E7.4-10540.
CR-138289

Detection of Moisture and Moisture Related Phenomena from Skylab

(E74-10540) DETECTION OF MOISTURE AND MOISTURE RELATED PHENOMENA FROM SKYLAB Monthly Progress Report, Apr. 1974 (Kansas Univ. Center for Research, Inc.) 17 p HC $4.00 CSCL 08H

N74-25858

Unclas
G3/13 00540

Joe R. Eagleman
Principal Investigator

Monthly Progress Report, April 1974

Atmospheric Science Laboratory
Center for Research, Inc.
University of Kansas

Detection of Moisture and Moisture Related
Phenomena from Skylab

Joe R. Eagleman
Principal Investigator

Ernest C. Pogge and Richard K. Moore
Co-investigators

Norman Hardy, Wen Lin, and Larry league
Graduate Research Assistants

Atmospheric Science Laboratory
Space Technology Center
Center for Research, Inc.
University of Kansas
Lawrence, Kansas 66045

Clayton D. Forbes, Technical Monitor
Principal Investigations
Management Office
Lyndon B. Johnson Space Center
Houston, Texas 77058

EREP NO. 540-A2 March 19, 1973 to August 31, 1974

Contract Number. NAS 9-13273

INITIAL S-193-SOIL MOISTURE CORRELATION

This is an initial attempt to correlate S-193 backscatter and temperature values with soil moisture for the 6-5-73 and 8-8-73 Texas sites. The S-193 pattern for both test sites is illustrated in Figures 1 and 2. These patterns were obtained by plotting the latitude and longitude coordinates for each S-193 sweep on topographic sheets then transferring the information to the maps in Figures 1 and 2. The temperature and backscatter values which had soil moisture measurements within the response area were determined and their values recorded. This resulted in 29 data pairs for antenna temperature and 23 data pairs for the scatterometer.

The results for the 6-5-73 Texas site are shown in Tables 1 and 2 and Figures 3 and 4. Table 1 shows the correlation coefficients derived from S-193 radiometer temperatures and soil moisture measurements. The highest correlation coefficients are -0.569 (0-50 mm), -0.565 (26-50 mm), and -0.557 (0-25 mm depth). Figure 3 shows a scattergram for the 0-25 mm depth. Correlation coefficients in Table 2 are derived from S-193 backscatter values and soil moisture measurements. The highest coefficient is quite low (-0.214) for the 0-25 mm depth. Figure 4 shows a scattergram for the 0-25 mm depth.

Similar statistics have been computed for the 8-8-73 Texas site. These are shown in Tables 3 and 4 and Figures 5 and 6. Table 3 shows that all the correlations between S-193 temperature and soil moisture are quite low with the highest correlation in the 25-50 mm depth (-0.144) and the 0-25 mm depth having a value of -0.068. Figure 5 shows a scattergram for the 0-25 mm depth. Correlation coefficients relating S-193 backscatter and soil moisture Table 4 indicate the higher values are 0.274 (0-50 mm), 0.272 (0-25 mm), 0.242 (26-50 mm) and 0.241 (0-75 mm depth). Figure 6 shows a scattergram for the 0-25 mm depth. For this data set the correlations were positive and low. In comparison with the June 5 data set relating backscatter coefficient with soil moisture content the correlations were low and negative.

This has been a first step in attempting to correlate S-193 radiometer temperature and backscatter coefficient with soil moisture content. Additional work must be performed before conclusive results can be obtained . Further work is in progress involving a detailed examination of each S-193 return area with characterization of amount of cloud cover, topography, as well as the type and quantity of vegetative cover.

