CHAPTER XVII. C-130 INSTRUMENTS

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A. WASHITA'94 APRIL C-130 FLIGHTLINES.

The NASA C-130 was one of the primary data collection tools used in the Washita'94 April experiment. The C-130 is based out of NASA Ames Research Center at Moffet Field, California. It is a low and medium altitude platform capable of speeds between 150 and 300 knots. For the Washita'94 experiment, the C-130 had the following operational sensors available; the NS001 multispectral scanner, the thermal infrared multispectral scanner (TIMS), and two Zeiss cameras. In addition to these instruments, the electronically steered thinned array radiometer (ESTAR) was installed. The following sections present a brief description of each instruments and, if available, an example of the data products. Since all sensors utilized the same set of flightlines, with a few exceptions, these are described in a separate section.

Flightline selection for the C-130 was determined primarily by the lines flown during the 1992 missions (Jackson and Schiebe, 1993) with the ESTAR and to provide coverage of the ground calibration/verification sites. The basic high altitude data set collected in 1992 was enlarged a bit in the east-west direction and two additional high altitude lines were added to provided coverage of the southern portion of the watershed.

The standard georeferencing procedures used in previous experiments have relied upon the use of video camera coverage. These tapes are reviewed using 1:24,000 scale maps and image data (SPOT and NS001) to determine time coverage of numerous points on each line. These points are then digitized (UTM coordinates) and recorded with the times. Due to the numerous road intersections in the region, the georeferencing accomplished using this method is considered to be quite accurate. It appears that there may be problems with the time coding of the video tapes caused by the mission manager manually changing the times in an attempt to match time codes being received from a GPS system. When we compared video and GPS based maps we observed unresolvable conflicts between the images based on the two sources of mapping information. The reference time of coverage is that recorded with the instrument data. This will match the GPS data stream but will not match the video. One of our intentions in this experiment was to compare the two sources of geolocation data because the GPS can be subject to several sources of error. However, we will have to accept the GPS as being correct due to the manual errors introduced. Video coverage was available on all dates except the high altitude lines on April 11 when clouds obscured the ground. Figure XVII-1 shows the locations and coding of the C-130 flightlines.

1. Low Altitude

The nominal altitude for the low altitude lines was 200 m. The primary purpose of these lines was to provide nadir high resolution coverage of uniform targets for verifying the ESTAR data interpretation algorithms. At this altitude, the NS001 and TIMS cannot scan fast enough to provide an image. However, data can be processed for field averages.
Line 1 provided coverage of Lake Ellsworth. It was flown at the beginning of each day's data collection. The primary purpose of this line was the calibration of the ESTAR instrument. During the flight, thermal infrared data was also acquired with a PRT-5 thermal infrared instrument. NS001 and TIMS data were also acquired over the lake. On all dates, a ground based measurement of lake water temperature was obtained from a pier.

Line 2 was flown west to east. It was selected to provide coverage of winter wheat in a silty soil region. Line 3 was also flown west to east and was selected to cover rangelands in a sandy soil region. Line 4 covered a group of sites that were selected primarily to provide a mixture of covers in adjacent fields to facilitate radar analyses. Line 4 was flown south to north. In addition line 4 was also flown at a second altitude primarily to satisfy the needs of TIMS and NS001 studies. At an altitude of 1300 m, this provided complete coverage for mapping at a high resolution.

2. High Altitude

This group of lines, referred to as the high altitude coverage lines, were flown at a nominal altitude of 2200 m and a ground speed of 80 m/s. These lines were designed to provide overlapping coverage by the ESTAR instrument of a large study area. Figure XVII-1 shows the location of these lines. Coverage typically took a total of 2 hours.Scan rates for the NS001 and TIMS were high enough to provide contiguous scan line coverage.

B. ESTAR L BAND SENSOR

The electronically steered thinned array radiometer (ESTAR) is a synthetic aperture microwave radiometer which operates at L band (21 cm, 1.4 GHz). ESTAR is a hybrid real and synthetic aperture radiometer. It employs a real aperture to obtain resolution along track and aperture synthesis to obtain resolution across track. The basic data collection parameters of the ESTAR are:

Center frequency	1.4 GHz
Polarization	Horizontal
Resolution	+/- 4 degrees (both along and across)
Swath Width	+/- 45 degrees
Bandwidth	25 MHZ
Integration Time	0.25 seconds

Additional details on the ESTAR instrument can be found in Le Vine et al. (1994). Application to soil moisture mapping is described in Jackson et al. (1993).

