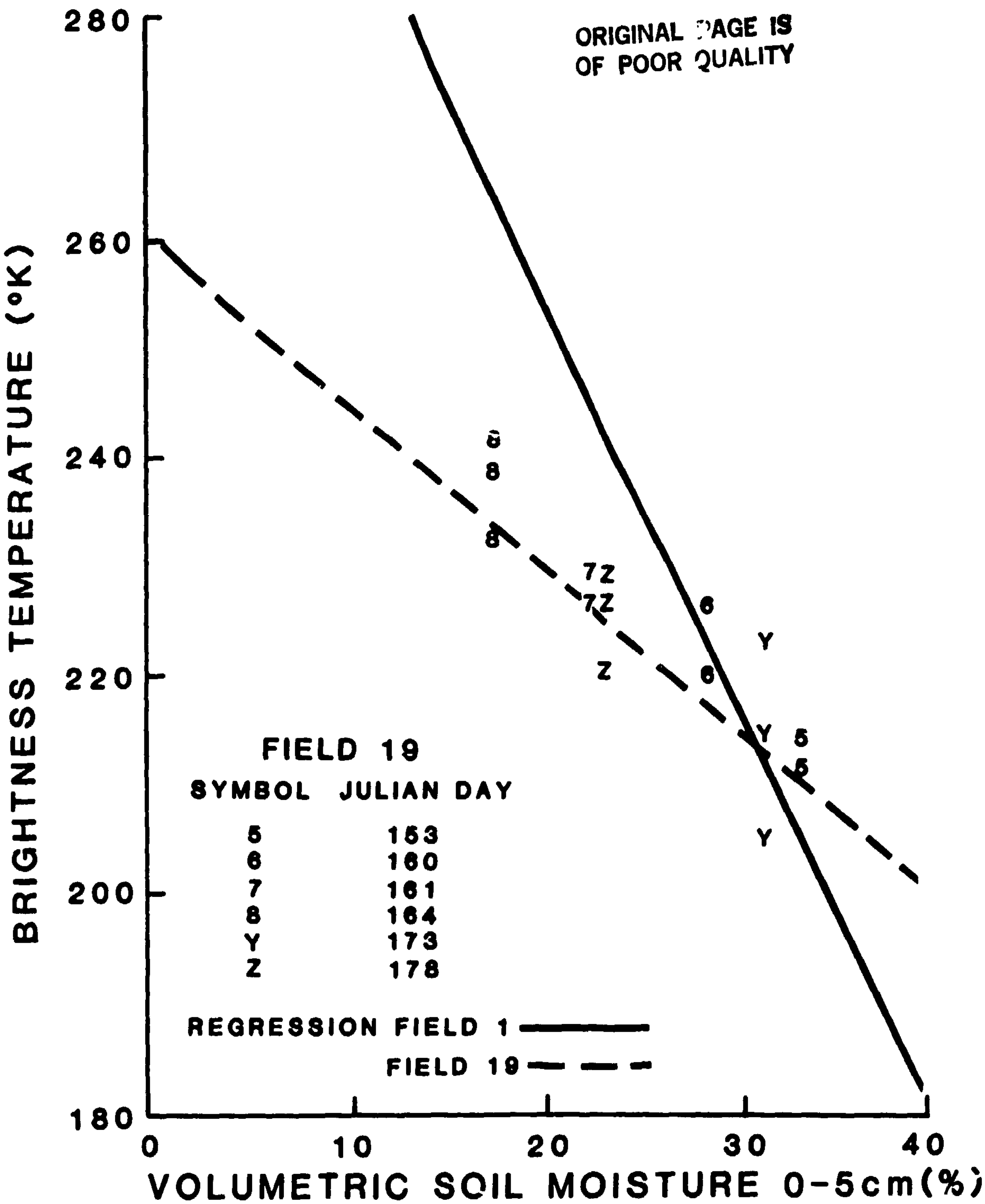

Figure 21. Brightness temperature vs soil moisture, field 19, center beam.

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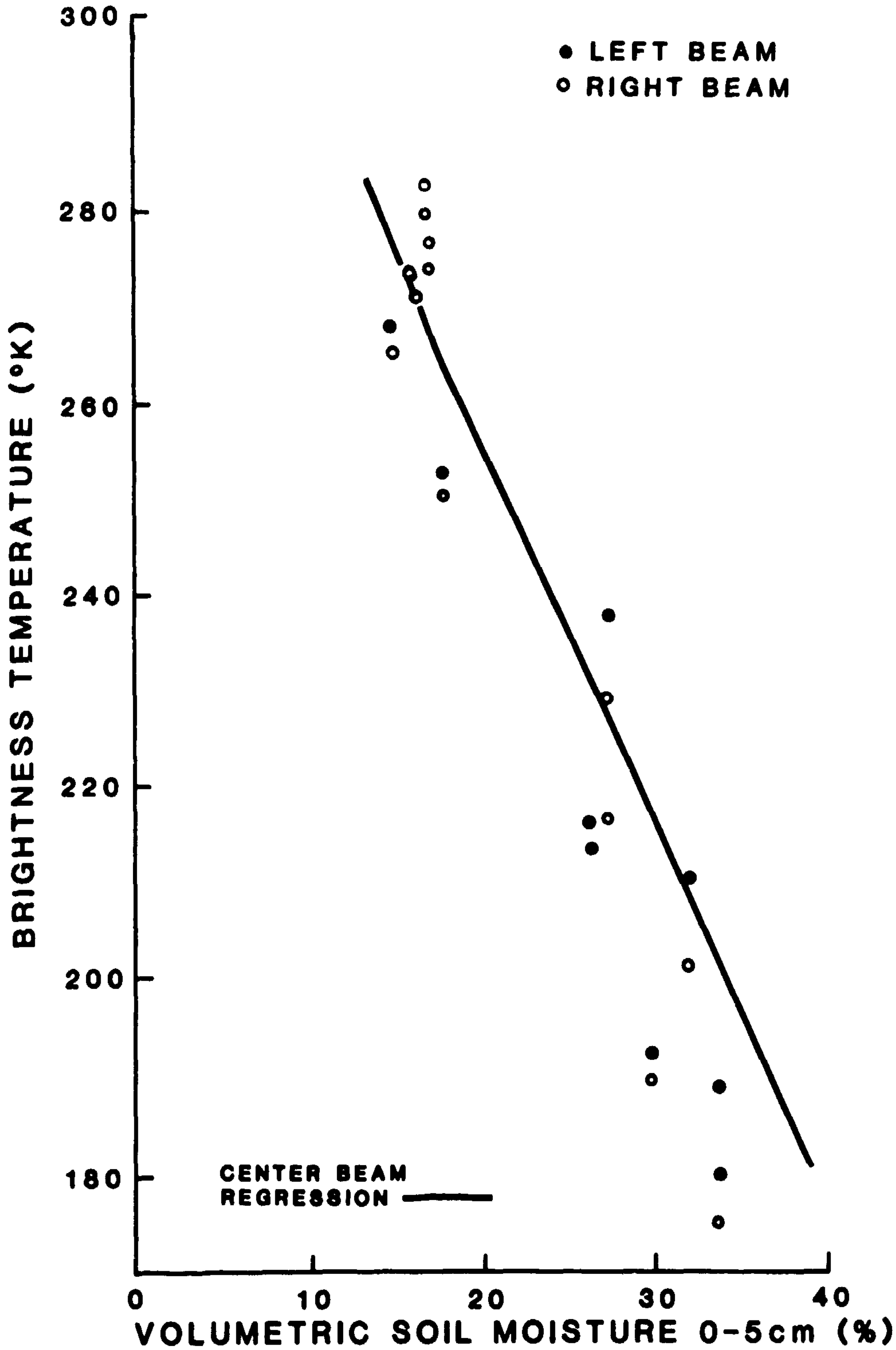

Figure 22. Brightness temperature vs soil moisture, field 1, side beams.

data explains the side beam observations fairly well under dry conditions. Previous research, such as the study by Wang et al. (1983), have shown that there is little difference in the T_B between 0 and 30° incidence angles for bare soils under dry conditions, however, as the soil becomes wetter the difference increases. These results exhibit these same trends.

Observations on the barley field (19) shown in Figure 23 suggest a uniform decrease in response for the side beams as compared to the center beam. These results must be interpreted with caution since there were no dry conditions observed. Comparisons to winter wheat data reported in O'Neill et al. (1983) show that the expected decrease in T_B between 0° and 30° incidence angles should be on the order of 15°K for this range of soil moisture conditions, which is approximately the amount observed here. Regression analyses of the side and center beams, which are summarized in Table 9, show that there is a strong linear relationship on a field basis with the exception of the no till and weed/stubble covered field 5. In addition, in most of these same fields there were poor linear relationships for the left and right beams. These results once again suggest spatial soil moisture patterns in these fields.

Due to the frequency of the flights in May and June and the variation in weather conditions, the data collected in this study are suitable for the analysis of temporal patterns of T_B and their relationship to climatic variables beyond surface soil moisture. For the present time, the analysis will use the cumulative evaporation pan values collected at the Wye Agricultural Experiment Station. This value represents an approximation of the cumulative outflow and inflow to the soil column. Pan evaporation is usually greater than free water or lake surface evaporation which is used to

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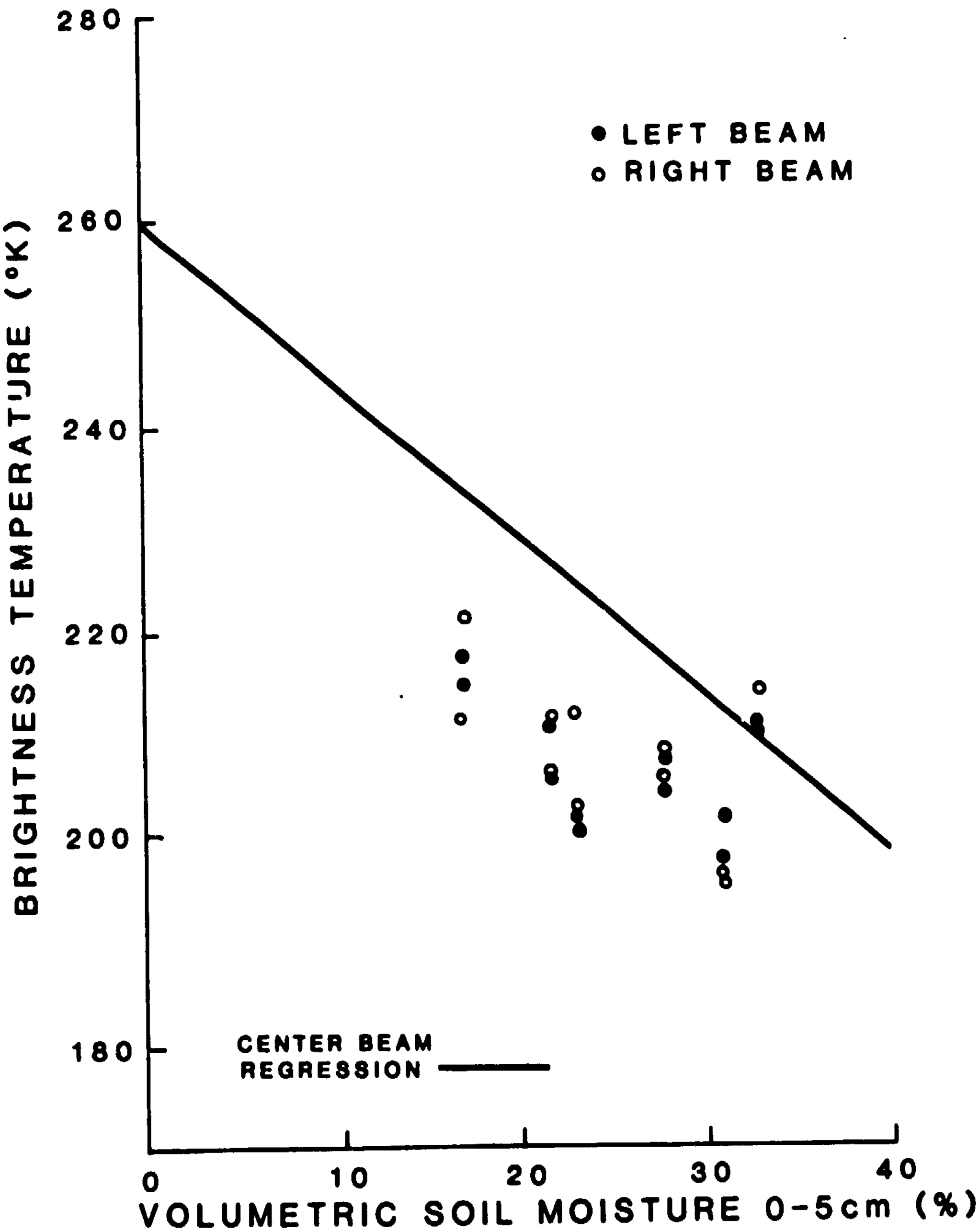

Figure 23. Brightness temperature vs soil moisture, field 19, side beams.

approximate the potential evapotranspiration. Potential evapotranspiration is used in conjunction with soil and vegetation parameters to compute actual evapotranspiration.

The cumulative daily evaporation pan data (ΣE_p) will be positive when evaporation for the period exceeds rainfall and vice versa. It was set to zero on Julian day 124 and plotted in Figure 10.

Figure 24 includes a plot of T_B as a function of Julian day. On its own it is difficult to interpret, however, when it is plotted with the ΣE_p relationship using an arbitrary scale, a remarkable similarity of pattern is apparent. The T_B is responding in a nearly identical way as the ΣE_p. During the extended drying period in early June the relationship is very strong. This might be expected with a bare soil condition. However, similar patterns are observed between the last two flights when there was nearly 100% cover.

With these results in mind, data from several other fields were analyzed. Figure 25 shows the results obtained for field 3 (tall weeds). Here the dynamic range is much less, however, the pattern is still apparent although not as dramatic.

Figure 26 is a plot of the data collected over field 5. This response is between the two extremes of fields 1 and 3, which is expected based on its cover. What is very important here is the fact that the T_B values follow a very clear pattern which, based on Figure 17, doesn't necessarily correspond to the VSM in the 0 to 5 cm soil layer.

Data collected over the two forest covered fields, 15 and 27, did not include ground conditions. Therefore, the only comparison that can be made is to general climatic variables. Having shown that there is reason to believe that a relationship exists between the T_B and ΣE_p, comparisons on the forest sites is possible.

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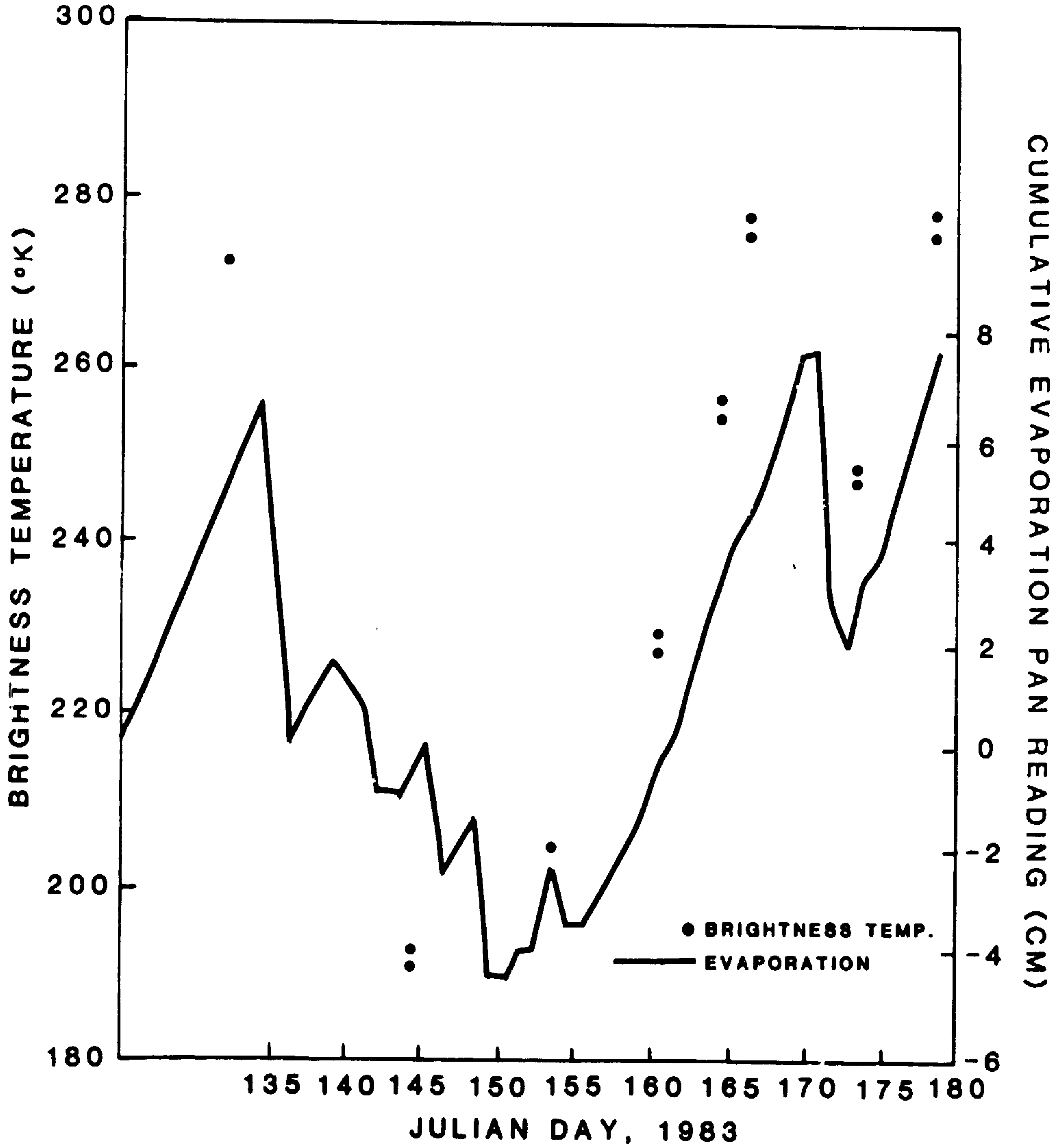

Figure 24. Brightness temperature vs Julian day and cumulative evaporation pan values, field 1, center beam.

