AgRISTARS

SR-P2-04277
NAS9-16528
NAS9-15466
NASA-CR-167647

A Joint Program for Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing

Supporting Research

May 1982

Technical Report

LARSPEC Spectroradiometer~Multiband Radiometer Data Formats

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LARS 050182

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Star Information Form

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
SR-P2-04277		

4. Title and Subtitle	5. Report Date
LARSPEC Spectroradiometer - Multiband Radiometer Data Formats	May 1982
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
L.L. Biehl	LARS 050182

9. Performing Organization Name and Address	10. Work Unit No.
Purdue University Laboratory for Applications of Remote Sensing 1220 Potter Drive West Lafayette, IN 47906-1399	11. Contract or Grant No. NAS9-15466 & NAS9-16528

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
David E. Pitts NASA Johnson Space Center Earth Resources Research Division, Houston, TX 77058	Technical
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Development of a crops and soils field research data base was initiated in 1972 at Purdue/LARS and expanded in the fall of 1974 by the National Aeronautics and Space Administration's Johnson Space Center with the cooperation of the Department of Agriculture as a part of the Large Area Crop Inventory Experiment. More recently the data base has continued as part of the AgRISTARS Supporting Research. The primary purpose for development of the data base is to provide fully annotated and calibrated multispectral sets of spectral, agronomic, and meteorological data for agricultural remote sensing research. LARSPEC is the name of the software system available for researchers using the Purdue/LARS computer facility to retrieve and analyze the agronomic, meteorological, and spectral data in the data base.

This paper describes the data base format for agronomic, meteorological, spectroradiometer, and multiband radiometer data; lists the contents and formats of each record of data; describes the codes that are used for some of the parameters; and lists the wavelength tables.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Data Base, Remote Sensing, LACIE, Agriculture, Spectral Data	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified		

*For sale by the National Technical Information Service, Springfield, Virginia 22161

NASA - JSC

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Abstract

Development of a crops and soils field research data base was initiated in 1972 at Purdue/LARS and expanded in the fall of 1974 by the National Aeronautics and Space Administration's Johnson Space Center with the cooperation of the Department of Agriculture as a part of the Large Area Crop Inventory Experiment. More recently the data base has continued as part of the AgRISTARS Supporting Research Project. The primary purpose for development of the data base is to provide fully annotated and calibrated multispectral sets of spectral, agronomic, and meteorological data for agricultural remote sensing research. LARSPEC is the name of the software system available for researchers using the Purdue/LARS computer facility to retrieve and analyze the agronomic, meteorological, and spectral data in the data base. This paper describes the data base format for agronomic, meteorological, spectroradiometer and multiband radiometer data, lists the contents and formats of each record of data, describes the codes that are used for some of the parameters and lists the wavelength tables.

1. Introduction

Development of a crops and soils scene radiation research data base was initiated in 1972 at Purdue/LARS and expanded in the fall of 1974 by the National Aeronautics and Space Administration's Johnson Space Center with the cooperation of the Department of Agriculture as a part of the Large Area Crop Inventory Experiment (1). More recently the data base has continued as part of the AgRISTARS Supporting Research. The primary purpose for development of the data base is to provide fully annotated and calibrated multispectral sets of spectral, agronomic, and meteorological data for agricultural remote sensing research.

Since 1974, scene radiation research data have been obtained at ten test sites in Indiana, Iowa, Kansas, Nebraska, North Dakota, and South Dakota over many crops including spring and winter wheat, barley, corn, soybeans, sorghum, sunflowers, hay and pasture, and fallow ground. In addition, the data base includes laboratory measurements of 250 different soils from 39 states. The spectral measurements to date include data collected by seven different spectroradiometer and multiband radiometer systems mounted on truck and helicopter platforms. The spectral measurements include the 0.4-2.4 μm wavelength portion of the electromagnetic spectrum. Additionally, there are some spectral measurements for the 2.7 to 14.0 μm wavelength range (2).

The spectral data obtained by the spectroradiometer and multiband radiometer systems are processed into comparable units, bidirectional reflectance factor, in order to make meaningful comparisons of data acquired by the different sensors at different times and locations. The spectroradiometer and multiband radiometer systems use reflectance reference surfaces with known reflectance properties. The truck-mounted systems use 1.2 meter square painted barium sulfate panels for a reflectance reference surface and the helicopter mounted systems use a 6 x 12 meter gray canvas panel. The spectral data were obtained following well defined field procedures to produce accurate bidirectional reflectance factor measurements, e.g. no clouds in the vicinity of the sun, frequent observations of the reflectance reference panel, solar illumination angles above 45 degrees, and instrument aperture sufficiently distant from the scene (3).

The agronomic measurements in the data base include crop development stage, plant height, percent soil cover, plant population, leaf area index, leaves per plants, fresh and dry biomass, plant water content, presence and severity of stress, soil moisture, grain yield, crop species, planting date, and row direction. Some experiments include measurements which are specific to that experiment such as canopy geometry and leaf nitrogen concentration. Other measurements supporting the laboratory spectral measurements of the 250 soils include the physical and chemical characteristics of the soils.

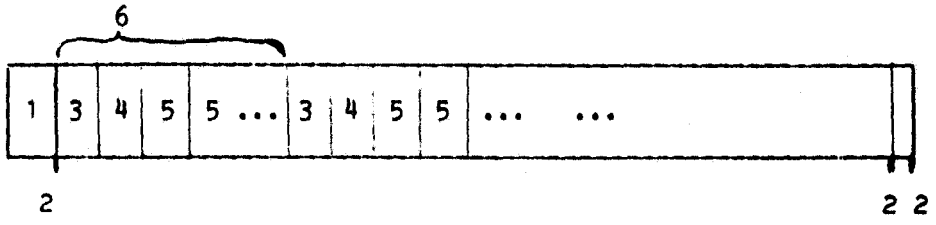
LARSPEC is the name of the software system available for researchers using the Purdue/LARS computer facility to retrieve, and analyze the agronomic, meteorological, and spectral data in the data base. The software system allows researchers to print, graph, and copy the data as required (4).

