E7.4-10.0.44
CR-135885

TITLE: "Reflectance of vegetation, soil, and water"

NUMBER OF INVESTIGATION: ERTS-1 GSFC ID AG 339

CONTRACT NUMBER: S-70251-AG, Task 3 (431-641-14-01-07)

PERIOD COVERED: August 19 - October 19, 1973

TYPE OF REPORT: Type I Report #5

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Objective of the Contract:

The seasonal changes in reflectance of various soils and of various crops grown in Hidalgo County, Texas, are being studied using ERTS-1, ground, and aircraft spectral data. Discrimination of specific crop and soil conditions is being attempted; chlorophyll content of plant leaves is being correlated with reflectance in the visible channels, and comparisons are being made between ERTS data and predictions from analytical models describing interaction of light with plant canopies.

Statement of Problems in the Report Period:

The color composite of scene 1308-16323 (May 27) has not yet been received. We're wondering if the order has been misplaced.

For some unknown reason none of the standing order photoproducts for the September 12, 1973, overpass have been received yet, even though some photoproducts from the September 30 overpass have been received. It was clear on September 12 but cloudy on September 30.

The retrospective order of CCT for scene 1308-16323 exhibited the "venetian blind" effect in band 7. The tapes were reordered but were found on delivery to be identical to the first batch. The 1:1,000,000 electron beam recorder images do not exhibit the effect. We are trying to get a tape set without this problem because band 7 is the one that should most closely relate to the leaf area index (LAI) determinations made in the field. The relation between near infrared reflectance and LAI cannot be tested for any other dates in the April-July period when LAI determinations were being made because each date the satellite came over was extremely cloudy.

Aircraft Data

On January 21, 1973, aircraft mission 226 was being conducted with the C-130B at the same time ERTS-1 came over. The simultaneously acquired aircraft and ERTS MSS data are being intensively compared for land use classification accuracy and correlation with ground truth. The results are to be presented at the 9th University of Michigan Symposium, if accepted. Table 1 is a summary of the optimal channels, classification categories used, and recognition results for training and test sets of ERTS-1 and aircraft support MSS data that have been analyzed to date. The summary shows that 95.4% correct identification of the training set was achieved for the January 21 aircraft data, and that 95.3% correct identification of the training set pixels was achieved for the same ground area using the ERTS data.

Use of ERTS-1 to Detect Iron-Deficient Grain Sorghum

A manuscript has been prepared on the subject. The abstract follows:

"This study was conducted to determine if multispectral data from ERTS-1 could be used to detect differences in chlorophyll concentration between iron-deficient (chlorotic) and apparently normal (green) grain sorghum (Sorghum bicolor (L.) Moench) plants in a 340-acre (139 hectares) field. Band 5 (0.6 to 0.7 μm) data were selected, representing the chlorophyll absorption band at the 0.65-μm wavelength. Chlorotic sorghum areas 2.8 acres (1.1 hectare) or larger in size were identified on a computer printout of band 5 data. This resolution is sufficient for practical applications in detecting iron-deficient sorghum in otherwise uniform fields."

Relation Between ERTS-1 Response and Vegetation Vigor or Density

Allen and Richardson ("Interaction of light with a plant canopy," J. Opt. Soc. Amer. 58:1023-1028, 1968) showed theoretically that reflectance from plant canopies, as measured from space, in the 0.75 to 1.35 μm wavelength interval could be used to predict leaf area index (LAI) of vegetation. Since LAI is a well known indicator of plant maturity and vigor, inferences based on space imagery should be possible regarding the maturity and probable yield of crops, or the animal carrying capacity of rangeland.

In this contract the reflectance measured in ERTS-1 bands 6 and 7 are being related to the LAI measured in 4 corn, 10 sorghum, and 10 cotton fields to test the relation between LAI measured in these selected fields and the predictions of the mathematical model.

Figure 1 shows the relation between radiometric response in ERTS-1 bands 4, 5, and 6 (band 7 data supplied to date is unuseable) for three sorghum fields differing in leaf area index. The response in band 6 is a function of vegetation density, whereas the decrease in bands 4 and 5 is due to the fact that the highly reflecting soil is obscured by the vegetation. That is, vegetation reflectance is essentially constant for LAI>1 in bands 4 and 5 but it increases in bands 6 and 7 as LAI increases. The simple correlation, r, between LAI and band 6 digital count was found to be 0.823** for the 10 cotton fields and 0.841** for the combined sorghum and corn fields. When the three crops were combined, the simple correlation dropped to 0.553** as a consequence of the different plant architecture and leaf display between the two plant types. The data will be studied further.

Significant Results and Practical Applications:

A study was conducted in a 340-acre (139 hectare) field of grain sorghum (Sorghum bicolor (L.) Moench) to determine if multispectral data from ERTS-1 could be used to detect differences in chlorophyll concentration between iron-deficient (chlorotic) and apparently normal (green) grain sorghum. Chlorotic sorghum areas 2.8 acres (1.1 hectares) or larger in size were identified on a computer printout of band 5 data which contains the chlorophyll absorption band at the 0.65 μm wavelength. ERTS resolution is sufficient for practical applications in detecting iron-deficient sorghum in otherwise uniform fields.

