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SOYBEAN CANOPY REFLECTANCE MODELING DATA SETS

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ABSTRACT

Numerous mathematical models of the interaction of radiation with vegetation canopies have been developed over the last two decades. However, data with which to exercise and validate these models have been scarce. During three days in the summer of 1980, experiments were conducted with the objective of gaining insight about the effects of solar illumination and view angles on soybean canopy reflectance. In concert with these experiments, extensive measurements of the soybean canopies were obtained.

This document is a compilation of the bidirectional reflectance factors; agronomic characteristics; canopy geometry; and leaf, stem, and pod optical properties of the soybean canopies. These data sets should be suitable for use with most vegetation canopy reflectance models.

SOYBEAN CANOPY REFLECTANCE MODELING DATA SETS

INTRODUCTION

This document is a compilation of data sets of bidirectional reflectance factors, agronomic characteristics, canopy geometry, and canopy optical parameters of soybeans acquired during the summer of 1980. The data collection techniques and preliminary results first appeared in Ranson et al. (1981) and were further developed by Ranson et al. (1985). In the meantime, portions of these data were distributed to the scientific community and numerous reviewed articles have appeared in the literature as a result (e.g., Kimes and Kirchner, 1982; Cooper et al., 1982; Goel and Strebel, 1983; Goel and Strebel, 1984; Goel and Thompson, 1984a; Goel and Thompson, 1984b; Chance and LeMaster, 1985; Strebel, Goel, and Ranson, 1985). The purpose of this technical report is to provide investigators with a detailed summary of data suitable for bidirectional reflectance and canopy reflectance modeling studies.

AGRONOMIC MEASUREMENTS

A commercial soybean field located approximately 13 km north-west of West Lafayette, Indiana was used for this study. The field was selected on the basis of uniformity in terms of slope (< 2%), soil type, drainage and planting pattern. The field was planted to soybeans (Glycine max, (L.) Merr. "Calahan 9250") at a seeding rate of 62 kg/ha in north-south oriented rows. The row spacing was 76 cm with a mean population density of 28 plants/m^2.

Agronomic data were acquired on three dates following spectral measurements during the summer of 1980. On the first two dates (July 18 and July 25) the soybean canopies were incomplete with well defined

rows. By the third date (August 28) the canopy was completely closed and exhibited minimal row structure (Figure 1).

Agronomic measurements describing the canopies were acquired within one day of the spectral measurements. These data included leaf area index (LAI), total fresh and dry phytomass, stage of development, percent canopy cover, canopy height, canopy width, leaf angle distribution and leaf spectral reflectance and transmittance.

Soybean phytomass and leaf area index were estimated from random samples of one meter lengths of row. The leaf area of a subsample of green leaves from each sample was obtained with an optical planimeter (LICOR Model LI-3000) and dry weights were obtained. LAI was estimated from a subsample of leaves and was based on the leaf area to weight ratio and the ground area of the sample. Stage of development was determined from ten plants using the Fehr and Caviness (1977) scale. Percent canopy cover was estimated by projecting a 35 mm color slide acquired from nadir onto a dot grid and calculating the percentage of dots hitting vegetation. Canopy cover represents the vertically projected foliage area. Canopy height and width were measured to the top leaf and the width across the row at the mid-height of the canopy, respectively. Table 1 summarizes the agronomic measurements for the three dates.

Soybean leaf angle measurements were made using a modification of the protractor method described by Nichiporovich (1961) and Kyle and Davies (1974). in addition to leaf inclination and azimuth angles, the three-dimensional locations (X,Y,Z) and leaf area were measured for each leaf sampled (except for the August 28 date when only leaf heights (Z) and leaf areas were obtained). A detailed description of the foliage geometry measurement procedure can be found in the next section.

CANOPY GEOMETRY MEASUREMENTS

Three-dimensional characterization of the soybean canopy was accomplished by measuring leaflet orientation (inclination and azimuth angles), as well as leaflet heights, distances from mid-row and distances along row as referenced to a 1.0 m x 1.3 m board with a grid of meter sticks attached to it. The location of the sample was random and the measurement board was placed at this location in the furrow halfway between adjacent rows. A windbreak was constructed to protect the sample from wind. The board was leveled and positioned vertically. The distance between the bottom of the board and the base of the plants was measured to correctly determine the leaflet heights. All leaflets within a 25 cm length of row were sampled starting with the uppermost leaf and progressing downward. Leaflet inclination angles were determined with an inclinometer similar to those described by Nichiporovich (1961) and Kyle and Davies (1974). Azimuths were measured with a simple apparatus consisting of a small plate equipped with a circular bubble

level and a dowel attached perpendicular to the face of the plate. A reference mark on the bubble level plate was oriented towards true north and the plate held parallel to the upper leaflet surface. The bubble level was graduated into 45^{o} segments with the position of the bubble 0 indicating the azimuth + 180^{o}. With the azimuth device still in place, the inclinometer was held parallel to the perpendicular dowel on the plate, thus indicating the angle from vertical to the leaf normal. The recorded angle was later converted to inclination. After the angle measurements were made, a meter stick was placed above the leaf and the distance from the center of the leaflet to the measurement board was recorded. With the meter stick perpendicular with the measurement board, the distance from a reference point on the board to the center of the leaflet and the height of the leaflet was recorded. The leaflet was then removed from the plant, numbered with a felt marking pen, and placed in an ice chest for leaf area measurement. Individual leaf areas were determined with an optical leaf area meter later the same day in the laboratory.

The geometry estimation procedure was performed simultaneously by two teams at different locations in the field. The measurements required about 2 hours to complete. All destructive sampling was conducted outside the total field of view perimeter for the reflectance measurements.

The canopies were stratified into 10 cm horizontal layers. The fractional LAI (FLAI) within each layer was calculated as the accumulated leaf area in a layer divided by the total leaf area. The fractional leaf area was then multiplied by the average LAI for a canopy as given in Table 1 to obtain the LAI in a given layer (XLAI) (Table 2).

The canopy was further stratified into leaf inclination angle bins of 10^{o}. The fractional leaf area for a given inclination angle bin and canopy layer was calculated as above. Tables 3-5 present the FLAI and number of leaves sampled for each leaf inclination angle bin and layer for the three canopies. Finally, the combined leaf angle probability densities and cumulative leaf angle frequency distributions for each canopy are presented in Table 6.

SOYBEAN CANOPY OPTICAL PROPERTIES

Plant canopy part (leaves, stems and pods) reflectance and transmittance data were obtained in the laboratory with a Beckman DK-2 spectrophotometer on 29 August 1980. To maintain the plant in good condition the plants were removed from the field with a substantial root ball in well watered containers and transported to the laboratory in an enclosed vehicle. Table 7 presents the average directional-hemispherical reflectance and transmittance of five random samples for soybean leaves from 450 to 1125 nm. Average directional-hemispherical reflectance for five samples of pods and mats of stems are also presented. Standard

deviations of the measurements are also given in Table 7. Table 8 lists the results for individual Exotech Model 100 wavelength band based on the DK-2 measurements (Table 7); Exotech responsivity (Figure 2); spectral irradiance of sunlight (Figure 3); and reflectance of a barium sulfate panel measured in the laboratory (Tables 9 and 10).

SOYBEAN FIELD REFLECTANCE FACTOR MEASUREMENTS

Spectral radiometric data for the soybean sun-view angle experiment were acquired with an Exotech Model 100 radiometer. The instrument has four spectral bands, 500-600nm, 600-700nm, 700-800nm, and 800-1100nm, corresponding to the bands on the Landsat MSS. Field stops were used to restrict the half power angular field of view (FOV) to 10^{o}. The instrument was attached to a mount capable of movement in the horizontal (azimuth) and vertical (zenith) planes. A truck with an extendible boom provided an aerial platform for the instrument at a nominal altitude of 10 m above the soil surface. Measurement hemispheres of radiometric data were acquired through all combinations of nominal view zenith angles (θ_V) of 0, 7, 22, 30, 45, and 60^{o} and view azimuth angles (φ_V) of 0, 45, 90, 135, 180, 225, 270, and 315^{o} as described by Ranson et al. (1981). The instrument was also positioned over a plot cleared of vegetation where bare soil reflectance was measured (Table 12).

These data were acquired at hourly intervals through the day under a variety of solar zenith (θ_S) and solar azimuth (φ_S) angles as long as sky conditions permitted (i.e. no clouds). Prior to and after each hemisphere of measurements, calibration measurements were acquired from a painted barium sulfate panel illuminated under the same conditions as the canopy to provide for calculation of reflectance factors (RF) (Robinson and Biehl, 1979). Calibration data were corrected to account for non-Lambertian reflectance properties of the panel at larger solar zenith angles. Shaded panel measurements were also made to estimate the percent skylight in the visible (500-600nm, 600-700nm) bands (Table 13). Color photographs (35 mm) were taken at each canopy and soil view position to document the field of view. A summary of the data sets collected is provided below in Table 11. A diagram of the coordinate system used is presented in Figure 4.

The soybean canopy reflectance factor data are listed in the Appendix as a set of matrices with the columns of view zenith angles and rows of view azimuth angles. Because of a non-level instrument platform the nominal view zenith angles were as shown in Table 14 for the 17 July data and Table 15 for the 24 July data. The equipment was modified to level the instrument platform, so no adjustments are required for the 27 August data.

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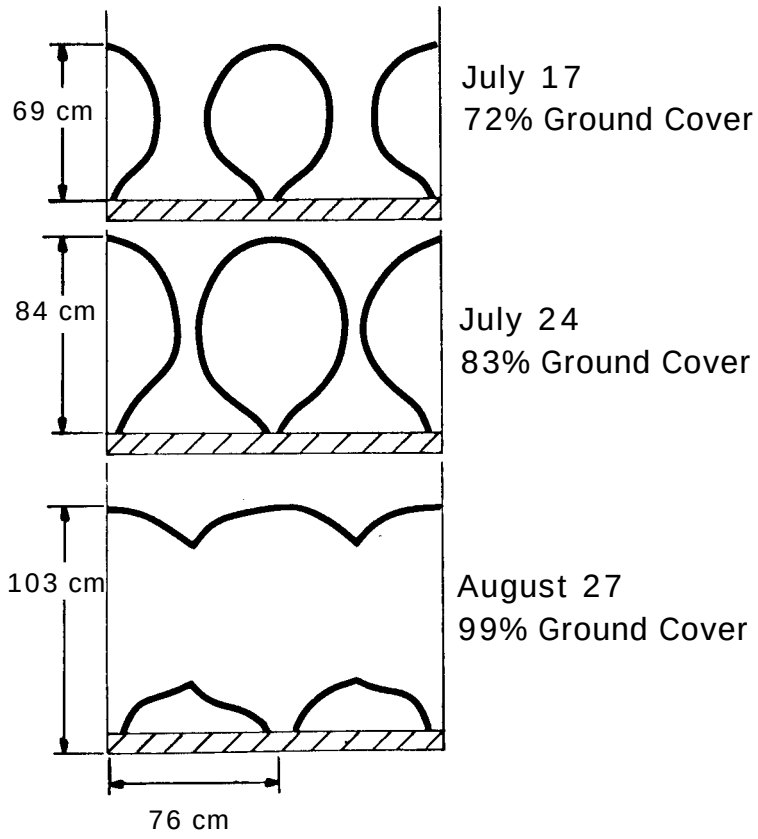

Figure 1. Idealized canopy profiles on the three measurement dates.