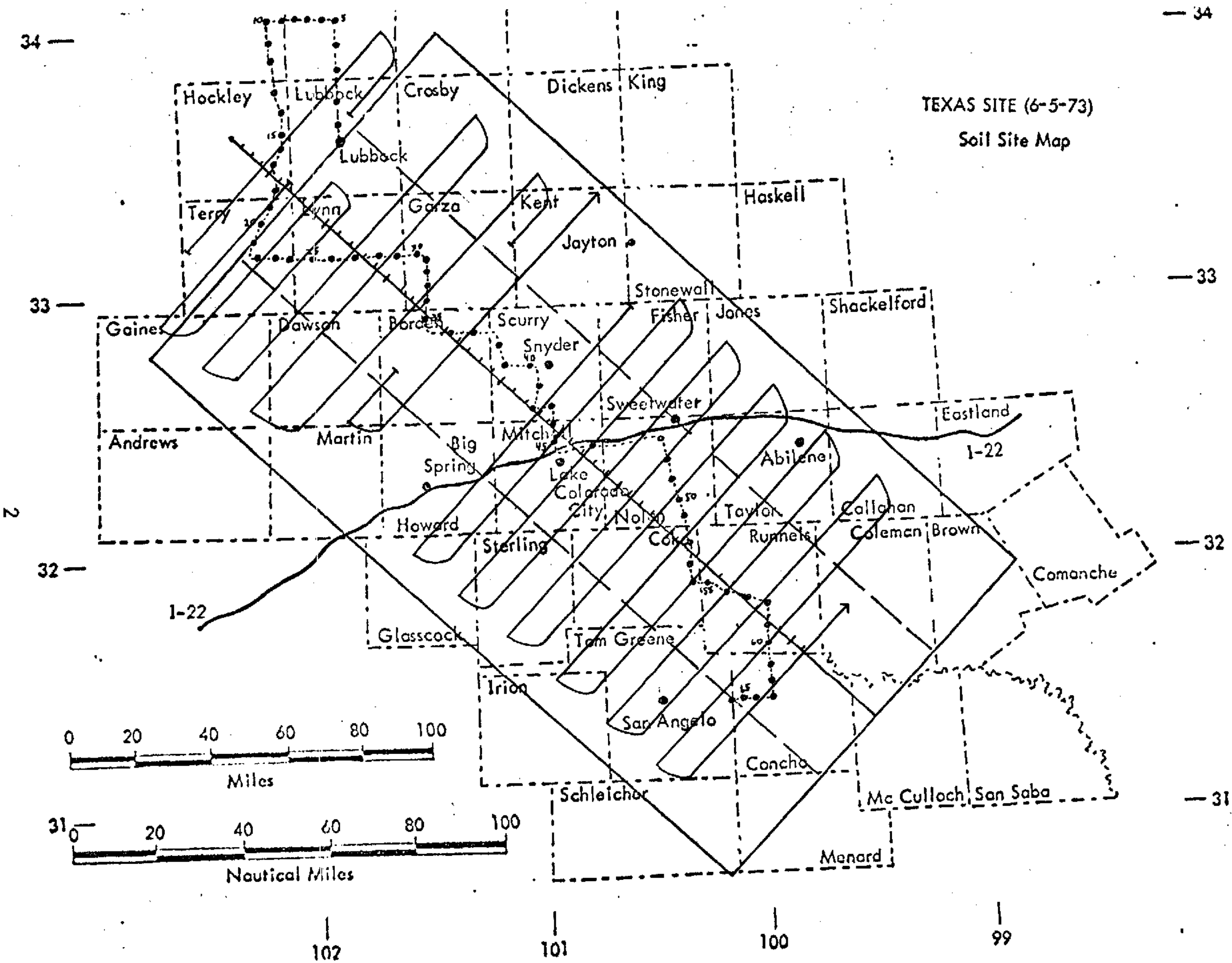

Figure 1. S-193 backscatter and temperature field of view (Texas 6-5-73).