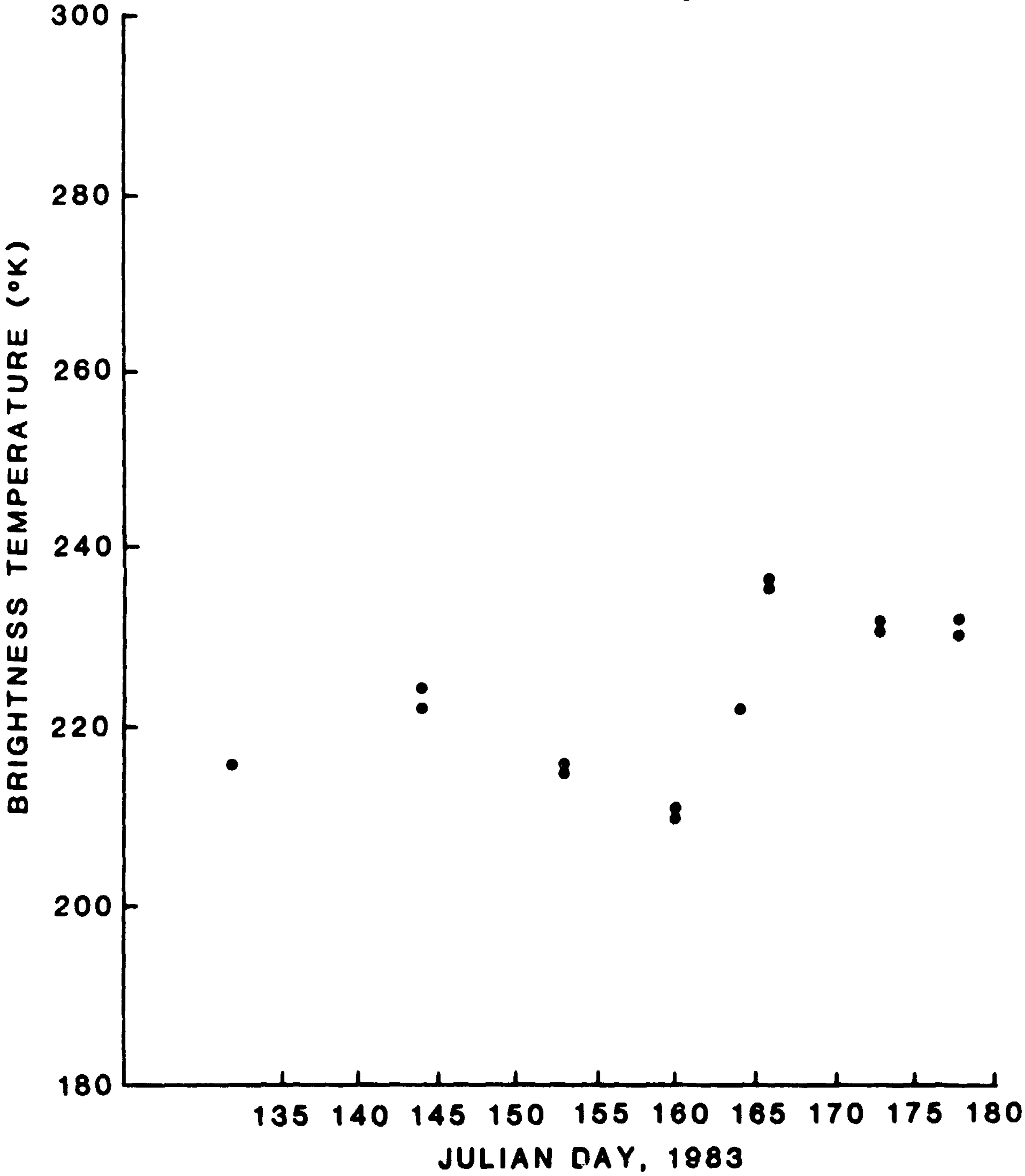

Figure 25. Brightness temperature vs Julian day, Field 3, center beam.

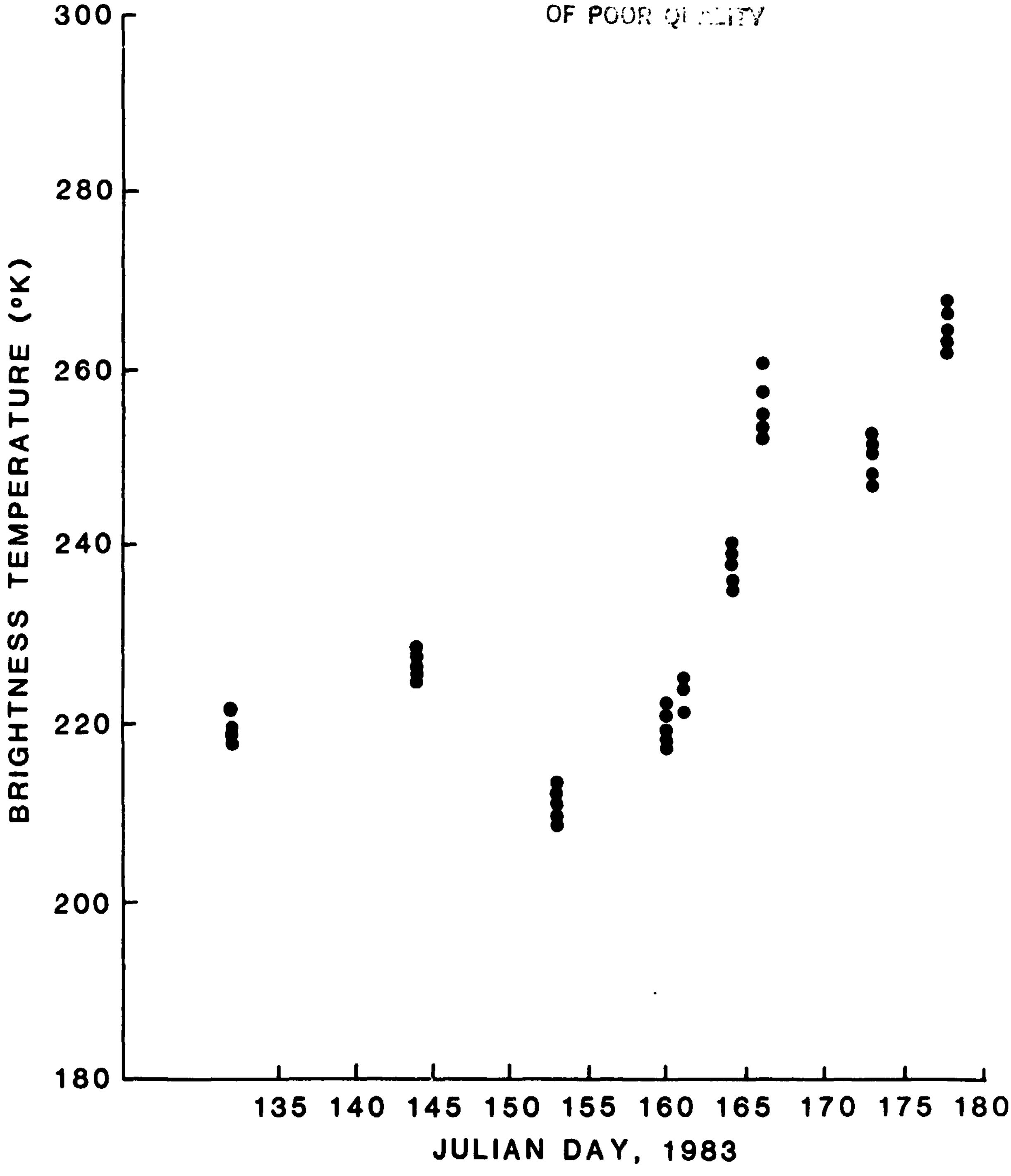

Figure 26. Brightness temperature vs Julian day, field 5, center beam.

Figure 27 is a plot of the data collected over field 27. A general trend similar to those observed in the weed field is present, however, the day-to-day variation is small and on the same order as the variation on a given day.

The results over field 15, the Choptank River cross-section, are quite different. As shown in Figure 28, the pattern is quite distinct. It is hypothesized that the reason for the variation in T_B is the extent of the flooded area beneath the trees. As the streamflow receded the width of a shallow channel such as this section of the Choptank River also recedes.

Another aspect of the forest sites that was considered was what difference might be expected in T_B between beams with such a dense cover. Responses for field 27 showed no consistent difference on any day. Greater variability was observed for field 15, which is probably related to spatial patterns.

7. SUMMARY

In May and June, 1983, NASA and USDA cooperated in the verification of a multi-sensor aircraft system developed to study soil moisture applications. This system consisted of a three beam push broom L band microwave radiometer, a thermal infrared scanned, a multispectral scanner, video and photographic cameras and an onboard navigational instrument. Ten flights were made of agricultural sites in Maryland and Delaware with little or no vegetation cover. Comparisons of aircraft and ground measuremnts showed that the system was reliable and consistent. Time series analysis of microwave and evaporation data showed a strong similarity that indicates a potential direction for future research.

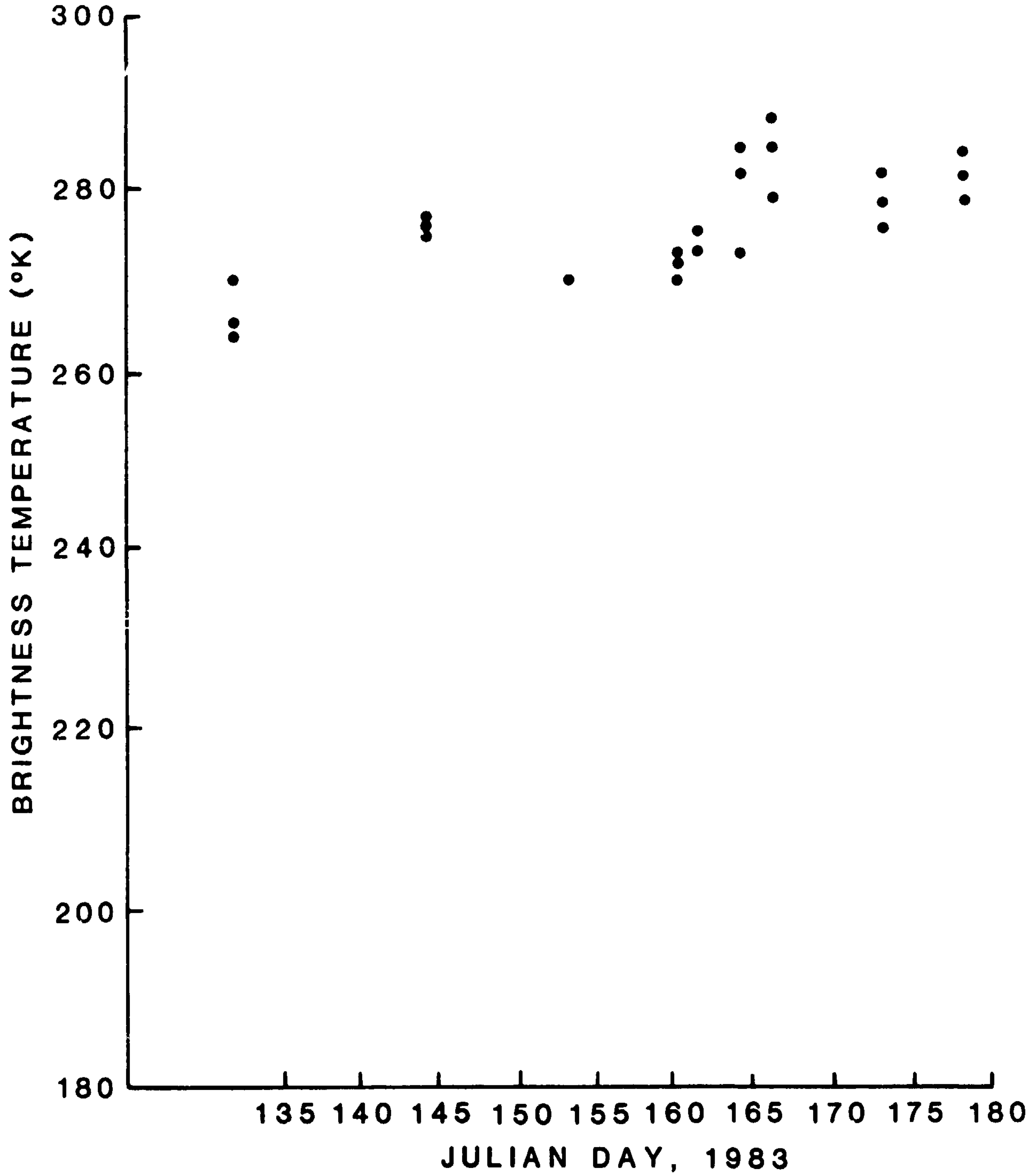

Figure 27. Brightness temperature vs Julian day, field 27, center beam.

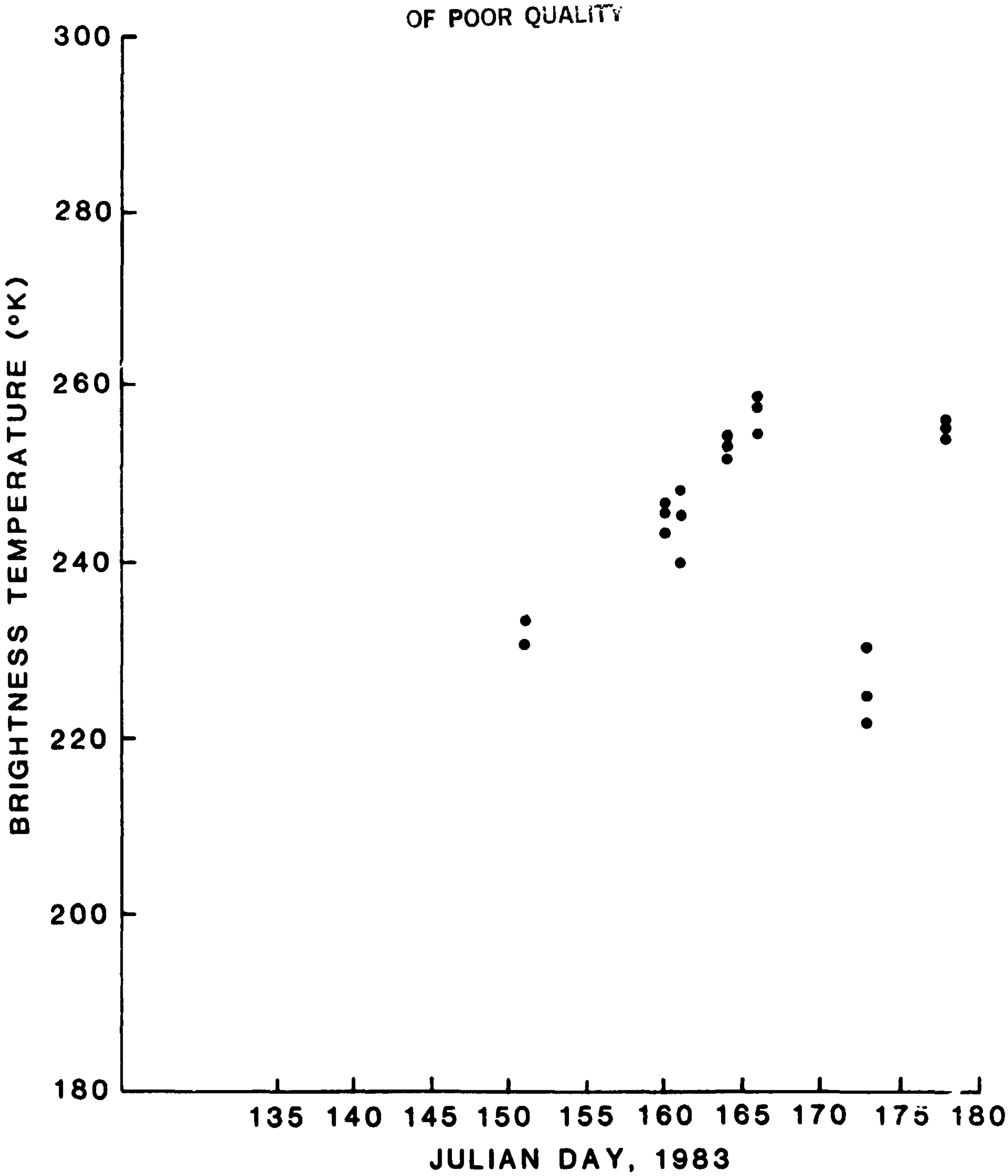

Figure 28. Brightness temperature vs Julian day, field 15, center beam.

8. ACKNOWLEDGEMENTS

The authors wish to express their sincere appreciation to the personnel of the Hydrology Laboratory, USDA/ARS/BARC, the Hydrological Sciences Branch NASA/GSFC and the Department of Agricultural and Natural Resources of Delaware State College for their assistance in the data collection effort. We are especially thankful to Dr. Russ Brinsfield of the Wye Agricultural Experiment Station for his assistance and cooperation in this project and to the individual farmers who allowed us to sample their fields.