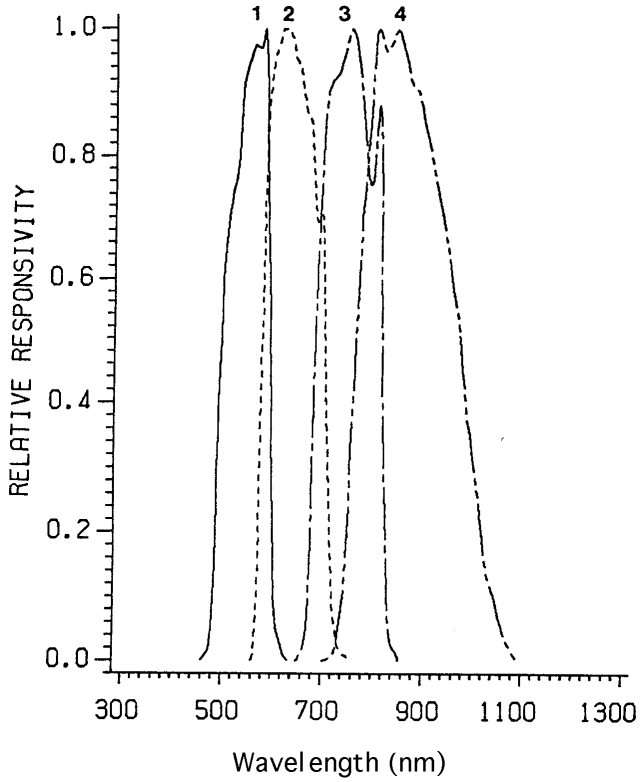

Figure 2. Relative responsivity of Exotech Model 100 wavelength bands.

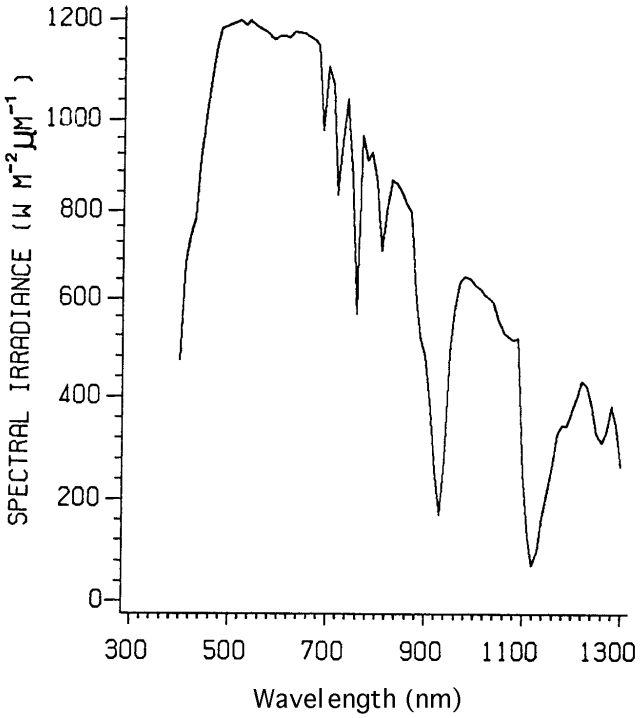

Figure 3. Solar spectral irradiance used in calculation of soybean plant part optical properties. Values derived from Suits, 1978, for two atmospheric air masses.

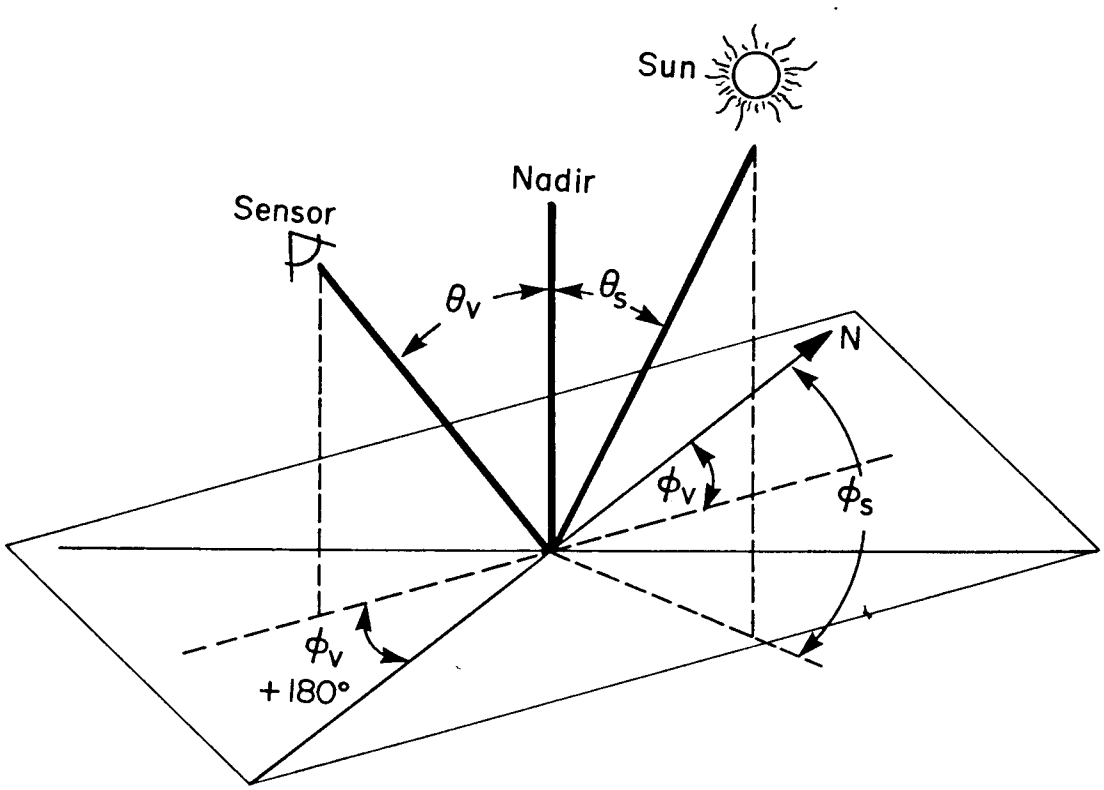

Figure 4. Diagram of coordinate system used for bidirectional reflectance factor measurements.

Table 1. Summary of Agronomic Measurements.
Standard deviations are noted in parentheses.

Date	Height	Width	Canopy Cover	Leaf Area Index	Total Fresh Phytomass	Total Dry Phytomass	Stage of Development
	---- cm ---		%		----- g/m^2 ----		
July 18	69 (4)	55 (5)	72 (4)	3.0 (0.5)	1145 (226)	230 (40)	V13R3
July 25	84 (3)	69 (4)	83 (3)	3.9 (0.6)	1540 (199)	320 (51)	vl4R3
August 28	102 (4)	104 (11)	99 (1)	2.9 (0.4)	2535 (476)	644 (95)	V2OR6

Table 2. Leaf area index by layer.

	Date					
	18 July		25 July		28 August	
HT	Num	XLAT	Num	XLAI	Num	XLAI
5	21	0.062	12	0.036	0	0.000
15	63	0.245	38	0.106	10	0.072
25	79	0.391	81	0.372	19	0.080
35	94	0.620	106	0.672	16	0.102
45	91	0.562	147	0.882	24	0.221
55	126	0.823	89	0.654	39	0.403
65	31	0.297	94	0.729	59	0.582
75	0	0.000	57	0.414	61	0.599
85	0	0.000	8	0.034	67	0.541
95	0	0.000	0	0.000	34	0.194
105	0	0.000	0	0.000	19	0.105
Total	505	3.000	632	3.900	348	2.900

HT = Layer midpoint height (cm)
Num = Number of leaves sampled per layer
XLAI = Layer leaf area index (one-sided leaf area/ground area)

Table 3. Number of leaves and fraction of leaf area index within a 10 cm layer and 10^{o} leaf inclination angle bin for 18 July soybean canopy.

HT	INCL	NUM	FLAI	HT	INCL	NUM	FLAI	HT	INCL	NUM	FLAI
5	5	2	0.006	25	35	22	0.121	45	65	3	0.015
5	15	3	0.006	25	45	13	0.068	45	75	4	0.012
5	25	7	0.020	25	55	6	0.031	45	85	1	0.008
5	35	5	0.016	25	65	4	0.015	55	5	10	0.039
5	45	2	0.008	25	75	1	0.002	55	15	11	0.079
5	55	1	0.003	25	85	0	0.000	55	25	27	0.157
5	65	1	0.003	35	5	4	0.030	55	35	32	0.247
5	75	0	0.000	35	15	16	0.108	55	45	21	0.153
5	85	0	0.000	35	25	14	0.089	55	55	13	0.100
15	5	8	0.027	35	35	13	0.087	55	65	3	0.024
15	15	13	0.050	35	45	19	0.128	55	75	8	0.024
15	25	14	0.064	35	55	12	0.077	55	85	1	0.001
15	35	12	0.045	35	65	9	0.064	65	5	0	0.000
15	45	6	0.023	35	75	2	0.008	65	15	6	0.055
15	55	6	0.021	35	85	5	0.029	65	25	8	0.073
15	65	3	0.009	45	5	4	0.017	65	35	9	0.086
15	75	1	0.005	45	15	19	0.114	65	45	2	0.021
15	85	0	0.000	45	25	10	0.075	65	55	4	0.041
25	5	6	0.033	45	35	17	0.111	65	65	1	0.010
25	15	14	0.067	45	45	21	0.122	65	75	1	0.010
25	25	13	0.055	45	55	12	0.086	65	85	0	0.000

HT = Layer midpoint height (cm)
INCL = Leaf inclination midpoint angle (degrees)
NUM = Number of leaves with given angle in given layer
FLAI = Fraction of leaf area index at given angle and layer

Table 4. Number of leaves and fraction of leaf area index within a 10 cm layer and 10^{o} leaf inclination angle bin for 25 July soybean canopy.

HT	INCL	NUM	FLAI	HT	INCL	NUM	FLAI	HT	INCL	NUM	FLAI
5	5	2	0.007	35	15	2	0.018	65	25	9	0.075
5	15	2	0.007	35	25	10	0.070	65	35	16	0.136
5	25	2	0.002	35	35	14	0.088	65	45	16	0.153
5	35	2	0.003	35	45	21	0.143	65	55	12	0.091
5	45	1	0.006	35	55	14	0.089	65	65	14	0.091
5	55	2	0.007	35	65	20	0.117	65	75	8	0.058
5	65	3	0.012	35	75	18	0.114	65	85	7	0.033
5	75	0	0.000	35	85	4	0.016	75	5	0	0.000
5	85	0	0.000	45	5	1	0.003	75	15	8	0.048
15	5	1	0.003	45	15	6	0.023	75	25	9	0.078
15	15	6	0.015	45	25	7	0.034	75	35	12	0.091
15	25	7	0.019	45	35	14	0.086	75	45	10	0.076
15	35	6	0.020	45	45	25	0.171	75	55	3	0.026
15	45	7	0.023	45	55	34	0.201	75	65	6	0.039
15	55	7	0.020	45	65	26	0.179	75	75	6	0.034
15	65	2	0.003	45	75	22	0.120	75	85	3	0.023
15	75	2	0.003	45	85	12	0.065	85	5	0	0.000
15	85	0	0.000	55	5	1	0.007	85	15	0	0.000
25	5	0	0.000	55	15	3	0.025	85	25	2	0.001
25	15	5	0.036	55	25	13	0.094	85	35	4	0.019
25	25	8	0.035	55	35	12	0.085	85	45	0	0.000
25	35	17	0.075	55	45	14	0.093	85	55	1	0.003
25	45	18	0.090	55	55	12	0.077	85	65	0	0.000
25	55	15	0.075	55	65	18	0.152	85	75	1	0.010
25	65	10	0.037	55	75	12	0.098	85	85	0	0.000
25	75	4	0.011	55	85	4	0.024				
25	85	4	0.013	65	5	4	0.016				
35	5	3	0.018	65	15	8	0.076				

HT = Layer midpoint height (cm)
INC = Leaf inclination midpoint angle (degrees)
NUM = Number of leaves with given angle in given layer
FLAI = Fraction of leaf area index at given angle and layer

Table 5. Number of leaves and fraction of leaf area index within a 10 cm layer and 10° leaf inclination angle bin for 28 August soybean canopy.