The first classification map of the study county has been produced. Vegetation (crops), rangeland, bare soil, water, and an undefined (all other) category occupied 15.2, 45.0, 19.1, 0.02, and 20.6% of the land area, respectively.

Publications:

Gausman, H. W., A. H. Gerbermann, and C. L. Wiegand.
Use of ERTS-1 to detect iron-deficient grain sorghum.
Photogram. Engin.

Richardson, A. J., M. R. Gautreaux, R. J. Torline, and C. L. Wiegand.
Land use classification accuracies and ground truth correlation from simultaneously acquired aircraft and ERTS-1 MSS data.
9th Remote Sensing Sympos., Ann Arbor (In preparation).

Recommendations Concerning Changes in Operations, Additional Investigations, Efforts, and Effort/Results as Related to the ERTS System:

None.

Changes in Standard Order Forms:

None.

ERTS Image Descriptor Form:

Attached.

Changes in Retrospective Data Requests:

None.

Planned Work for the Next Reporting Period:

During the next reporting period, analysis of the January 21, 1973, (scene 1182-16322) ERTS-1 overpass data and the aircraft data for the same day (Mission 226) should be completed. Time will also be spent on manuscript preparation.

The leaf area index data will be studied as it relates to bands 6 and 7 ERTS-1 MSS data of May 27 (scene 1308-16323).

The relations between ground truth (percent plant cover, soil type, plant height, planting configuration [plant density],soil surface conditions, etc.) and MSS digital counts will continue to be investigated in order to determine the degree to which MSS digital counts can be predicted from ground truth. Comparisons will also be made among legal description acreages, farmable acreage, and acreage actually devoted to crops.

Statistical estimates of the acreages devoted to winter vegetables will continue to be produced as the winter vegetable season progresses and estimates of special situations, such as the fall 1973 cotton stalk destruction progress, will be made.

The spectra of the range sites representative of the rangelands in the county will be extracted from ERTS-1 CCT tapes and will be used to improve the rangeland estimates in the county-wide classification maps that are produced.

Considerable time will be involved in preparing the next Type II report, since there should be a large number of topics to cover.

ERTS IMAGE DESCRIPTOR FORM

USER NAME Craig L. Wiegand DATE October 19, 1973

USER ID AG 339

AGENCY USDA-ARS

PRODUCT ID (Include Band and Product)	Weslago File Number	Frequently Used Descriptors *				DESCRIPTORS	FLIGHT DATE
		COAST	CROPLAND	RANGELAND	LAKES		
1326-16315-5	#187					Clouds	6/14/73
1345-16372-5	#191					Clouds	7/3/73
1362-16313-5	#195	X				Clouds	7/20/73
1362-16315-5	#199		X	X		Clouds	7/20/73
1363-16371-5	#203			X			7/21/73
1363-16373-5	#207			X			7/21/73
1380-16311-5	#219					Clouds	8/7/73
1380-16314-5	#223					Clouds	8/7/73
1398-16305-5	#227			X		Clouds	8/25/73
1398-16312-5	#231					Clouds	8/25/73
1399-16364-5	#211					Clouds	8/26/73
1399-16370-5	#215					Clouds	8/26/73

*For Descriptors which will occur frequently, write the descriptor terms in these column heading spaces now and use a check (✓) mark in the appropriate ID lines. (For other descriptors, write the term under the DESCRIPTORS column).

MAIL TO ERTS User Services
Code 563 413
Bldg 23 Room E
NASA GSFC
Greenbelt, Md. 20771

Table 1. Optimal channels, classification categories, and recognition results for training and test sets of ERTS-1 and aircraft support MSS data.

	Aircraft		ERTS-1			
	M207 7/26/72	M226 1/21/73	12/16/72		1/21/73	
No. of fields:	Research Farm (61K pixels)	84	11	292	82	Whole county
Categories (and recognition %):	(Test set) cotton(70) citrus(67) grasses(71) sugarcane(88) bare soil(95) water (98)	(Test set) bare soil(80) vegetables(48) immature crops & mixed shrubs(36)	(Training set) bare soil(93) mix.shrubs(87) pepper(75) tomato(96) weeds(94)	(Test set) bare soil(76) citrus(60) mix.shrubs( ) cabbage, tomato, carrot } (67) mix.grasses(54)	(Test set) bare soil(90) vegetables(48) immature crops & mixed shrubs(16)	bare soil ( ) rangeland ( ) vegetables( ) water ( ) all other ( )
Optimal channels:	7,8,3,18,1, 14,2	3,8,5,10,7	7,4,6,5	5,6,7,4	7,4,5	7,4,5
Recognition results:	(Training set)	(Training set)	(Training set)	(Training set)	(Training set)	Training set was 82 fields
Best channel	56.9	71.4	44.8	----	87.9	
2 best channels	66.9	92.5	85.1	----	93.3	
3 best channels	82.6	94.1	86.6	96.3	95.3	
4 best channels	86.6	94.6	91.0	98.8		
5 best channels	91.9	95.4				
Avg. Overall:	92.8	95.4	91.0	98.8	95.3	