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APPENDIX I

AIRCRAFT AND GROUND MEASUREMENTS

DELMARVA SITES, 1983

LISTING CODES

Date	= Calendar date
Day	= Julian day, 1983
Field	= Field number
Line	= Line number
Run	= Run number
Dirc	= Flightline general direction; 0 = west to east and 1 = east to west
Crop	= Crop type code, see Table 2
PCover	= Percent ground cover
Hgt	= Crop height (cm)
Row	= Row direction, see Table 5
Till	= Tillage code, see Table 3
Rough	= Soil surface roughness code, see Table 4
BD	= Soil bulk density (g/cm^3)
T1	= Soil temperature at 5 cm (^{o}C)
T2	= Soil temperature at 10 cm (^{o}C)
T3	= Soil temperature at 15 cm (^{o}C)
TIR	= Field thermal infrared temperature, hand held (^{o}C)
VSM1	= Volumetric soil moisture 0-5 cm (%)
VSM2	= Volumetric soil moisture 5-10 cm (%)
VSM3	= Volumetric soil moisture 10-15 cm (%)
SD1	= Standard deviation of volumetric soil moisture 0-5 cm (%)
SD2	= Standard deviation of volumetric soil moisture 5-10 cm (%)
SD3	= Standard deviation of volumetric soil moisture 10-15 cm (%)
TBL	= L band brightness temperature, left beam (^{o}K)
TBC	= L band brightness temperature, center beam (^{o}K)
TBR	= L band brightness temperature, right beam (^{o}K)
SDL	= Standard deviation of brightness temperatures, left beam (^{o}K)
SDC	= Standard deviation of brightness temperatures, center beam (^{o}K)
SDR	= Standard deviation of brightness temperatures, right beam (^{o}K)

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OBS	DATE	DAY	FIELD	LINE	RUN	DIRC	CROP	PCOVER	HGT	ROW	TILL	ROUGH	BD	T1	T2	T3	TIR	VSM1	VSM2	VSM3	SD1	SD2	SD3	TRL	TRC	TRR	SDL	SDC	SDR
1	31483	73	1	1	1	1	4	90	3	2	1	1	1.48	13	.	5	.	32.3	.	28.1	.	.	.	202	224	211	8	9	6
2	31483	73	1	1	2	1	4	90	3	2	1	1	1.48	13	.	5	.	32.3	.	28.1	.	.	.	204	222	211	4	9	5
3	31483	73	1	1	3	1	4	90	3	2	1	1	1.48	13	.	5	.	32.3	.	28.1	.	.	.	202	221	.	8	3	.
4	51283	132	1	1	1	0	2	0	0	2	1	3	1.11	18	.	14	36	13.7	.	.	4.1	.	.	269	271	267	6	10	6
5	52483	144	1	1	1	0	2	0	8	2	1	2	1.34	19	18	18	19	34.2	33.7	34.7	3.7	.	.	192	192	177	12	8	6
6	52483	144	1	1	2	0	2	0	8	2	1	2	1.34	19	18	18	19	34.2	33.7	34.7	3.7	.	.	178	191	176	8	11	5
7	53183	151	1	.	.	.	2	10	15	2	1	2	1.34	22	20	19	21	32.1	30.5	28.3	2.9	1.3	1.9	.	.	.	.	.	.
8	60283	153	1	1	1	0	2	10	20	2	1	2	1.34	21	18	18	22	30.0	29.1	28.9	4.9	.	.	195	204	191	12	8	9
9	60283	153	1	1	2	0	2	10	20	2	1	2	1.34	21	18	18	22	30.0	29.1	28.9	4.9	.	.	195	202	190	10	10	5
10	60983	160	1	1	1	0	2	25	45	2	1	2	1.34	21	20	20	24	26.2	32.0	28.7	4.3	2.6	0.8	219	228	214	9	9	7
11	60983	160	1	1	2	0	2	25	45	2	1	2	1.34	21	20	20	24	26.2	32.0	28.7	4.3	2.6	0.8	215	230	214	11	6	6
12	61083	161	1	.	.	.	2	25	45	2	1	2	1.34	22	16	16	24	25.4	26.1	27.6	5.9	1.5	0.4	.	.	.	.	.	.
13	61383	164	1	1	1	0	2	50	60	2	1	2	1.20	31	27	25	31	16.9	19.0	20.5	2.7	0.5	0.2	254	254	252	5	16	3
14	61383	164	1	1	2	0	2	50	60	2	1	2	1.20	31	27	25	31	16.9	19.0	20.5	2.7	0.5	0.2	253	256	253	5	13	3
15	61583	166	1	1	1	0	2	50	60	2	1	3	1.20	28	27	26	30	15.5	16.6	16.9	2.3	1.6	1.3	272	276	275	4	17	3
16	61583	166	1	1	2	0	2	50	60	2	1	3	1.20	28	27	26	30	15.5	16.6	16.9	2.3	1.6	1.3	273	277	275	3	16	2
17	62283	173	1	1	1	0	2	75	120	2	1	2	1.34	27	.	22	27	27.3	.	.	3.3	.	.	239	249	218	4	4	17
18	62283	173	1	1	2	0	2	75	120	2	1	2	1.34	27	.	22	27	27.3	.	.	3.3	.	.	238	248	230	4	4	11
19	62783	178	1	1	1	0	2	100	165	2	1	2	1.34	26	24	24	30	16.2	22.3	21.3	4.8	5.2	3.4	276	276	280	3	18	3
20	62783	178	1	1	2	0	2	100	165	2	1	2	1.34	26	24	24	30	16.2	22.3	21.3	4.8	5.2	3.4	278	278	285	3	15	8
21	31483	73	2	1	2	1	5	100	3	2	1	1	1.48	13	.	5	.	42.0	.	.	.	.	.	209	209	206	9	4	4
22	51283	132	2	1	1	0	1	25	3	2	1	2	1.34	21	.	14	30	13.2	.	25.5	2.0	.	3.5	.	.	.	.	.	.
23	52483	144	2	1	1	0	1	0	0	2	1	4	1.11	19	18	18	19	26.2	29.0	32.6	4.6	.	.	.	.	.	.	.	.
24	52483	144	2	1	2	0	1	0	0	2	1	4	1.11	19	18	18	19	26.2	29.0	32.6	4.6	.	.	.	.	.	.	.	.
25	53183	151	2	.	.	.	1	0	0	2	1	3	1.34	.	.	.	21	35.6	.	.	0.8	.	.	.	.	.	.	.	.
26	60283	153	2	1	2	0	1	0	0	2	1	3	1.34	19	17	17	.	29.4	32.3	31.1	2.6	.	.	.	215	193	.	10	8
27	60983	160	2	1	1	0	1	0	0	2	1	3	1.11	21	20	19	28	17.7	21.9	24.3	1.8	.	.	254	271	261	7	2	1
28	60983	160	2	1	2	0	1	0	0	2	1	3	1.11	21	20	19	28	17.7	21.9	24.3	1.8	.	.	256	272	262	4	1	1
29	61083	161	2	.	.	.	1	0	0	2	1	3	1.11	18	17	17	35	15.3	21.6	23.1	3.0	.	.	.	.	.	.	.	.
30	61383	164	2	1	1	0	1	0	0	2	1	2	1.20	34	27	23	40	8.8	20.8	23.6	5.2	.	.	271	278	271	3	1	2
31	61383	164	2	1	2	0	1	0	0	2	1	2	1.20	34	27	23	40	8.8	20.8	23.6	5.2	.	.	271	277	272	5	1	2
32	61583	166	2	1	1	0	3	0	3	2	1	2	1.20	35	28	24	43	5.3	23.7	26.8	3.8	.	.	283	288	283	5	1	2
33	61583	166	2	1	2	0	3	0	3	2	1	2	1.20	35	28	24	43	5.3	23.7	26.8	3.8	.	.	281	287	283	6	2	1
34	62283	173	2	1	1	0	3	0	5	2	1	2	1.34	24	22	21	29	28.4	33.1	30.7	4.3	7.0	4.8	209	214	208	5	3	1
35	62283	173	2	1	2	0	3	0	5	2	1	2	1.34	24	22	21	29	28.4	33.1	30.7	4.3	7.0	4.8	203	217	202	6	6	2
36	62783	178	2	1	1	0	3	0	10	2	1	2	1.34	31	26	24	33	18.9	26.8	29.0	3.7	.	.	.	269	258	.	1	1
37	62783	178	2	1	2	0	3	0	10	2	1	2	1.34	31	26	24	33	18.9	26.8	29.0	3.7	.	.	.	270	260	.	2	2
38	31483	73	3	1	1	1	4	100	15	2	2	1	1.48	13	.	5	.	.	.	.	.	.	.	206	234	.	2	2	.
39	31483	73	3	1	2	1	4	100	15	2	2	1	1.48	13	.	5	.	.	.	.	.	.	.	.	229	262	.	11	7
40	51283	132	3	1	1	0	4	100	15	2	2	1	1.49	18	.	17	25	26.7	.	29.6	5.2	.	.	227	216	222	15	9	5
41	52483	144	3	1	1	0	4	100	15	2	2	1	1.49	20	19	18	19	36.4	36.0	35.6	5.1	.	.	237	224	220	12	12	12
42	52483	144	3	1	2	0	4	100	15	2	2	1	1.49	20	19	18	19	36.4	36.0	35.6	5.1	.	.	231	220	219	19	9	12
43	53183	151	3	.	.	.	4	100	15	2	2	1	1.49	21	20	19	21	39.4	42.7	40.3	4.1	.	.	.	.	.	.	.	.
44	60283	153	3	1	1	0	4	100	15	2	2	1	1.49	21	20	19	29	35.0	36.9	33.6	3.8	.	.	.	214	230	.	9	16
45	60283	153	3	1	2	0	4	100	15	2	2	1	1.49	21	20	19	29	35.0	36.9	33.6	3.8	.	.	206	215	218	10	11	7
46	60983	160	3	1	1	0	4	100	15	2	2	1	1.49	24	23	22	30	43.7	28.2	27.0	28.1	.	.	.	208	.	.	4	.
47	60983	160	3	1	2	0	4	100	15	2	2	1	1.49	24	23	22	30	43.7	28.2	27.0	28.1	.	.	.	208	230	.	5	35
48	61083	161	3	.	.	.	4	100	15	2	2	1	1.49	22	19	19	26	31.3	29.9	29.1	4.7	.	.	.	.	.	.	.	.
49	61383	164	3	1	1	0	4	100	15	2	2	1	1.49	28	26	23	34	27.6	30.7	30.9	7.9	3.4	5.2	.	.	.	.	.	.
50	61383	164	3	1	2	0	4	100	15	2	2	1	1.49	28	26	23	34	27.6	30.7	30.9	7.9	3.4	5.2	.	221	215	.	8	12
51	61583	166	3	1	1	0	4	100	15	2	2	1	1.49	29	27	24	40	30.1	22.1	22.4	25.3	.	.	223	235	.	18	11	.

PRECEDING PAGE BLANK NOT FILMED

PAGE 56 INTENTIONALLY BLANK

ORIGINAL PAGE IS
OF POOR QUALITY

OBS	DATE	DAY	FIELD	LINE	RUN	DIRC	CROP	PCOVER	HGT	ROW	TILL	ROUGH	BD	T1	T2	T3	TIR	VSM1	VSM2	VSM3	SD1	SD2	SD3	THL	TRC	TRR	SDL	SDC	SDR
52	61583	166	3	1	2	0	4	100	15	2	2	1	1.49	29	27	24	40	30.1	22.1	22.4	25.3	.	.	.	236	228	.	10	13
53	62283	173	3	1	1	0	4	100	15	2	2	1	1.49	26	23	22	32	33.7	33.7	33.1	3.1	8.4	5.3	223	231	.	8	5	.
54	62283	173	3	1	2	0	4	100	15	2	2	1	1.49	26	23	22	32	33.7	33.7	33.1	3.1	8.4	5.3	219	229	.	8	6	.
55	62783	178	3	1	1	0	4	100	15	2	2	1	1.48	28	26	24	35	26.1	27.1	28.5	9.9	.	.	.	231	222	.	11	6
56	62783	178	3	1	2	0	4	100	15	2	2	1	1.48	28	26	24	35	26.1	27.1	28.5	9.9	.	.	.	232	223	.	11	6
57	31483	73	4	1	2	1	5	100	3	1	1	1	1.48	9	.	7	.	30.2	.	37.7	.	.	.	185	227	215	4	4	5
58	51283	132	4	1	1	0	2	0	0	1	1	4	1.11	20	.	14	28	8.8	.	20.5	4.5	.	5.2	277	279	229	8	6	7
59	52483	144	4	1	1	0	2	0	8	1	1	3	1.11	19	.	19	18	25.8	22.3	21.1	4.2	1.6	2.9	171	183	175	5	8	4
60	53183	151	4	.	.	.	2	10	10	2	1	2	1.34	20	.	19	20	36.4	30.2	30.1	23.1	10.6	10.7	.	.	.	.	.	.
61	60283	153	4	1	1	0	2	10	15	1	1	2	1.34	22	.	16	26	34.2	28.4	28.4	24.1	6.5	7.6	190	207	199	8	8	10
62	60283	153	4	1	2	0	2	10	15	1	1	2	1.34	22	.	16	26	34.2	28.4	28.4	24.1	6.5	7.6	192	211	199	7	7	10
63	60983	160	4	3	1	0	2	20	38	3	1	2	1.34	23	24	20	23	22.9	21.5	25.2	6.3	7.1	8.1	228	225	207	1	4	1
64	61083	161	4	.	.	.	2	20	38	2	1	2	1.34	22	.	18	21	20.0	22.9	23.4	5.4	6.3	6.7	.	.	.	.	.	.
65	61383	164	4	3	1	0	2	30	45	3	1	2	1.34	31	.	23	35	16.6	21.1	22.2	4.6	6.6	6.6	262	268	254	4	6	14
66	61383	164	4	3	2	0	2	30	45	3	1	2	1.34	31	.	23	35	16.6	21.1	22.2	4.6	6.6	6.6	262	270	250	3	5	16
67	61583	166	4	3	1	0	2	40	45	3	1	2	1.34	31	.	23	.	12.6	18.9	19.1	4.3	6.3	6.1	.	296	.	.	4	.
68	61583	166	4	3	2	0	2	40	45	3	1	2	1.34	31	.	23	.	12.6	18.9	19.1	4.3	6.3	6.1	280	286	270	4	4	11
69	62283	173	4	3	1	0	2	50	90	3	1	2	1.34	27	.	22	30	28.6	27.5	25.9	5.9	8.7	8.0	226	239	234	3	5	10
70	62283	173	4	3	2	0	2	50	90	3	1	2	1.34	27	.	22	30	28.6	27.5	25.9	5.9	8.7	8.0	227	238	236	4	5	12
71	62783	178	4	3	1	0	2	75	125	3	1	2	1.34	29	.	24	30	11.7	13.1	13.4	2.4	2.7	3.6	276	283	230	5	2	7
72	62783	178	4	3	2	0	2	75	125	3	1	2	1.34	29	.	24	30	11.7	13.1	13.4	2.4	2.7	3.6	276	282	220	5	3	6
73	31483	73	5	1	2	1	5	100	3	1	3	1	1.48	5	.	1	.	33.6	.	30.9	.	.	.	218	224	209	11	2	4
74	31483	73	5	2	2	1	5	100	3	3	3	1	1.48	5	.	1	.	33.6	.	30.9	.	.	.	210	230	214	3	4	5
75	51283	132	5	1	1	0	2	100	3	1	3	1	1.49	15	.	14	28	28.4	.	.	4.6	.	.	203	218	205	3	5	7
76	51283	132	5	2	1	0	2	100	3	3	3	1	1.49	15	.	14	28	28.4	.	.	4.6	.	.	203	218	218	10	10	8
77	51283	132	5	2	3	0	2	100	3	3	3	1	1.49	15	.	14	28	28.4	.	.	4.6	.	.	210	218	224	11	5	14
78	51283	132	5	3	1	0	2	100	3	3	3	1	1.49	15	.	14	28	28.4	.	.	4.6	.	.	208	220	214	3	4	5
79	52483	144	5	1	1	0	2	100	10	1	3	1	1.48	20	.	20	17	40.3	30.3	29.7	18.4	3.7	4.3	216	224	215	4	4	3
80	52483	144	5	1	2	0	2	100	10	1	3	1	1.48	20	.	20	17	40.3	30.3	29.7	18.4	3.7	4.3	211	224	214	6	6	7
81	52483	144	5	2	1	0	2	100	10	3	3	1	1.48	20	.	20	17	40.3	30.3	29.7	18.4	3.7	4.3	211	225	214	5	6	6
82	52483	144	5	2	2	0	2	100	10	3	3	1	1.48	20	.	20	17	40.3	30.3	29.7	18.4	3.7	4.3	213	226	213	6	6	5
83	52483	144	5	2	3	0	2	100	10	3	3	1	1.48	20	.	20	17	40.3	30.3	29.7	18.4	3.7	4.3	211	225	216	3	3	5
84	52483	144	5	3	1	0	2	100	10	3	3	1	1.48	20	.	20	17	40.3	30.3	29.7	18.4	3.7	4.3	212	228	224	6	6	6
85	52483	144	5	3	2	0	2	100	10	3	3	1	1.48	20	.	20	17	40.3	30.3	29.7	18.4	3.7	4.3	211	228	225	4	5	5
86	53183	151	5	.	.	.	2	100	10	3	3	1	1.48	20	20	19	20	31.4	29.8	27.7	6.3	9.3	9.3	.	.	.	.	.	.
87	60283	153	5	1	1	0	2	100	15	1	3	1	1.48	22	17	17	26	33.1	27.4	28.2	6.3	4.8	6.6	193	210	195	4	4	3
88	60283	153	5	1	2	0	2	100	15	[illegible]	[illegible]	1	1.48	22	17	17	26	33.1	27.4	28.2	6.3	4.8	6.6	192	209	195	6	4	4
89	60283	153	5	2	1	0	2	100	15	[illegible]	3	1	1.48	22	17	17	26	33.1	27.4	28.2	6.3	4.8	6.6	195	209	195	7	8	7
90	60283	153	5	2	2	0	2	100	15	3	3	1	1.48	22	17	17	26	33.1	27.4	28.2	6.3	4.8	6.6	194	208	194	7	8	4
91	60283	153	5	2	3	0	2	100	15	3	3	1	1.48	22	17	17	26	33.1	27.4	28.2	6.3	4.8	6.6	196	209	195	6	7	8
92	60283	153	5	3	1	0	2	100	15	3	3	1	1.48	22	17	17	26	33.1	27.4	28.2	6.3	4.8	6.6	198	213	208	3	2	5
93	60283	153	5	3	2	0	2	100	15	3	3	1	1.48	22	17	17	26	33.1	27.4	28.2	6.3	4.8	6.6	198	213	207	3	3	3
94	60983	160	5	1	1	0	2	20	38	1	3	1	1.48	24	22	21	24	31.1	25.8	25.9	7.2	1.9	1.9	201	217	204	2	3	3
95	60983	160	5	1	2	0	2	20	38	1	3	1	1.48	24	22	21	24	31.1	25.8	25.9	7.2	1.9	1.9	202	218	204	4	4	3
96	60983	160	5	2	1	0	2	20	38	3	3	1	1.48	24	22	21	24	31.1	25.8	25.9	7.2	1.9	1.9	197	217	203	8	8	5
97	60983	160	5	2	2	0	2	20	38	3	3	1	1.48	24	22	21	24	31.1	25.8	25.9	7.2	1.9	1.9	202	218	203	4	5	4
98	60983	160	5	2	3	0	2	20	38	3	3	1	1.48	24	22	21	24	31.1	25.8	25.9	7.2	1.9	1.9	206	218	205	2	3	5
99	60983	160	5	3	1	0	2	20	38	3	3	1	1.48	24	22	21	24	31.1	25.8	25.9	7.2	1.9	1.9	204	222	208	3	2	2
100	60983	160	5	3	2	0	2	20	38	3	3	1	1.48	24	22	21	24	31.1	25.8	25.9	7.2	1.9	1.9	206	222	210	6	2	2
101	61083	161	5	2	2	0	2	20	38	3	3	1	1.48	23	20	18	24	34.5	28.2	28.5	5.5	6.5	7.1	208	222	209	6	7	5
102	61083	161	5	3	1	0	2	20	38	3	3	1	1.48	23	20	18	24	34.5	28.2	28.5	5.5	6.5	7.1	211	224	218	2	3	3