HT	INCL	NUM	FLAI	HT	INCL	NUM	FLAI	HT	INCL	NUM	FLAI
5	0	0	0.000	45	5	1	0.012	75	65	6	0.058
5	15	0	0.000	45	25	2	0.013	75	75	4	0.031
5	25	0	0.000	45	35	5	0.050	75	85	8	0.062
5	35	0	0.000	45	45	5	0.049	85	5	2	0.008
5	45	0	0.000	45	55	3	0.024	85	15	3	0.023
5	55	0	0.000	45	65	4	0.038	85	25	2	0.019
5	65	0	0.000	45	75	2	0.021	85	35	7	0.047
5	75	0	0.000	45	85	2	0.014	85	45	11	0.098
5	85	0	0.000	55	5	5	0.055	85	55	11	0.101
15	5	0	0.010	55	15	1	0.013	85	65	16	0.133
15	15	1	0.013	55	25	4	0.036	85	75	10	0.085
15	35	2	0.008	55	35	7	0.083	85	85	5	0.028
15	55	2	0.014	55	45	4	0.043	95	5	0	0.000
15	65	3	0.020	55	55	3	0.037	95	15	0	0.000
15	75	1	0.010	55	65	5	0.043	95	25	0	0.000
15	85	1	0.007	55	75	6	0.054	95	35	0	0.000
25	5	0	0.000	55	85	4	0.039	95	45	7	0.035
25	15	1	0.006	65	5	2	0.026	95	55	7	0.042
25	25	3	0.014	65	15	2	0.015	95	65	10	0.066
25	35	5	0.023	65	25	5	0.052	95	75	7	0.043
25	45	6	0.023	65	35	8	0.086	95	85	3	0.008
25	55	1	0.003	65	45	9	0.092	105	5	0	0.000
25	75	1	0.005	65	55	15	0.136	105	15	0	0.000
25	85	2	0.007	65	65	5	0.042	105	25	1	0.008
35	5	0	0.000	65	75	7	0.082	105	35	1	0.003
35	15	0	0.000	65	85	6	0.051	105	45	4	0.026
35	25	4	0.024	75	5	0	0.000	105	55	5	0.028
35	35	3	0.027	75	15	3	0.034	105	65	1	0.002
35	45	1	0.004	75	25	5	0.052	105	75	1	0.007
35	55	3	0.021	75	35	4	0.048	105	85	6	0.031
35	75	2	0.011	75	45	11	0.116				
35	85	3	0.015	75	55	20	0.199				

HT = Layer midpoint height (cm)
INCL = Leaf inclination midpoint angle (degrees)
NUM = Number of leaves with given angle in given layer
FLAI = Fraction of leaf area index at given angle and layer

Table 6. Percent occurrence of each leaf inclination angle bin (f'(θ)) and cumulative percent occurrence (F(θ)) for three soybean canopies.

	JULY 18		JULY 25		AUGUST 28	
ANGLE	f'(θ)	F(θ)	f'(θ)	F(θ)	f'(θ)	F(θ)
5	5.1	5.1	1.2	1.2	3.5	3.5
15	15.9	21.0	6.4	7.6	3.6	7.1
25	17.8	38.8	10.5	18.1	7.5	14.6
35	23.8	62.6	15.5	33.6	12.9	27.5
45	17.5	80.1	19.3	52.9	16.8	44.3
55	12.0	92.1	15.1	67.0	20.9	65.2
65	4.7	96.7	16.1	83.1	13.9	79.1
75	2.0	98.7	11.5	94.6	12.0	91.1
85	1.3	100.0	4.4	100.0	8.9	100.0

Table 7. Average directional-hemispherical reflectance (R) and transmittance (T) and standard deviations (SD) of soybean canopy parts. Reported values are based on 5 observations per sample.

		Leaves				Stem Mat		Pods	
Wave-length	Reso-lution	R	SD	T	SD	R	SD	R	SD
- - - - nm - - - -		- % -							
450	4	5.5	0.7	0.6	0.2	6.0	0.3	7.3	1.3
475	4	5.5	0.6	0.7	0.2	6.1	0.4	8.1	1.4
500	4	5.6	0.7	1.9	0.7	7.7	0.4	11.0	2.0
525	5	9.5	1.1	9.9	4.2	16.7	1.1	22.9	4.2
550	6	11.5	1.3	13.6	4.4	19.8	1.3	26.7	4.4
575	7	8.2	1.1	9.9	3.3	16.5	1.3	24.2	3.9
600	9	6.7	0.5	6.4	2.5	13.4	1.1	20.8	3.6
625	15	5.8	0.6	5.1	1.7	11.5	0.9	18.4	3.1
650	24	5.5	0.8	3.7	1.1	9.5	0.8	15.6	2.5
675	40	5.6	0.7	3.5	1.0	9.2	0.7	14.6	2.1
* 700	64-77	14.1	0.6	12.8	1.0	21.7	3.6	26.6	4.4
725	77	29.4	0.4	33.7	0.7	43.4	7.2	49.0	8.5
750	78	38.3	1.1	43.3	0.9	52.0	7.4	57.9	8.9
775	81	43.1	1.2	48.4	0.9	57.6	7.1	63.0	9.5
800	83	45.6	1.4	50.9	1.4	60.4	6.7	65.2	9.8
825	86	46.4	1.1	52.3	1.5	61.6	6.7	66.0	9.9
850	86	46.5	1.0	52.7	1.7	62.0	6.4	65.7	9.7
875	83	46.2	1.0	52.8	1.7	61.6	6.3	64.8	9.5
900	81	45.9	1.0	53.0	1.7	60.9	6.0	63.1	8.7
925	80	45.9	1.1	53.2	1.9	60.2	5.9	61.3	8.0
950	78	45.9	1.1	53.5	1.8	58.7	5.6	58.7	7.2
975	76	45.8	1.0	53.6	1.8	57.6	5.5	56.6	6.5
1000	72	45.7	0.8	53.9	1.9	57.6	5.6	56.1	6.2
1025	70	45.9	1.1	54.1	2.0	58.3	5.5	57.1	6.4
1050	70	45.8	1.1	54.4	2.1	59.4	5.6	58.9	7.0
1075	70	45.6	1.1	54.7	2.1	59.9	5.5	59.8	7.3
1100	70	45.3	1.0	54.6	2.1	58.9	5.5	58.4	7.2
1125	70	44.8	0.9	54.4	2.0	56.8	5.3	55.0	6.3

* Average response of photomultiplier tube and lead sulfide detectors.

Table 8. Reflectance and transmittance measurements of plant canopy parts in Exotech 100 bands. These are computed values based on DK-2 measurements, responsivity of Exotech 100 bands, spectral irradiance, and spectral reflectance of a barium sulfate panel.

Canopy Part Measurement	EXOTECH 100 Band (nm)			
	500-600	600-700	700-800	800-1100
	- - - - - - - - - - - - - - % - - - - - - - - - - - - - -			
Leaf Reflectance	8.78	7.31	32.9	45.4
Leaf Transmittance	9.32	6.39	36.4	51.8
Stem Reflectance	15.77	12.99	45.4	59.8
Pod Reflectance	22.21	19.38	50.7	63.0

Table 9. Reflectance of barium sulfate panel used in the field as reference surface for canopy reflectance factor measurements. Reflectances shown are for illumination zenith angle of 10^{o}

Wavelength	Reflectance
nm	%
450	91.8
475	92.8
500	93.8
525	93.7
550	93.5
575	93.4
600	93.2
625	93.1
650	93.0
675	93.0
700	92.9
725	92.6
750	92.2
775	92.2
800	92.1
825	92.0
850	91.9
875	91.8
900	91.6
925	91.6
950	91.5
975	91.5
1000	91.5
1025	91.4
1050	91.3
1075	91.2
1100	91.1
1125	91.0
1150	90.9
1175	90.8
1200	90.6
1225	90.5
1250	90.3
1275	90.0
1300	89.7

Table 10. Reflectance of painted barium sulfate panel in Landsat bands as used to calibrate canopy reflectance factor data.

Band	Irradiance Zenith Angle (degrees)						
	10	20	30	40	50	55	65
	- % -
500-600	93.5	91.0	89.0	88.0	86.8	85.0	81.4
600-700	93.0	90.7	88.6	87.7	86.2	85.3	83.3
700-800	92.3	89.9	87.5	86.9	86.0	84.4	81.2
800-1100	91.6	89.3	86.9	86.6	85.7	84.0	80.6

Table 11. Summary of Sun-view Angle Data Sets.

Date	Start Time	End Time	Solar Angle Range		Number of Sets	Cloud Cover
			Zenith Max-Min-Max	Azimuth Min-Max		
	CUT(hours)		- - - - - - degrees - - - - - -			%
July 17	1759	2135	19-50	183-265	5	10-20
July 24	1514	1849	40-21-24	109-214	6	1-20
August 27	1555	2159	40-30-60	132-257	12	0

Table 12. Bare soil reflectance factors.

Date	SZ	SA	Rl	R2	R3	R4	CC
July 17	28	233	9.13	11.67	15.81	19.25	10
	34	245	8.79	11.15	15.32	18.48	20
	42	256	8.20	10.46	14.50	17.49	10
	50	265	7.45	9.75	13.66	16.50	10
July 24	37	113	8.18	10.36	14.40	17.52	1
	31	124	8.77	11.11	15.27	18.58	*20*
	25	142	9.30	11.81	16.15	19.61	10
	22	161	9.51	12.07	16.48	19.97	5
	21	188	9.70	12.28	16.69	20.16	5
	24	214	9.10	11.49	15.61	18.86	20
Aug 27	37	139	11.78	14.31	19.74	23.22	0
	34	148	11.87	14.58	20.00	23.69	0
	31	167	12.12	14.88	19.90	23.56	0
	30	178	12.31	15.08	20.48	24.26	0
	32	200	12.22	14.98	20.33	24.13	0
	33	209	12.17	14.90	20.29	24.10	0
	36	220	11.95	14.65	19.88	23.54	0
	39	227	11.86	14.61	19.84	23.55	0
	46	239	11.62	14.36	19.51	23.10	0
	49	245	11.07	13.64	18.92	22.46	0
	56	253	10.76	13.31	18.27	21.64	0
	63	260	10.29	12.99	17.44	21.03	0

SZ = Sun zenith angle
SA = Sun azimuth angle,
Rl - R4 = Reflectance factors in Exotech radiometer bands 1 through 4.
CC = Estimated cloud cover (%)

Table 13. Percent skylight estimates.

Date	SZ	SA	Rl	R2
July 17	51	265	11.15	7.73
July 24	41	108	9.60	6.70
	36	114	9.37	6.77
	29	129	9.62	7.19
	24	144	9.04	6.67
	21	163	10.12	7.52
	22	198	12.10	9.66
August 27	37	140	22.91	18.56
	32	158	26.17	21.80
	31	169	23.20	19.10
	30	179	22.76	18.67
	32	196	21.82	17.93
	34	210	21.89	18.03
	36	217	23.51	19.22
	40	228	23.43	19.22
	45	238	26.28	21.34
	50	245	27.02	21.69
	55	252	31.38	25.03
	61	258	36.26	29.56

SZ = Solar zenith angle (degrees)
SA = Solar azimuth angle (degrees)
Rl-R2 = Skylight in bands 1 and 2, respectively

Table 14. Actual View Zenith Angles Used for 17 July.

View Azimuth Angle (degrees)	View Zenith Angle, degrees						
	0	7	15	22	30	45	60
0	0	7	15	22	30	45	60
45	4	11	19	26	34	49	64
90	3	10	18	25	33	48	63
135	2	9	17	24	32	47	62
180	0	7	15	22	30	45	60
225	-1	6	14	21	29	44	59
270	-2	5	13	20	28	43	58
315	-1	6	14	21	29	44	59

Table 15. Actual View Zenith Angles Used for 24 July.

View Azimuth Angle (degrees)	View Zenith Angle, degrees						
	0	7	15	22	30	45	60
0	0	7	15	*22*	30	45	60
45	4	11	19	26	34	49	64
90	1	8	16	23	31	46	61
135	0	7	15	22	30	45	60
180	0	7	15	22	30	45	60
225	-2	5	13	*20*	28	43	58
270	-2	5	13	20	28	43	58
315	-1	6	14	21	29	44	59

APPENDIX

SOYBEAN FIELD REFLECTANCE FACTOR DATA SETS

EXOTECH BANDS:
1 = 500-600 nm,
2 = 600-700 nm
3 = 700-800 nm,
4 = 800-1100 nm.