The ESTAR coverage during April is summarized in Table XVII-1. Figure XVII-2 presents preliminary brightness temperature maps acquired by the ESTAR on the first and last flight dates. The patterns observed and the levels match those obtained in 1992 (Jackson and Schiebe, 1993).

C. NS001 SENSOR

1) Bands and specifications

The NS001 multispectral scanner operates in the seven Landsat-D Thematic Mapper bands plus a band from 1.13 to 1.35 µm. The nominal bandwidths are as follows:

Band	Spectral bandwidth, µm
1	0.458-0.519
2	0.529-0.603
3	0.633-0.697
4	0.767-0.910
5	1.13-1.35
6	1.57-1.71
7	2.10-2.38
8	10.9-12.3

Sensor specification are:

IFOV:	2.5 mrad
Ground Resolution:	7.6 meters at 3000 meters
Total Scan Angle:	100°
Swath Width:	7.2 km at 3000 meters
Pixels/Scan Line:	699

2) Data Summary

Data were acquired with the NS001 sensor during the April campaign over both the low and high altitude flight lines described in section A. However, at the low level flight lines (nominal agl 200m), the NS001 instrument cannot scan fast enough to provide a continuous image. However, one north-south flight line (Low level line 4) over Site 1 was flown at approximately 1300 m agl, providing full coverage of the Site 1 area at roughly 3 meter pixel resolution. The group of 5 high altitude lines were designed to provide almost full coverage of the study area. NS001 data were not acquired on days with substantial cloud cover. The optimal days (i.e., days with least cloud cover during NS001 flights) were April 6 and 7. No C-130 data were available during the August or October campaigns.

D. REFERENCES

Jackson, T. J. and Schiebe, F. R. (Ed.) 1993. Hydrology data report WASHITA’92. USDA NAWQL 93-1.

Jackson, T. J., Le Vine, D. M., Griffis, A., Goodrich, D. C., Schmugge, T. J., Swift, C. T., and O'Neill, P. E. 1993. Soil moisture and rainfall estimation over a semiarid environment with the ESTAR microwave radiometer. IEEE Trans. on Geosci. and Remote Sensing, in press.

Le Vine, D. M., Griffis, A. J., Swift, C. T., and Jackson, T. J. 1994. ESTAR: a synthetic aperture microwave radiometer for remote sensing applications. Proc. of the IEEE, vol. 82, pp. 1787-1801.

Table XVII-1. Washita’94 April C-130 ESTAR Coverage

Date	Time	Low Altitude Lines	High Altitude Lines
40694	pm	1-4	1-5
40794	am	1-4	1-7
40794	pm	1-4	1-7
40994	pm	1-4 (no mid)	1-5
41194	pm	1-4 (no mid)	1-7