OBS	DATE	DAY	FIELD	LINE	RUN	DIRC	CROP	PCOVER	HGT	ROW	TILL	ROUGH	RD	T1	T2	T3	TIR	VSM1	VSM2	VSM3	SD1	SD2	SD3	TRL	TRC	TBR	SDL	SDC	SDR
103	61083	161	5	3	2	0	2	20	38	3	3	1	1.48	23	20	18	24	34.5	28.2	28.5	5.5	6.5	7.1	211	223	217	3	2	3
104	61383	164	5	1	1	0	2	100	45	1	3	1	1.48	29	24	.	34	29.4	33.5	.	6.6	4.2	.	221	235	226	4	4	5
105	61383	164	5	1	2	0	2	100	45	1	3	1	1.48	29	24	.	34	29.4	33.5	.	6.6	4.2	.	222	235	227	4	5	5
106	61383	164	5	2	1	0	2	100	45	3	3	1	1.48	29	24	.	34	29.4	33.5	.	6.6	4.2	.	221	237	227	7	7	4
107	61383	164	5	2	2	0	2	100	45	3	3	1	1.48	29	24	.	34	29.4	33.5	.	6.6	4.2	.	223	238	231	7	7	11
108	61383	164	5	2	3	0	2	100	45	3	3	1	1.48	29	24	.	34	29.4	33.5	.	6.6	4.2	.	224	237	231	2	3	3
109	61583	166	5	1	1	0	2	100	45	1	3	1	1.48	28	.	23	.	27.2	23.7	25.7	5.6	1.8	1.6	237	250	241	3	4	5
110	61583	166	5	1	2	0	2	100	45	1	3	1	1.48	28	.	23	.	27.2	23.7	25.7	5.6	1.8	1.6	236	251	242	4	5	5
111	61583	166	5	2	1	0	2	100	45	3	3	1	1.48	28	.	23	.	27.2	23.7	25.7	5.6	1.8	1.6	246	258	258	9	8	11
112	61583	166	5	2	2	0	2	100	45	3	3	1	1.48	28	.	23	.	27.2	23.7	25.7	5.6	1.8	1.6	248	260	260	8	7	10
113	61583	166	5	2	3	0	2	100	45	3	3	1	1.48	28	.	23	.	27.2	23.7	25.7	5.6	1.8	1.6	244	253	244	5	3	3
114	62283	173	5	1	1	0	2	100	90	1	3	1	1.48	26	26	24	27	31.9	29.8	29.7	4.4	4.4	5.7	244	249	243	3	2	3
115	62283	173	5	1	2	0	2	100	90	1	3	1	1.48	26	26	24	27	31.9	29.8	29.7	4.4	4.4	5.7	245	248	242	4	3	3
116	62283	173	5	2	1	0	2	100	90	3	3	1	1.48	26	26	24	27	31.0	29.8	29.7	4.4	4.4	5.7	242	252	244	6	5	4
117	62283	173	5	2	2	0	2	100	90	3	3	1	1.48	26	26	24	27	31.0	29.8	29.7	4.4	4.4	5.7	241	251	244	6	5	5
118	62283	173	5	2	3	0	2	100	90	3	3	1	1.48	26	26	24	27	31.0	29.8	29.7	4.4	4.4	5.7	240	251	242	7	3	4
119	62783	178	5	1	1	0	2	75	125	1	3	1	1.48	27	.	24	30	26.0	27.6	27.7	4.8	2.3	2.2	261	263	263	4	2	2
120	62783	178	5	1	2	0	2	75	125	1	3	1	1.48	27	.	24	30	26.0	27.6	27.7	4.8	2.3	2.2	261	263	263	4	2	2
121	62783	178	5	2	1	0	2	75	125	3	3	1	1.48	27	.	24	30	26.0	27.6	27.7	4.8	2.3	2.2	256	265	261	6	5	4
122	62783	178	5	2	2	0	2	75	125	3	3	1	1.48	27	.	24	30	26.0	27.6	27.7	4.8	2.3	2.2	256	264	260	7	6	5
123	62783	178	5	2	3	0	2	75	125	3	3	1	1.48	27	.	24	30	26.0	27.6	27.7	4.8	2.3	2.2	260	265	264	3	1	2
124	62783	178	5	3	1	0	2	75	125	3	3	1	1.48	27	.	24	30	26.0	27.6	27.7	4.8	2.3	2.2	280	284	274	4	3	16
125	62783	178	5	3	2	0	2	75	125	3	3	1	1.48	27	.	24	30	26.0	27.6	27.7	4.8	2.3	2.2	280	285	280	5	4	9
126	51283	132	6	2	1	0	2	0	0	2	1	3	1.11	20	14	15	28	13.3	18.1	22.3	3.2	.	3.0	.	273	273	.	2	2
127	51283	132	6	2	3	0	2	0	0	2	1	3	1.11	20	14	15	28	13.3	18.1	22.3	3.2	.	3.0	.	271	262	.	3	5
128	52483	144	6	2	1	0	2	0	5	2	1	3	1.11	19	15	.	19	28.7	31.6	.	3.7	.	.	156	.	165	4	.	2
129	52483	144	6	2	2	0	2	0	5	2	1	3	1.11	19	15	.	19	28.7	31.6	.	3.7	.	.	160	.	165	4	.	1
130	52483	144	6	2	3	0	2	0	5	2	1	3	1.11	19	15	.	19	28.7	31.6	.	3.7	.	.	.	178	172	.	5	5
131	53183	151	6	.	.	.	2	10	10	2	1	2	1.34	21	.	18	21	35.5	.	34.9	3.1	.	6.3	.	.	.	.	.	.
132	60283	153	6	2	1	0	2	10	15	2	1	2	1.34	19	17	.	.	34.1	35.1	.	5.0	.	.	175	.	172	12	.	11
133	60283	153	6	2	2	0	2	10	15	2	1	2	1.34	19	17	.	.	34.1	35.1	.	5.0	.	.	.	174	175	.	3	9
134	60283	153	6	2	3	0	2	10	15	2	1	2	1.34	19	17	.	.	34.1	35.1	.	5.0	.	.	174	180	174	6	5	7
135	60983	160	6	2	1	0	2	20	20	2	1	2	1.34	23	19	19	23	29.4	29.4	29.7	5.0	.	.	195	.	185	5	.	5
136	60983	160	6	2	2	0	2	20	20	2	1	2	1.34	23	19	19	23	29.4	29.4	29.7	5.0	.	.	196	.	183	6	.	4
137	60983	160	6	2	3	0	2	20	20	2	1	2	1.34	23	19	19	23	29.4	29.4	29.7	5.0	.	.	189	.	189	11	.	6
138	61083	161	6	.	.	.	2	20	20	2	1	2	1.34	21	17	17	24	26.6	28.8	29.6	5.7	.	.	.	.	.	.	.	.
139	61383	164	6	2	1	0	2	30	45	2	1	2	1.34	32	26	24	32	19.2	31.2	31.2	5.8	.	.	236	.	231	3	.	5
140	61383	164	6	2	2	0	2	30	45	2	1	2	1.34	32	26	24	32	19.2	31.2	31.2	5.8	.	.	237	.	230	4	.	5
141	61383	164	6	2	3	0	2	30	45	2	1	2	1.34	32	26	24	32	19.2	31.2	31.2	5.8	.	.	.	.	234	.	.	4
142	61583	166	6	2	1	0	2	40	45	2	1	3	1.11	29	26	23	.	18.3	25.0	25.2	5.3	.	.	.	294	.	.	3	.
143	61583	166	6	2	3	0	2	40	45	2	1	3	1.11	29	26	23	.	18.3	25.0	25.2	5.3	.	.	230	.	276	14	.	3
144	62283	173	6	2	1	0	2	50	90	2	1	2	1.24	24	.	22	30	32.1	31.4	31.9	2.7	.	.	213	.	233	3	.	3
145	62283	173	6	2	2	0	2	50	90	2	1	2	1.24	24	.	22	30	32.1	31.4	31.9	2.7	.	.	206	241	235	4	2	3
146	62283	173	6	2	3	0	2	50	90	2	1	2	1.24	24	.	22	30	32.1	31.4	31.9	2.7	.	.	.	242	195	.	2	12
147	62783	178	6	2	1	0	2	100	125	2	1	2	1.24	27	23	22	30	16.6	18.9	21.2	4.0	.	.	257	280	.	5	2	.
148	62783	178	6	2	2	0	2	100	125	2	1	2	1.24	27	23	22	30	16.6	18.9	21.2	4.0	.	.	267	280	.	1	0	.
149	62783	178	6	2	3	0	2	100	125	2	1	2	1.24	27	23	22	30	16.6	18.9	21.2	4.0	.	.	.	277	.	.	2	.
150	31483	73	7	2	2	1	.	50	.	2	.	.	.	13	.	5	.	.	.	.	.	.	.	193	209	202	3	8	12
151	51283	132	7	2	1	0	2	100	15	2	1	1	1.49	19	13	16	23	24.9	13.7	24.9	7.1	.	.	.	.	249	.	.	12
152	51283	132	7	2	3	0	2	100	15	2	1	1	1.49	19	13	16	23	24.9	13.7	24.9	7.1	.	.	206	218	.	11	5	.
153	52483	144	7	2	1	0	2	100	15	2	1	2	1.34	20	19	.	19	43.9	35.3	.	25.2	.	.	209	223	221	5	5	2

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OBS	DATE	DAY	FIELD	LINE	RUN	DIRC	CROP	PCOVER	HGT	ROW	TILL	ROUGH	BD	T1	T2	T3	TTP	VSM1	VSM2	VSM3	SD1	SD2	SD3	TRL	TRC	TRR	SDL	SDC	SDR
154	52483	144	7	2	2	0	2	100	15	2	1	2	1.34	23	19	.	19	43.9	35.3	.	25.2	.	.	213	220	234	8	7	6
155	53183	151	7	.	.	.	2	50	15	2	1	2	1.34	21	.	19	21	34.8	.	40.0	6.9	.	.	.	.	.	.	.	.
156	60283	153	7	2	1	0	2	50	15	2	1	2	1.34	20	.	19	.	29.2	.	.	2.3	.	.	187	197	212	9	7	20
157	60283	153	7	2	2	0	2	50	15	2	1	2	1.34	20	.	19	.	29.2	.	.	2.3	.	.	189	207	225	5	5	15
158	60283	153	7	2	3	0	2	50	15	2	1	2	1.34	20	.	19	.	29.2	.	.	2.3	.	.	205	202	.	13	3	.
159	60983	160	7	2	1	0	1	0	0	2	1	3	1.11	22	19	19	28	21.8	32.5	26.8	6.4	.	.	242	254	250	3	2	6
160	60983	160	7	2	2	0	1	0	0	2	1	3	1.11	22	19	19	28	21.8	32.5	26.8	6.4	.	.	242	256	251	5	4	5
161	60983	160	7	2	3	0	1	0	0	2	1	3	1.11	22	19	19	28	21.8	32.5	26.8	6.4	.	.	241	250	229	4	3	8
162	61083	161	7	.	.	.	1	0	0	2	1	3	1.11	18	.	17	24	20.2	.	.	3.6	.	.	.	.	.	.	.	.
163	61383	164	7	2	1	0	3	0	0	2	1	2	1.20	30	.	23	43	17.0	.	.	5.2	.	.	275	282	280	2	1	4
164	61383	164	7	2	2	0	3	0	0	2	1	2	1.20	30	.	23	43	17.0	.	.	5.2	.	.	274	283	283	2	2	4
165	61383	164	7	2	3	0	3	0	0	2	1	2	1.20	30	.	23	43	17.0	.	.	5.2	.	.	270	282	.	1	1	.
166	61583	166	7	2	1	0	3	0	0	2	1	3	1.20	29	.	24	.	13.1	.	.	4.3	.	.	.	296	.	.	3	.
167	61583	166	7	2	3	0	3	0	0	2	1	3	1.20	29	.	24	.	13.1	.	.	4.3	.	.	280	294	.	2	1	.
168	62283	173	7	2	1	0	3	0	5	2	1	3	1.34	26	22	21	29	33.6	35.8	34.5	1.8	.	.	201	221	226	6	5	13
169	62283	173	7	2	2	0	3	0	5	2	1	3	1.34	26	22	21	29	33.6	35.8	34.5	1.8	.	.	207	217	229	10	5	9
170	62283	173	7	2	3	0	3	0	5	2	1	3	1.34	26	22	21	29	33.6	35.8	34.5	1.8	.	.	211	228	.	6	3	.
171	62783	178	7	2	1	0	3	0	10	2	1	3	1.34	29	24	22	32	19.9	26.3	26.9	5.1	.	.	256	267	269	3	2	6
172	62783	178	7	2	2	0	3	0	10	2	1	3	1.34	29	24	22	32	19.9	26.3	26.9	5.1	.	.	256	269	269	2	3	7
173	62783	178	7	2	3	0	3	0	10	2	1	3	1.34	29	24	22	32	19.9	26.3	26.9	5.1	.	.	252	269	261	3	2	4
174	31483	73	8	2	2	1	4	90	3	2	1	1	1.48	13	.	6	.	43.8	.	38.5	.	.	.	191	205	195	16	16	19
175	51283	132	8	2	1	0	2	0	0	2	1	3	1.11	23	15	.	28	16.9	17.4	.	4.4	7.4	.	259	265	264	15	18	10
176	51283	132	8	2	3	0	2	0	0	2	1	3	1.11	23	15	.	28	16.9	17.4	.	4.4	7.4	.	256	263	256	15	14	7
177	52483	144	8	2	1	0	2	0	8	2	1	4	1.11	21	21	19	19	44.7	31.7	29.1	24.8	.	.	156	169	.	5	6	.
178	52483	144	8	2	2	0	2	0	8	2	1	4	1.11	21	21	19	19	44.7	31.7	29.1	24.8	.	.	157	171	171	5	4	6
179	52483	144	8	2	3	0	2	0	8	2	1	4	1.11	21	21	19	19	44.7	31.7	29.1	24.8	.	.	160	177	195	4	4	14
180	53183	151	8	.	.	.	2	10	13	2	1	2	1.34	21	.	19	20	40.9	.	36.6	6.8	.	4.1	.	.	.	.	.	.
181	60283	153	8	2	1	0	2	10	13	2	1	2	1.34	18	16	.	22	40.5	45.7	.	3.0	.	.	160	176	176	3	8	10
182	60283	153	8	2	2	0	2	10	13	2	1	2	1.34	18	16	.	22	40.5	45.7	.	3.0	.	.	158	176	176	7	8	5
183	60283	153	8	2	3	0	2	10	13	2	1	2	1.34	18	16	.	22	40.5	45.7	.	3.0	.	.	168	174	183	6	5	10
184	60983	160	8	2	1	0	2	20	20	2	1	2	1.34	23	.	17	23	34.4	.	.	6.2	.	.	170	187	192	7	14	7
185	60983	160	8	2	2	0	2	20	20	2	1	2	1.34	23	.	17	23	34.4	.	.	6.2	.	.	173	185	188	7	9	5
186	60983	160	8	2	3	0	2	20	20	2	1	2	1.34	23	.	17	23	34.4	.	.	6.2	.	.	181	189	207	2	8	10
187	61083	161	8	.	.	.	2	20	20	2	1	2	1.34	21	18	17	24	28.6	22.8	22.7	6.2	.	.	.	.	.	.	.	.
188	61383	164	8	2	1	0	2	30	38	2	1	2	1.20	31	26	23	32	23.0	23.0	27.8	3.3	.	.	207	221	228	9	16	8
189	61383	164	8	2	2	0	2	30	38	2	1	2	1.20	31	26	23	32	23.0	23.0	27.8	3.3	.	.	206	223	229	11	15	7
190	61383	164	8	2	3	0	2	30	38	2	1	2	1.20	31	26	23	32	23.0	23.0	27.8	3.3	.	.	211	220	245	3	8	5
191	61583	166	8	2	1	0	2	40	38	2	1	3	1.20	28	23	22	.	19.5	24.3	23.1	3.1	.	.	258	271	277	18	20	14
192	61583	166	8	2	3	0	2	40	38	2	1	3	1.20	28	23	22	.	19.5	24.3	23.1	3.1	.	.	259	270	280	14	17	8
193	62283	173	8	2	1	0	2	50	60	2	1	3	1.34	25	22	23	30	36.9	35.5	32.9	2.8	4.0	2.8	235	248	247	6	4	5
194	62283	173	8	2	2	0	2	50	60	2	1	3	1.34	25	22	23	30	36.9	35.5	32.9	2.8	4.0	2.8	235	247	246	4	4	4
195	62283	173	8	2	3	0	2	50	60	2	1	3	1.34	25	22	23	30	36.9	35.5	32.9	2.8	4.0	2.8	235	248	230	3	3	8
196	62783	178	8	2	1	0	2	75	90	2	1	2	1.24	28	25	22	30	18.8	24.3	24.9	2.3	.	.	272	279	278	4	5	2
197	62783	178	8	2	2	0	2	75	90	2	1	2	1.24	28	25	22	30	18.8	24.3	24.9	2.3	.	.	272	280	279	4	5	3
198	62783	178	8	2	3	0	2	75	90	2	1	2	1.24	28	25	22	30	18.8	24.3	24.9	2.3	.	.	267	279	276	2	3	4
199	31483	73	9	2	2	1	.	80	.	2	.	.	.	5	.	1	.	.	.	.	.	.	.	193	224	207	7	8	7
200	51283	132	9	2	1	0	1	100	3	2	3	1	1.48	23	.	15	29	25.3	.	31.7	5.4	.	1.1	213	222	237	5	8	11
201	51283	132	9	2	3	0	1	100	3	2	3	1	1.48	23	.	15	20	25.3	.	31.7	5.4	.	1.1	231	225	252	7	9	3
202	52483	144	9	2	1	0	2	100	3	2	3	1	1.48	23	21	18	18	52.3	58.1	55.7	22.3	.	.	192	209	215	8	11	8
203	52483	144	9	2	2	0	2	100	3	2	3	1	1.48	23	21	18	18	52.3	58.1	55.7	22.3	.	.	193	212	218	8	10	8
204	52483	144	9	2	3	0	2	100	3	2	3	1	1.48	23	21	18	18	52.3	58.1	55.7	22.3	.	.	186	220	.	4	4	.