17 July	Tables A.1 - A.5
24 July	Tables B.1 - B.6
27 August	Tables C.1 - C.12

Table A.l. Soybean canopy reflectance factors for 17 July, 1980. Sun Zenith Angle = 20 degrees, Sun azimuth angle 195 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		---------- % ----------						
1	0	5.59*	5.88	6.21	6.30	5.76	4.86	4.42
	45	5.59	6.52	-	5.61	4.69	3.92	3.86
	90	5.59	5.60	4.94	4.17	3.83	3.74	3.71
	135	5.59	5.71	4.73	4.29	3.94	3.62	3.77
	180	5.59	5.22	4.72	4.53	4.47	4.57	4.27
	225	5.59	5.03	4.46	4.10	3.11	2.77	3.02
	270	5.59	4.90	4.05	3.29	2.96	2.82	2.89
	315	5.59	5.36	4.93	4.15	3.39	2.98	2.94
2	0	5.58	5.80	6.16	6.01	5.52	4.71	4.22
	45	5.58	6.59	-	5.33	4.12	3.36	3.13
	90	5.58	5.60	4.72	3.60	3.36	3.12	3.00
	135	5.58	5.74	4.67	4.19	3.54	3.08	3.08
	180	5.58	5.33	4.89	4.58	4.44	4.49	3.89
	225	5.58	5.04	4.28	4.00	2.86	2.25	2.47
	270	5.58	4.90	3.91	2.86	2.39	2.28	2.34
	315	5.58	5.26	4.81	3.88	2.98	2.42	2.34
3	0	26.94	29.04	29.99	31.58	30.84	27.86	26.89
	45	26.94	30.14	-	29.33	26.73	28.65	30.60
	90	26.94	27.44	27.43	26.95	26.63	28.53	28.41
	135	26.94	26.28	25.32	24.73	24.95	23.70	25.53
	180	26.94	25.50	24.45	24.08	23.93	22.89	24.50
	225	26.94	25.52	24.46	22.52	20.53	22.00	24.71
	270	26.94	25.34	23.66	23.01	22.51	24.18	25.85
	315	26.94	27.17	25.91	24.40	23.07	24.77	26.51
4	0	38.69	41.62	42.87	45.12	44.35	40.46	39.36
	45	38.69	42.95	-	42.22	42.47	42.38	45.48
	90	38.69	39.40	39.88	39.55	39.27	42.49	42.36
	135	38.69	37.71	36.61	36.30	36.15	34.99	37.82
	180	38.69	36.88	35.63	35.03	34.90	33.27	35.91
	225	38.69	36.71	35.49	33.16	30.45	33.14	37.30
	270	38.69	36.76	34.54	34.19	33.74	36.43	39.15
	315	38.69	38.91	37.64	35.82	34.10	37.20	40.09

* Values for 0 degree view zenith angle are means of all nadir observations.

Table A.2. Soybean canopy reflectance factors for 17 July, 1980. Sun Zenith Angle = 26 degrees, Sun azimuth angle 228 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -						
1	0	.-*	4.21	4.02	3.92	3.83	3.41	3.41
	45	-	-	-	7.12	5.96	4.70	4.22
	go	4.11	5.51	5.87	5.73	5.21	4.66	4.04
	135	4.11	4.88	4.90	4.69	4.81	4.36	4.13
	180	4.11	3.99	3.84	3.69	4.01	3.94	4.03
	225	4.11	3.79	3.22	3.25	2.61	2.68	3.13
	270	4.11	3.67	2.93	2.67	2.97	2.58	2.78
	315	4.11	3.62	3.24	2.75	2.70	2.66	2.64
2	0	3.79	3.83	3.56	3.39	3.29	2.93	2.86
	45	3.79	-	-	7.07	5.44	3.91	3.36
	90	3.79	5.34	5.65	5.32	4.59	3.97	3.36
	135	3.79	4.73	4.77	4.49	4.48	3.87	3.37
	180	3.79	3.79	3.63	3.61	3.70	3.63	3.46
	225	3.79	3.52	2.78	2.89	2.21	2.17	2.54
	270	3.79	3.30	2.53	2.17	2.06	2.06	2.20
	315	3.79	3.20	2.84	2.28	2.27	2.15	2.10
3	0	22.66	24.21	24.35	25.39	25.94	24.15	24.66
	45	22.66	-	-	29.73	30.60	29.31	30.48
	90	22.66	24.53	26.99	28.24	27.81	30.11	28.45
	135	22.66	22.46	23.65	23.58	25.14	24.16	25.19
	180	22.66	20.71	20.28	19.44	20.91	20.82	22.37
	225	22.66	22.23	21.78	19.93	19.53	21.62	24.22
	270	22.66	22.18	21.00	21.44	21.14	22.97	25.20
	315	22.66	22.77	21.46	21.20	20.83	23.30	24.80
4	0	35.42	37.08	37.31	38.78	39.21	36.80	37.36
	45	35.42	-	-	45.32	47.95	46.50	48.57
	90	35.42	38.70	42.75	44.41	43.88	47.38	45.42
	135	35.42	35.95	37.87	37.99	39.96	38.19	40.03
	180	35.42	33.75	32.90	31.36	33.39	33.06	35.53
	225	35.42	34.13	33.21	30.50	30.32	33.50	37.34
	270	35.42	34.23	32.63	33.07	32.66	35.65	39.14
	315	35.42	34.61	33.16	32.91	32.27	36.01	38.57

* Values for 0 degree view zenith angle are means of all nadir observations.

Table A.3. Soybean canopy reflectance factors for 17 July, 1980. Sun Zenith Angle = 32 degrees, Sun azimuth angle 242 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -						
1	0	3.46*	3.55	-	3.86	3.81	3.h5	3.52
	45	3.46	3.74	-	5.26	5.58	5.06	4.89
	90	3.46	4.12	5.07	5.72	5.93	5.12	4.82
	135	3.46	3.95	4.27	4.52	4.66	4.63	4.44
	180	3.46	3.31	3.26	3.20	3.24	3.50	3.68
	225	3.46	3.24	3.09	2.91	2.90	2.88	3.19
	270	3.46	-	-	2.69	2.71	2.93	3.09
	315	3.46	-	-	2.98	2.92	2.98	3.01
2	0	2.89	2.85	-	3.04	3.00	2.72	2.77
	45	2.89	3.20	-	4.76	4.94	4.26	3.89
	90	2.89	3.58	4.54	5.23	5.37	4.10	3.95
	135	2.89	3.46	3.86	4.07	4.04	4.24	3.67
	180	2.89	2.84	2.88	2.81	2.79	2.99	3.04
	225	2.89	2.89	2.59	2.43	2.28	2.32	2.49
	270	2.89	-	-	2.15	2.13	2.28	2.38
	315	2.89	-	-	2.34	2.35	2.27	2.32
3	0	24.86	24.65	-	29.65	29.48	27.79	27.74
	45	24.86	25.80	-	28.72	33.09	34.29	36.75
	90	24.86	26.47	30.21	32.64	34.18	36.05	34.98
	135	24.86	24.97	26.73	28.22	29.84	28.50	30.37
	180	24.86	23.66	22.88	22.02	22.78	22.81	24.84
	225	24.86	23.04	24.48	22.27	23.73	24.41	26.78
	270	24.86	-	-	23.75	23.64	26.21	28.02
	315	24.86	-	-	24.97	24.16	26.52	27.66
4	0	36.67	34.65	-	44.05	43.64	41.19	40.86
	45	36.67	37.98	-	40.25	47.91	49.90	53.83
	90	36.67	38.57	43.73	46.84	49.15	52.47	51.30
	135	36.67	36.48	39.22	41.06	43.50	41.35	44.33
	180	36.67	34.82	33.94	32.98	34.03	33.33	36.31
	225	36.67	34.13	36.62	32.98	35.91	37.12	40.42
	270	36.67	-	-	35.97	35.88	39.78	42.55
	315	36.67	-	-	37.67	36.37	39.93	41.94

* Values for 0 degree view zenith angle are means of all nadir observations.

Table A.4. Soybean canopy reflectance factors for 17 July, 1980. Sun Zenith Angle = 40 degrees, Sun azimuth angle 253 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		---------- % ----------						
1	0	3.10*	3.39	3.23	3.29	3.43	3.38	3.63
	45	3.10	3.21	-	3.40	4.56	5.21	5.27
	90	3.10	3.62	4.22	4.69	6.12	6.51	5.80
	135	3.10	3.50	3.91	4.04	4.66	5.23	4.80
	180	3.10	3.15	3.17	3.27	3.34	3.66	3.98
	225	3.10	3.13	2.92	2.88	2.73	2.80	3.25
	270	3.10	-	2.83	2.81	2.65	2.86	3.21
	315	3.10	2.97	2.73	2.67	2.83	2.89	3.08
2	0	.	2.78	2.64	2.62	2.77	2.77	2.86
	45	2.57	2.65	-	2.79	3.76	4.30	4.16
	90	2.57	3.02	3.53	4.09	5.38	5.34	4.74
	135	2.57	2.96	3.27	3.45	3.92	4.62	3.94
	180	2.57	2.62	2.69	2.70	2.78	3.03	3.27
	225	2.57	2.57	2.39	2.56	2.29	2.29	2.62
	270	2.57	-	2.33	2.23	2.14	2.33	2.54
	315	2.57	2.47	2.22	2.19	2.34	2.32	2.44
3'	0	23.86	25.58	26.21	27.60	28.27	27.12	27.60
	45	23.86	24.94	-	23.84	32.71	36.73	40.77
	90	23.86	26.08	29.69	31.37	36.13	43.06	41.27
	135	23.86	24.98	27.54	28.03	32.30	32.41	33.96
	180	23.86	24.29	23.94	24.19	25.85	24.85	27.38
	225	23.86	24.28	23.78	22.19	22.64	24.53	27.56
	270	23.86	-	23.78	24.00	23.65	25.67	28.90
	315	23.86	24.06	23.12	23.50	24.34	25.56	27.84
4	0	35.57	38.20	39.21	41.41	41.88	40.37	40.83
	45	35.57	37.22	-	34.56	47.70	53.50	59.80
	90	35.57	38.30	43.52	46.13	49.75	62.02	60.08
	135	35.57	36.80	40.66	41.03	47.04	46.91	49.64
	180	35.57	36.07	35.67	35.99	38.40	36.30	40.25
	225	35.57	36.07	35.47	33.24	34.30	36.92	41.58
	270	35.57	-	35.84	35.71	35.54	38.73	43.82
	315	35.57	35.64	34.86	35.35	36.56	38.59	42.17

* Values for 0 degree view zenith angle are means of all nadir observations.

Table A.5. Soybean canopy reflectance factors for 17 July, 1980. Sun Zenith Angle = 49 degrees, Sun azimuth angle 263 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -						
1	0	3.14*	3.36	3.27	3.28	3.38	3.34	3.64
	45	3.14	3.07	-	3.42	3.79	5.05	5.72
	90	3.14	3.53	3.91	4.19	5.26	6.79	7.17
	135	3.14	3.26	3.63	3.99	4.42	4.88	5.42
	180	3.14	3.19	3.11	3.32	3.36	3.64	4.04
	225	3.14	3.10	3.11	2.96	2.83	3.10	3.58
	270	3.14	2.97	2.78	2.86	2.90	3.25	3.73
	315	3.14	3.03	2.83	2.74	2.87	3.10	3.33
2	0	2.58	2.79	2.68	2.66	2.73	2.73	2.90
	45	2.58	2.48	-	2.82	2.91	4.03	4.49
	90	2.58	2.88	3.16	3.39	4.22	5.38	5.80
	135	2.58	2.66	2.96	3.24	3.55	4.01	4.37
	180	2.58	2.57	2.59	2.70	2.77	2.98	3.26
	225	2.58	2.57	2.59	2.43	2.28	2.60	2.88
	270	2.58	2.46	2.32	2.31	2.41	2.65	2.98
	315	2.58	2.4Q	2.33	2.22	2.33	2.46	2.65
3	0	26.13	27.86	28.30	28.90	29.09	28.78	29.78
	45	26.13	25.74	-	27.78	30.64	40.36	46.04
	90	26.13	28.41	30.49	32.73	38.14	44.22	50.80
	135	26.13	25.84	28.28	29.70	32.47	34.64	39.93
	180	26.13	26.17	25.53	26.00	25."4	26.46	28.74
	225	26.13	25.78	25.78	24.02	24.58	26.36	30.22
	270	26.13	25.68	25.32	25.92	26.07	28.03	31.91
	315	26.13	26.19	25.41	25.16	25.10	27.61	29.98
4	0	38.83	41.38	42.60	43.18	43.45	42.97	43.91
	45	38.83	38.09	-	41.14	44.32	59.03	67.07
	90	38.83	41.64	44.75	48.54	55.30	62.52	72.95
	135	38.83	38.26	42.08	43.82	47.47	50.50	58.20
	180	38.83	38.70	37.93	38.29	37.95	38.95	42.14
	225	38.83	38.53	38.38	36.20	36.61	39.91	45.48
	270	38.83	38.79	38.43	38.78	39.50	42.10	48.02
	315	38.83	38.66	38.22	38.19	37.69	41.62	45.19

* Values for 0 degree view zenith angle are means of all nadir observations.