This document describes the data base format for agronomic, meteorological, spectroradiometer and multiband radiometer data. Section 2 lists the contents and formats of each record of data, section 3 describes the codes that are used for some of the parameters and section 4 lists the wavelength tables.

Periodically additional parameters may be added to the identification records (in the unused words). Therefore, this document may be updated from year to year.

2. LARSPEC Tape Format (1/26/82).

Tape Format Diagram



1. Tape identifier record
2. Tape file mark
3. Observation identification record
4. Sample group record
5. Data record
6. One complete observation

Tape Identifier

The tape identifier consists of 8 words or 32 bytes. Word 1 is the tape number in EBCDIC character format. Words 2 through 8 contain an alphanumeric character string identifying the tape use. The character string is: FIELD SPECTRORADIOMETER DATA.

Observation Identification Record

The observation ID record is a list of descriptive parameters. There are two different sets of parameters. One set is for crop descriptive information and one set is for soil descriptive information. The parameters vary in type from general such as date and time to specialized such as soil Munsell color. Not all parameters are applicable to every observation and therefore, may be unused for a given observation. There are five types of parameters with respect to format; they are: integer full word, real full word, and alphanumeric strings of lengths 4, 8, and 16 characters. In addition, there is a 148 character field for comments. The parameter positions, names, and formats are given in Tables 2-1 and 2-2.

The complete observation identification record contains 300 words or 1200 eight-bit bytes. Words which are not used or parameters which are not observed are set to hexidecimal 10000000 - termed a 'null' value.

Table 2-1. Crops Observation Identification Record

Word(s)	Name	LARSPEC Mnemonic Code	Format
1	Run sequencer	RUSE	Integer
2	Serial number	SENU	Integer
3	Experiment number	EXNU	Integer
4	Observation number	OBNU	Integer
5	Date data collected (yymmdd)	DACO	Integer
6	Month data collected	MODA	Integer
7	Day data collected	DADA	Integer
8	Year data collected	YEDA	Integer
9	Time data collected (hhmmss)	TIDA	Integer
10-13	Experiment name	EXNA	Alphanumeric (4A4)
14-17	Principal investigator	PRIN	Alphanumeric (4A4)
18-21	Scene type	SCTY	Alphanumeric (4A4)
22-25	Location	LOCA	Alphanumeric (4A4)
26	Air temperature (^{o}C)	AITE	Real
27	Barometric pressure (mmHg)	BAPR	Real
28	Relative humidity (percent)	REHU	Real
29	Cloud cover (percent)	CLCO	Integer
30	Wind speed (km/hr)	WISP	Integer
31	Visibility (kilometers)	VISI	Integer
32-35	Cloud type and altitude	CLTY	Alphanumeric (4A4)
36	Wind direction (degrees)	WIDI	Integer
37	Reformatting date (yymmdd)	REDA	Integer

Table 2-1. Crops Observation Identification Record, con't.

Word(s)	Name	LARSPEC Mnemonic Code	Format
38	Reformatting calibration code	RECA	Integer
39	Irradiance zenith angle (degrees)	IRZE	Integer
40	View zenith angle (degrees)	VIZE	Integer
41	View azimuth angle (degrees clockwise from north)	VIAZ	Integer
42	Distance to ground (meters)	DIGR	Real
43	Focal distance (meters)	FOCA	Real
44	Field of view (degrees)	FIVI	Real
45-46	Location latitude (dddmmss)	LOLA	Alphanumeric (2A4)
47-48	Location longitude (dddmmss)	LOLO	Alphanumeric (2A4)
49-50	Flight line	FLLI	Alphanumeric (2A4)
51-54	Photograph serial number	PHSE	Alphanumeric (4A4)
55	Number of sample groups	NUSG	Integer
56	Level(s) of factor 1	LOF1	Integer
57	Level(s) of factor 2	LOF2	Integer
58	Level(s) of factor 3	LOF3	Integer
59	Level(s) of factor 4	LOF4	Integer
60	Level(s) of factor 5	LOF5	Integer
61	Level(s) of factor 6	LOF6	Integer
62	Field number	FLNU	Integer
63	Replication number	RENU	Integer
64	Plot number	PLNU	Integer
65-68	Species	SPEC	Alphanumeric (4A4)

Table 2-1. Crops Observation Identification Record, con't.

Word(s)	Name	LARSPEC Mnemonic Code	Format
69-72	Variety	VARI	Alphanumeric (4A4)
73-76	Maturity	MATU	Alphanumeric (4A4)
77	Height (meters)	HEIG	Real
78	Row width (meters)	ROWI	Real
79	Plant count (per m^2)	PLCO	Real
80	Fruit count (per m^2)	FRCO	Real
81	Percent ground cover (percent)	PEGR	Integer
82	Leaves per plant	LEPL	Real
83	Leaf area index	LEAR	Real
84	Moisture stress	MOST	Alphanumeric (A4)
85	Nutrient deficiency	NUDE	Alphanumeric (A4)
86	Weedy	WEED	Alphanumeric (A4)
87	Disease infection	DIIN	Alphanumeric (A4)
88	Insect infection	ININ	Alphanumeric (A4)
89	Hail or wind damage	HAWI	Alphanumeric (A4)
90	Lodging damage	LODA	Alphanumeric (4A)
91	Other stress	OTST	Alphanumeric (A4)
92-101	Stress comments	STCO	Alphanumeric (10A4)
102-107	(not used)	-	-
108	Grain moisture content for yield measurement (percent)	GMOS	Real
109	Maturity stage - numerical	NMAT	Real
110	Crop yield (kg/ha)	YELD	Real
111	Grain test weight (kg/hectoliter)	TSWT	Real

Table 2-1. Crops Observation Identification Record, con't.