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OBS	DATE	DAY	FIELD	LINE	RUN	DIRC	CROP	PCOVER	HGT	ROW	TILL	ROUGH	BD	T1	T2	T3	TIR	VSM1	VSM2	VSM3	SD1	SD2	SD3	THL	TRC	TRR	SDL	SDC	SDR
205	53183	151	9	.	.	.	2	100	5	2	3	1	1.48	21	.	18	19	48.8	.	63.7	7.7	.	.	.	.	.	.	.	.
206	60283	153	9	2	1	0	2	100	5	2	3	1	1.48	21	17	.	17	49.0	42.8	.	7.6	.	.	176	192	.	4	6	.
207	60283	153	9	2	2	0	2	100	5	2	3	1	1.48	21	17	.	17	49.0	42.8	.	7.6	.	.	175	192	.	5	6	.
208	60383	153	9	2	3	0	2	100	5	2	3	1	1.48	21	17	.	17	49.0	42.8	.	.	.	.	177	192	.	1	4	.
209	60983	160	9	2	1	0	2	10	15	2	3	1	1.48	23	19	19	24	35.7	38.9	39.8	7.2	.	.	176	196	204	4	4	11
210	60983	160	9	2	2	0	2	10	15	2	3	1	1.48	23	19	19	24	35.7	38.9	39.8	7.2	.	.	178	197	196	2	2	9
211	60983	160	9	2	3	0	2	10	15	2	3	1	1.48	23	19	19	24	35.7	38.9	39.9	7.2	.	.	188	195	209	2	1	4
212	61083	161	9	.	.	.	2	10	15	2	3	1	1.48	22	19	18	28	39.2	45.5	46.2	6.5	.	.	.	.	.	.	.	.
213	61383	164	9	2	1	0	2	100	30	2	3	1	1.48	30	26	23	35	36.7	28.0	27.8	9.0	.	.	198	212	212	1	4	8
214	61383	164	9	2	2	0	2	100	30	2	3	1	1.48	30	26	23	35	36.7	28.0	27.8	9.0	.	.	196	213	218	5	5	13
215	61383	164	9	2	3	0	2	100	30	2	3	1	1.48	30	26	23	35	36.7	28.0	27.8	9.0	.	.	205	211	232	3	2	4
216	61583	166	9	2	1	0	2	100	30	2	3	1	1.48	30	26	24	.	31.4	42.8	41.5	9.2	.	.	206	226	225	2	6	10
217	61583	166	9	2	3	0	2	100	30	2	3	1	1.48	30	26	24	.	31.4	42.8	41.5	9.2	.	.	224	225	243	3	3	5
218	62283	173	9	2	1	0	2	100	45	2	3	1	1.48	27	.	23	30	38.4	31.9	28.5	5.1	.	.	199	218	228	5	9	7
219	62283	173	9	2	2	0	2	100	45	2	3	1	1.48	27	.	23	30	38.4	31.9	28.5	5.1	.	.	196	217	220	3	6	5
220	62283	173	9	2	3	0	2	100	45	2	3	1	1.48	27	.	23	30	38.4	31.9	28.5	5.1	.	.	199	219	237	2	6	2
221	62783	178	9	2	1	0	2	100	60	2	3	1	1.48	28	.	24	33	34.4	.	.	4.3	.	.	219	230	224	2	8	4
222	62783	178	9	2	2	0	2	100	60	2	3	1	1.48	28	.	24	33	34.4	.	.	4.3	.	.	217	231	230	3	4	7
223	62783	178	9	2	3	0	2	100	60	2	3	1	1.48	28	.	24	33	34.4	.	.	4.3	.	.	234	231	253	2	2	2
224	31483	73	10	2	2	1	4	100	3	2	1	1	1.48	5	.	1	.	.	.	.	.	.	.	229	241	219	3	4	4
225	51283	132	10	2	1	0	1	100	30	2	2	1	1.49	20	.	14	28	.	.	.	.	.	.	218	223	228	16	7	8
226	51283	132	10	2	3	0	1	100	30	2	2	1	1.49	20	.	14	28	.	.	.	.	.	.	227	220	241	7	2	10
227	52483	144	10	2	1	0	1	100	30	2	2	1	1.49	20	18	17	19	48.3	52.5	49.1	8.0	.	.	226	225	224	19	16	10
228	52483	144	10	2	2	0	1	100	30	2	2	1	1.49	20	18	17	19	48.3	52.5	49.1	8.0	.	.	226	224	228	17	15	6
229	52483	144	10	2	3	0	1	100	30	2	2	1	1.49	20	18	17	19	48.3	52.5	49.1	8.0	.	.	226	229	.	11	4	.
230	53183	151	10	.	.	.	4	100	30	2	2	1	1.49	.	.	.	18	56.6	.	.	6.5	.	.	.	.	.	.	.	.
231	60283	153	10	2	1	0	4	100	30	2	2	1	1.49	18	17	.	20	52.9	49.1	.	9.7	.	.	207	214	203	12	9	10
232	60283	153	10	2	2	0	4	100	30	2	2	1	1.49	18	17	.	20	52.9	49.1	.	9.7	.	.	206	210	.	17	11	.
233	60283	153	10	2	3	0	4	100	30	2	2	1	1.49	18	17	.	20	52.9	49.1	.	9.7	.	.	214	210	209	16	8	3
234	60983	160	10	2	1	0	4	100	30	2	2	1	1.49	24	.	20	26	50.4	.	.	7.1	.	.	207	210	202	8	6	6
235	60983	160	10	2	2	0	4	100	30	2	2	1	1.49	24	.	20	26	50.4	.	.	7.1	.	.	210	214	204	8	3	6
236	60983	160	10	2	3	0	4	100	30	2	2	1	1.49	24	.	20	26	50.4	.	.	7.1	.	.	215	216	207	4	4	3
237	61083	161	10	2	2	0	4	100	30	2	2	1	1.49	21	.	20	26	45.5	.	.	9.8	.	.	209	214	208	8	5	7
238	61383	164	10	2	1	0	4	100	30	2	2	1	1.49	30	.	23	34	37.0	.	.	5.3	.	.	218	223	217	13	6	5
239	61383	164	10	2	2	0	4	100	30	2	2	1	1.49	30	.	23	34	37.0	.	.	5.3	.	.	227	226	244	10	5	6
240	61383	164	10	2	3	0	4	100	30	2	2	1	1.49	30	.	23	34	37.0	.	.	5.3	.	.	227	223	224	4	3	1
241	61583	166	10	2	1	0	4	100	30	2	2	1	1.49	29	.	23	.	39.5	.	.	9.3	.	.	225	233	225	6	7	6
242	61583	166	10	2	3	0	4	100	30	2	2	1	1.49	29	.	23	.	39.5	.	.	9.3	.	.	237	236	232	2	2	2
243	62283	173	10	2	1	0	3	0	0	2	1	3	1.11	27	.	22	28	35.0	33.7	33.8	2.3	.	.	187	203	193	3	2	2
244	62283	173	10	2	2	0	3	0	0	2	1	3	1.11	27	.	22	28	35.0	33.7	33.8	2.3	.	.	187	205	192	3	2	2
245	62283	173	10	2	3	0	3	0	0	2	1	3	..11	27	.	22	28	35.0	33.7	33.8	2.3	.	.	194	202	212	2	1	4
246	62783	178	10	2	1	0	3	0	5	2	1	3	1.11	29	26	24	33	22.6	26.2	26.4	3.4	.	.	244	259	246	2	1	3
247	62783	178	10	2	2	0	3	0	5	2	1	3	1.11	29	26	24	33	22.6	26.2	26.4	3.4	.	.	243	258	244	2	3	4
248	62783	178	10	2	3	0	3	0	5	2	1	3	1.11	29	26	24	33	22.6	26.2	26.4	3.4	.	.	249	257	252	3	3	3
249	31483	73	11	3	2	1	5	50	3	2	1	1	1.48	14	.	8	.	37.8	.	40.8	.	.	.	180	197	178	1	7	7
250	51283	132	11	3	1	0	1	50	5	2	1	1	1.34	20	.	15	28	23.0	.	26.1	5.4	.	5.7	268	270	265	3	7	7
251	52483	144	11	3	1	0	1	50	5	2	1	1	1.34	20	.	19	19	38.9	38.8	43.1	5.0	7.1	14.1	185	186	187	29	6	7
252	52483	144	11	3	2	0	1	50	5	2	1	1	1.34	20	.	19	19	38.9	38.8	43.1	5.0	7.1	14.1	186	186	199	28	5	10
253	53183	151	11	.	.	.	2	0	0	2	1	3	1.11	21	21	.	21	36.5	31.8	.	20.2	2.5	.	.	.	.	.	.	.
254	60283	153	11	3	1	0	2	0	0	2	1	3	1.11	18	18	.	.	29.1	29.0	.	2.9	2.8	.	180	186	188	26	6	7
255	60283	153	11	3	2	0	2	0	0	2	1	3	1.11	18	18	.	.	29.1	29.0	.	2.9	2.8	.	193	193	181	34	15	9

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OBS	DATE	DAY	FIELD	LINE	RUN	DIRC	CROP	PCOVER	HGT	ROW	TILL	ROUGH	BD	T1	T2	T3	TIR	VSM1	VSM2	VSM3	SD1	SD2	SD3	TRL	TRC	TRR	SDL	SDC	SDR
256	60983	160	11	3	1	0	2	10	5	2	1	2	1.34	21	.	20	28	30.9	.	.	3.4	.	.	194	203	191	5	4	7
257	60983	160	11	3	2	0	2	10	5	2	1	2	1.34	21	.	20	28	30.9	.	.	3.4	.	.	195	205	191	3	3	6
258	61083	161	11	3	1	0	2	10	5	2	1	2	1.34	18	17	17	25	33.4	38.2	35.2	4.3	.	.	204	212	206	4	5	7
259	61083	161	11	3	2	0	2	10	5	2	1	2	1.34	18	17	17	25	33.4	38.2	35.2	4.3	.	.	204	215	208	8	8	10
260	61383	164	11	3	1	0	1	0	0	2	1	3	1.11	34	.	23	40	18.5	19.9	20.7	3.4	1.7	1.4	234	239	231	5	7	7
261	61383	164	11	3	2	0	1	0	0	2	1	3	1.11	34	.	23	40	18.5	19.9	20.7	3.4	1.7	1.4	235	239	232	7	9	9
262	61583	166	11	3	1	0	1	0	0	2	1	3	1.11	35	.	24	.	14.8	.	.	3.6	.	.	282	.	283	3	.	4
263	61583	166	11	3	2	0	1	0	0	2	1	3	1.11	35	.	24	.	14.8	.	.	3.6	.	.	271	290	278	23	3	2
264	62283	173	11	3	1	0	2	0	5	2	1	3	1.34	24	.	21	28	36.4	35.3	32.6	2.7	1.4	4.4	203	219	211	5	2	5
265	62283	173	11	3	2	0	2	0	5	2	1	3	1.34	24	.	21	28	36.4	35.3	32.6	2.7	1.4	4.4	202	210	212	4	3	4
266	62783	178	11	3	1	0	2	0	10	2	1	3	1.34	31	28	26	33	20.3	22.9	22.8	1.4	.	.	259	270	264	2	3	3
267	62783	178	11	3	2	0	2	0	10	2	1	3	1.34	31	28	26	33	20.3	22.9	22.8	1.4	.	.	262	270	262	4	3	3
268	31483	73	12	3	2	1	4	100	3	2	1	1	1.48	14	.	8	.	.	.	.	.	.	.	166	186	169	5	4	2
269	51283	132	12	3	1	0	1	100	15	2	2	1	1.48	19	.	18	25	21.6	.	27.1	8.2	.	.	222	230	227	17	18	20
270	52483	144	12	3	1	0	1	100	15	2	2	1	1.49	20	.	18	19	55.4	.	.	26.3	.	.	170	186	194	3	4	7
271	52483	144	12	3	2	0	1	100	15	2	2	1	1.49	20	.	18	19	55.4	.	.	26.3	.	.	168	186	203	4	3	12
272	53183	151	12	.	.	.	1	100	15	2	2	1	1.49	.	.	.	.	38.3	.	.	1.7	.	.	.	.	.	.	.	.
273	60283	153	12	3	1	0	1	100	15	2	2	1	1.49	23	.	21	22	37.4	.	32.4	3.2	.	0.4	162	177	176	3	3	5
274	60283	153	12	3	2	0	1	100	15	2	2	1	1.49	23	.	21	22	37.4	.	32.4	3.2	.	0.4	164	179	177	3	3	5
275	60983	160	12	3	1	0	1	100	15	2	2	1	1.49	24	.	22	26	29.8	.	.	4.0	.	.	171	186	179	6	3	7
276	60983	160	12	3	2	0	1	100	15	2	2	1	1.49	24	.	22	26	29.8	.	.	4.0	.	.	172	186	174	3	5	6
277	61083	161	12	3	1	0	1	100	15	2	2	1	1.49	21	20	20	25	41.2	38.5	36.7	26.3	.	.	178	190	193	5	4	7
278	61083	161	12	3	2	0	1	100	15	2	2	1	1.49	21	20	20	25	41.2	38.5	36.7	26.3	.	.	178	191	188	7	4	7
279	61383	164	12	3	1	0	4	100	15	2	2	1	1.49	28	.	23	32	27.5	26.7	26.3	7.1	7.3	5.0	204	212	203	6	11	10
280	61383	164	12	3	2	0	4	100	15	2	2	1	1.49	28	.	23	32	27.5	26.7	26.3	7.1	7.3	5.0	205	214	205	6	10	9
281	61583	166	12	3	1	0	4	100	15	2	2	1	1.49	28	27	25	.	25.0	26.8	26.3	3.1	1.3	0.9	243	246	228	7	6	10
282	61583	166	12	3	2	0	4	100	15	2	2	1	1.49	28	27	25	.	25.0	26.8	26.3	3.1	1.3	0.9	240	244	225	9	7	12
283	62283	173	12	3	1	0	1	0	0	2	1	3	1.11	24	.	21	29	29.2	30.4	27.2	1.9	.	.	222	233	219	15	14	8
284	62283	173	12	3	2	0	1	0	0	[illegible]	1	3	1.11	24	.	21	29	29.2	30.4	27.2	1.9	.	.	224	235	219	15	13	6
285	62783	178	12	3	1	0	3	0	0	2	1	3	1.11	34	28	27	39	12.6	20.8	22.1	3.2	0.9	1.5	271	279	274	2	2	3
286	62783	178	12	3	1	0	3	0	0	2	1	3	1.11	34	28	27	39	12.6	20.8	22.1	3.2	0.9	1.5	273	279	271	2	1	5
287	31483	73	13	3	1	1	4	50	3	2	1	1	1.48	14	.	8	.	36.6	.	36.7	.	.	.	197	212	198	5	5	6
288	31483	73	13	3	2	1	4	50	3	2	1	1	1.48	14	.	8	.	36.6	.	36.7	.	.	.	202	216	197	0	0	0
289	51283	132	13	3	1	0	2	0	0	2	1	3	1.11	19	.	18	30	15.3	.	21.7	2.0	.	.	249	247	253	23	26	10
290	52483	144	13	3	1	0	2	0	8	2	1	2	1.34	19	.	19	18	41.6	44.5	44.5	2.8	.	.	160	177	196	5	8	10
291	52483	144	13	3	2	0	2	0	8	2	1	2	1.34	19	.	19	18	41.6	44.5	44.5	2.8	.	.	161	172	200	2	4	10
292	53183	151	13	.	.	.	2	10	13	2	1	2	1.34	.	.	.	.	58.8	.	.	35.7	.	.	.	.	.	.	.	.
293	60283	153	13	3	1	0	2	10	15	2	1	2	1.34	20	.	18	22	43.1	.	33.5	25.8	.	.	167	179	183	7	2	10
294	60283	153	13	3	2	0	2	10	15	2	1	2	1.34	20	.	18	22	43.1	.	33.5	25.8	.	.	164	173	189	3	6	5
295	60983	160	13	3	1	0	2	20	20	2	1	2	1.34	21	.	19	24	30.7	.	.	7.1	.	.	199	193	191	8	4	3
296	60983	160	13	3	2	0	2	20	20	2	1	2	1.34	21	.	19	24	30.7	.	.	7.1	.	.	206	197	188	6	3	4
297	61083	161	13	3	1	0	2	20	20	2	1	2	1.34	22	19	.	24	41.7	31.0	.	28.7	.	.	201	201	.	6	6	.
298	61083	161	13	3	2	0	2	20	20	2	1	2	1.34	22	19	.	24	41.7	31.0	.	28.7	.	.	204	198	208	7	7	3
299	61383	164	13	3	1	0	2	30	45	2	1	2	1.20	24	.	23	33	18.2	18.2	17.8	6.2	.	.	239	231	228	8	5	2
300	61383	164	13	3	2	0	2	30	45	2	1	2	1.20	24	.	23	33	18.2	18.2	17.8	6.2	.	.	242	232	229	12	12	4
301	61583	166	13	3	1	0	2	40	45	2	1	3	1.20	28	24	23	38	14.4	18.9	19.1	6.5	.	.	292	296	282	3	3	7
302	61583	166	13	3	2	0	2	40	45	2	1	3	1.20	28	24	23	38	14.4	18.9	19.1	6.5	.	.	297	290	265	5	10	20
303	62283	173	13	3	1	0	2	50	90	2	1	2	1.34	26	.	23	29	32.8	32.0	31.6	3.5	1.0	0.9	255	258	237	2	2	3
304	62283	173	13	3	2	0	2	50	90	2	1	2	1.34	26	.	23	29	32.8	32.0	31.6	3.5	1.0	0.9	254	257	228	1	1	2
305	62783	178	13	3	1	0	2	80	120	2	1	2	1.34	33	27	.	30	14.4	24.6	.	5.7	2.6	.	285	287	283	3	2	1
306	62783	178	13	3	2	0	2	80	120	2	1	2	1.34	33	27	.	30	14.4	24.6	.	5.7	2.6	.	284	286	277	2	1	3