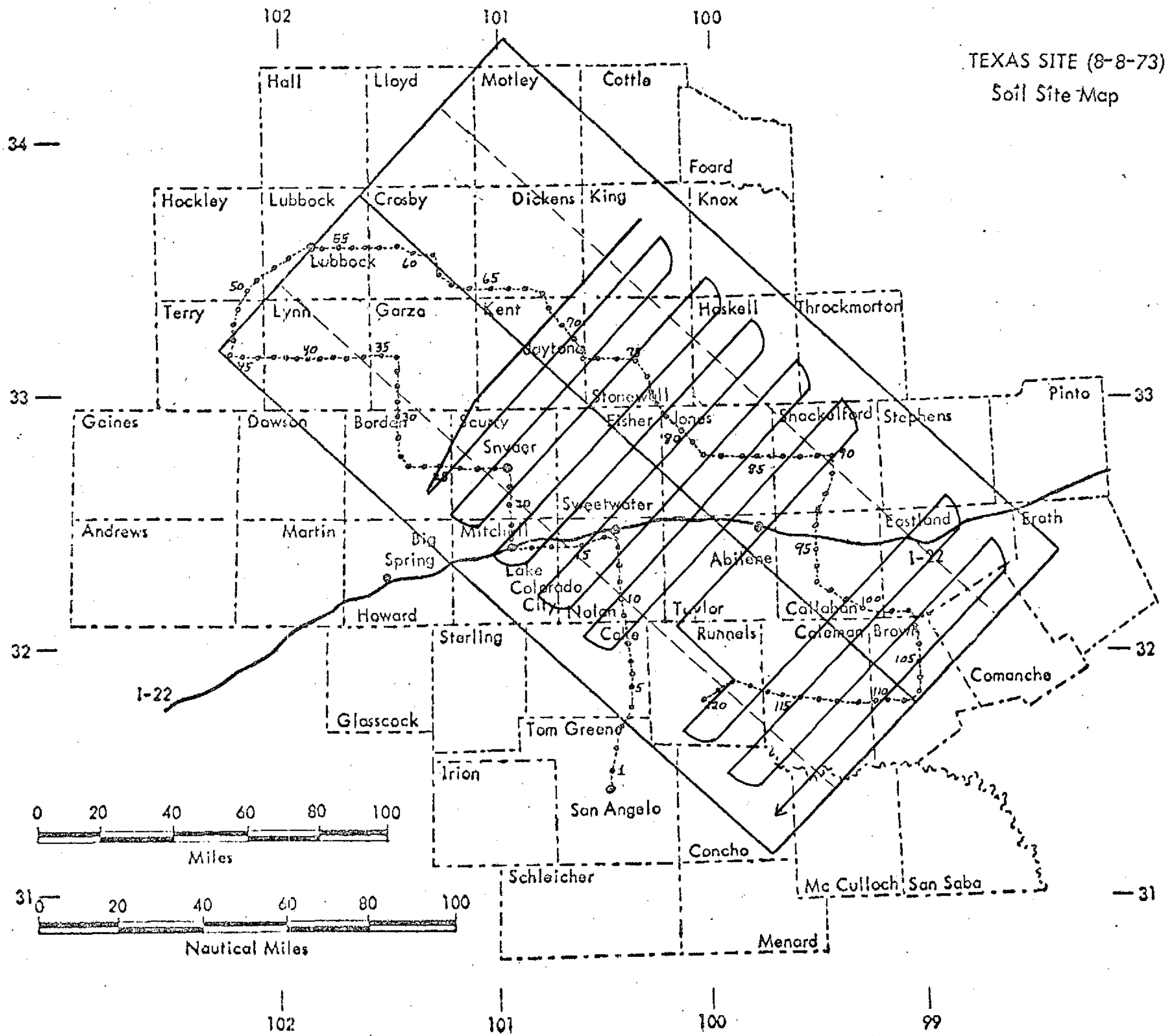

Figure 2. S-193 backscatter and temperature field of view (8-8-73 Texas).

TABLE 1

CORRELATION BETWEEN SOIL MOISTURE AND S-193 ANTENNA TEMPERATURE

Soil Moisture Layer	Correlation Coefficient	Regression Equation (6-5-73 Texas)
0 - 25 mm	-0.557	SM = 216.95 - 0.756AT
26 - 50 mm	-0.565	SM = 188.60 - 0.637AT
51 - 75 mm	-0.467	SM = 142.63 - 0.469AT
76 - 100 mm	-0.440	SM = 127.62 - 0.411AT
101 - 125 mm	-0.393	SM = 114.91 - 0.364AT
126 - 150 mm	-0.484	SM = 150.52 - 0.492AT
0 - 50 mm	-0.569	SM = 202.80 - 0.691AT
0 - 75 mm	-0.545	SM = 182.73 - 0.617AT
76 - 150 mm	-0.447	SM = 131.01 - 0.422AT
0 - 150 mm	-0.506	SM = 156.85 - 0.520AT

Sample Size = 28
SM = Soil Moisture
AT = Antenna Temperature(K°)

TABLE 2

CORRELATION BETWEEN SOIL MOISTURE AND S-193 BACKSCATTER COEFFICIENT

		6-5-73 Texas
Soil Moisture Layer	Correlation Coefficient	Regression Equation
0 - 25 mm	-0.214	SM = 4.46 - 0.536BC
26 - 50 mm	-0.135	SM =-7.60 - 1.962BC
51 - 75 mm	-0.141	SM =-14.64 - 2.749BC
76 - 100 mm	-0.159	SM =-14.11 - 2.791BC
101 - 125 mm	-0.172	SM =-13.23 - 2.755BC
126 - 150 mm	-0.060	SM =-7.38 - 2.121BC
0 - 50 mm	-0.191	SM =-1.56 - 1.248BC
0 - 75 mm	-0.153	SM =-5.92 - 1.748BC
76 - 150 mm	-0.132	SM =-11.56 - 2.556BC
0 - 150 mm	-0.074	SM =-8.74 - 2.152BC

Sample Size = 23
SM = Soil Moisture
BC = Backscatter Coefficient(db)