Aircraft Scanner			ERTS-1 Scanner	
Channel No.	Wavelength, μm		Channel No.	Wavelength, μm
1	0.375-0.405	ultraviolet		
2	0.40-0.44	ultraviolet	4	0.5-0.6
3	0.466-0.495	visible	5	0.6-0.7
4	0.53-0.58	visible	6	0.7-0.8
5	0.588-0.643	visible		
7	0.72-0.76	visible	7	0.8-1.1
8	0.770-0.81	reflective IR		
14	3.78-4.04	mixed IR		
18	8.800-9.3	thermal IR		

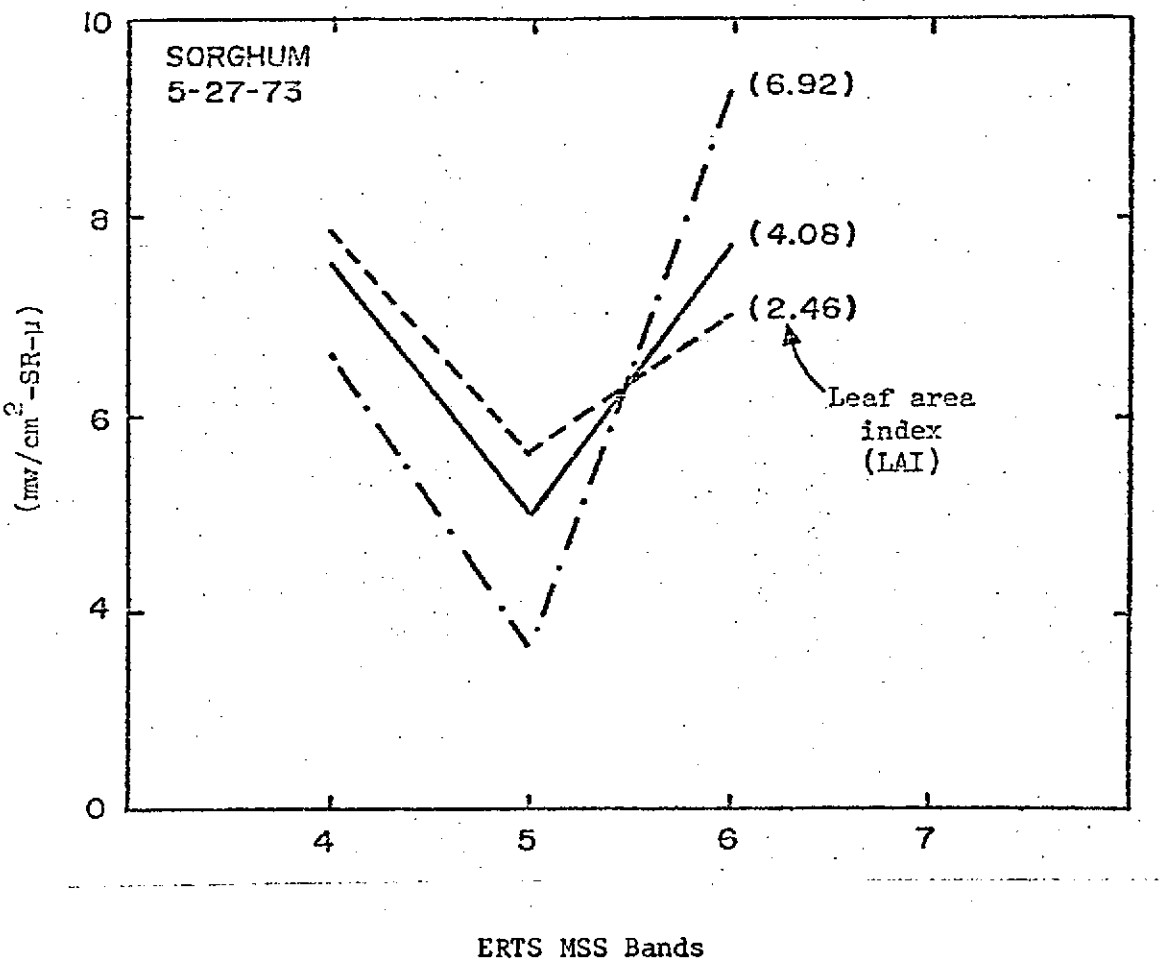

Figure 1. Radiometric response of the ERTS-1 MSS bands 4, 5, and 6 on the May 27, 1973, overpass for three sorghum fields varying in leaf area index.