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OBS	DATE	DAY	FIELD	LINE	RUN	DIRC	CROP	PCOVER	HGT	ROW	TILL	ROUGH	RD	T1	T2	T3	TIR	VSM1	VSM2	VSM3	SD1	SD2	SD3	TRL	TRC	TBR	SDL	SDC	SDR
307	31483	73	14	3	1	1	5	100	3	2	1	1	1.48	14	.	7	.	37.2	.	37.8	.	.	.	231	230	197	8	5	5
308	31483	73	14	3	2	1	5	100	3	2	1	1	1.48	14	.	7	.	37.2	.	37.8	.	.	.	217	215	202	18	7	5
309	51283	132	14	3	1	0	2	0	0	2	1	4	1.11	20	.	18	30	15.3	.	23.4	3.8	.	0.3	278	278	260	3	3	9
310	52483	144	14	3	2	0	2	0	5	2	1	2	1.34	19	.	19	19	.	.	.	.	.	.	149	172	.	11	8	.
311	53183	151	14	.	.	.	2	10	5	2	1	2	1.34	.	.	.	21	.	.	.	.	.	.	.	.	.	.	.	.
312	60283	153	14	3	1	0	2	10	8	2	1	2	1.34	20	.	19	23	.	.	.	.	.	.	152	190	.	10	12	.
313	60283	153	14	3	2	0	2	10	8	2	1	2	1.34	20	.	19	23	.	.	.	.	.	.	150	173	.	14	11	.
314	60983	160	14	3	1	0	2	10	10	2	1	2	1.34	21	19	.	22	38.9	33.1	.	19.5	8.9	.	162	181	184	11	15	6
315	60983	160	14	3	2	0	2	10	10	2	1	2	1.34	21	19	.	22	38.9	33.1	.	19.5	8.9	.	169	176	183	17	12	8
316	61083	161	14	3	2	0	2	10	10	2	1	2	1.34	19	.	19	21	44.9	31.6	.	29.0	6.0	.	174	.	.	25	.	.
317	61383	164	14	3	1	0	2	20	25	2	1	2	1.34	24	.	22	33	29.8	26.1	.	19.3	4.7	.	199	201	213	17	12	9
318	61383	164	14	3	2	0	2	20	25	2	1	2	1.34	24	.	22	33	29.8	26.1	.	19.3	4.7	.	204	201	214	20	16	12
319	61583	166	14	3	1	0	2	20	30	2	1	2	1.34	27	25	.	33	26.8	23.5	.	20.7	3.9	.	239	243	233	24	19	19
320	61583	166	14	3	2	0	2	20	30	2	1	2	1.34	27	25	.	33	26.8	23.5	.	20.7	3.9	.	236	236	218	19	14	11
321	62283	173	14	3	1	0	2	40	60	2	1	2	1.34	26	.	24	26	31.6	.	.	4.6	.	.	201	205	212	19	9	5
322	62283	173	14	3	2	0	2	40	60	2	1	2	1.34	26	.	24	26	31.6	.	.	4.6	.	.	193	209	.	10	11	.
323	62783	178	14	3	1	0	2	50	60	2	1	2	1.34	27	24	23	31	20.6	26.2	29.1	5.5	8.8	6.2	242	250	250	10	11	8
324	62783	178	14	3	2	0	2	50	60	2	1	2	1.34	27	24	23	31	20.6	26.2	29.1	5.5	8.8	6.2	240	249	249	8	10	5
325	60283	151	15	4	1	0	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	246	230	245	20	19	12
326	60283	151	15	4	3	0	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	248	232	248	11	18	4
327	60983	160	15	4	1	0	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	254	243	247	15	20	12
328	60983	160	15	4	2	0	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	253	244	248	15	21	10
329	60983	160	15	4	3	0	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	256	241	252	11	15	6
330	61083	161	15	4	1	0	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	253	244	248	16	20	11
331	61083	161	15	4	2	0	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	257	248	249	16	20	10
332	61083	161	15	4	3	0	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	254	239	255	11	10	4
333	61383	164	15	4	1	1	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	255	254	266	10	17	15
334	61383	164	15	4	2	0	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	263	254	258	14	18	9
335	61383	164	15	4	3	0	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	269	252	278	7	14	17
336	61583	166	15	4	1	0	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	264	257	262	14	18	9
337	61583	166	15	4	2	0	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	264	258	262	15	19	9
338	61583	166	15	4	3	0	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	265	254	262	10	14	6
339	62283	173	15	4	1	0	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	242	221	243	23	27	13
340	62283	173	15	4	2	0	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	249	225	234	20	30	15
341	62283	173	15	4	3	1	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	245	230	256	8	23	15
342	62783	178	15	4	1	1	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	255	254	266	14	20	16
343	62783	178	15	4	2	0	.	100	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	265	255	260	15	20	13
344	62783	178	15	4	3	0	.	160	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	265	255	259	13	17	6
345	31483	73	16	2	2	1	.	.	.	2	.	.	.	5	.	1	.	.	.	.	.	.	.	199	200	186	13	10	[illegible]
346	51283	132	16	2	1	0	1	100	3	2	3	1	1.48	15	.	14	28	.	.	.	.	.	.	205	208	216	12	6	9
347	51283	132	16	2	3	0	1	100	3	2	3	1	1.48	15	.	14	28	.	.	.	.	.	.	222	213	239	14	10	8
348	52483	144	16	2	1	0	2	100	3	2	3	1	1.48	19	19	19	19	57.1	38.3	28.6	23.2	.	.	180	194	209	3	8	5
349	52483	144	16	2	2	0	2	100	3	2	3	1	1.48	19	19	19	19	57.1	38.3	28.6	23.2	.	.	175	189	192	10	9	9
350	52483	144	16	2	3	0	2	100	3	2	3	1	1.48	19	19	19	19	57.1	38.3	28.6	23.2	.	.	181	202	227	10	6	8
351	53183	151	16	.	.	.	2	100	3	2	3	1	1.48	20	.	17	17	51.3	.	42.3	8.8	.	.	.	.	.	.	.	.
352	60283	153	16	2	1	0	2	100	10	2	3	1	1.48	19	.	18	26	42.4	.	.	7.1	.	.	164	184	180	3	5	19
353	60283	153	16	2	2	0	2	100	10	2	3	1	1.48	19	.	18	26	42.4	.	.	7.1	.	.	168	183	180	9	7	6
354	60283	153	16	2	3	0	2	100	10	2	3	1	1.48	19	.	18	26	42.4	.	.	7.1	.	.	190	186	197	12	10	21
355	60983	160	16	2	1	0	2	100	15	2	3	1	1.48	23	21	20	23	36.4	43.7	44.3	6.3	.	.	169	188	182	3	3	4
356	60983	160	16	2	2	0	2	100	15	2	3	1	1.48	23	21	20	23	36.4	43.7	44.3	6.3	.	.	173	187	181	5	5	6
357	60983	160	16	2	3	0	2	100	15	2	3	1	1.48	23	21	20	[illegible]	36.4	43.7	44.3	6.3	.	.	190	187	190	9	3	5

ORIGINAL PAGE IS
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OBS	DATE	DAY	FIELD	LINE	RUN	DIRC	CROP	PCOVER	HGT	ROW	TILL	ROUGH	RD	T1	T2	T3	TIR	VSM1	VSM2	VSM3	SD1	SD2	SD3	TRL	TRC	TBR	SDL	SDC	SDR
358	61083	161	16	2	2	0	2	100	15	2	3	1	1.48	22	19	18	28	40.0	42.5	42.3	3.8	.	.	177	193	189	7	5	6
359	61383	164	16	2	1	0	2	100	25	2	3	1	1.48	30	26	24	38	34.3	40.0	39.7	8.4	.	.	189	202	194	6	2	2
360	61383	164	16	2	2	0	2	100	25	2	3	1	1.48	30	26	24	38	34.3	40.0	39.7	8.4	.	.	197	208	221	5	3	7
361	61383	164	16	2	3	0	2	100	25	2	3	1	1.48	30	26	24	38	34.3	40.0	39.7	8.4	.	.	198	204	209	4	4	6
362	61583	166	16	2	1	0	2	100	30	2	3	1	1.48	29	26	24	.	38.5	31.6	30.6	7.1	.	.	200	222	208	7	5	5
363	61583	166	16	2	3	0	2	100	30	2	3	1	1.48	29	26	24	.	38.5	31.6	30.6	7.1	.	.	211	219	218	7	3	7
364	62283	173	16	2	1	0	2	100	60	2	3	1	1.48	25	.	23	26	39.8	34.7	34.9	1.1	.	.	193	206	214	11	11	9
365	62283	173	16	2	2	0	2	100	60	2	3	1	1.48	25	.	23	26	39.8	34.7	34.9	1.1	.	.	197	202	206	15	9	9
366	62283	173	16	2	3	0	2	100	60	2	3	1	1.48	25	.	23	26	39.8	34.7	34.9	1.1	.	.	207	204	222	7	6	9
367	62783	178	16	2	1	0	2	100	75	2	3	1	1.48	27	26	24	30	35.7	36.2	37.4	3.5	.	.	209	220	216	14	5	9
368	62783	178	16	2	2	0	2	100	75	2	3	1	1.48	27	26	24	30	35.7	36.2	37.4	3.5	.	.	209	222	218	14	8	12
369	62783	178	16	2	3	0	2	100	75	2	3	1	1.48	27	26	24	30	35.7	36.2	37.4	3.5	.	.	221	224	234	4	6	8
370	53183	151	17	.	.	.	5	75	30	2	1	2	1.44	.	.	.	.	19.0	.	20.7	4.1	.	3.0	.	.	.	.	.	.
371	60283	153	17	4	1	0	5	75	30	2	1	2	1.44	.	.	.	.	15.2	.	14.6	4.3	.	3.6	225	242	240	13	10	9
372	60283	153	17	4	3	0	5	75	30	2	1	2	1.44	.	.	.	.	15.2	.	14.6	4.3	.	3.6	229	242	243	12	7	5
373	60983	160	17	4	1	0	5	75	30	2	1	2	1.44	.	.	.	.	13.5	.	12.0	3.9	.	2.8	247	257	260	17	10	8
374	60983	160	17	4	2	0	5	75	30	2	1	2	1.44	.	.	.	.	13.5	.	12.0	3.9	.	2.8	250	257	261	17	9	8
375	60983	160	17	4	3	0	5	75	30	2	1	2	1.44	.	.	.	.	13.5	.	12.0	3.9	.	2.8	247	256	260	14	9	6
376	61083	161	17	4	1	0	5	75	30	2	1	2	1.44	.	.	.	.	12.1	.	12.4	3.8	.	3.4	254	263	266	17	7	7
377	61083	161	17	4	2	0	5	75	30	2	1	2	1.44	.	.	.	.	12.1	.	12.4	3.8	.	3.4	254	260	260	17	11	9
378	61083	161	17	4	3	0	5	75	30	2	1	2	1.44	.	.	.	.	12.1	.	12.4	3.8	.	3.4	252	272	264	13	6	3
379	61383	164	17	4	1	1	5	75	30	2	1	2	1.44	.	.	.	.	12.8	.	12.8	5.9	.	3.1	259	244	247	10	27	24
380	61383	164	17	4	2	0	5	75	30	2	1	2	1.44	.	.	.	.	12.8	.	12.8	5.9	.	3.1	250	250	264	25	26	8
381	61383	164	17	4	3	0	5	75	30	2	1	2	1.44	.	.	.	.	12.8	.	12.8	5.9	.	3.1	252	269	277	19	5	8
382	61583	166	17	4	1	0	5	80	3	2	1	2	1.44	.	.	.	.	13.5	.	15.0	5.3	.	3.0	268	274	268	8	9	8
383	61583	166	17	4	2	0	5	80	3	2	1	2	1.44	.	.	.	.	13.5	.	15.0	5.3	.	3.0	267	276	270	8	11	10
384	61583	166	17	4	3	0	5	80	3	2	1	2	1.44	.	.	.	.	13.5	.	15.0	5.3	.	3.0	267	274	273	5	7	5
385	62283	173	17	4	1	0	3	0	0	2	1	2	1.26	25	.	23	.	18.7	.	19.3	5.4	.	2.6	207	213	219	21	10	14
386	62283	173	17	4	2	0	3	0	0	2	1	2	1.26	25	.	23	.	18.7	.	19.3	5.4	.	2.6	204	221	215	22	10	13
387	62283	173	17	4	3	1	3	0	0	2	1	2	1.26	25	.	23	.	18.7	.	19.3	5.4	.	2.6	222	224	211	8	14	17
388	62783	178	17	4	1	1	3	25	5	2	1	2	1.44	30	.	27	.	10.7	.	11.2	2.7	.	3.2	259	273	263	8	9	11
389	62783	178	17	4	2	0	3	25	5	2	1	2	1.44	30	.	27	.	10.7	.	11.2	2.7	.	3.2	261	273	262	10	10	8
390	62783	178	17	4	3	0	3	25	5	2	1	2	1.44	30	.	27	.	10.7	.	11.2	2.7	.	3.2	245	272	270	12	8	6
391	53183	151	18	.	.	.	6	50	15	2	1	2	1.44	.	.	.	.	24.0	.	20.8	4.5	.	4.5	.	.	.	.	.	.
392	60283	153	18	4	1	0	1	0	0	2	1	3	1.26	.	.	.	.	17.9	.	.	3.1	.	.	216	231	222	23	22	24
393	60283	153	18	4	3	0	1	0	0	2	1	3	1.26	.	.	.	.	17.9	.	.	3.1	.	.	211	226	223	16	15	15
394	60983	160	18	4	1	0	6	50	15	2	1	2	1.44	.	.	.	.	17.6	.	16.7	3.4	.	1.9	250	262	255	7	10	5
395	60983	160	18	4	2	0	6	50	15	2	1	2	1.44	.	.	.	.	17.6	.	16.7	3.4	.	1.9	250	263	255	6	9	6
396	60983	160	18	4	3	0	6	50	15	2	1	2	1.44	.	.	.	.	17.6	.	16.7	3.4	.	1.9	246	264	258	4	6	3
397	61083	161	18	4	1	0	1	50	0	2	1	2	1.26	.	.	.	.	13.5	.	14.8	2.6	.	4.7	252	265	257	5	8	5
398	61083	161	18	4	2	0	1	50	0	2	1	2	1.26	.	.	.	.	13.5	.	14.8	2.6	.	4.7	253	265	254	6	7	6
399	61083	161	18	4	3	0	1	50	0	2	1	2	1.26	.	.	.	.	13.5	.	14.8	2.6	.	4.7	251	268	265	6	3	2
400	61383	164	18	4	1	1	1	0	0	2	1	2	1.26	.	.	.	.	10.5	.	16.3	3.1	.	1.9	263	275	264	4	4	4
401	61383	164	18	4	2	0	1	0	0	2	1	2	1.26	.	.	.	.	10.5	.	16.3	3.1	.	1.9	260	272	264	7	13	6
402	61383	164	18	4	3	0	1	0	0	2	1	2	1.26	.	.	.	.	10.5	.	16.3	3.1	.	1.9	268	278	301	6	3	2
403	61583	166	18	4	1	0	1	5	3	2	1	2	1.26	.	.	.	.	11.6	.	15.6	2.8	.	2.0	273	286	277	5	8	6
404	61583	166	18	4	2	0	1	5	3	2	1	2	1.26	.	.	.	.	11.6	.	15.6	2.8	.	2.0	273	286	277	6	9	6
405	61583	166	18	4	3	0	1	5	3	2	1	2	1.26	.	.	.	.	11.6	.	15.6	2.8	.	2.0	268	287	281	6	5	2
406	62283	173	18	4	1	0	5	10	10	2	1	2	1.46	28	.	25	.	25.7	.	28.0	4.8	.	4.9	191	209	198	5	4	10
407	62283	173	18	4	2	0	5	10	10	2	1	2	1.46	28	.	25	.	25.7	.	28.0	4.8	.	4.9	190	207	198	6	5	8
408	62283	173	18	4	3	1	5	10	10	2	1	2	1.46	28	.	25	.	25.7	.	28.0	4.8	.	4.9	205	214	192	7	3	7