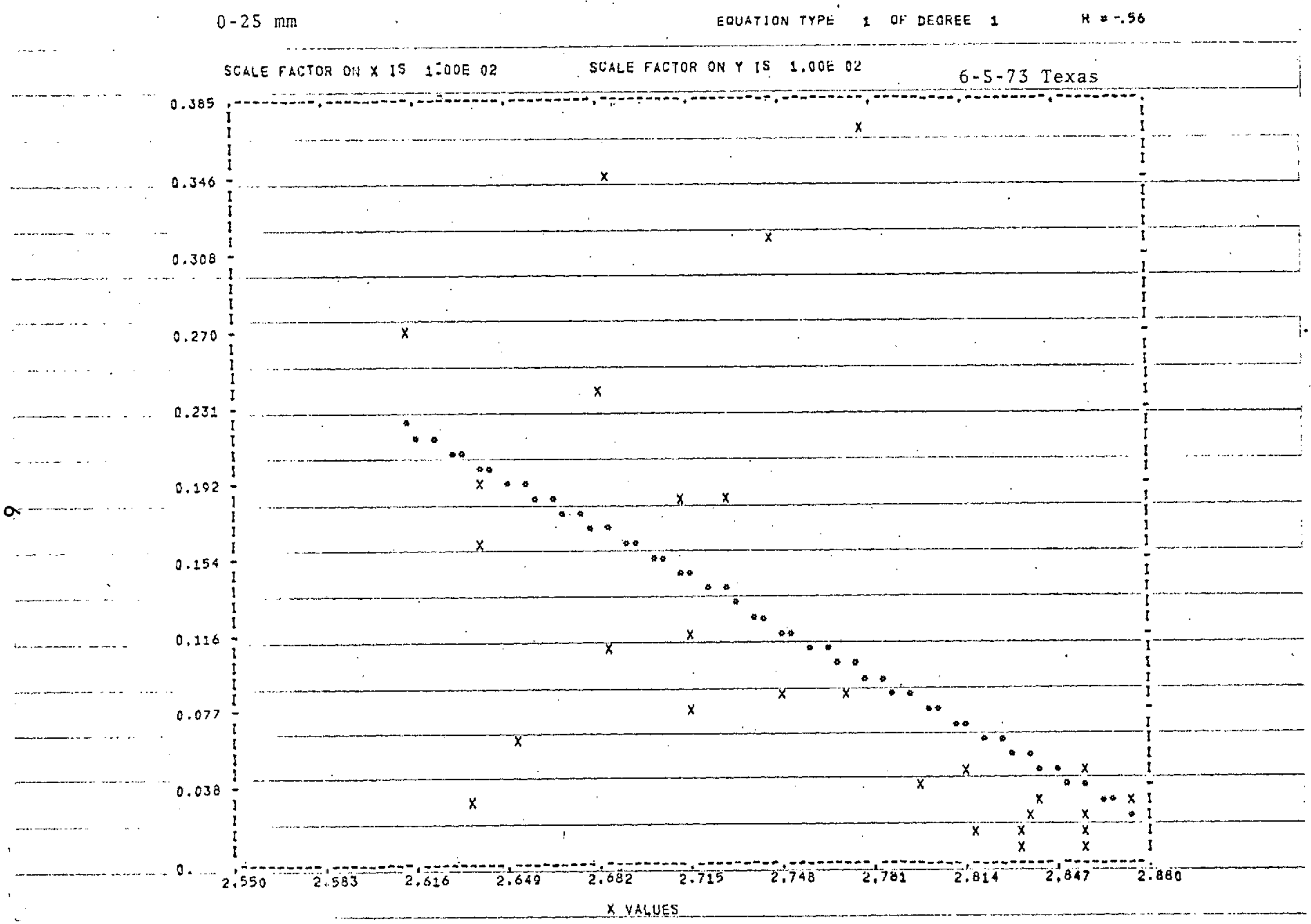

Figure 3. Correlation scattergram---S-193 antenna temperature vs. soil moisture, 0-25 mm depth, Texas 6-5-73.

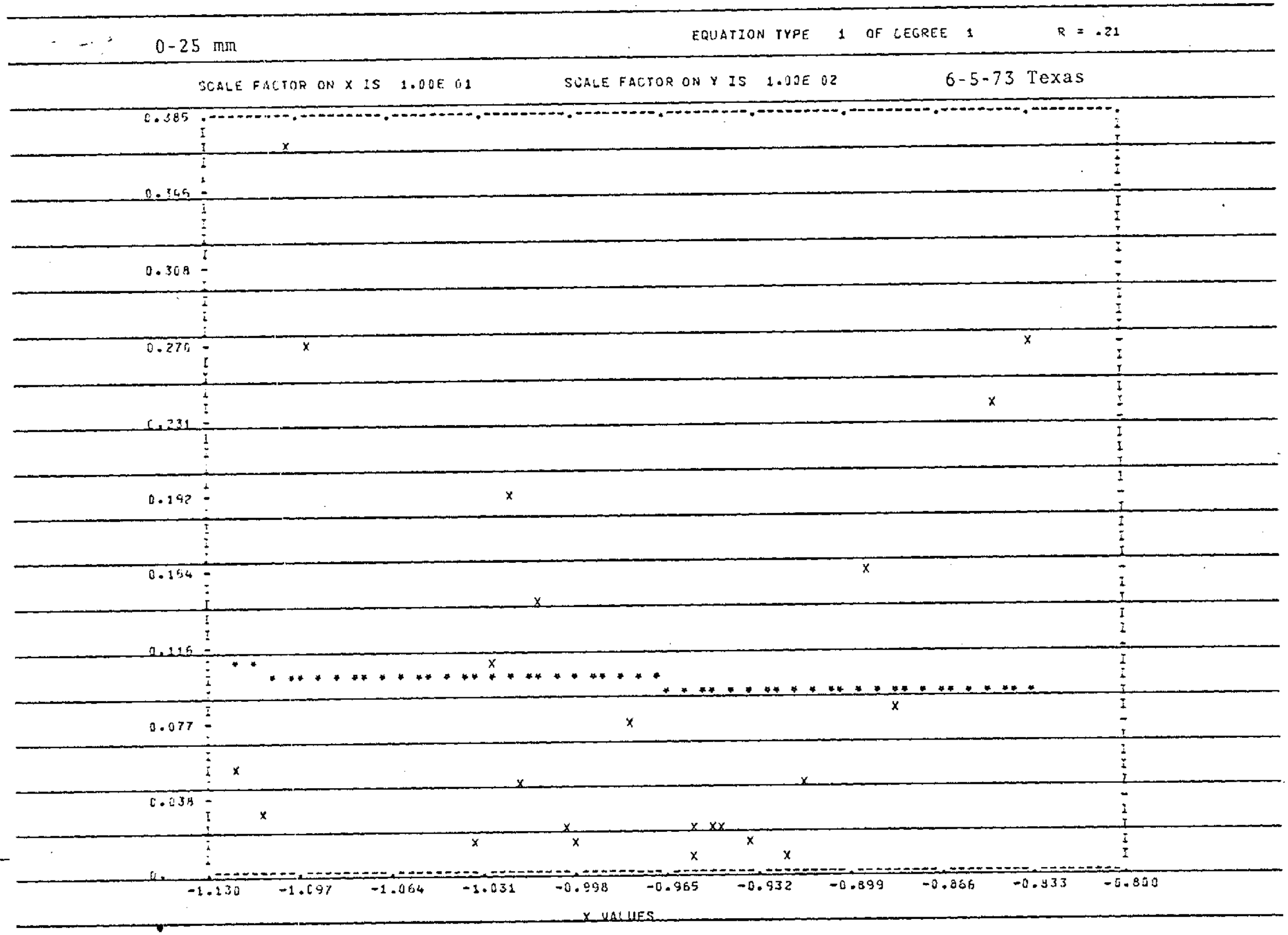

Figure 4. Correlation scattergram---S-193 backscatter vs. soil moisture, 0-25 mm depth, Texas 6-5-73.