Table B.1. Soybean canopy reflectance factors for 24 July, 1980. Sun Zenith Angle 38 degrees, Sun azimuth angle 111 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		---------- % ----------						
1	0	3.00*	3.15	3.16	3.22	3.41	3.43	3.89
	45	3.00	2.94	-	2.79	3.03	3.31	4.02
	90	3.00	2.82	2.67	2.78	2.75	3.29	4.16
	135	3.00	2.76	2.69	2.60	2.75	2.96	3.116
	180	3.00	3.12	2.89	2.82	2.66	2.80	3.12
	225	3.00	2.53	3.11	3.45	3.41	3.74	3.68
	270	3.00	3.19	3.02	3.88	4.76	5.16	4.60
	315	3.00	3.17	3.41	-	4.42	5.10	5.08
2	0	2.52	2.61	2.61	2.67	2.75	2.84	3.15
	45	2.52	2.48	-	2.29	2.118	2.76	3.26
	90	2.52	2.39	2.27	2.28	2.31	2.72	3.44
	135	2.52	2.29	2.25	2.19	2.29	2.44	2.85
	180	2.52	2.60	2.42	2.35	2.25	2.33	2.52
	225	2.52	2.12	2.57	2.98	2.85	3.08	3.03
	270	2.52	2.62	2.48	3.25	4.07	4.31	3.78
	315	2.52	2.60	2.85	-	3.73	4.24	4.20
3	0	26.03	27.72	27.66	28.22	29.68	28.59	29.42
	45	26.03	26.53	-	25.30	28.67	29.00	32.39
	90	26.03	25.52	25.31	27.27	26.75	29.48	32.30
	135	26.03	24.70	24.65	23.67	25.10	26.10	28.72
	180	26.03	26.42	25.60	25.53	23.74	24.67	27.35
	225	26.03	22.11	26.30	27.15	28.74	32.84	33.62
	270	26.03	26.75	23.74	29.50	34.45	38.57	37.71
	315	26.03	26.15	28.37	-	33.41	37.82	39.62
4	0	39.72	41.76	42.04	42.64	44.88	43.26	43.98
	45	39.72	40.56	-	38.71	43.58	44.24	48.96
	90	39.72	39.23	38.88	41.72	41.32	45.23	48.75
	135	39.72	37.98	37.68	36.22	38.45	39.78	43.60
	180	39.72	40.13	39.00	39.32	36.22	37.56	41.50
	225	39.72	33.96	39.36	41.03	43.32	49.78	51.17
	270	39.72	40.42	35.66	43.91	51.12	57.15	56.56
	315	39.72	39.69	42.77	-	50.00	56.20	59.02

* Values for 0 degree view zenith angle are means of all nadir observations.

Table B.2. Soybean canopy reflectance factors for 24 July, 1980. Sun Zenith Angle = 32 degrees, Sun azimuth angle 121 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -						
1	0	3.13*	3.33	3.20	3.32	3.65	3.49	3.78
	45	3.13	3.01	-	2.84	3.11	3.24	3.73
	90	3.13	2.86	2.73	2.84	2.66	3.17	3.79
	135	3.13	2.99	2.61	2.56	2.66	2.94	3.33
	180	3.18	3.09	2.93	2.81	2.67	2.88	3.25
	225	3.13	3.14	3.1'5	3.89	3.71	3.43	3.32
	270	3.13	2.87	4.15	4.51	4.93	4.35	4.04
	315	3.13	3.32	3.79	4.23	5.16	5.20	4.63
2	0	2.65	2.75	2.66	2.72	2.96	2.91	3.09
	45	2.65	2.55	-	2.39	2.57	2.65	3.03
	90	2.65	2.53	2.37	2.34	2.24	2.59	3.08
	135	2.65	2.46	2.21	2.16	2.21	2.44	2.71
	180	2.65	2.60	2.45	2.36	2.26	2.39	2.64
	225	2.65	2.58	2.93	3.57	3.34	2.89	2.73
	270	2.65	2.37	3.67	3.97	4.36	3.65	3.35
	315	2.65	2.75	3.24	3.74	4.45	4.44	3.87
3	0	25.70	27.96	27.40	28.59	30.24	28.37	28.90
	45	25.70	26.05	-	25.14	28.61	28.83	31.82
	90	25.70	25.05	25.23	27.00	26.09	29.28	31.35
	135	25.70	24.35	23.71	22.69	24.23	25.81	27.87
	180	25.70	25.61	25.01	24.70	23.07	24.42	27.36
	225	25.70	25.28	27.03	27.02	28.00	30.31	30.50
	270	25.70	22.64	28.98	31.77	33.26	33.99	33.99
	315	25.70	26.08	29.09	29.14	33.94	36.51	36.72
4	0	39.00	41.98	41.43	43.33	45.47	42.87	43.26
	45	39.00	39.85	-	38.36	43.43	44.01	48.16
	90	39.00	38.42	38.66	41.45	40.30	44.92	47.54
	135	39.00	37.24	36.51	34.66	37.13	39.31	42.42
	180	39.00	38.98	38.14	37.70	35.06	37.04	41.56
	225	39.00	37.65	40.84	40.62	42.03	46.15	46.74
	270	39.00	34.35	43.39	47.42	49.27	50.91	51.45
	315	39.00	39.21	43.50	43.35	49.64	53.99	55.03

* Values for 0 degree view zenith angle are means of all nadir observations.

Table B.3. Soybean canopy reflectance factors for 24 July, 1980. Sun Zenith Angle = 26 degrees, Sun azimuth angle 136 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -						
1	0	3.29*	3.24	3.52	3.66	3.79	3.67	3.75
	45	3.29	3.32	-	2.99	3.17	3.19	3.73
	90	3.29	2.98	2.83	2.91	2.80	3.09	3.66
	135	3.29	2.86	2.66	2.50	2.70	2.75	3.25
	180	3.29	3.34	3.07	2.86	2.94	2.99	3.21
	225	3.29	-	3.78	4.22	3.85	3.16	2.96
	270	3.29	3.85	4.63	4.73	4.25	3.50	3.38
	315	3.29	3.40	-	-	6.30	4.35	4.93
2	0	2.86	2.67	2.98	3.08	3.16	3.06	3.09
	45	2.86	2.79	-	2.52	2.63	2.62	3.02
	90	2.86	2.59	2.50	2.41	2.30	2.53	2.98
	135	2.86	2.40	2.26	2.11	2.25	2.25	2.65
	180	2.86	2.90	2.70	2.48	2.64	2.62	2.63
	225	2.86	-	3.46	4.16	3.63	2.61	2.43
	270	2.86	3.46	4.35	4.36	3.80	2.95	2.79
	315	2.86	3.02	-	-	5.93	3.61	3.78
3	0	24.66	26.32	27.67	29.05	30.56	28.92	28.93
	45	24.66	25.44	-	24.90	27.95	27.97	31.07
	90	24.66	24.84	24.37	25.74	25.77	28.30	29.97
	135	24.66	23.14	22.47	21.98	23.86	24.31	26.70
	180	24.66	25.09	24.01	23.66	22.63	23.50	26.31
	225	24.66	-	26.86	26.27	26.65	28.40	28.44
	270	24.66	27.02	29.01	30.46	29.81	30.30	30.77
	315	24.66	23.70	-	-	34.39	33.51	35.03
4	0	37.33	39.29	41.91	43.83	45.84	43.59	43.46
	45	37.33	38.78	-	37.67	42.33	42.64	46.88
	90	37.33	38.07	37.19	39.44	39.36	43.35	45.40
	135	37.33	35.50	34.40	33.74	36.59	37.15	40.50
	180	37.33	37.78	36.53	35.99	34.25	35.52	39.89
	225	37.33	-	40.17	38.88	40.01	43.29	43.69
	270	37.33	40.25	43.03	45.34	44.72	45.86	46.88
	315	37.33	35.74	-	-	49.39	49.91	51.94

* Values for 0 degree view zenith angle are means of all. nadir observations.

Table B.4. Soybean canopy reflectance factors for 24 July, 1980. Sun Zenith Angle = 22 degrees, Sun azimuth angle 156 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -						
1	0	4.15*	3.70	-	4.56	4.40	3.99	3.91
	45	4.15	3.77	-	3.23	3.40	3.59	4.07
	90	4.15	3.37	2.94	2.89	2.86	3.39	3.34
	135	4.15	3.115	2.89	2.78	2.76	2.89	3.00
	180	4.15	3.91	3.59	3.40	3.51	3.29	3.27
	225	4.15	4.35	4.25	4.11	3.30	3.01	3.27
	270	4.15	4.62	4.69	4.00	3.47	3.44	3.39
	315	4.15	4.po	-	5.70	4.65	3.83	3.84
2	0	3.89	3.33	-	3.95	3.84	3.53	3.41
	45	3.89	3.33	-	2.76	2.84	2.94	3.34
	90	3.89	2.91	2.53	2.48	2.39	2.78	2.70
	135	3.89	3.21	2.55	2.39	2.34	2.39	2.41
	180	3.89	3.71	3.39	3.21	3.37	3.05	2.73
	225	3.89	4.19	4.13	3.98	3.00	2.50	2.70
	270	3.89	4.42	4.94	3.57	2.94	2.84	2.78
	315	3.89	4.75	-	5.37	4.21	3.18	3.13
3	0	26.88	25.34	-	31.83	31.67	29.47	29.19
	45	26.88	26.94	-	26.32	28.94	28.95	30.92
	90	26.88	25.44	24.73	25.74	25.90	29.16	29.28
	135	26.88	23.90	22.91	22.35	23.57	24.74	26.36
	180	26.88	25.53	24.77	24.03	23.23	23.53	26.72
	225	26.88	27.28	26.69	25.97	25.24	26.63	27.61
	270	26.88	28.32	28.12	28.53	27.18	29.03	29.59
	319	26.88	28.76	-	32.22	30.68	31.06	32.32
4	0	39.96	37.98	-	46.71	46.97	44.17	43.92
	45	39.96	40.45	-	39.63	43.82	43.67	46.38
	90	39.96	38.42	37.65	39.53	39.72	44.28	44.49
	135	39.96	36.06	34.85	33.97	35.99	37.66	40.28
	180	39.96	38.17	37.27	36.34	35.00	35.51	40.47
	225	39.96	40.62	39.83	38.54	38.07	40.73	42.09
	270	39.96	42.14	41.79	42.79	41.00	44.00	45.08
	315	39.96	42.43	-	47.27	45.28	46.78	48.85

* Values for 0 degree view zenith angle are means of all nadir observations.