Word(s)	Name	LARSPEC Mnemonic Code	Format
112	Plant moisture weight (g/m^2)	PMOW	Real
113	Day of year data collected	JUDA	Integer
114	Days since planting	DAPL	Integer
115	Calibration table number	CATN	Integer
116	Irradiance azimuth angle (degrees clockwise from north)	IRAZ	Integer
117-118	Illumination	ILLU	Alphanumeric (2A4)
119	Latest ID update (yymmdd)	LAID	Integer
120	Row direction	RODI	Alphanumeric (A4)
121	Planting date (yymmdd)	PLDA	Integer
122	Dry biomass - total (g/m^2)	DBTO	Real
123	Dry biomass - green leaves (g/m^2)	DBGL	Real
124	Dry biomass - yellow leaves (g/m^2)	DBYL	Real
125	Dry biomass - brown leaves (g/m^2)	DBBL	Real
126	Dry biomass - stem (g/m^2)	DBST	Real
127	Dry biomass - fruit (g/m^2)	DBFR	Real
128-131	Soil series name	SENA	Alphanumeric (4A4)
132	Sand content (percent)	PESA	Real
133	Silt content (percent)	PESI	Real
134	Clay content (percent)	PECL	Real
135-138	Textural class	TEXT	Alphanumeric (4A4)
139-142	Munsell color	MUCO	Alphanumeric (4A4)

Table 2-1. Crops Observation Identification Record, con't.

Word(s)	Name	LARSPEC Mnemonic Code	Format
143-146	Moisture (field) content	MOFI	Alphanumeric (4A4)
147	Moisture (laboratory) content (%)	MOLA	Real
148-151	Surface condition	SUCO	Alphanumeric (4A4)
152	Drainage class	DRCL	Integer
153-154	Horizon	HORI	Alphanumeric (2A4)
155	Number of photogra[illegible]	PHRO	Integer
156-157	Photograph frames	PHFR	Alphanumeric (2A4)
158	Target temperature (^{o}C)	TATE	Real
159	Target length (meters)	TALE	Real
160	Target width (meters)	TAWI	Real
161	Field area (hectares)	FIAR	Real
162	Plant moisture (percent)	PLMO	Integer
163	Leaf condition - percent green	GRLE	Integer
164	Leaf condition - percent yellow	YELE	Integer
165	Leaf condition - percent brown	BRLE	Integer
166	Emergence date (yymmdd)	EMDA	Integer
167	Dry biomass - weeds (g/m^2)	DBWE	Real
168	Fresh biomass - total (g/m^2)	FRBI	Real
169	(not used)	-	-
170	Experimenter's parameter 01	EP01	Real
171	Experimenter's parameter 02	EP02	Real
172	Experimenter's parameter 03	EP03	Real
173	Experimenter's parameter 04	EP04	Real

Table 2-1. Crops Observation Identification Record, con't.

Word(s)	Name	LARSPEC Mnemonic Code	Format
174	Experimenter's parameter 05	EP05	Real
175	Experimenter's parameter 06	EP06	Real
176	Experimenter's parameter 07	EP07	Real
177	Experimenter's parameter 08	EP08	Real
178	Experimenter's parameter 09	EP09	Real
179	Experimenter's parameter 10	EP10	Real
180	Radiant Temperature (°C)	RATE	Real
181	Wet bulb temperature (°C)	WBTE	Real
182-183	Data quality factor 1 (wavelength, coefficient of variation)	DQF1	2*Real
184-185	Data quality factor 2 (wavelength, coefficient of variation)	DQF2	2*Real
186-187	Data quality factor 3 (wavelength, coefficient of variation)	DQF3	2*Real
188-189	Data quality factor 4 (wavelength, coefficient of variation)	DQF4	2*Real
190-191	Data quality factor 5 (wavelength, coefficient of variation)	DQF5	2*Real
192-193	Data quality factor 6 (wavelength, coefficient of variation)	DQF6	2*Real
194-195	Data quality factor 7 (wavelength, coefficient of variation)	DQF7	2*Real
196-[illegible]	Facility name	FANA	Alphanumeric (4A4)
200-[illegible]	Comments	COMM	Alphanumeric (37A4)
237-240	Instrument name	INNA	Alphanumeric (4A4)
241	Scan rate (scans/second)	SCRA	Real
242	Reflective wavelength calibration observation ?	CAOB	Integer

Table 2-1. Crops Observation Identification Record, con't.

Word(s)	Name	LARSPEC Mnemonic Code	Format
243	(not used)	-	-
244	High square wave voltage level	HISQ	Real
245	Low square wave voltage level	LOSQ	Real
246	Thermal wavelength calibration observation 1	TC01	Integer
247	Thermal wavelength calibration observation 2	TC02	Integer
248	Observation identification record set	RIRF	Integer
249	Level(s) of factor 7	LOF7	Integer
250	Level(s) of factor 8	LOF8	Integer
251-254	Previous land use	PUSE	Alphanumeric (4A4)
255-260	(not used)	-	-
261	Instrument type	INST	Integer
262	Uncalibrated data flag	UNCA	Integer
263	Reflective wavelength calibration observation 2	COB2	Integer
264-300	(not used)	-	-

Table 2-2. Soils Observation Identification Record.

