

## CHAPTER XVII DC-8 SAR

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### A. INTRODUCTION

The objectives of the Synthetic Aperture Radar flights with the DC-8 NASA aircraft during WASHITA-92 were to provide a spatial and temporal record of soil moisture changes during the study period. The measurement strategy was carried out with two principal goals; one to provide additional data over areas where detailed ground data have been taken for development and testing of radar scattering models and inversion algorithms, and two, to provide wall-to-wall coverage of the Little Washita watershed to evaluate the capability of the synoptic processing mode for mapping soil moisture. Implicit within these objectives is the need to provide a time series of measurements to define the temporal patterns.

### B. METHODS

To obtain the time series of soil moisture changes in the Little Washita Basin it was necessary to be able to fly every day in which we expected some change in moisture conditions from the previous day. Because we were fortunate to start with extremely wet conditions and to receive no rain for the entire study period, we were able to follow the drying trend by flying every day, except for one, which was a necessary crew rest day.

To obtain the necessary spatial coverage, we followed two flight line strategies; one, to provide overlapping coverage of the entire Little Washita Basin with four parallel flight lines, and two, to fly a pattern of varying azimuth and incidence angles over the region of several different agricultural fields where truck radar data and detailed field measurements were taken.

In addition to the coverage described above which was flown every day (except for the rest day), there were several one time flight lines for coverage of drainage basins north of the Little Washita, the East Bitter Creek area for comparison with earlier L and X band SAR flights by JPL and ERIM, and an area of high salinity below the Lake Chickasha dam. The general pattern of the flight lines is shown in figure XVII-1.

#### 1. Instruments:

The radar system on board the NASA DC-8 was first installed in the airplane in 1987. The current radar is a substantially upgraded version of the original L-band SAR

that was destroyed in a fire in 1985. The new NASA/JPL Airborne Imaging Radar system incorporates all the characteristics of the old system but also includes P-band and C-band channels. The new system is capable of producing fully polarimetric data from all three frequencies simultaneously, yielding twelve coherent, co-registered radar images of any target scene with approximately 10 m resolution. A comprehensive description of the radar and DC-8 capabilities are given in table XVII-1.

Table XVII-1 NASA/JPL Airborne Imaging Radar (AIR) Parameters

	L-Band	C-Band	P-Band
Frequency (Mhz)	1260-1237.5	5310-5287.5	450-427.5
Center Frequency (Mhz)	1248.75	5298.75	438.75
Wavelength (m)	0.2402	0.05662	0.6838
Pulse Length (μs)	11.25	11.25	11.25
Bandwidth (Mhz)	19	19	19
Chirp Rate (Mhz/μs)	1.6	1.6	1.6
Peak Power (W)	6000	1000	1000
Ave. Power (W)	110	19	19
Antenna Size (inches)	63 x 18	55 x 6.5	72 x 36
Az. 3dB Beamwidth (deg)	8	2.5	19
El. 3dB Beamwidth (deg)	44	50	38
Nominal Gain (d3)	18.3	23.3	14.1
Nominal Altitude (ft)		15,000 to 40,000	
Nominal ground speed (kts)		500	
PRF/Polarization (Hz)		250 to 750	
(=1.36 or 0.68 x ground speed)			
Look Angle Range (deg)		30 to 70	
Caltone Frequency (MHz)		21.796875	
Caltone Input Level (dBm)		-70	
Receiver Gain (d3)		30 to 56	
Digital Sampling Rate (MHz)		45	
No. of Bits/Real Sample (no I and Q)			8
Tape Recorder Rate (Mbits/s)		80	
Tape Recorder Capacity (min/tape)		15	
Azimuth Presum Factor		PRF/8	
Azimuth Pixel Spacing (m)		.03 or 12.1	(1-look or 4-look)
Slant Range Pixel Spacing (m)		6.67	
Number of Looks		1 or 4	
Image Size (I-look Complex) (pixels)		4096 x 750	(Az x rg)
Data Modes		Dual or quad-pol one, two, or three frequencies	

2. Data collected:

As stated above, the JPL DC-8 flew data collection flights each day of the WASHITA '92 experiment except for the crew rest day of June 15, 1993. Table XVII-2 lists all of the start and stop latitude and longitude points for each flight line flown during WASHITA '92.