Table B.5. Soybean canopy reflectance factors for 24 July, 1980. Sun Zenith Angle = 21 degrees, Sun azimuth angle 182 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -						
1	0	4.66*	5.12	-	6.13	5.33	4.71	4.53
	45	4.66	5.04	-	4.12	4.00	3.70	3.81
	90	4.66	4.15	3.66	3.34	3.19	3.39	3.56
	135	4.66	4.02	3.56	3.31	3.06	3.06	3.22
	180	4.66	4.26	3.82	3.63	3.63	3.46	3.46
	225	4.66	4.31	3.68	3.50	2.90	2.83	3.12
	270	4.66	4.43	3.78	3.51	3.10	3.06	3.19
	315	4.66	4.83	4.72	4.35	3.77	3.54	3.55
2	0	4.50	4.87	-	5.66	4.83	4.26	4.03
	45	4.50	4.77	-	3.68	3.33	3.18	3.09
	90	4.50	3.80	3.25	2.83	2.68	2.78	2.87
	135	4.50	3.96	3.39	3.23	2.67	2.54	2.61
	180	4.50	4.26	3.71	3.55	3.54	3.22	2.93
	225	4.50	4.13	3.49	3.28	2.39	2.32	2.56
	270	4.50	4.17	3.51	2.99	2.59	2.53	2.59
	315	4.50	4.58	4.46	3.87	3.21	2.88	2.89
3	0	27.71	30.19	-	33.77	33.68	30.69	29.57
	45	27.71	29.21	-	28.13	30.53	29.81	31.63
	90	27.71	26.36	26.06	26.66	26.52	29.62	30.06
	135	27.71	24.51	24.22	23.05	24.28	25.41	27.04
	180	27.71	25.14	24.54	24.18	23.84	23.99	26.91
	225	27.71	26.59	24.76	24.08	24.67	26.00	27.23
	270	27.71	27.07	25.15	26.93	25.74	27.47	28.45
	315	27.71	28.48	28.87	28.00	27.60	28.91	30.35
4	0	40.86	44.32	-	48.24	49.18	45.45	43.81
	45	40.86	42.64	-	41.68	45.80	44.91	47.56
	90	40.86	39.16	39.14	40.52	40.21	44.99	45.45
	135	40.86	36.45	36.38	34.74	36.81	38.58	41.06
	180	40.86	37.39	36.71	36.33	35.78	36.05	40.69
	225	40.86	39.52	37.28	36.30	37.46	39.77	41.65
	270	40.86	40.09	37.57	40.30	39.24	41.88	43.45
	315	40.86	41.90	42.04	41.96	41.21	43.63	45.94

Values for 0 degree view zenith angle are means of all nadir observations.

Table B.6. Soybean canopy reflectance factors for 24 July, 1980. Sun Zenith Angle = 23 degrees, Sun azimuth angle 210 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		---------- % ----------						
1	0	4.17*	4.43	4.60	4.61	4.53	4.12	4.12
	45	4.17	-	-	5.43	4.44	3.96	-
	90	4.17	4.87	-	4.03	3.69	3.57	3.63
	135	4.17	4.43	4.35	3.97	3.58	3.34	3.47
	180	4.17	3.98	3.56	3.51	3.@16	3.45	3.61
	225	4.17	3.68	3.03	2.89	2.64	2.70	2.95
	270	4.17	3.74	3.11	3.02	2.80	2.82	2.98
	315	4.17	4.05	3.64	3.42	3.30	3.06	3.06
2	0	3.86	4.00	4.18	4.05	3.91	3.64	3.57
	45	3.86	-	-	5.00	3.81	3.30	-
	90	3.86	4.58	-	3.36	3.11	2.96	2.92
	135	3.86	4.35	4.19	3.74	3.21	2.77	2.82
	180	3.86	3.87	3.tl	3.26	3.21	3.12	3.01
	225	3.86	3.35	2.64	2.55	2.22	2.20	2.38
	270	3.86	3.34	2.70	2.54	2.34	2.29	2.40
	315	3.86	3.68	3.16	2.92	2.77	2.50	2.46
3	0	26.39	29.36	29.57	31.60	32.16	29.19	28.81
	45	26.39	-	-	31.55	32.24	31.78	-
	90	26.39	28.28	-	28.96	29.20	31.55	31.64
	135	26.39	25.09	25.47	24.65	25.99	26.37	28.21
	180	26.39	24.45	23.78	24.01	23.74	23.35	27.09
	225	26.39	25.16	23.64	22.50	22.92	25.38	26.29
	270	26.39	26.13	23.98	24.96	24.27	26.23	27.37
	315	26.39	26.36	26.24	26.02	26.60	27.52	28.33
4	0	39.12	43.36	43.61	46.56	47.51	43.30	42.64
	45	39.12	-	-	46.06	47.69	47.64	-
	90	39.12	41.76	-	43.17	43.69	47.67	47.69
	135	39.12	37.26	37.53	36.61	39.02	39.67	42.50
	180	39.12	36.43	35.71	36.08	35.67	34.96	40.70
	225	39.12	37.77	35.72	33.94	34.98	39.01	40.19
	270	39.12	38.80	36.20	38.21	37.22	40.08	41.80
	315	39.12	39.10	39.12	39.06	40.09	41.79	43.10

* Values for 0 degree view zenith angle are means of all nadir observations.

Table C.l. Soybean canopy reflectance factors for 27 August, 1980. Sun Zenith Angle = 38 degrees, Sun azimuth angle 136 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -						
1	0	3.50*	3.25	3.74	4.05	4.25	4.44	4.95
	45	3.50	3.66	3.56	3.60	3.62	3.88	4.50
	90	3.50	3.62	3.43	3.51	3.54	3.81	4.59
	135	3.50	3.61	3.29	3.28	3.31	3.74	4.34
	180	3.50	3.50	3.43	3.41	3.44	3.62	4.13
	225	3.50	3.46	3.36	3.44	3.42	3.80	4.01
	270	3.50	3.45	3.52	3.73	3.91	4.02	4.40
	315	3.50	3.60	3.97	4.18	-	5.16	5.13
2	0	2.97	2.70	3.17	3.46	3.60	3.76	4.21
	45	2.97	3.13	3.04	3.06	3.09	3.30	3.79
	90	2.97	3.13	2.92	2.98	3.03	3.25	3.87
	135	2.97	3.06	2.79	2.76	2.80	3.15	3.62
	180	2.97	2.94	2.91	2.91	2.91	3.10	3.48
	225	2.97	2.92	2.86	2.96	2.90	3.22	3.36
	270	2.97	2.93	2.99	3.17	3.34	3.41	3.69
	315	2.97	3.04	3.34	3.55	-	4.45	4.35
3	0	30.80	28.54	32.51	34.25	36.15	36.35	38.02
	45	30.80	32.36	32.02	31.12	31.06	32.81	34.84
	90	30.80	31.14	30.03	30.65	30.48	32.12	33.93
	135	30.80	30.92	29.08	28.38	28.23	30.11	32.55
	180	30.80	30.61	29.63	29.39	29.02	29.20	32.38
	225	30.80	31.82	30.77	30.07	30.60	32.68	33.51
	270	30.80	32.00	31.49	33.04	33.11	34.14	36.82
	315	30.80	31.89	32.74	34.84	-	40.11	40.61
4	0	45.80	42.41	48.35	50.52	53.28	53.51	55.44
	45	45.80	48.18	47.70	46.33	46.05	48.67	51.28
	go	45.80	46.45	44.76	45.54	45.37	47.97	50.09
	135	45.80	45.92	43.29	42.52	41.92	44.37	47.81
	180	45.80	45.65	43.95	43.78	43.21	43.15	47.92
	225	45.80	47.10	45.67	44.63	45.70	48.47	49.66
	270	45.80	47.79	46.79	49.11	48.90	50.31	54.26
	315	45.80	47.29	48.53	51.32	-	58.34	59.33

* Values for 0 degree view zenith angle are means of all nadir observations.

Table C.2. Soybean canopy reflectance factors for 27 August, 1980. Sun Zenith Angle = 35 degrees, Sun azimuth angle 145 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		---------- % ----------						
1	0	3.42*	3.46	3.53	4.19	4.30	4.46	4.86
	45	3.42	3.84	3.56	3.70	3.63	4.01	4.57
	90	3.42	3.54	3.44	3.56	3.54	3.81	4.43
	135	3.42	3.56	3.33	3.42	3.52	3.82	4.17
	180	3.42	3.58	3.39	3.38	3.47	3.55	3.97
	225	3.42	3.37	3.45	3.26	3.29	3.66	3.82
	270	3.42	3.45	3.47	3.62	3.72	3.77	4.08
	315	3.42	-	3.92	-	-	4.70	4.74
2	0	2.94	3.00	2.95	3.61	3.66	3.78	4.12
	45	2.94	3.30	3.03	3.14	3.10	3.)12	3.87
	90	2.94	3.05	2.95	3.04	3.02	3.23	3.76
	135	2.94	3.12	2.84	2.94	3.00	3.23	3.48
	180	2.94	3.06	2.87	2.87	2.94	3.00	3.31
	225	2.94	2.86	2.97	2.79	2.80	3.13	3.18
	270	2.94	2.96	2.99	3.10	3.19	3.19	3.41
	315	2.94	-	3.38	-	-	4.05	4.02
3	0	-	30.60	29.25	34.28	36.02	36.38	37.36
	45	29.86	32.18	31.29	31.61	31.59	33.67	35.35
	90	29.86	30.62	30.32	31.01	31.37	32.39	33.55
	135	29.86	30.20	28.78	28.98	29.54	30.42	31.92
	180	29.86	30.68	29.27	28.62	29.03	28.91	31.95
	225	29.86	31.38	29.75	28.44	29.52	31.81	32.20
	270	29.86	31.14	30.99	32.10	31.98	32.73	35.21
	315	29.86	-	32.98	-	-	38.13	38.86
4	0	44.47	45.95	42.92	50.17	53.17	53.51	54.54
	45	44.47	47.17	46.64	46.77	46.79	49.77	51.85
	90	44.47	45.64	44.84	46.22	46.78	48.30	49.32
	135	44.47	44.92	42.78	43.28	43.85	44.95	46.99
	180	44.47	45.46	43.67	42.61	43.21	42.80	47.42
	225	44.47	46.78	44.52	42.34	43.96	47.32	47.83
	270	44.47	46.54	46.32	47.86	47.38	48.50	52.13
	315	44.47	-	48.55	-	-	55.84	57.04

* Values for 0 degree view zenith angle are means of all nadir observations.

Table C.3. Soybean canopy reflectance factors for 27 August 1980. Sun Zenith Angle = 32 degrees, Sun azimuth angle 163 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -						
1	0	3.41*	3.56	3.91	-	-	4.63	5.07
	45	3.41	3.61	3.53	3.67	3.64	4.09	4.55
	90	3.41	3.46	3.30	3.40	3.33	3.54	4.32
	135	3.41	3.41	3.10	3.24	3.32	3.54	3.92
	180	3.41	3.30	3.15	3.14	3.26	3.38	3.81
	225	3.41	3.23	3.33	3.18	3.11	3.41	3.62
	270	3.41	3.31	3.36	3.43	3.44	-	3.83
	315	3.41	3.54	3.81	3.94	4.13	4.33	4.43
2	0	2.97	3.03	3.35	-	-	3.96	4.33
	45	2.97	3.12	3.05	3.14	3.12	3.49	3.81
	90	2.97	3.02	2.81	2.93	2.87	2.99	3.62
	135	2.97	3.05	2.69	2.80	2.84	3.00	3.25
	180	2.97	2.85	2.72	2.70	2.80	2.85	3.17
	225	2.97	2.71	2.85	2.72	2.63	2.88	2.98
	270	2.97	2.82	2.89	2.95	2.92	-	3.18
	315	2.97	3.03	3.28	3.36	3.56	3.66	3.71
3	0	28.71	31.04	31.26	-	-	35.60	36.32
	45	28.71	30.54	30.21	30.00	30.19	33.25	34.37
	90	28.71	29.38	28.84	29.72	30.01	30.98	32.51
	135	28.71	28.56	26.75	27.44	27.83	28.60	29.83
	180	28.71	27.97	27.05	26.31	26.76	26.91	30.34
	225	28.71	29.66	28.29	26.64	27.19	29.55	30.35
	270	28.71	29.68	29.14	29.58	28.87	-	32.38
	315	28.71	30.06	31.18	31.94	31.78	34.18	35.46
4	0	42.81	46.40	46.20	-	-	52.22	52.82
	45	42.81	44.92	45.12	44.52	44.74	49.03	50.44
	90	42.81	43.55	43.07	44.41	44.88	46.39	48.01
	135	42.81	42.78	39.97	40.94	41.53	42.35	43.96
	180	42.81	41.77	40.41	39.35	39.98	40.04	45.18
	225	42.81	44.48	42.4Q	39.85	40.72	43.99	45.22
	270	42.81	44.47	43.66	44.12	42.96	-	48.13
	315	42.81	44.90	45.99	47.28	46.81	50.13	52.38

* Values for 0 degree view zenith angle are means of all nadir observations.