ORIGINAL PAGE IS
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OBS	DATE	DAY	FIELD	LINE	RUN	DIRC	CROP	PCOVER	HGT	ROW	TILL	ROUGH	RD	T1	T2	T3	TIR	VSM1	VSM2	VSM3	SD1	SD2	SD3	THL	TRC	TRR	SDL	SDC	SDR
409	62783	178	18	4	1	1	5	15	20	2	1	2	1.46	33	.	27	.	13.9	.	17.1	2.8	.	2.8	262	270	256	12	10	20
410	62783	178	18	4	2	0	5	15	20	2	1	2	1.46	33	.	27	.	13.9	.	17.1	2.8	.	2.8	251	273	270	20	7	9
411	62783	178	18	4	3	0	5	15	20	2	1	2	1.46	33	.	27	.	13.9	.	17.1	2.8	.	2.8	231	277	274	13	5	3
412	53183	151	19	.	.	.	7	100	90	2	1	2	1.44	.	.	.	.	36.5	.	27.8	8.2	.	2.0	.	.	.	.	.	.
413	60283	153	19	4	1	0	7	100	90	2	1	2	1.44	.	.	.	.	32.6	.	34.1	5.3	.	5.8	208	213	214	4	10	5
414	60283	153	19	4	3	0	7	100	90	2	1	2	1.44	.	.	.	.	32.6	.	34.1	5.3	.	5.8	209	215	231	2	5	3
415	60983	160	19	4	1	0	7	100	90	2	1	2	1.44	.	.	.	.	28.3	.	19.0	8.8	.	1.1	208	222	210	3	3	5
416	60983	160	19	4	2	0	7	100	90	2	1	2	1.44	.	.	.	.	28.3	.	19.0	8.8	.	1.1	205	228	205	4	3	8
417	60983	160	19	4	3	0	7	100	90	2	1	2	1.44	.	.	.	.	28.3	.	19.0	8.8	.	1.1	208	221	241	4	4	4
418	61083	161	19	4	1	0	7	100	90	2	1	2	1.44	.	.	.	.	21.7	.	16.4	6.0	.	.	211	227	213	5	7	7
419	61083	161	19	4	2	0	7	100	90	2	1	2	1.44	.	.	.	.	21.7	.	16.4	6.0	.	.	206	230	206	3	2	8
420	61083	161	19	4	3	0	7	100	90	2	1	2	1.44	.	.	.	.	21.7	.	16.4	6.0	.	.	214	228	268	8	10	3
421	61383	164	19	4	1	1	7	100	90	2	1	2	1.44	36	.	34	.	17.1	.	15.9	6.6	.	4.5	212	242	215	5	6	5
422	61383	164	19	4	2	0	7	100	90	2	1	2	1.44	36	.	34	.	17.1	.	15.9	6.6	.	4.5	218	240	222	6	5	12
423	61383	164	19	4	3	0	7	100	90	2	1	2	1.44	36	.	34	.	17.1	.	15.9	6.6	.	4.5	229	232	282	3	5	25
424	61583	166	19	4	1	0	7	100	90	2	1	2	1.44	.	.	.	.	.	.	.	.	.	.	223	250	234	6	4	12
425	61583	166	19	4	2	0	7	100	90	2	1	2	1.44	.	.	.	.	.	.	.	.	.	.	231	242	238	8	6	13
426	61583	166	19	4	3	0	7	100	90	2	1	2	1.44	.	.	.	.	.	.	.	.	.	.	232	244	273	7	2	5
427	62283	173	19	4	1	0	7	100	90	2	1	2	1.44	26	.	23	.	31.3	.	26.2	6.9	.	3.3	203	206	196	6	10	7
428	62283	173	19	4	2	0	7	100	90	2	1	2	1.44	26	.	23	.	31.3	.	26.2	6.9	.	3.3	197	216	195	9	5	9
429	62283	173	19	4	3	1	7	100	90	2	1	2	1.44	26	.	23	.	31.3	.	26.2	6.9	.	3.3	199	224	194	4	4	6
430	62783	178	19	4	1	1	7	100	90	2	1	2	1.44	.	.	.	.	22.8	.	19.1	9.1	.	.	203	230	202	4	7	7
431	62783	178	19	4	2	0	7	100	90	2	1	2	1.44	.	.	.	.	22.8	.	19.1	9.1	.	.	201	222	212	10	4	2
432	62783	178	19	4	3	0	7	100	90	2	1	2	1.44	.	.	.	.	22.8	.	19.1	9.1	.	.	209	228	229	9	2	7
433	53183	151	20	.	.	.	2	10	10	4	1	2	1.26	.	.	.	.	20.3	.	18.7	4.7	.	2.8	.	.	.	.	.	.
434	60283	153	20	4	1	0	2	5	15	4	1	2	1.34	.	.	.	.	19.6	.	20.4	7.3	.	4.6	217	220	221	7	12	9
435	60283	153	20	4	3	0	2	5	15	4	1	2	1.34	.	.	.	.	19.6	.	20.4	7.3	.	4.6	215	225	229	8	6	3
436	60983	160	20	4	1	0	2	5	15	4	1	2	1.34	.	.	.	.	15.4	.	19.0	5.3	.	7.6	239	258	248	18	4	7
437	60983	160	20	4	2	0	2	5	15	4	1	2	1.34	.	.	.	.	15.4	.	19.0	5.3	.	7.6	241	258	243	14	11	12
438	60983	160	20	4	3	0	2	5	15	4	1	2	1.34	.	.	.	.	15.4	.	19.0	5.3	.	7.6	242	252	265	7	7	5
439	61083	161	20	4	1	0	2	5	15	4	1	2	1.34	.	.	.	.	15.0	.	20.9	5.4	.	7.7	252	274	253	24	6	12
440	61083	161	20	4	2	0	2	5	15	4	1	2	1.34	.	.	.	.	15.0	.	20.9	5.4	.	7.7	256	274	254	19	8	13
441	61083	161	20	4	3	0	2	5	15	4	1	2	1.34	.	.	.	.	15.0	.	20.9	5.4	.	7.7	262	268	268	5	6	2
442	61383	164	20	4	1	1	2	20	30	4	1	2	1.36	36	.	30	.	11.6	.	17.9	3.6	.	8.4	265	281	273	16	15	10
443	61383	164	20	4	2	0	2	20	30	4	1	2	1.36	36	.	30	.	11.6	.	17.9	3.6	.	8.4	263	281	265	21	11	14
444	61383	164	20	4	3	0	2	20	30	4	1	2	1.36	36	.	30	.	11.6	.	17.9	3.6	.	8.4	277	275	281	10	10	38
445	61583	166	20	4	1	0	2	30	50	4	1	2	1.36	.	.	.	.	13.2	.	18.9	5.6	.	8.3	277	294	281	18	5	12
446	61583	166	20	4	2	0	2	30	50	4	1	2	1.36	.	.	.	.	13.2	.	18.9	5.6	.	8.3	279	291	281	18	9	9
447	61583	166	20	4	3	0	2	30	50	4	1	2	1.36	.	.	.	.	13.2	.	18.9	5.6	.	8.3	279	288	289	7	8	5
448	62283	173	20	4	1	0	2	50	75	4	1	2	1.36	31	.	26	.	21.6	.	19.8	5.3	.	4.4	209	237	214	18	7	18
449	62283	173	20	4	2	0	2	50	75	4	1	2	1.36	31	.	26	.	21.6	.	19.8	5.3	.	4.4	206	237	213	17	7	19
450	62283	173	20	4	3	1	2	50	75	4	1	2	1.36	31	.	26	.	21.6	.	19.8	5.3	.	4.4	223	235	201	11	13	4
451	62783	178	20	4	1	1	2	80	125	4	1	2	1.36	26	.	.	.	12.2	.	15.2	5.8	.	5.1	269	279	264	15	15	10
452	62783	178	20	4	2	0	2	80	125	4	1	2	1.36	26	.	.	.	12.2	.	15.2	5.8	.	5.1	246	267	276	13	30	9
453	62783	178	20	4	3	0	2	80	125	4	1	2	1.36	26	.	.	.	12.2	.	15.2	5.8	.	5.1	227	272	264	10	17	14
454	60983	160	21	4	1	0	2	5	15	2	2	1	1.54	.	.	.	.	17.5	.	22.6	4.5	.	3.5	243	247	242	14	7	7
455	60983	160	21	4	2	0	2	5	15	2	2	1	1.54	.	.	.	.	17.5	.	22.6	4.5	.	3.5	243	247	242	14	7	7
456	60993	160	21	4	3	0	2	5	15	2	2	1	1.54	.	.	.	.	17.5	.	22.6	4.5	.	3.5	230	247	258	13	3	6
457	61083	161	21	4	1	0	2	5	15	2	2	1	1.54	26	.	24	.	14.7	.	19.7	3.2	.	3.1	248	252	247	11	6	7
458	61083	161	21	4	2	0	2	5	15	2	2	1	1.54	26	.	24	.	14.7	.	19.7	3.2	.	3.1	249	252	247	12	7	6
459	61083	161	21	4	3	0	2	5	15	2	2	1	1.54	26	.	24	.	14.7	.	19.7	3.2	.	3.1	245	253	266	12	3	5

OBS	DATE	DAY	FIELD	LINE	RUN	DIRC	CROP	PCOVER	HGT	ROW	TILL	ROUGH	RD	T1	T2	T3	TIR	VSM1	VSM2	VSM3	SD1	SD2	SD3	TRL	TRC	TRR	SDL	SDC	SDR
460	61383	164	21	4	1	1	2	30	45	2	2	1	1.54	31	.	29	.	13.5	.	18.5	2.5	.	3.9	259	269	266	4	4	9
461	61383	164	21	4	2	0	2	30	45	2	2	1	1.54	31	.	29	.	13.5	.	18.5	2.5	.	3.9	263	268	264	9	5	5
462	61383	164	21	4	3	0	2	30	45	2	2	1	1.54	31	.	29	.	13.5	.	18.5	2.5	.	3.9	269	271	295	9	3	13
463	61583	166	21	4	1	0	2	50	60	2	2	1	1.54	36	.	33	.	10.8	.	17.6	2.8	.	2.4	276	282	279	5	6	4
464	61583	166	21	4	2	0	2	50	60	2	2	1	1.54	36	.	33	.	10.8	.	17.6	2.8	.	2.4	277	282	279	4	7	4
465	61583	166	21	4	3	0	2	50	60	2	2	1	1.54	36	.	33	.	10.8	.	17.6	2.8	.	2.4	273	283	260	4	4	5
466	62283	173	21	4	1	0	2	70	90	2	2	1	1.54	26	.	22	.	31.1	.	28.5	8.6	.	8.4	234	235	241	21	12	8
467	62283	173	21	4	2	0	2	70	90	2	2	1	1.54	26	.	22	.	31.1	.	28.5	8.6	.	8.4	233	237	241	23	8	8
468	62283	173	21	4	3	1	2	70	90	2	2	1	1.54	26	.	22	.	31.1	.	28.5	8.6	.	8.4	255	240	234	11	5	22
469	62783	178	21	4	1	1	2	80	125	2	2	1	1.54	26	.	23	.	14.2	.	17.8	3.7	.	3.0	266	271	268	6	8	9
470	62783	178	21	4	2	0	2	80	125	2	2	1	1.54	26	.	23	.	14.2	.	17.8	3.7	.	3.0	264	272	268	11	8	5
471	62783	178	21	4	3	0	2	80	125	2	2	1	1.54	26	.	23	.	14.2	.	17.8	3.7	.	3.0	246	274	274	9	3	2
472	53183	151	22	.	.	.	4	10	10	1	2	1	1.34	.	.	.	.	19.8	.	16.6	3.0	.	.	.	.	.	.	.	.
473	60283	153	22	5	1	0	2	30	15	1	2	1	1.34	.	.	.	.	24.4	.	27.2	4.0	.	7.0	217	.	.	3	.	.
474	60983	160	22	5	1	0	2	40	30	1	2	1	1.34	.	.	.	.	17.4	.	19.6	2.9	.	4.6	228	240	228	3	4	8
475	60983	160	22	5	2	1	2	40	30	1	2	1	1.34	.	.	.	.	17.4	.	19.6	2.9	.	4.6	227	245	229	11	4	7
476	61083	161	22	5	1	0	2	40	30	1	2	1	1.34	.	.	.	.	15.1	.	17.5	3.2	.	2.8	230	238	237	4	3	5
477	61383	164	22	5	1	0	2	50	63	1	2	1	1.34	24	.	22	.	15.2	.	17.1	2.7	.	4.3	242	251	239	3	4	6
478	61383	164	22	5	2	1	2	50	63	1	2	1	1.34	24	.	22	.	15.2	.	17.1	2.7	.	4.3	237	254	244	11	4	4
479	61583	166	22	5	1	0	2	60	75	1	2	1	1.34	21	.	.	.	13.4	.	11.7	2.8	.	1.4	252	267	251	4	4	5
480	61583	166	22	5	2	1	2	60	75	1	2	1	1.34	21	.	.	.	13.4	.	11.7	2.8	.	1.4	253	268	254	3	5	9
481	62283	173	22	5	1	0	2	70	80	1	2	1	1.34	24	.	.	.	19.6	.	19.0	2.1	.	1.7	246	256	242	3	3	2
482	62283	173	22	5	2	1	2	70	80	1	2	1	1.34	24	.	.	.	19.6	.	19.0	2.1	.	1.7	244	258	248	3	2	2
483	62783	178	22	5	1	0	2	80	125	1	2	1	1.34	25	.	.	.	12.7	.	11.5	4.3	.	3.0	257	274	264	2	3	3
484	62783	178	22	5	2	1	2	80	125	1	2	1	1.34	25	.	.	.	12.7	.	11.5	4.3	.	3.0	263	275	269	2	3	3
485	53183	151	23	.	.	.	2	10	5	1	1	2	1.26	.	.	.	.	16.9	.	18.0	2.7	.	.	.	.	.	.	.	.
486	60283	153	23	5	1	0	2	15	8	1	1	2	1.34	.	.	.	.	15.0	.	16.5	2.1	.	1.9	196	209	.	9	11	.
487	60983	160	23	5	1	0	2	30	20	1	1	2	1.34	.	.	.	.	13.9	.	13.8	2.6	.	1.6	243	253	238	6	5	5
488	60983	160	23	5	2	1	2	30	20	1	1	2	1.34	.	.	.	.	13.9	.	13.8	2.6	.	1.6	235	254	246	6	7	6
489	61083	161	23	5	1	0	2	30	20	1	1	2	1.34	.	.	.	.	12.4	.	.	2.5	.	.	243	254	242	6	4	4
490	61083	161	23	5	2	1	2	30	20	1	1	2	1.34	.	.	.	.	12.4	.	.	2.5	.	.	241	257	248	4	6	5
491	61383	164	23	5	1	0	2	40	38	1	1	2	1.34	.	.	.	.	11.7	.	14.6	2.7	.	3.0	256	267	253	7	4	3
492	61383	164	23	5	2	1	2	40	38	1	1	2	1.34	.	.	.	.	11.7	.	14.6	2.7	.	3.0	251	268	257	3	4	7
493	61583	166	23	5	1	0	2	50	50	1	1	2	1.34	.	.	.	.	10.6	.	10.3	2.4	.	1.7	269	283	268	4	6	4
494	61583	166	23	5	2	1	2	50	50	1	1	2	1.34	.	.	.	.	10.6	.	10.3	2.4	.	1.7	268	285	270	6	3	6
495	62283	173	23	5	1	0	2	50	60	1	1	2	1.45	.	.	.	.	18.7	.	18.3	3.4	.	3.9	223	232	222	8	8	6
496	62283	173	23	5	2	1	2	50	60	1	1	2	1.45	.	.	.	.	18.7	.	18.3	3.4	.	3.9	222	235	226	6	7	8
497	62783	178	23	5	1	0	2	60	50	1	1	2	1.45	.	.	.	.	9.5	.	9.7	2.0	.	1.8	267	275	259	6	3	14
498	62783	178	23	5	2	1	2	60	50	1	1	2	1.45	.	.	.	.	9.5	.	9.7	2.0	.	1.8	257	276	268	6	4	6
499	53183	151	24	.	.	.	1	0	0	3	1	2	1.26	.	.	.	.	14.4	.	13.7	3.5	.	2.7	.	.	.	.	.	.
500	60283	153	24	5	1	0	1	0	0	3	1	2	1.26	.	.	.	.	13.5	.	15.5	4.2	.	2.8	211	226	213	9	6	9
501	60983	160	24	5	1	0	6	10	25	3	1	2	1.26	.	.	.	.	9.0	.	20.0	1.8	.	5.1	257	264	257	6	11	10
502	60983	160	24	5	2	1	6	10	25	3	1	2	1.26	.	.	.	.	9.0	.	20.0	1.8	.	5.1	255	266	259	10	11	7
503	61083	161	24	5	1	0	6	10	25	3	1	2	1.26	.	.	.	.	8.9	.	9.2	3.2	.	2.4	261	267	260	8	13	11
504	61083	161	24	5	2	1	6	10	25	3	1	2	1.26	.	.	.	.	8.9	.	9.2	3.2	.	2.4	259	270	263	12	10	7
505	61383	164	24	5	1	0	6	15	25	3	1	2	1.26	.	.	.	.	10.9	.	10.8	2.2	.	2.2	.	282	274	.	12	13
506	61383	164	24	5	2	1	6	15	25	3	1	2	1.26	.	.	.	.	10.9	.	10.8	2.2	.	2.2	.	283	.	.	11	.
507	61583	166	24	5	1	0	6	20	30	3	1	2	1.26	.	.	.	.	3.8	.	8.1	1.6	.	2.3	284	289	284	9	11	11
508	61583	166	24	5	2	1	6	20	30	3	1	2	1.26	.	.	.	.	3.8	.	8.1	1.6	.	2.3	279	293	.	14	5	.
509	62283	173	24	5	1	0	6	30	30	3	1	2	1.45	26	.	.	.	13.0	.	13.1	4.8	.	5.2	223	240	230	14	12	13
510	62283	173	24	5	2	1	6	30	30	3	1	2	1.45	26	.	.	.	13.0	.	13.1	4.8	.	5.2	230	242	227	14	11	14