Word(s)	Name	LARSPEC Mnemonic Code	Format
1	Run sequencer	RUSE	Integer
2	Serial number	SENU	Integer
3	Experiment number	EXNU	Integer
4	Observation number	OBNU	Integer
5	Date data collected (yymmdd)	DACO	Integer
6	Month data collected	MODA	Integer
7	Day data collected	DADA	Integer
8	Year data collected	YEDA	Integer
9	Time data collected (hhmmss)	TIDA	Integer
10-13	Experiment name	EXNA	Alphanumeric (4A4)
14-17	Principal investigator	PRIN	Alphanumeric (4A4)
18-21	Scene type	SCTY	Alphanumeric (4A4)
22-25	Location	LOCA	Alphanumeric (4A4)
26	Air temperature (^{o}C)	AITE	Real
27	Barometric pressure (mmHg)	BAPR	Real
28	Relative humidity (percent)	REHU	Real
29	Cloud cover (percent)	CLCO	Real
30	Wind speed (km/hr)	WISP	Integer
31	Visibility (kilometers)	VISI	Integer
32-35	Cloud type and altitude	CLTY	Alphanumeric (4A4)
36	Wind direction (degrees)	WIDI	Integer
37	Reformatting date (yymmdd)	REDA	Integer
38	Reformatting calibration code	RECA	Integer

Table 2-2. Soils Observation Identification Record, con't.

Word(s)	Name	LARSPEC Mnemonic Code	Format
39	Irradiance zenith angle (degrees)	IRZE	Integer
40	View zenith angle (degrees)	VIZE	Integer
41	View azimuth angle (degrees clockwise from north)	VIAZ	Integer
42	Distance to ground (meters)	DIGR	Real
43	Focal distance (meters)	FOCA	Real
44	Field of view (degrees)	FIVI	Real
45-46	Location latitude (dddmmss)	LOLA	Alphanumeric (2A4)
47-48	Location longitude (dddmmss)	LOLO	Alphanumeric (2A4)
49-50	Flightline	FLLI	Alphanumeric (2A4)
51-54	Photograph serial number	PHSE	Alphanumeric (4A4)
55	Number of sample groups	NUSG	Integer
56	Level(s) of factor 1	LOF1	Integer
57	Level(s) of factor 2	LOF2	Integer
58	Level(s) of factor 3	LOF3	Integer
59	Level(s) of factor 4	LOF4	Integer
60	Level(s) of factor 5	LOF5	Integer
61	Level(s) of factor 6	LOF6	Integer
62	Soil order	ORDR	Alphanumeric (A4)
63	Soil suborder	SUBO	Alphanumeric (A4)
64-65	Soil great group	GRGR	Alphanumeric (2A4)
66	Particle size class	PASI	Integer
67	Contrasting particle size class	COPA	Integer

Table 2-2. Soils Observation Identification Record, con't.

Word(s)	Name	LARSPEC Mnemonic Code	Format
68	Mineralogy class	MICL	Integer
69	Other taxonomic modifiers	OMOD	Integer
70-71	Temperature regime	TERE	Alphanumeric (2A4)
72-73	Moisture zone	MOZO	Alphanumeric (2A4)
74	Slope class	SLOP	Integer
75	Erosion phase	EROS	Integer
76	Physiographic position	PHYS	Integer
77	Parent material	PAMA	Integer
78-81	Subgroup name	SUNA	Alphanumeric (4A4)
82	Year soil sample collected	YEAR	Integer
83	State abbreviation	STAB	Alphanumeric (A4)
84	County code	COCO	Integer
85	Multiple sampling number	MSNU	Integer
86	Consecutive sampling number	CSNU	Integer
87	Soil testing lab number	STLN	Integer
88	Organic carbon (percent)	ORCA	Real
89	Water pH	WAPH	Real
90	Buffer pH	BUPH	Real
91	Calcium (meq/100g)	CALC	Real
92	Magnesium (meq/100g)	MAGN	Real
93	Sodium (meq/100g)	SODI	Real
94	Potassium (meq/100g)	POTA	Real
95	Extractable acidity (meq/100g)	EXAC	Real

Table 2-2. Soils Observation Identification Record, con't.

Word(s)	Name	LARSPEC Mnemonic Code	Format
96	Cation exchange capacity	CAEX	Real
97	Base saturation (percent)	BASA	Integer
98	Iron oxide (percent)	IRON	Real
99	Aluminum oxide (percent)	ALUM	Real
100	Manganese oxide (percent)	MANG	Real
101	Silicon dioxide (percent)	SILI	Real
102	Available phosphorous (kg/hectare)	AVPH	Integer
103	Available potassium (kg/hectare)	AVPO	Integer
104	Soil moisture tension (bars)	MOTE	Real
105	USDA Sand content (percent)	SAND	Real
106	USDA Silt content (percent)	SILT	Real
107	USDA Clay content (percent)	CLAY	Real
108	USDA Very coarse sand (percent)	VCSA	Real
109	USDA Coarse sand (percent)	COSA	Real
110	USDA Medium sand (percent)	MESA	Real
111	USDA Fine sand (percent)	FISA	Real
112	USDA Very fine sand (percent)	VFSA	Real
113	Day of year data collected	JUDA	Integer
114	(not used)	-	-
115	Calibration table number	CATN	Integer
116	Irradiance azimuth angle (degrees clockwise from north)	IRAZ	Integer
117-118	Illumination	ILLU	Alphanumeric (2A4)
119	Latest ID update (yymmdd)	LAID	Integer

Table 2-2. Soils Observation Identification Record, con't.