Table C.4. Soybean canopy reflectance factors for 27 August, 1980. Sun Zenith Angle = 31 degrees, Sun azimuth angle 174 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -						
1	0	3.51*	3.70	3.97	-	-	4.57	4.97
	45	3.51	3.72	3.74	3.89	3.98	4.18	4.65
	90	3.51	3.60	3.46	3.65	3.57	3.73	4.29
	135	3.51	3.47	3.34	3.37	3.40	3.72	3.98
	180	3.51	3.42	3.33	3.29	3.43	3.48	3.80
	225	3.51	3.33	3.33	3.07	3.14	3.44	3.65
	270	3.51	3.36	3.32	3.40	3.33	3.51	3.76
	315	3.51	3.60	3.68	3.81	3.94	4.12	4.35
2	0	3.02	3.15	3.43	-	-	3.91	4.21
	45	3.02	3.16	3.19	3.32	3.41	3.53	3.91
	90	3.02	3.08	2.96	3.12	3.06	3.14	3.58
	135	3.02	3.04	2.88	2.88	2.88	3.12	3.32
	180	3.02	2.92	2.85	2.81	2.92	2.90	3.12
	225	3.02	2.78	2.89	2.64	2.67	2.92	3.03
	270	3.02	2.85	2.85	2.92	2.85	2.96	3.13
	315	3.02	3.06	3.13	3.26	3.40	3.52	3.64
3	0	28.91	31.91	31.64	-	-	35.61	36.64
	45	28.91	30.88	30.96	30.89	31.14	33.36	34.65
	90	28.91	29.88	29.45	30.62	30.97	31.49	32.47
	135	28.91	28.56	27.60	27.49	28.04	28.90	29.44
	180	28.91	28.47	27.64	26.83	27.48	27.10	30.06
	225	28.91	29.88	27.88	26.43	27.62	29.92	30.69
	270	28.91	29.46	29.03	29.56	28.79	30.00	32.33
	315	28.91	30.03	30.80	31.50	31.12	34.17	35.33
4	0	43.12	47.48	46.87	-	-	52.39	53.47
	45	43.12	45.87	46.21	45.81	46.03	49.35	50.84
	go	43.12	44.66	43.87	45.64	46.06	47.03	48.00
	135	43.12	42.84	41.16	41.08	41.77	42.78	43.34
	180	43.12	42.46	41.19	40.05	40.87	40.23	44.73
	225	43.12	44.93	42.10	39.51	41.41	44.71	45.73
	270	43.12	44.15	43.37	44.12	43.08	44.61	48.19
	315	43.12	44.91	45.81	46.90	45.90	50.27	52.24

* Values for 0 degree view zenith angle are means of all nadir observations.

Table C.5. Soybean canopy reflectance factors for 27 Augustt 1980. Sun Zenith Angle = 31 degrees, Sun azimuth angle 196 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -						
1	0	3.45*	3.51	3.81	4.26	4.43	4.38	4.77
	45	3.45	3.65	3.76	4.20	4.42	4.69	4.91
	90	3.45	3.58	3.62	3.76	3.82	3.97	4.54
	135	3.45	3.54	3.48	3.49	3.60	3.73	3.99
	180	3.45	3.48	3.22	3.24	3.40	3.49	3.80
	225	3.45	3.17	3.31	3.07	3.10	3.39	3.85
	270	3.45	3.18	3.19	3.25	3.27	3.36	3.84
	315	3.45	3.50	3.50	3.55	3.68	3.83	4.08
2	0	2.95	2.97	3.24	3.67	3.77	3.69	4.00
	45	2.95	3.09	3.17	3.63	3.83	3.93	4.20
	90	2.95	3.05	3.06	3.18	3.22	3.38	3.80
	135	2.95	3.03	2.98	3.02	3.06	3.16	3.28
	180	2.95	3.10	2.77	2.77	2.89	2.93	3.12
	225	2.95	2.65	2.81	2.61	2.59	2.83	3.17
	270	2.95	2.69	2.70	2.74	2.76	2.80	3.15
	315	2.95	2.98	2.96	2.99	3.14	3.19	3.41
3	45	28.56	30.49	30.78	32.09	33.41	36.33	36.81
	90	28.56	29.36	29.81	30.85	32.37	33.30	34.19
	135	28.56	28.43	27.81	27.90	29.06	29.53	30.34
	180	28.56	27.99	27.05	26.21	27.13	27.44	30.58
	225	28.56	29.13	27.91	25.99	27.11	29.02	30.68
	270	28.56	28.52	27.62	28.54	27.94	28.92	32.03
	315	28.56	29.36	30.00	30.15	29.79	32.20	34.01
4	0	-	46.34	45.97	49.11	53.23	51.82	52.19
	45	42.53	45.20	45.88	47.07	49.06	53.88	53.88
	90	42.53	44.00	44.28	45.95	48.14	49.38	50.16
	135	42.53	42.70	41.67	41.76	42.99	43.64	44.70
	180	42.53	41.48	40.40	39.01	40.45	40.81	45.55
	225	42.53	43.84	41.65	38.88	40.54	43.21	45.47
	270	42.53	42.87	41.25	42.73	41.65	43.12	47.65
	315	42.53	43.48	44.70	44.87	43.95	47.66	50.26

* Values for 0 degree view zenith angle are means of all nadir observations.

Table C.6. Soybean canopy reflectance factors for 27 August, 1980. Sun Zenith Angle = 33 degrees, Sun azimuth angle 206 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		---------- % ----------						
1	0	3.48*	3.64	3.86	4.18	4.38	4.54	5.18
	45	3.48	3.87	3.85	4.42	4.67	4.81	5.02
	90	3.48	3.78	3.74	3.95	3.88	4.06	4.55
	135	3.48	3.66	3.56	3.60	3.63	3.74	3.97
	180	3.48	3.52	3.37	3.39	3.42	3.43	3.88
	225	3.48	3.32	3.29	3.05	3.14	3.39	3.80
	270	3.48	3.35	3.24	3.35	3.29	3.41	3.92
	315	3.48	3.48	3.54	3.59	3.68	3.96	4.21
2	0	2.97	3.011	3.28	3.59	3.71	3.82	4.36
	45	2.97	3.29	3.27	3.85	4.10	4.11	4.29
	90	2.97	3.25	3.19	3.35	3.29	3.43	3.81
	135	2.97	3.15	3.05	3.13	3.12	3.17	3.29
	180	2.97	3.15	2.92	2.92	2.93	2.87	3.23
	225	2.97	2.78	2.82	2.61	2.65	2.87	3.13
	270	2.97	2.83	2.74	2.85	2.80	2.85	3.25
	315	2.97	2.94	2.98	3.04	3.13	3.33	3.50
3	0	28.88	31.89	31.67	33.45	35.81	35.62	36.79
	45	28.88	31.69	31.73	33.23	34.59	37.08	37.40
	90	28.88	30.56	30.86	31.93	32.77	33.79	34.86
	135	28.88	29.40	28.42	28.99	29.37	29.56	30.49
	180	28.88	28.63	28.10	27.30	27.52	27.22	30.67
	225	28.88	30.05	28.05	26.05	27.58	29.18	30.92
	270	28.88	29.32	28.10	29.14	28.18	29.26	32.33
	315	28.88	29.70	30.30	30.54	30.11	32.31	33.90
4	0	42.88	47.37	46.72	49.34	52.92	52.30	53.29
	45	42.88	46.83	47.17	48.69	50.57	54.27	54.54
	90	42.88	45.42	45.75	47.49	48.49	50.06	51.05
	135	42.88	43.75	42.81	43.17	43.44	43.69	44.82
	180	42.88	42.53	41.95	40.53	40.69	40.40	45.54
	225	42.88	45.00	42.13	38.92	41.24	43.57	45.88
	270	42.88	43.95	42.08	43.58	42.11	43.59	48.05
	315	42.88	44.16	45.07	45.42	44.48	47.54	50.19

* Values for 0 degree view zenith angle are means of allnadir observations.

Table C.7. Soybean canopy reflectance factors for 27 August, 1980. Sun Zenith Angle = 36 degrees, Sun azimuth angle 217 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -						
1	0	3.42*	3.58	3.73	4.06	4.18	4.42	4.84
	45	3.42	3.68	3.82	4.36	-	5.27	5.32
	90	3.42	3.61	3.72	3.97	4.11	4.19	4.83
	135	3.42	3.63	3.43	3.69	3.76	3.93	4.07
	180	3.42	3.39	3.29	3.39	3.52	3.56	3.99
	225	3.42	3.31	3.27	3.13	3.18	3.54	3.98
	270	3.42	3.24	3.18	3.23	3.29	3.42	3.88
	315	3.42	3.45	3.45	3.48	3.61	3.87	4.07
2	0	2.91	3.00	3.16	3.44	3.52	3.70	4.04
	45	2.91	3.13	3.25	3.79	-	4.53	4.54
	90	2.91	3.06	3.18	3.37	3.49	3.52	4.19
	135	2.91	3.09	2.93	3.17	3.20	3.32	3.41
	180	2.91	2.95	2.83	2.90	3.01	3.00	3.31
	225	2.91	2.76	2.79	2.66	2.69	2.96	3.28
	270	2.91	2.71	2.69	2.74	2.76	2.84	3.20
	315	2.91	2.94	2.91	2.96	3.05	3.22	3.38
3	0	28.73	31.31	30.97	32.66	34.73	35.10	35.85
	45	28.73	30.89	31.00	32.49	-	38.90	38.80
	90	28.73	29.90	30.38	32.25	34.07	34.87	36.02
	135	28.73	29.58	28.37	29.25	30.02	30.49	31.17
	180	28.73	28.15	27.29	27.03	27.75	27.89	31.09
	225	28.73	30.12	27.99	26.30	27.11	29.40	31.17
	270	28.73	29.57	27.58	28.19	27.67	29.05	31.88
	315	28.73	29.27	29.38	30.19	29.17	31.76	33.17
4	0	42.64	46.54	45.95	48.01	51.06	51.61	52.30
	45	42.64	45.86	45.91	47.47	-	56.51	56.34
	go	42.64	44.53	44.97	47.64	50.19	51.53	52.58
	135	42.64	43.93	42.27	43.31	44.36	44.90	45.73
	180	42.64	41.89	40.78	40.12	41.17	41.27	46.02
	225	42.64	45.02	41.90	39.29	40.57	43.73	46.06
	270	42.64	44.26	41.31	41.90	41.12	43.20	47.39
	315	42.64	43.65	43.66	44.93	43.04	46.94	49.10

* Values for 0 degree view zenith angle are means of all nadir observations.