TABLE 3

CORRELATION BETWEEN SOIL MOISTURE AND S-193 ANTENNA TEMPERATURE

		8-8-73 Texas
Soil Moisture Layer	Correlation Coefficient	Regression Equation
0 - 25 mm	-0.068	SM = 18.76 - 0.058AT
26 - 50 mm	-0.144	SM = 71.40 - 0.234AT
51 - 75 mm	-0.082	SM = 50.77 - 0.154AT
76 - 100 mm	-0.056	SM = 43.34 - 0.123AT
101 - 125 mm	0.037	SM =-13.48 + 0.080AT
126 - 150 mm	0.037	SM =-12.76 + 0.079AT
0 - 50 mm	-0.126	SM = 45.04 - 0.146AT
0 - 75 mm	-0.108	SM = 46.88 - 0.149AT
76 - 150 mm	0.005	SM = 5.79 + 0.012AT
0 - 150 mm	-0.040	SM = 26.43 - 0.069AT

Sample Size = 33
SM = Soil Moisture
AT = Antenna Temperature(K°)

TABLE 4

CORRELATION BETWEEN SOIL MOISTURE AND S-193 BACKSCATTER COEFFICIENT

8-8-73 Texas

Soil Moisture Layer	Correlation Coefficient	Regression Equation
0 - 25 mm	0.272	SM = 12.96 + 1.008BC
26 - 50 mm	0.242	SM = 19.20 + 1.384BC
51 - 75 mm	0.189	SM = 21.57 + 1.392BC
76 - 100 mm	0.087	SM = 16.48 + 0.745BC
101 - 125 mm	0.158	SM = 24.15 + 1.393BC
126 - 150 mm	0.143	SM = 22.35 + 1.188BC
0 - 50 mm	0.274	SM = 16.09 + 1.197BC
0 - 75 mm	0.241	SM = 17.93 + 1.263BC
76 - 150 mm	0.131	SM = 20.98 + 1.108BC
0 - 150 mm	0.178	SM = 19.46 + 1.186BC

Sample Size = 36
SM = Soil Moisture
BC = Backscatter Coefficient(db)