Table XVII-2. DC-8 SAR Flight line log giving direction and start/stop Latitude and Longitude.

Date	Flight line #	Start/Stop Latitude	Start/Stop Longitude
6/10	300-1	34 50.0/35 05.0	-97 53.7/-98 25.2
	300-2	34 59.3/35 14.1	-97 44.6/-98 16.2
	300-3	35 01.1/35 16.1	-97 42.6/-98 14.4
6/10	270-1	35 04.1/35 03.0	-98 07.5/-97 43.0
	90-1	34 57.4/34 57.4	-98 08.2/-97 39.5
	90-2	34 55.0/34 54.8	-98 12.7/-97 35.8
6/10	120-1	34 55.0/34 41.7	-98 24.3/-97 56.2
	120-2	35 00.1/34 44.6	-98 26.3/-97 54.6
	120-3	35 04.4/34 47.5	-98 25.3/-97 49.8
6/10	120-4	35 05.2/34 51.7	-98 17.6/-97 49.2
	180-1	35 21.9/34 48.3	-97 57.3/-97 56.9
6/11	120-1	34 57.1/34 42.1	-98 28.8/-97 57.1
	120-2	35 00.2/34 45.2	-98 26.4/-97 54.6
	120-3	35 03.7/34 48.3	-98 23.9/-97 51.4
6/11	300-1	34 50.4/35 05.4	-97 54.4/-98 25.9
	300-2	34 59.7/35 13.9	-97 47.8/-98 15.3
	300-3	35 00.5/35 17.3	-97 41.4/-98 16.8
6/11	90-1	34 57.3/34 57.4	-98 03.2/-97 34.9
	90-2	34 54.8/34 54.8	-98 07.3/-97 34.6
	270-1	35 03.7/35 03.7	-97 37.4/-98 09.7
6/12	120-1	34 53.3/34 40.0	-98 25.9/-97 57.7
	120-2	34 58.5/34 41.7	-98 28.3/-97 52.9
	120-3	35 00.6/34 45.0	-98 23.7/-97 51.0
6/12	300-1	34 50.5/35 03.7	-97 54.3/-98 22.4
	300-2	34 57.8/35 14.4	-97 41.6/-98 16.8
	300-3	35 01.3/35 16.3	-97 43.7/-98 15.4
6/12	120-4	35 02.7/34 47.6	-98 20.0/-97 48.4
	120-5	35 06.4/34 51.3	-98 20.1/-97 48.4
	300-4	34 56.8/35 11.9	-97 47.0/-98 18.8
6/12	180-1	35 13.8/34 56.9	-97 57.2/-97 57.3
	270-1	34 57.4/35 03.7	-97 47.0/-98 03.3

Table XVII-2. (Cont.) DC-8 SAR Flight line log giving direction and start/stop Latitude and Longitude.