Table C.8. Soybean canopy reflectance factors for 27 August, 1980. Sun Zenith Angle = 38 degrees, Sun azimuth angle 225 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -						
1	0	3.45*	3.58	3.73	4.02	4.22	4.29	4.85
	45	3.45	3.72	3.80	4.30	-	5.57	5.54
	90	3.45	3.66	3.81	4.07	4.26	4.45	4.99
	135	3.45	3.64	3.54	3.76	3.91	4.00	4.17
	180	3.45	3.45	3.38	3.44	3.55	3.62	4.04
	225	3.45	3.32	3.35	3.20	3.29	3.65	4.19
	270	3.45	3.26	3.10	3.24	3.32	3.46	4.15
	315	3.45	3.37	3.39	3.45	3.46	3.79	4.21
2	0	2.93	2.99	3.14	3.40	3.54	3.59	4.06
	45	2.93	3.16	3.22	3.68	-	4.81	4.70
	90	2.93	3.13	3.24	3.45	3.64	3.75	4.20
	135	2.93	3.13	3.00	3.23	3.36	3.38	3.48
	180	2.93	3.08	2.89	2.94	3.02	3.06	3.35
	225	2.93	2.78	2.88	2.72	2.77	3.08	3.43
	270	2.93	2.74	2.61	2.72	2.79	2.88	3.44
	315	2.93	2.84	2.84	2.92	2.94	3.16	3.50
3	0	28.97	31.33	31.20	32.39	34.92	34.89	36.35
	45	28.97	31.11	31.67	32.84	-	40.14	39.71
	90	28.97	30.35	31.24	32.56	34.46	36.00	37.29
	135	28.97	29.48	28.97	29.87	30.52	30.88	31.81
	180	28.97	28.59	27.83	27.47	27.91	28.16	31.46
	225	28.97	30.53	28.49	26.80	28.07	30.00	32.30
	270	28.97	29.75	27.58	28.49	28.06	29.34	32.98
	315	28.97	29.04	29.30	30.10	28.98	31.78	33.97
4	0	43.10	46.41	46.20	47.69	51.29	51.32	52.96
	45	43.10	46.02	47.02	47.86	-	58.05	57.51
	go	43.10	45.12	46.19	48.15	50.77	52.93	54.26
	135	43.10	43.78	43.04	44.13	44.99	45.37	46.52
	180	43.10	42.39	41.48	40.79	41.31	41.59	46.52
	225	43.10	45.61	42.70	39.91	41.77	44.40	47.58
	270	43.10	44.59	41.30	42.45	41.69	43.59	48.78
	315	43.10	43.16	43.57	44.82	42.85	46.85	50.11

* Values for 0 degree view zenith angle are means of all nadir observations.

Table C.9. Soybean canopy reflectance factors for 27 August, 1980. Sun Zenith Angle = 44 degrees, Sun azimuth angle 237 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		---------- % ----------						
1	0	3.50*	3.61	3.80	4.01	4.29	4.35	4.97
	45	3.50	3.73	3.78	4.27	4.61	5.36	5.94
	90	3.50	3.72	3.99	4.26	4.53	4.98	5.76
	135	3.50	3.73	3.77	3.97	4.05	4.36	4.69
	180	3.50	3.52	3.55	3.56	3.70	3.86	4.34
	225	3.50	3.45	3.51	3.25	3.41	3.94	4.59
	270	3.50	3.45	3.23	3.40	3.49	3.69	4.65
	315	3.50	3.37	3.53	3.47	3.56	3.98	4.46
2	0	2.95	3.00	3.18	3.38	3.57	3.61	4.11
	45	2.95	3.16	3.18	3.59	3.92	4.55	5.00
	90	2.95	3.16	3.38	3.60	3.84	4.20	4.83
	135	2.95	3.14	3.18	3.38	3.43	3.68	3.92
	180	2.95	2.97	3.03	3.04	3.11	3.24	3.60
	225	2.95	2.89	2.98	2.76	2.86	3.28	3.79
	270	2.95	2.89	2.68	2.84	2.92	3.06	3.87
	315	2.95	2.83	2.96	2.91	2.99	3.30	3.69
3	0	29.49	31.73	31.75	33.09	35.48	35.29	37.04
	45	29.49	31.41	32.08	33.73	34.87	40.45	42.29
	90	29.49	30.60	32.46	33.99	36.51	39.30	41.78
	135	29.49	30.59	30.63	31.40	31.90	33.24	34.77
	180	29.49	29.25	29.14	28.43	29.54	29.66	32.97
	225	29.49	31.25	29.70	27.37	28.86	31.38	34.30
	270	29.49	30.84	28.70	29.83	28.84	30.53	34.75
	315	29.49	29.22	30.29	30.15	29.46	32.21	34.76
4	0	43.53	46.85	46.91	48.61	51.79	51.63	53.63
	45	43.53	46.21	47.31	49.10	50.69	58.40	60.74
	90	43.53	45.18	47.58	49.73	53.29	57.16	60.10
	135	43.53	45.11	44.94	46.08	46.66	48.49	50.32
	180	43.53	43.19	43.05	41.93	43.54	43.42	48.36
	225	43.53	46.32	44.12	40.53	42.77	46.52	50.08
	270	43.53	45.84	42.73	44.24	42.51	45.09	50.89
	315	43.53	43.30	44.78	44.64	43.35	47.26	50.96

* Values for 0 degree view zenith angle are means of all nadir observations.

Table C.10. Soybean canopy reflectance factors for 27 August, 1980. Sun Zenith Angle = 48 degrees, Sun azimuth angle 243 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -						
1	0	3.52*	3.58	3.63	3.92	4.19	4.24	4.88
	45	3.52	3.75	3.79	4.09	4.lt4	5.14	5.95
	90	3.52	3.73	3.86	4.19	4.52	5.12	6.08
	135	3.52	3.57	-	3.88	4.14	4.41	4.80
	180	3.52	3.52	3.43	3.52	3.65	3.90	4.40
	225	3.52	3.41	3.44	3.10	3.49	4.04	4.71
	270	3.52	3.28	3.23	3.34	3.37	3.68	4.81
	315	3.52	3.45	3.40	3.56	3.45	3.93	4.49
2	0	2.98	3.00	3.06	3.30	3.50	3.55	4.07
	45	2.98	3.16	3.18	3.44	3.78	4.35	5.02
	90	2.98	3.13	3.23	3.51	3.82	4.32	5.13
	135	2.98	3.02	-	3.28	3.50	3.71	4.03
	180	2.98	2.95	2.90	2.98	3.08	3.27	3.67
	225	2.98	2.86	2.95	2.57	2.92	3.46	3.90
	270	2.98	2.78	2.70	2.80	2.82	3.07	4.05
	315	2.98	2.92	2.85	3.04	2.88	3.29	3.76
3	0	29.50	31.12	30.61	32.47	34.63	34.20	36.33
	45	29.50	30.77	31.79	32.76	34.98	38.81	42.35
	90	29 50	30.92	32.10	33.18	36.24	40.12	43.42
	135	29.50	29.21	-	30.94	32.14	32.93	35.47
	180	29.50	28.88	28.49	28.98	29.13	29.95	33.13
	225	29.50	30.87	28.97	26.84	29.24	31.16	34.66
	270	29.50	29.18	28.82	28.97	28.42	29.92	34.94
	315	29.50	29.89	29.90	29.56	29.23	31.66	34.35
4	0	43.56	46.14	45.12	47.62	50.79	50.20	52.72
	45	43.56	45.21	46.96	47.82	51.08	56.01	60.81
	90	43.56	45.37	47.21	48.24	52.94	58.28	62.25
	135	43.56	43.00	-	45.48	46.83	47.79	51.31
	180	43.56	42.40	42.09	42.41	42.76	43.74	48.49
	225	43.56	45.88	43.07	39.72	43.35	45.96	50.65
	270	43.56	43.54	42.82	43.03	42.05	44.18	51.17
	315	43.56	44.23	44.32	43.68	43.21	46.72	50.43

* Values for 0 degree view zenith angle are means of all nadir observations.

Table C.11. Soybean canopy reflectance factors for 27 August, 1980. Sun Zenith Angle = 55 degrees, Sun azimuth angle 251 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -						
1	0	3.66*	3.83	3.85	4.08	4.50	4.54	5.26
	45	3.66	3.95	3.88	4.28	4.4P	4.87	6.29
	90	3.66	3.85	4.18	4.37	4.74	5.67	6.98
	135	3.66	3.76	3.98	4.14	4.35	4.82	5.42
	180	3.66	3.67	-	3.83	3.81	4.18	4.80
	225	3.66	3.66	3.65	3.38	3.75	4.50	5.14
	270	3.66	3.51	3.'17	3.60	3.82	4.28	5.50
	315	3.66	3.60	3.63	3.73	3.76	4.35	5.12
2	0	3.08	3.22	3.25	3.40	3.78	3.82	4.42
	45	3.08	3.34	3.23	3.59	3.79	4.00	5.30
	90	3.08	3.25	3.50	3.65	4.01	4.82	5.98
	135	3.08	3.19	3.36	3.54	3.66	4.05	4.58
	180	3.08	3.09	-	3.26	3.21	3.53	4.03
	225	3.08	3.10	3.13	2.84	3.17	3.88	4.39
	270	3.08	2.94	2.87	3.02	3.22	3.65	4.74
	315	3.08	2.99	3.05	3.15	3.17	3.69	4.36
3	0	30.30	32.67	32.04	33.32	35.89	35.82	38.19
	45	30.30	32.20	32.58	34.23	35.68	35.26	44.31
	90	30.30	31.38	34.06	34.54	37.89	42.92	48.24
	135	30.30	30.45	31.87	32.72	33.65	35.35	38.63
	180	30.30	30.29	-	30.42	30.39	31.32	34.78
	225	30.30	31.62	30.64	27.71	30.44	31.62	36.21
	270	30.30	30.74	29.27	30.39	29.75	31.72	36.79
	315	30.30	30.68	30.36	30.34	30.10	32.92	36.02
4	0	44.63	48.27	47.10	48.62	52.34	52.19	55.13
	45	44.63	47.20	47.78	49.84	52.10	50.29	63.39
	go	44.63	46.25	49.94	50.39	55.16	62.07	68.70
	135	44.63	44.71	46.71	48.02	48.99	51.09	55.49
	180	44.63	44.41	-	44.58	44.44	45.65	50.63
	225	44.63	46.71	45.48	40.92	44.73	46.05	52.65
	270	44.63	45.26	42.99	44.93	43.69	46.45	53.35
	315	44.63	45.30	44.69	44.65	44.27	48.03	52.39

Values for 0 degree view zenith angle are means of all nadir observations.

Table C.12. Soybean canopy reflectance factors for 27 August, 1980. Sun Zenith Angle = 61 degrees, Sun azimuth angle 258 degrees.

Band	View Azimuth Angle	View Zenith Angle, degrees 0	7	15	22	30	45	60
		- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -						
1	0	3.86*	4.22	4.13	4.35	4.75	4.93	5.61
	45	3.86	4.18	4.10	4.51	4.68	4.94	6.45
	90	3.86	4.13	4.45	4.60	5.08	5.74	7.75
	135	3.86	4.07	4.27	4.52	4.67	5.14	5.88
	180	3.86	4.06	3.95	4.11	4.21	4.41	4.99
	225	3.86	4.08	3.95	3.74	4.08	4.83	5.73
	270	3.86	3.99	3.74	3.97	4.12	4.67	6.26
	315	3.86	3.91	3.99	4.10	4.12	4.85	5.65
2	0	3.26	3.60	3.53	3.70	4.07	4.21	4.82
	45	3.26	3.56	3.44	3.80	3.97	4.10	5.50
	90	3.26	3.48	3.75	3.86	4.33	4.91	6.86
	135	3.26	3.47	3.66	3.88	3.97	4.37	5.02
	180	3.26	3.44	3.36	3.50	3.59	3.77	4.28
	225	3.26	3.47	3.43	3.20	3.48	4.32	5.00
	270	3.26	3.39	3.18	3.42	3.60	4.11	5.66
	315	3.26	3.29	3.41	3.52	3.58	4.24	5.01
3	0	30.85	34.17	33.61	34.49	36.14	36.84	38.77
	45	30.85	32.97	33.53	35.31	37.03	35.17	44.97
	90	30.85	32.69	35.52	35.60	39.51	43.22	52.05
	135	30.85	31.61	33.57	34.56	35.20	36.88	40.91
	180	30.85	31.76	31.03	31.26	32.00	31.84	35.07
	225	30.85	33.37	31.41	28.65	30.99	32.61	37.80
	270	30.85	32.41	29.82	31.58	29.87	31.66	38.20
	315	30.85	31.63	31.21	31.48	30.66	33.58	36.42
4	0	45.25	50.21	49.39	50.50	52.87	53.56	55.94
	45	45.25	48.18	49.14	51.23	54.03	50.55	64.54
	90	45.25	47.86	51.73	51.94	57.48	62.63	74.20
	135	45.25	46.20	49.14	50.46	51.20	53.34	58.86
	180	45.25	46.41	45.52	45.64	46.85	46.37	51.04
	225	45.25	49.14	46.75	42.09	45.53	47.63	54.63
	270	45.25	47.66	43.88	46.65	43.87	46.37	55.28
	315	45.25	46.55	45.76	46.18	44.84	48.81	52.83

* Values for 0 degree view zenith angle are means of all nadir observations.