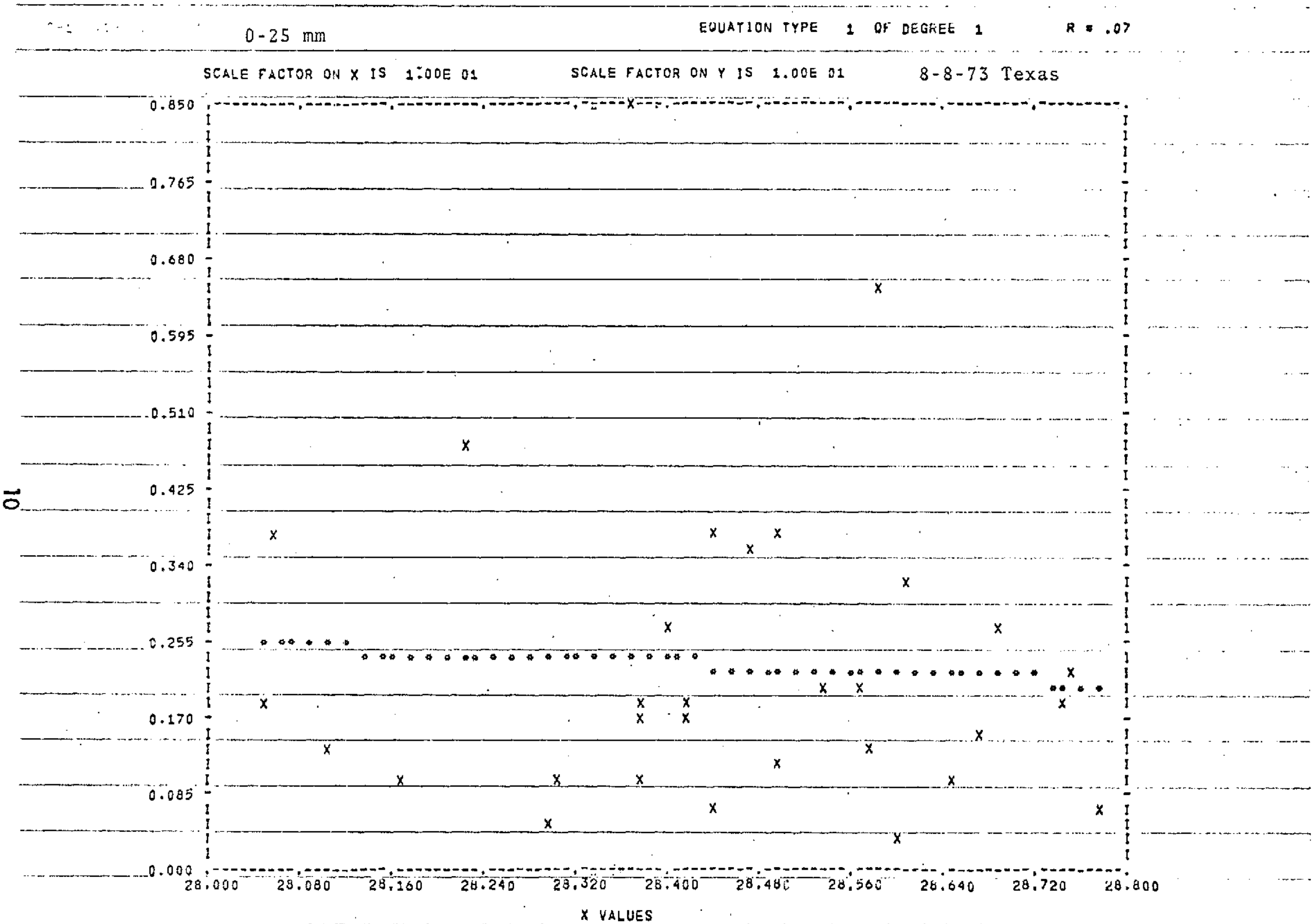

Figure 5. Correlation scattergram---S-193 antenna temperature vs. soil moisture, 0-25 mm depth, Texas 8-8-73.

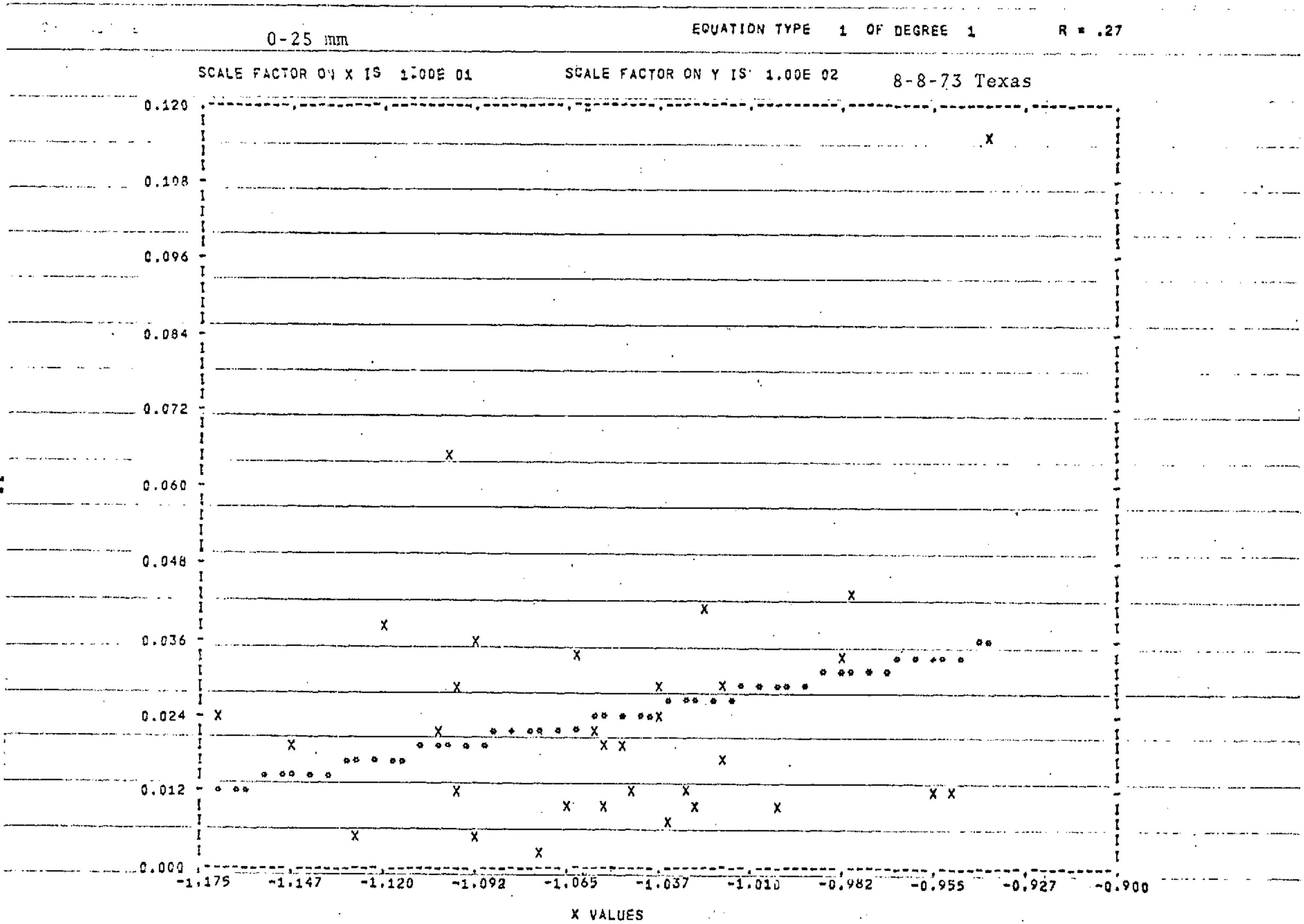

Figure 6. Correlation scattergram---S-193 backscatter vs. soil moisture, 0-25 mm depth, Texas 8-8-73.