Word(s)	Name	LARSPEC Mnemonic Code	Format
120	USDA Coarse silt (percent)	COSI	Real
121	(not used)	-	-
122	Electrical conductivity (mmhos/cm)	ELCO	Real
123	Erosion factor (k)	ERFA	Real
124	Wind erodibility group	WIER	Integer
125	Engineering lab number	ELNU	Integer
126	Sample portion	SAPO	Real
127	Liquid limit	LILI	Integer
128-131	Soil series name	SENA	Alphanumeric (4A4)
132	Plastic limit	PLLI	Integer
133	Activity	ACTI	Integer
134	Liquidity index	LIIN	Integer
135-138	Textural class	TEXT	Alphanumeric (4A4)
139-142	Munsell color (moist)	MUCO	Alphanumeric (4A4)
143	Shrinkage limit	SHLI	Integer
144	Shrinkage ratio	SHRA	Real
145	Volumetric shrinkage	VOSH	Real
146	Linear shrinkage	LISH	Real
147	Compression index	COIN	Real
148	ASTM Medium sand (percent)	MSAN	Real
149	ASTM Fine sand (percent)	FSAN	Real
150	ASTM Fines (percent)	FINE	Real
151	Specific gravity (g/cm^3)	SPGR	Real
152	Drainage class	DRCL	Integer

Table 2-2. Soils Observation Identification Record, con't.

Word(s)	Name	LARSPEC Mnemonic Code	Format
153-154	Horizon	HORI	Alphanumeric (2A4)
155	Photograph roll number	PHRO	Integer
156-157	Photograph frames	PHFR	Alphanumeric (2A4)
158-159	AASHO soil classification	ASHO	Alphanumeric (2A4)
160-169	Surface description	SUDE	Alphanumeric (10A4)
170	Experimenter's parameter 01	EP01	Real
171	Experimenter's parameter 02	EP02	Real
172	Experimenter's parameter 03	EP03	Real
173	Experimenter's parameter 04	EP04	Real
174	Experimenter's parameter 05	EP05	Real
175	Experimenter's parameter 06	EP06	Real
176	Experimenter's parameter 07	EP07	Real
177	Experimenter's parameter 08	EP08	Real
178	Experimenter's parameter 09	EP09	Real
179	Experimenter's parameter 10	EP10	Real
180	Radiant temperature (°C)	RATE	Real
181	Wet bulb temperature (°C)	WBTE	Real
182-183	Data quality factor 1 (wavelength, coefficient of variation)	DQF1	2*Real
184-185	Data quality factor 2 (wavelength, coefficient of variation)	DQF2	2*Real
186-187	Data quality factor 3 (wavelength, coefficient of variation)	DQF3	2*Real
188-189	Data quality factor 4 (wavelength, coefficient of variation)	DQF4	2*Real
190-191	Data quality factor 5 (wavelength, coefficient of variation)	DQF5	2*Real

Table 2-2. Soils Observation Identification Record, con't.

Word(s)	Name	LARSPEC Mnemonic Code	Format
192-193	Data quality factor 6 (wavelength, coefficient of variation)	DQF6	2*Real
194-195	Data quality factor 7 (wavelength, coefficient of variation)	DQF7	2*Real
196-199	Facility name	FANA	Alphanumeric (4A4)
200-236	Comments	COMM	Alphanumeric (37A4)
237-240	Instrument name	INNA	Alphanumeric (4A4)
241	Scan rate (scans/second)	SCRA	Real
242	Reflective wavelength calibration observation 1	CAOB	Integer
243	Unified soil classification	UNIF	Alphanumeric (A4)
244	High square wave voltage level	HISQ	Real
245	Low square wave voltage level	LOSQ	Real
246	Thermal calibration observation 1	TCO1	Integer
247	Thermal calibration observation 2	TCO2	Integer
248	Observation identification record set	RIRF	Integer
249	Soil elevation (meters)	SOEL	Integer
250	Experimenter's parameter 11	EP11	Real
251	Experimenter's parameter 12	EP12	Real
252	Experimenter's parameter 13	EP13	Real
253	Water content (percent)	WACO	Real
254	Bulk density (g/cm^3)	BUDF	Real
255	Plasticity index	PLIN	Integer
256	USDA Fine silt (percent)	FISI	Real
257	Munsell color hue 1 (moist)	HUE1	Real

Table 2-2. Soils Observation Identification Record, con't.

Word(s)	Name	LARSPEC Mnemonic Code	Format
258	Munsell color hue 2 (moist)	HUE2	Alphanumeric (4A4)
259	Munsell color value (moist)	VALU	Real
260	Munsell color chroma (moist)	CHRO	Real
261	Instrument type	INST	Integer
262	Uncalibrated data flag	UNCA	Integer
263	Reflective wavelength calibrated observation 2	COB2	Integer
264-300	(not used)	-	-

Sample Group Record (Radiometer Type Instrument)

The sample group record for radiometer type data contains the detector name, detector range (gain), detector equilization (filter), number of samples in the sample group (=1), the spectral band wavelength limits, the calibrated data value for band, the uncalibrated data value for band, and the sample group or wavelength band number. There are 10 words of information for each sample group (or wavelength band). The number of sample groups is given in the identification record (word 55). The sample group record contains ID(55)*10 words or ID(55)*10*4 bytes. Words which have no data are set to hexidecimal 10000000. The words, names, and formats are given in Table 2-3.

Table 2-3. Description of sample group record for radiometer type data.

Word(s)	Name	LARSPEC Mnemonic Code	Format
1-2	Detector name	DENA	Alphanumeric (2A4)
3	Detector range	DERA	Real
4	Detector equilization	DEEQ	Real
5	Number of samples (=1)	NUSA	Integer
6	Lower wavelength band limit (μm)	WABA	Real
7	Upper wavelength band limit (μm)	WABA	Real
8	Calibrated data value	-	Real
9	Uncalibrated data value	-	Real
10	Sample group	-	Integer
11-M			

Where M = ID(55)*10. Repeat words 1-10 for ID(55) sample groups.