OBS	DATE	DAY	FIELD	LINF	RUN	DIRC	CROP	PCOVER	HGT	ROW	TILL	POUGH	RD	T1	T2	T3	TIR	VSM1	VSM2	VSM3	SD1	SD2	SD3	TRL	TRC	TRR	SDL	SDC	SDR
511	62783	178	24	5	1	0	6	40	30	3	1	2	1.45	28	.	.	.	4.0	.	5.7	3.4	.	3.9	275	287	281	11	7	11
512	62783	178	24	5	2	1	6	40	30	3	1	2	1.45	28	.	.	.	4.0	.	5.7	3.4	.	3.9	279	288	278	10	8	11
513	53183	151	25	.	.	.	2	10	10	1	1	4	1.26	.	.	.	.	19.0	.	20.0	3.6	.	3.6	.	.	.	.	.	.
514	60283	153	25	.	.	.	2	30	10	1	1	4	1.34	.	.	.	.	16.9	.	16.7	3.6	.	1.5	.	.	.	.	.	.
515	60983	160	25	5	2	1	2	40	50	1	1	3	1.34	.	.	.	.	12.9	.	13.8	1.6	.	6.6	248	261	.	1	5	.
516	61083	161	25	5	2	1	2	40	50	1	1	3	1.34	.	.	.	.	12.3	.	13.0	1.4	.	1.0	254	266	.	3	2	.
517	61383	164	25	5	1	0	2	50	75	1	1	3	1.34	26	.	.	.	12.0	.	15.1	3.1	.	1.7	277	278	271	5	1	2
518	61383	164	25	5	2	1	2	50	75	1	1	3	1.34	26	.	.	.	12.0	.	15.1	3.1	.	1.7	266	279	276	4	2	4
519	61583	166	25	5	1	0	2	70	80	1	1	3	1.34	20	.	.	.	8.6	.	8.2	1.5	.	0.7	287	300	295	1	1	2
520	62283	173	25	5	1	0	2	80	80	1	1	3	1.49	.	.	.	.	18.5	.	18.4	3.9	.	5.1	249	247	233	6	3	9
521	62283	173	25	5	2	1	2	80	80	1	1	3	1.49	.	.	.	.	18.5	.	18.4	3.9	.	5.1	235	252	276	3	3	3
522	62783	178	25	5	1	0	2	100	125	1	1	3	1.49	28	.	.	.	5.6	.	13.9	3.2	.	3.0	285	292	.	1	1	.
523	62783	178	25	5	2	1	2	100	125	1	1	3	1.49	28	.	.	.	5.6	.	13.9	3.2	.	3.0	283	292	287	4	2	3
524	53183	151	26	.	.	.	1	0	0	1	1	2	1.26	.	.	.	.	17.6	.	17.5	3.5	.	1.4	.	.	.	.	.	.
525	60283	153	26	5	1	0	1	0	0	1	1	2	1.26	.	.	.	.	17.8	.	18.2	2.6	.	2.4	252	263	258	4	2	2
526	60983	160	26	5	1	0	3	5	5	1	1	2	1.26	.	.	.	.	13.3	.	.	2.6	.	.	262	271	267	6	1	2
527	60983	160	26	5	2	1	3	5	5	1	1	2	1.26	.	.	.	.	13.3	.	.	2.6	.	.	265	270	265	1	1	5
528	61083	161	26	5	1	0	3	5	5	1	1	2	1.26	.	.	.	.	12.1	.	11.1	5.6	.	.	262	273	269	9	1	2
529	61083	161	26	5	2	1	3	5	5	1	1	2	1.26	.	.	.	.	12.1	.	11.1	5.6	.	.	266	272	266	4	3	4
530	61383	164	26	5	1	0	3	10	10	1	1	2	1.26	.	.	.	.	8.9	.	14.5	5.4	.	6.0	275	279	279	1	0	1
531	61383	164	26	5	2	1	3	10	10	1	1	2	1.26	.	.	.	.	8.9	.	14.5	5.4	.	6.0	275	282	275	3	2	6
532	61583	166	26	5	1	0	3	15	15	1	1	2	1.26	20	.	.	.	9.5	.	10.6	1.6	.	1.5	281	291	289	8	2	2
533	61583	166	26	5	2	1	3	15	15	1	1	2	1.26	20	.	.	.	9.5	.	10.6	1.6	.	1.5	286	291	288	1	1	3
534	62283	173	26	5	1	0	3	20	20	1	1	2	1.39	24	.	.	.	17.9	.	16.8	2.7	.	2.3	241	264	260	11	3	2
535	62283	173	26	5	2	1	3	20	20	1	1	2	1.39	24	.	.	.	17.9	.	16.8	2.7	.	2.3	259	261	246	3	3	11
536	62783	178	26	5	1	0	3	30	30	1	1	2	1.39	25	.	.	.	5.3	.	14.7	5.9	.	5.0	277	297	284	10	1	7
537	62783	178	26	5	2	1	3	30	30	1	1	2	1.39	25	.	.	.	5.3	.	14.7	5.9	.	5.0	.	292	277	.	5	15
538	51283	132	27	1	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	271	262	272	3	13	6
539	51283	132	27	2	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	267	269	274	11	3	3
540	51283	132	27	3	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	272	262	273	5	6	3
541	52483	144	27	1	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	271	275	273	6	7	9
542	52483	144	27	2	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	272	275	275	13	5	12
543	52483	144	27	3	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	274	275	276	5	4	7
544	60283	153	27	3	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	268	268	270	10	8	6
545	60983	160	27	1	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	270	270	276	7	9	2
546	60983	160	27	2	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	268	272	271	12	5	5
547	60983	160	27	3	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	274	270	273	2	6	5
548	61083	161	27	2	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	275	274	278	3	2	4
549	61083	161	27	3	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	274	272	276	4	4	5
550	61383	164	27	1	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	280	273	285	8	11	7
551	61383	164	27	2	1	0	1	[illegible]	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	282	282	268	10	2	43
552	61383	164	27	3	1	0	[illegible]	[illegible]	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	281	283	285	2	2	8
553	61583	166	27	1	1	0	[illegible]	[illegible]	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	284	277	289	3	10	7
554	61583	166	27	2	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	252	288	261	59	5	59
555	61583	166	27	3	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	280	284	283	3	3	8
556	62283	173	27	1	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	275	275	281	8	9	2
557	62283	173	27	2	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	274	278	277	8	3	5
558	62283	173	27	3	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	276	281	279	2	2	3
559	62783	178	27	1	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	282	278	284	2	9	6
560	62783	178	27	2	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	278	281	283	8	4	4
561	62783	178	27	3	1	0	1	100	248	4	1	1	1.20	.	.	.	.	.	.	.	.	.	.	281	283	287	2	2	7

APPENDIX II
CLIMATOLOGICAL DATA - DELMARVA PENINSULA
May and June 1983

LISTING CODES

DAY	=	Julian Day, 1983
R1	=	Daily rainfall, Wye Institute, MD (cm)
R2	=	Daily rainfall, Centerville, MD (cm)
R3	=	Daily rainfall, Denton, MD (cm)
R4	=	Daily rainfall, Royal Oak, MD (cm)
R5	=	Daily rainfall, Dover, DE (cm)
R6	=	Daily rainfall, Milford, DE (cm)
R7	=	Daily rainfall, Willow Grove, DE (cm)
R8	=	Daily rainfall, Darling, DE (cm)
EVAP	=	Daily pan evaporation (cm)
TAIR	=	Mean daily air temperature (°C)
TDEW	=	Mean daily dew point temperature (°C)
WIND	=	Daily wind (km/day)
RAD	=	Solar radiation (Langleys)
PET	=	Penman daily potential evapotranspiration (cm)

PRECEDING PAGE BLANK NOT FILMED

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OBS	DAY	R1	R2	R3	R4	R5	R6	R7	R8	EPAN	EVAP	PET	TAIR	TDEW	WIND	RAD
1	124	0.63	1.19	1.70	1.09	1.57	1.07	.	.	-0.66	0.27	0.40	15.0	6.6	297	373
2	125	0.00	0.00	0.00	0.00	0.00	0.00	.	.	0.57	0.57	0.43	14.8	6.9	147	527
3	126	0.00	0.00	0.00	0.00	0.00	0.00	.	.	0.78	0.78	0.58	13.4	1.8	193	676
4	127	0.00	0.00	0.00	0.00	0.00	0.00	.	.	0.91	0.91	0.55	15.5	7.0	286	600
5	128	0.10	0.00	0.00	0.00	0.00	0.00	.	.	0.42	0.55	0.43	17.7	12.0	359	439
6	129	0.00	0.00	0.13	0.28	0.00	0.08	.	.	0.86	0.86	0.60	11.3	0.0	375	618
7	130	0.00	0.00	0.00	0.00	0.00	0.00	.	.	0.81	0.81	0.61	11.8	-0.7	263	693
8	131	0.00	0.00	0.00	0.00	0.00	0.00	.	.	0.58	0.58	0.53	13.1	2.3	143	671
9	132	0.00	0.00	0.00	0.00	0.00	0.00	.	.	0.81	0.81	0.54	12.9	4.1	197	681
10	133	0.00	0.00	0.00	0.00	0.00	0.00	.	.	0.69	0.69	0.51	15.1	7.5	127	666
11	134	0.00	0.00	0.00	0.00	0.00	0.00	.	.	0.69	0.69	0.46	19.4	13.9	131	585
12	135	1.40	1.35	2.36	0.58	1.60	0.08	.	.	-1.57	0.30	0.39	21.2	17.7	166	502
13	136	3.17	3.89	3.38	2.64	5.56	3.91	.	.	-5.11	0.00	0.06	12.5	10.6	429	66
14	137	0.00	0.18	0.15	0.61	0.53	0.00	.	.	0.50	0.50	0.54	10.8	2.4	266	693
15	138	0.00	0.00	0.00	0.00	0.00	0.00	.	.	0.79	0.79	0.49	14.0	7.3	170	650
16	139	0.13	0.00	0.08	0.05	0.00	0.00	.	.	0.28	0.36	0.31	15.5	9.9	305	321
17	140	0.25	0.25	0.84	0.08	0.99	0.58	.	.	-0.23	0.05	0.25	19.7	17.0	259	315
18	141	2.92	5.08	1.52	1.75	1.73	1.42	.	.	-0.39	0.00	0.09	19.8	18.4	139	162
19	142	1.27	0.63	0.84	1.52	0.84	1.35	.	.	-1.91	0.00	0.06	18.6	17.4	197	127
20	143	0.51	0.76	0.05	0.00	1.80	0.28	0.00	0.00	0.13	0.20	0.43	21.8	18.1	154	552
21	144	0.00	0.63	0.00	0.00	0.13	0.03	0.00	0.00	0.49	0.49	0.44	18.3	12.1	270	478
22	145	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.81	0.57	17.1	9.1	151	701
23	146	2.16	0.13	0.10	0.15	0.38	1.68	0.76	0.00	-2.54	0.33	0.38	17.5	13.6	224	485
24	147	0.51	2.41	1.73	2.59	1.45	1.07	0.89	1.40	0.02	0.45	0.55	14.8	8.5	251	699
25	148	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.68	0.42	16.0	8.8	127	527
26	149	0.02	1.14	0.58	1.04	0.58	0.43	0.63	0.51	-3.12	13.46	0.12	17.6	15.3	113	199
27	150	0.13	1.57	0.25	1.55	0.46	0.15	2.16	0.63	-0.08	0.10	0.24	20.1	17.6	139	344
28	151	0.13	0.00	5.08	1.96	0.10	0.94	0.00	0.00	0.55	0.50	0.23	18.1	14.1	162	285
29	152	0.13	0.13	0.20	0.46	0.13	0.71	0.13	0.00	0.33	0.33	0.23	16.9	12.1	100	301
30	153	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	1.46	1.46	0.56	17.3	10.2	178	689
31	154	1.52	0.00	0.00	0.00	0.00	0.00	0.76	0.63	-1.26	0.56	0.33	19.4	14.5	166	397
32	155	0.13	1.02	0.89	1.63	0.61	0.97	0.00	0.00	0.05	0.25	0.29	20.5	16.7	259	327
33	156	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.77	0.77	0.59	22.0	14.8	131	684
34	157	0.38	0.00	0.00	0.00	0.08	0.30	0.63	0.13	0.49	0.71	0.44	22.3	18.5	209	537
35	158	0.13	0.00	0.00	0.00	0.08	0.08	0.00	0.00	0.41	0.70	0.42	21.1	16.1	127	520
36	159	0.38	1.78	0.46	0.43	0.38	0.41	0.38	0.38	0.55	0.20	0.50	20.2	14.1	100	631
37	160	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.05	1.05	0.57	17.9	10.9	263	647
38	161	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.71	0.51	17.6	11.7	151	657
39	162	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	0.98	0.58	21.8	14.9	189	643
40	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84	0.84	0.57	24.0	17.0	124	656
41	164	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	0.88	0.53	25.2	19.4	89	631
42	165	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.52	25.1	19.2	108	608
43	166	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84	0.84	0.56	24.8	18.9	139	648
44	167	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.58	25.1	19.5	147	674
45	168	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.99	0.99	0.55	24.6	19.1	120	659
46	169	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.71	0.71	0.47	24.5	18.9	112	547
47	170	0.25	0.25	3.30	0.00	0.46	0.56	2.54	0.76	0.15	0.30	0.26	23.5	20.8	104	356
48	171	3.30	1.02	5.31	6.83	0.48	0.30	4.06	4.44	-4.69	0.00	0.13	21.8	20.3	116	217
49	172	0.51	3.68	0.33	4.70	9.68	8.66	4.06	3.68	-0.87	0.00	0.08	20.1	18.6	212	140
50	173	0.00	0.00	0.00	0.00	0.38	0.05	0.00	0.00	0.74	0.74	0.58	21.6	15.3	205	659
51	174	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.78	0.54	20.2	14.3	81	700
52	175	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.81	0.56	25.9	20.0	189	603
53	176	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.16	1.16	0.72	24.0	14.6	239	691
54	177	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.86	0.86	0.62	22.6	13.4	116	700
55	178	0.00	0.00	0.00	0.00	0.00	0.00	2.16	1.90	0.99	0.99	0.63	27.0	21.4	209	673