AIRCRAFT RADIOMETER-SCATTEROMETER DATA

Preliminary analysis of the data generated by the AAFE Radscat underflight of June 6, 1973 has been directed mainly toward the radiometer output. This part of the analysis indicates that the instrument responded to a variety of landscape phenomena. Because the aircraft radscat views a relatively small area on the ground and because the soil sample grid was devised for Skylab radiometer footprints, and is therefore quite coarse, there is much less detailed ground truth information corresponding to the aircraft track. Therefore, much of the detailed ground information was taken from the color aerial photography of scale 1:16,188.

Figures 7 and 8 are plots of scatterometer traces (above) and radiometer traces (below). These figures cover a fairly broad range of terrain features for examination. From these plots it is obvious that the radiometer responds as expected in most instances. There was generally only small variations in the type of landscape included in this sample set. However, temperature variations do show some indications of a response to changes in surface character. In most cases, however, the variations within each category are as great as the variation between categories. There are some obvious exceptions to this generalization. A significant temperature decrease occurs at 356.5 seconds with the vertical-vertical polarization. This corresponds to a significant change of vegetation type and the presence of a stream, both of which tend to indicate a cooler environment.

Minor increases in the temperature, corresponding to the points at which the beam crosses a road are also apparent from the horizontal-horizontal return. Two major temperature increases are evident at 336.4 and 345.0 seconds. Unfortunately, initial examination of the corresponding points on the simultaneous photography fails to yield any information which would explain these major changes although investigations are continuing.

Figure 8 crosses a similar landscape to that of Figure 7, however, it is immediately apparent that the temperature variation is much greater. For most cases, temperature increases and decreases are readily explained. In those cases where the radiometer passes across depressions, the temperature drops in response to the higher moisture content of the soil. Soils which have been cultivated and are located on flat or upland terrain tend to show significantly higher temperatures than soils in depressions or uncultivated soils. Similarly, the response to road surfaces is again quite significant, as the temperature increases to over 300°K.