Sample Group Record (Spectroradiometer Type Instrument)

The sample group record for spectroradiometer type data contains information describing the detector name, detector range (gain), detector equilization (filter), number of samples in the sample group, the wavelength coefficients, and the sample group number. There are 10 words of information for each sample group. The number of sample groups is given in the identification record (word 55). The sample group record contains ID(55)*10 words or ID(55)*10*4 bytes. Words which have no data are set to hexidecimal 10000000.

There are two ways to describe the wavelengths for the data samples. One way is applicable for a linear array of wavelengths for a given sample group and one way is applicable for a non-linear array of wavelengths.

Details of the sample group record for spectroradiometer are given in Table 2-4.

Table 2-4. Description of sample group record for spectroradiometer type data.

Word(s)	Name	LARSPEC Mnemonic Code	Format
	Linear array of wavelengths		
1-2	Detector name	DENA	Alphanumeric (2A4)
3	Detector range	DERA	Real
4	Detector equalization	DEEQ	Real
5	Number of samples	NUSA	Integer
6	Initial wavelength value for sample group minus one increment	WABA	Real
7	Wavelength increment between samples	WABA	Real
8	(not used)	-	-
9	(not used)	-	-
10	Sample group number	-	Integer
11-M			
	Non-linear array of wavelengths		
1-2	Detector name	DENA	Alphanumeric (2A4)
3	Detector range	DERA	Real
4	Detector equalization	DEEQ	Real
5	Number of samples	NUSA	Integer
6	Initial wavelength value for sample group	WABA	Real
7	Last wavelength value for sample group	WABA	Real
8	Wavelength table number. See section 4.	-	Real
9	Code indicating that wavelengths are described in a table (=-2.)	-	Real
10	Sample group number	-	Integer
11-M			

Where M = ID(55)*10. Repeat words 1-10 for ID(55) sample groups in order of appearance in data records.

Data Records (Spectroradiometer Type Instrument)

Data records for spectroradiometer type data follow their corresponding observation identification and sample group records. There are no data records, as such, for radiometer type data. One data record follows for each detector sample group defined in the sample group record and in the order defined, Table 2-5. Each record contains a record sequence number and calibrated data values in 4 byte floating point format.

Table 2-5. Description of data records

Word(s)	Contents	Format
1	Zero	Integer
2	Data record sequence number. This is the sequence number of the data record. The first data record after the sample groups record will be 1, the second will be 2, etc. If the data in the record have been lost, the number will be negative.	Integer
3-M	Where M=NS+2 and NS is the number of floating point calibrated data values given in sample group word 5, 15, 25, etc. Data values are set to -1. if no information is available for particular wavelengths.	Real

3. LARSPEC Identification Record Codes.

Some of the parameters in the identification record contain codes which describe the observation. There are some coded parameters which apply to all data and some which apply to only a particular experiment such as 'Levels of Factor 1' or 'Experimenter Parameter'. The coded parameters which apply to all data are described in this section. Coded parameters which apply to a particular experiment are described in the 'Experiment Summary' for that experiment.

The parameters which are coded for the crops and soils identification records are listed in Table 3-1 along with the number of the table which describes the codes.

Table 3-1. Coded parameters for crops and soils identification records (ID) which apply to all data.

ID Words	Parameter Name	LARSPEC Mnemonic Code	Description Table Number
	Crops ID Record		
2	Serial number	SENU	3-2
38	Reformatting calibration code	RECA	3-3
135-138	Soil textural class	TEXT	3-4
152	Drainage class	DRCL	3-5
248	Identification record set	RIRF	3-6
261	Instrument type	INST	3-7
	Soils ID Record		
2	Serial number	SENU	3-2
38	Reformatting calibration code	RECA	3-3
62	Soil order	ORDR	3-8
66	Particle size class	PASI	3-9
67	Contrasting particle size class	COPA	3-10
68	Mineralogy class	MICL	3-11
69	Other taxonomic modifiers	OMOD	3-12
70-71	Temperature regime	TERE	3-13
74	Slope class	SLOP	3-14
75	Erosion phase	EROS	3-15
76	Physiographic position	PHYS	3-16
77	Parent material	PAMA	3-17
135-138	Soil textural class	TEXT	3-4
152	Drainage class	DRCL	3-5
248	Identification record set	RIRF	3-6
261	Instrument type	INST	3-7

Table 3-2. Descriptions of codes for serial number.

The 'ones' column represents specific versions of the calibrated spectral data. For example the data from the Exotech 20C in its original wavelength format may be coded as 0 in the 'ones' column of the serial number. The spectral data after being averaged into .01 μm bands may be coded as 6 in the 'ones' column of the serial number. The 'hundreds' and 'tens' columns of the serial number is a two digit number which is a code for the specific instrument used to collect the spectral data. See below.

Code	Instrument
00	Exotech Model 20C spectroradiometer
01	Exotech Model 20D spectroradiometer
02	FSS or S191H spectroradiometer
03	FSAS or VISS interferometer
04	Exotech Model 100A (SN 3434) multiband radiometer
05	Exotech Model 100A (SN 3431) multiband radiometer
06	Barnes PRT-5 (SN 161) radiometer
07	Barnes PRT-6
08	Clevenger spectroradiometer
09	Barnes Model 12-1000 (prototype) multiband radiometer
10	Barnes Model 12-1000 (SN 0102) multiband radiometer
11	Barnes Model 12-1000 (SN 0103) multiband radiometer
12	Barnes Model 12-1000 (SN 0104) multiband radiometer
13	Barnes Model 12-1000 (SN 0105) multiband radiometer
14	Barnes Model 12-1000 (SN 0106) multiband radiometer
15	Barnes Model 12-1000 (SN 0107) multiband radiometer
16	Barnes Model 12-1000 (SN 0108) multiband radiometer
17	Barnes Model 12-1000 (SN 0109) multiband radiometer
18	Barnes Model 12-1000 (SN 0110) multiband radiometer
19	Barnes Model 12-1000 (SN 0111) multiband radiometer
20	Barnes Model 12-1000 (SN 0114) multiband radiometer
21	Barnes Model 12-1000 (SN 0115) multiband radiometer
22	Barnes Model 12-1000 (SN 0116) multiband radiometer
23	Barnes Model 12-1000 (SN 0118) multiband radiometer
24	Barnes Model 12-1000 (SN 0117) multiband radiometer

Table 3-3. Description of reformatting calibration codes.