Date	Flight line #	Start/Stop Latitude	Start/Stop Longitude
	90-1	34 57.4/34 57.4	-98 03.3/-97 47.0
	90-2	34 54.8/34 54.8	-98 04.1/-97 39.6
6/13	180-1	35 14.6/34 54.6	-97 57.3/-97 57.4
	90-1	34 57.4/34 57.4	-98 02.2/-97 46.0
	90-2	34 54.8/34 54.8	-98 05.8/-97 41.6
	270-1	35 03.7/35 03.7	-97 38.2/-97 58.8
6/13	120-4	35 02.2/34 48.9	-98 19.8/-97 51.8
	120-5	35 06.2/34 51.1	-98 20.0/-97 48.1
	300-4	34 55.7/35 11.9	-97 43.6/-98 18.8
6/13	120-1	34 53.6/34 38.7	-98 26.1/-97 54.6
	120-2	34 57.2/34 42.1	-98 25.5/-97 53.7
	120-3	35 00.4/34 45.5	-98 24.4/-97 52.9
6/14	300-1	34 50.3/35 05.3	-97 54.2/-98 25.9
	300-2	34 59.4/35 14.4	-97 45.1/-98 16.8
	300-3	35 00.8/35 15.9	-97 42.3/-98 14.1
6/14	120-1	34 53.4/34 40.1	-98 25.9/-97 57.8
	120-2	34 58.5/34 41.7	-98 28.0/-97 52.7
	120-3	35 00.2/34 45.2	-98 23.4/-97 51.9
6/14	180-1	35 14.5/34 54.6	-97 57.1/-97 57.2
	90-1	34 57.5/34 57.5	-98 04.5/-97 40.2
	90-2	34 55.0/34 54.9	-98 03.7/-97 43.3
	270-1	35 03.6/35 03.6	-97 44.1/-98 00.2
6/14	300-4	34 56.6/35 11.7	-97 46.8/-98 18.6
	120-4	35 02.4/34 47.4	-98 19.9/-97 48.4
	120-5	35 06.3/34 51.2	-98 19.7/-97 47.9
6/16	120-1	34 53.4/34 40.1	-98 26.0/-97 57.8
	120-2	34 58.6/34 41.7	-98 28.0/-97 52.9
	120-3	35 00.0/34 45.0	-98 23.4/-97 51.7
6/16	300-3	35 01.3/35 16.2	-97 43.0/-98 14.5
	120-4	35 02.4/34 49.0	-98 19.9/-97 51.8
	120-5	35 05.8/34 50.8	-98 18.8/-97 47.2
6/16	90-1	34 57.5/34 57.4	-98 06.8/-97 37.3
	90-2	34 54.8/34 54.9	-98 06.4/-97 33.7
	270-1	35 03.5/35 03.7	-97 35.4/-98 11.9
6/17	120-1	34 53.4/34 40.1	-98 25.8/-97 57.6
	120-2	35 01.8/34 43.1	-98 34.4/-97 55.8
	120-3	34 58.8/34 45.0	-98 20.7/-97 51.7
6/17	120-4	?	?
	120-5	?	?
	300-3	?	?

Table XVII-2. (Cont.) DC-8 SAR Flight line log giving direction and start/stop Latitude and Longitude.

Date	Flight line #	Start/Stop Latitude	Start/Stop Longitude
6/17	90-1	34 57.5/34 57.5	-98 02.8/-97 34.1
	90-2	34 54.8/34 54.9	-98 07.6/-97 35.2
	270-1	35 03.6/35 03.6	-97 36.4/-98 09.4
6/18	120-4	35 02.3/34 49.0	-98 19.8/-97 51.7
	120-5	35 07.4/34 50.8	-98 22.2/-97 47.1
	300-3	35 01.4/35 16.4	-97 43.4/-98 15.2
6/18	90-1	34 57.5/34 57.5	-98 05.5/-97 37.0
	90-2	34 54.9/34 54.9	-98 08.3/-97 35.7
	270-1	35 03.7/35 03.6	-97 37.7/-98 06.1
6/18	120-1	34 52.9/34 39.6	-98 24.8/-97 56.7
	120-2	34 58.7/34 41.8	-98 28.3/-97 53.1
	120-3	35 00.5/34 44.9	-98 23.9/-97 51.4

### 3. Data processing

A quick look L-band HH image is produced during the flight and this medium is used for cursory evaluation of the flight as well as for selecting what parts of the flight lines and target areas are to be processed. The data are processed at the JPL SAR processing facility. SAR processing is an expensive and time consuming procedure; consequently, we have not simply requested that all the data be processed. Our initial processing order consisted of a sample of wet, medium and dry days and a selection of synoptic processing for the wall-to-wall coverage and some frame processing for the detailed study areas. Table XVII-2 lists the processing requested as of February 93. Additional processing will be requested after some analysis has been completed or there are special requests from other investigators.