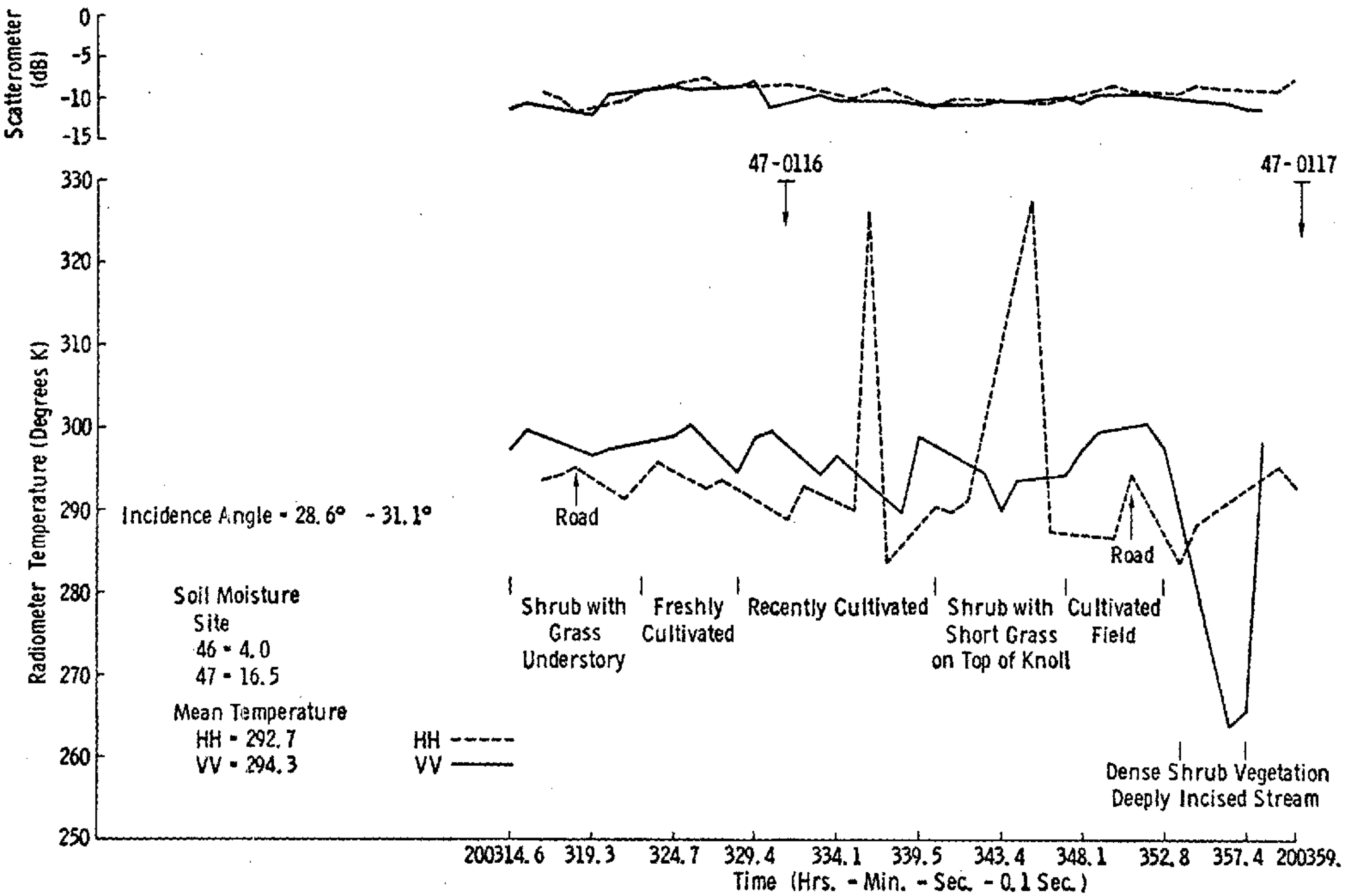

Figure 7. Upper plot represents a scatterometer trace for an average incidence angle of 30°. Lower plot represents a radiometer trace for an average incidence angle of 30°. The radscat data were obtained simultaneously with radar photography. Note: the large temperature increases on the HH trace are currently unexplained.

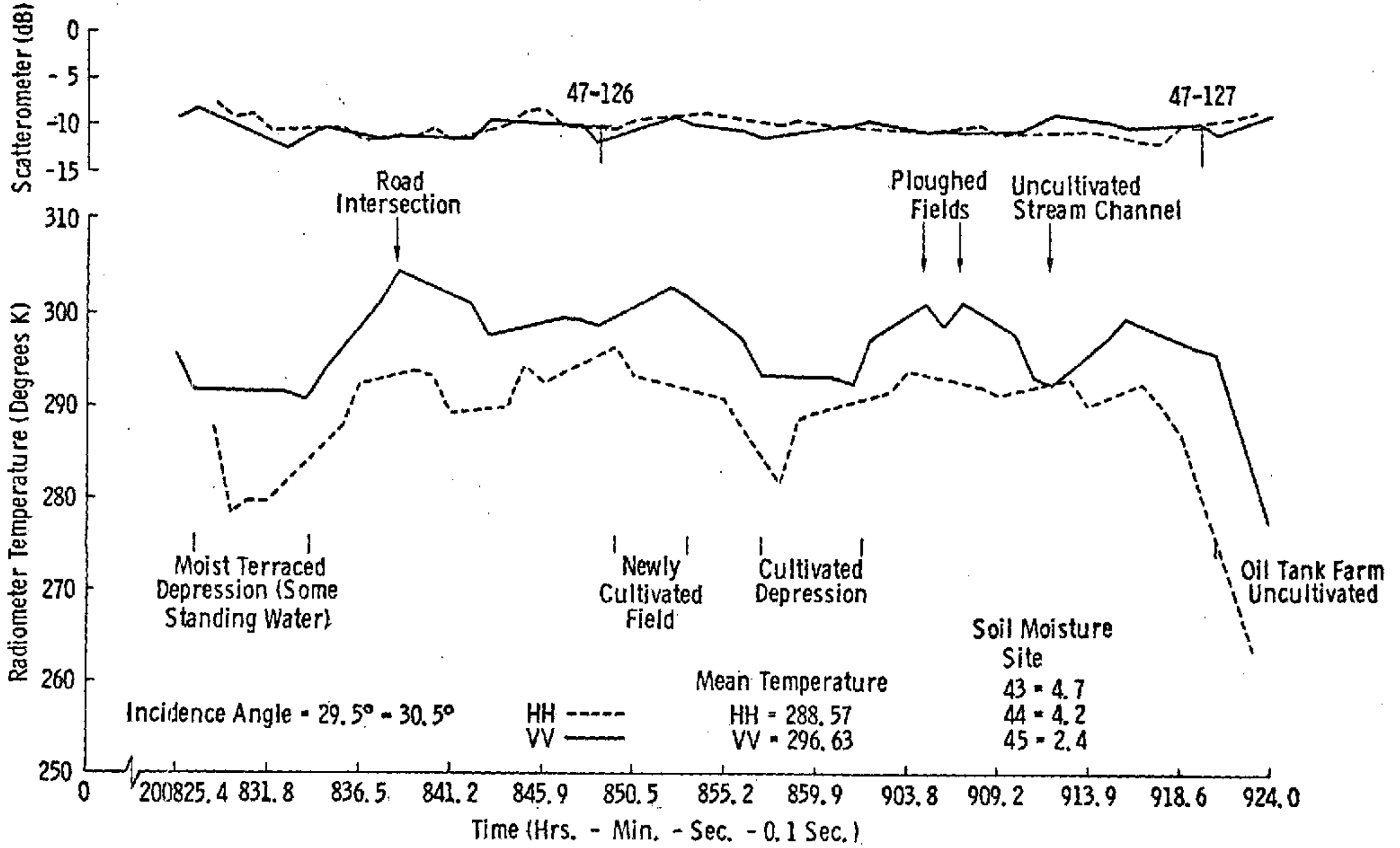

Figure 8. Same as Figure 7, but more definite responses to known terrain variations are apparent.

Further work is required to do a comprehensive interpretation, therefore, other test sites are currently being analysed for the June 6 mission. Also, some statistical analysis in the form of standard deviations and correlations between scatterometer and radiometer data are essential to determine what sorts of terrain features are contributing to the response of these instruments.