Code	Description
	Reflectance (Bidirectional Reflectance Factor)
1	Direct scene to reference comparison
2	Scene to reference comparison with solar port transfer
3	Scene to reference comparison with sun angle correction
11	Direct scene to reference comparison with field of view transfer
12	Scene to reference comparison with solar port transfer and field of view transfer
13	Scene to reference comparison with sun angle correction and field of view transfer
23	Scene to interpolated reference comparison obtained from reference surface observations collected before and after scene observation.
33	Scene to interpolated reference comparison obtained from reference surface observations collected before and after scene observations and with field of view transfer.
	Irradiance ($\mu W\ cm^{-2}\ \mu m^{-1}$)
4	Irradiance calculated using most recent irradiance table
5	Scene to irradiance calibration lamp comparison
	Irradiance Table ($\mu W\ cm^{-2}\ \mu m^{-1}\ volt^{-1}$)
24	Instrument irradiance table

Table 3-3. Description of reformatting calibration codes, cont'd.

Code	Description
	Reflective Radiance ($\mu W\ cm^{-2}\ \mu m^{-1}\ sr^{-1}$)
6	Radiance calculated using most recent radiance table
7	Scene to radiance calibration lamp comparison
16	Radiance calculated using most recent radiance table and field of view transfer
	Reflective Radiance Table ($\mu W\ cm^{-2}\ \mu m^{-1}\ sr^{-1}\ volt^{-1}$)
26	Instrument radiance table
	Emissive Radiance ($\mu W\ cm^{-2} \mu m^{-1}\ sr^{-1}$)
8	Radiance computed using cold and hot calibration blackbodies
	Other Calibration
9	Ratio of two runs (percent)
10	Wavelength calibration

Table 3-4. Description of codes for textural class.

Code	Textural Class Names
COARSE SAND	Coarse Sand
SAND	Sand
F. SAND	Fine Sand
V. F. SAND	Very Fine Sand
L. COARSE SAND	Loamy Coarse Sand
L. SAND	Loamy Sand
L. F. Sand	Loamy Fine Sand
L. V. F. SAND	Loamy Very Fine Sand
COARSE SANDY LOAM	Coarse Sandy Loam
SANDY LOAM	Sandy Loam
F. SANDY LOAM	Fine Sandy Loam
V. F. SANDY LOAM	Very Fine Sandy Loam
LOAM	Loam
SILT LOAM	Silt Loam
SILT	Silt
SANDY CLAY LOAM	Sandy Clay Loam
CLAY LOAM	Clay Loam
SILTY CLAY LOAM	Silty Clay Loam
SANDY CLAY	Sandy Clay
SILTY CLAY	Silty Clay
CLAY	Clay
MUCK	Muck

Table 3-5. Description of codes for drainage class.

Code	Drainage Class
0	Very poorly drained
1	Poorly drained
2	Imperfectly or somewhat poorly drained
3	Moderately well drained
4	Well drained
5	Somewhat excessively drained
6	Excessively drained

Table 3-6. Description of codes for identification record set.

Code	Description
1	Crops identification record
2	Soils identification record

Table 3-7. Description of codes for instrument type.

Code	Description
Hexidecimal '10000000'	Spectroradiometer instrument
1	Multiband radiometer instrument

Table 3-8. Description of codes for soil order.

Code	Soil Order
ALF	Alfisol
ID	Aridisol
ENT	Entisol
IST	Histosol
EPT	Inceptisol
OLL	Mollisol
OX	Oxisol
OD	Spodosol
ULT	Ultisol
ERT	Vertisol

Table 3-9. Description of codes for particle size class.

Code	Particle Size Class
1	Fragmental
2	Sandy-skeletal
3	Loamy skeletal
4	Clayey-skeletal
5	Sandy
6	Loamy
7	Coarse-loamy
8	Fine-loamy
9	Coarse-silty
10	Fine-silty
11	Clayey
12	Fine
13	Very-fine

Table 3-10. Description of codes for contrasting particle size classes.

Code	Contrasting Particle Size Class
1	Cindery over sandy or sandy-skeletal
2	Cindery over loamy
3	Sandy-skeletal over loamy if the loamy material has <50 percent fine or coarser sand
4	Sandy over loamy if the loamy material has <50 percent fine or coarser sand
5	Sandy over clayey
6	Ashy over cindery
7	Ashy over loamy-skeletal
8	Ashy over loamy
9	Loamy-skeletal over fragmental
10	Loamy-skeletal over sandy
11	Loamy-skeletal over clayey if there is an absolute difference of >25 percent in the percentages of clay in the fine earth fractions
12	Clayey-skeletal over sandy
13	Medial over fragmental
14	Medial over cindery
15	Medial over sandy or sandy-skeletal
16	Medial over loamy-skeletal
17	Medial over loamy
18	Medial over clayey
19	Medial over thixotropic
20	Coarse-loamy over fragmental
21	Coarse-loamy over sandy or sandy-skeletal if the coarse-loamy material has <50 percent fine or coarser sand
22	Loamy over sandy or sandy-skeletal if the loamy material has <50 percent fine or coarser sand
23	Coarse-loamy over clayey
24	Coarse-silty over sandy or sandy-skeletal
25	Coarse-silty over clayey
26	Fine-loamy over framental
27	Fine-loamy over sandy or sandy-skeletal
28	Fine-loamy over clayey if there is an absolute difference of >25 percent in the percentage of clay
29	Fine-silty over fragmental
30	Fine-silty over sandy or sandy-skeletal
31	Fine-silty over clayey if there is an absolute difference of >25 percent in the percentages of clay
32	Clayey over fragmental
33	Clayey over sandy or sandy-skeletal
34	Clayey over loamy-skeletal if there is an absolute difference of >25 percent in the percentages of clay in the fine-earth fraction

Table 3-10. Description of codes for contrasting particle size classes, con't.