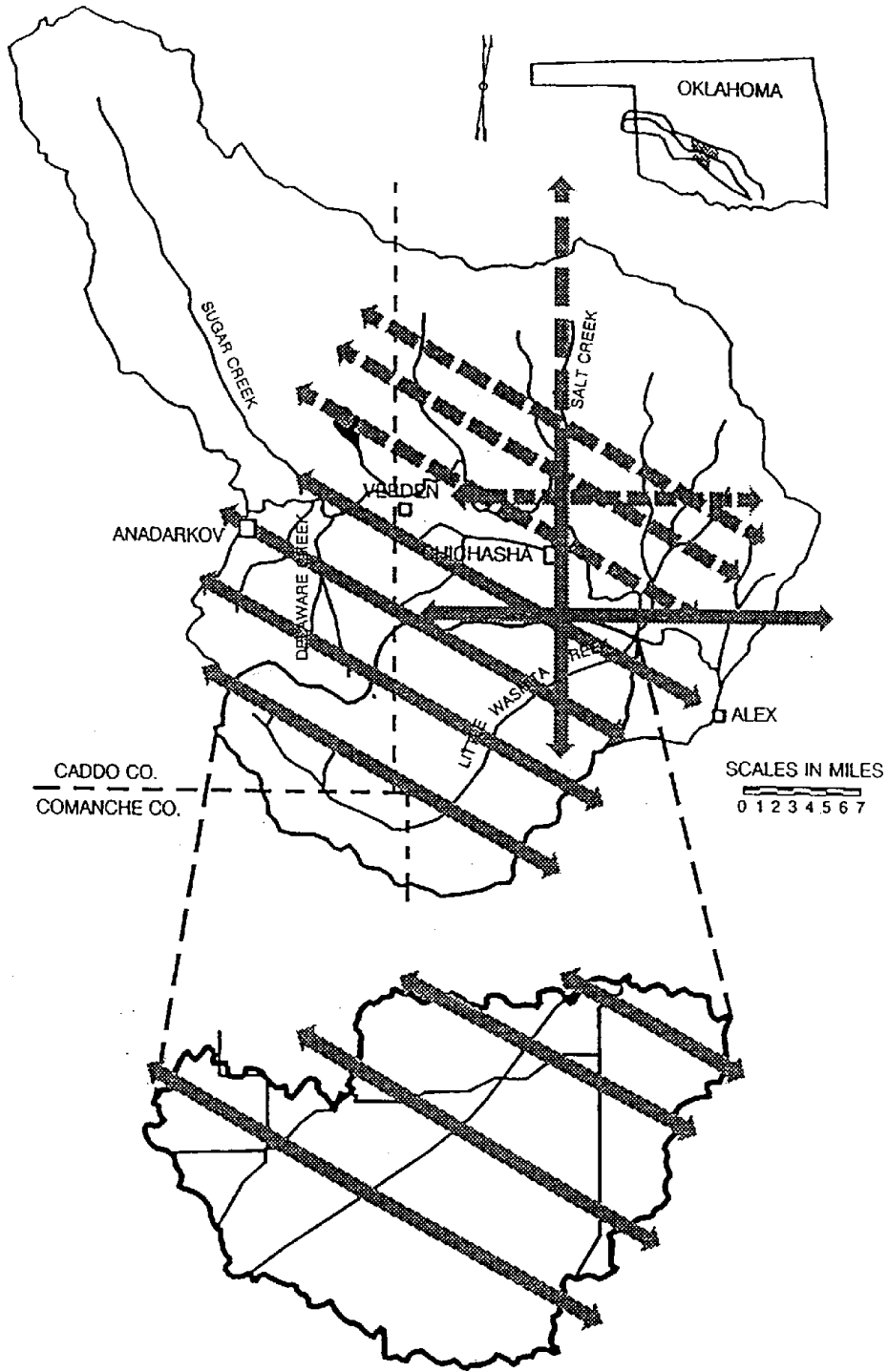
### 4. Data form and calibration

The standard AIRSAR frame product consists of a sixteen-look (20 MHz) or eight-look (40 MHz) "polarization compressed" digital file for each frequency on a 2 Gbyte 8 mm tape cartridge. These data are then used as input to polarization synthesis software to create an image. There is also a synoptic product which consists of a floating point digital image file for each frequency. The synoptic image is good for large areas (i.e., the wall-to-wall coverage for WASHITA-92) but is limited to single frequency and polarizations with a degraded spatial resolution of about 120m. In addition to the standard frame processing, we have requested the scattering matrix for

each scene identified (not, however, the synoptic scenes). The standard frame processing provides an image of about 12 km in azimuth and 8 km in range with a spatial resolution of about 6 by 12 m. Since 1990, JPL is providing calibrated images for the standard products.

### C. REFERENCES

Freeman, A., Y. Shen, J. van Zyl and J.D. Klein, 1991, Calibration of NASA/JPL, DC-8 SAR data. Proc. IEEE, IGARSS 91 Symposium. Helsinki, Finland. pp. 1377-1380.



A765.001

Figure XVII-1. SAR flightlines.