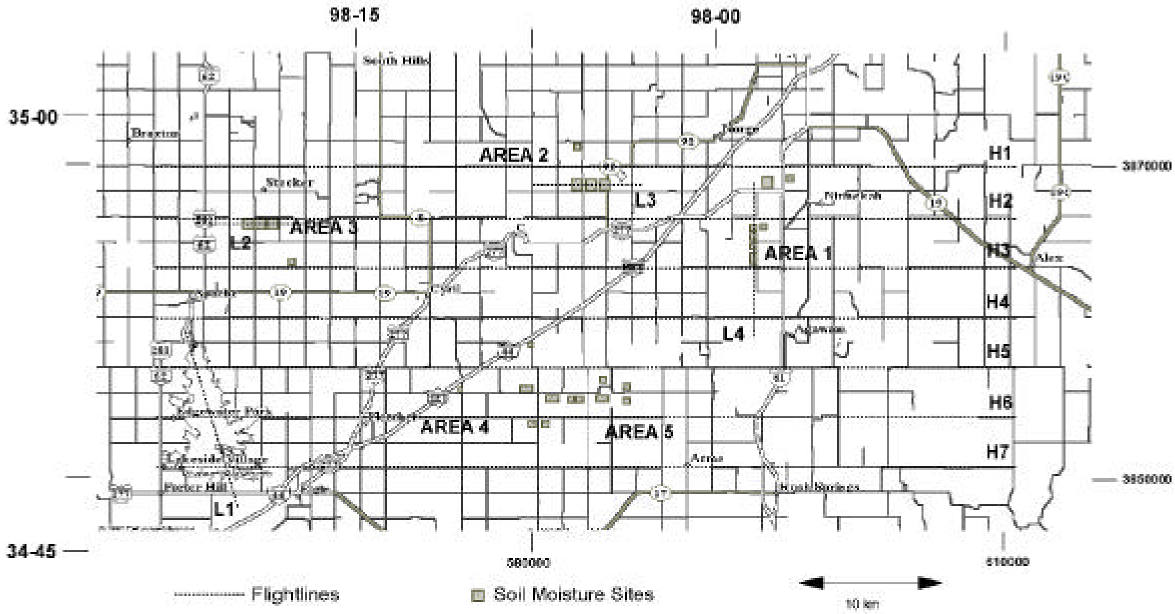

Figure XVII-1. Washita'94 April ESTAR/C-130 Flightlines

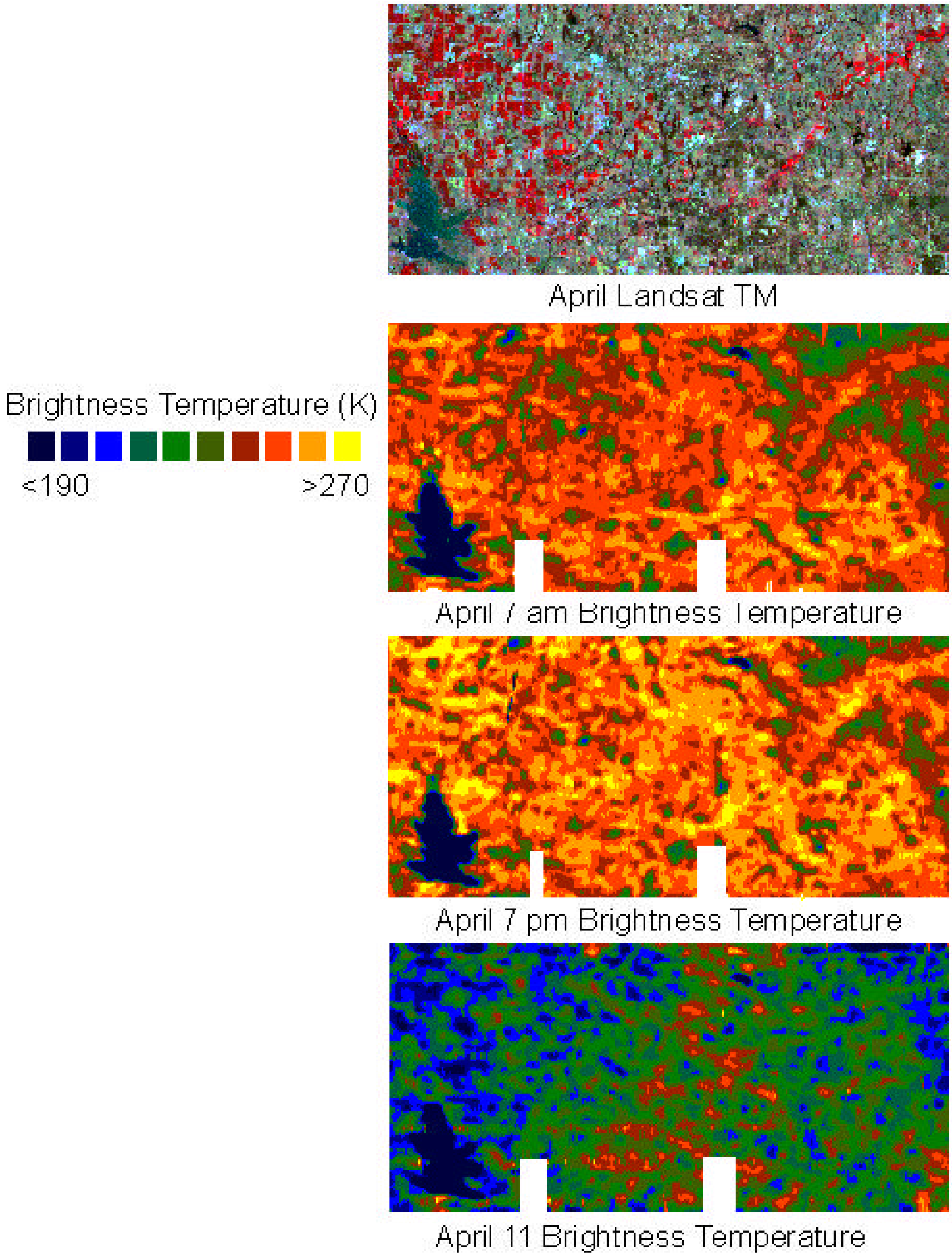

Figure XVII-2. Washita'94 April ESTAR brightness temperature images.