Code	Contrasting Particle Size Class
35	Clayey over loamy if there is an absolute difference of >25 percent in percentages of clay
36	Clayey over fine-silty if there is an absolute difference of >25 percent in the percentages of clay
37	Thixotropic over fragmental
38	Thixotropic over sandy or sandy-skeletal
39	Thixotropic over loamy-skeletal
40	Thixotropic over loamy

Table 3-11. Description of codes for mineralogy class.

Code	Mineralogy Class
1	Mixed
2	Carbonatic
3	Ferritic
4	Gibbsitic
5	Oxidic
6	Serpentinitic
7	Gypsic
8	Glauconitic
9	Micaceous
10	Siliceous
11	Halloysitic
12	Kaolinitic
13	Montmorillonitic
14	Illitic
15	Vermiculitic
16	Chloritic
17	Ferrihumic
18	Coprogenous
19	Diatomaceous
20	Marly

Table 3-12. Description of codes for other taxonomic modifiers.

Code	Other Taxonomic Modifiers
Calcareous and reaction classes	
1	Calcareous
2	Noncalcareous
3	Acid
4	Nonacid
Depth of soil	
5	Micro
6	Shallow
Consistence	
7	Ortstein
8	Noncemented
Classes of coatings (on sands)	
9	Coated
10	Uncoated
Reaction classes of Histosols	
11	Euic
12	Dysic
Modifiers that replace names of particle-size classes	
13	Cindery
14	Ashy
15	Ashy-skeletal
16	Medial
17	Medial-skeletal
18	Thixotropic
19	Thixotropic-skeletal

Table 3-13. Description of codes for temperature regime.

Code	Temperature Regime
PERGELIC	Pergelic
CRYIC	Cryic
FRIGID	Frigid
MESIC	Mesic
THERMIC	Thermic
HTHERMIC	Hyperthermic
IFRIGID	Isofrigid
IMESIC	Isomesic
ITHERMIC	Isothermic
IHTHERM	Isohyperthermic

Table 3-14. Description of codes for slope class.

Code	Slope Class
1	A class slope (0% to 1-3%)
2	B class slope (1-3% to 5-8%)
3	C class slope (5-8% to 10-16%)
4	D class slope (10-16% to 20-30%)
5	E class slope (20-30% to 45-65%)
6	F class slope (45-65% or higher)

Table 3-15. Description of codes for erosion phase.

Code	Erosion Phase
0	Uneroded soil
1	Slightly eroded
2	Moderately eroded
3	Severely eroded
4	Depositional

Table 3-14. Description of codes for slope class.

Code	Slope Class
1	A class slope (0% to 1-3%)
2	B class slope (1-3% to 5-8%)
3	C class slope (5-8% to 10-16%)
4	D class slope (10-16% to 20-30%)
5	E class slope (20-30% to 45-65%)
6	F class slope (45-65% or higher)

Table 3-15. Description of codes for erosion phase.

Code	Erosion Phase
0	Uneroded soil
1	Slightly eroded
2	Moderately eroded
3	Severely eroded
4	Depositional

Table 3-16. Description of codes for physiographic position.

Code	Physiographic Position
1	Floodplains
2	Terrace
3	Upland
4	Depression

Table 3-17. Description of codes for parent material.

Code	Parent Material
	Weathering of Hard Rocks in Place--Residuum
1 -	Igneous
2 -	Granite
3 -	Syenite
4 -	Basalt
5 -	Andesite
6 -	Diabase
7 -	Rhyolite
8 -	Sedimentary
9 -	Limestone
10 -	Sandstone
11 -	Siltstone
12 -	Shale
13 -	Conglomerate
14 -	Metamorphic
15 -	Gneiss
16 -	Schist
17 -	Slate
18 -	Marble
19 -	Quartzite
20 -	Phyllite
21 -	Soft Rock--Residuum
22 -	Marl and soft limestone
23 -	Ash and cinderstone
24 -	Caliche
25 -	Chalk
	Transported Materials
26 -	Alluvium
27 -	Local non-calcareous
28 -	Local calcareous
29 -	General non-calcareous
30 -	General calcareous

Table 3-17. Description of codes for parent material, con't.

Code	Parent Material
	Transported Materials (con't.)
31	Colluvium
32	Lacustrine non-calcareous
33	Lacustrine calcareous
34	Marine sediments
35	Beach deposits
36	Loess
37	Eolian sands
38	General Eolian sediments
39	Glacial drift
	40 - Till
	41 - Till calcareous
	42 - Coarse textured, loose porous till
	43 - Sandy with some gravel
	44 - Medium textured, gritty
	45 - Medium textured, silty, relatively free of grit
	46 - Fine textured with a predominance of silt and clay
	47 - Glaciofluvial deposits
	48 - Glacial outwash
	49 - Glaciolacustrine materials
	50 - Varves
51	Organic materials
52	Loamy sediments
53	Silty sediments
54	Calcareous silt loam
55	Marsh deposits
56	Pedisediments

4. Sample Group Wavelength Tables

The sample group wavelength tables define the wavelengths for a nonlinear wavelength group of data. The wavelengths table are given in Table 4-1. The format of the wavelength table file that the LARSPEC software system uses is given in Table 4-2. A copy of the wavelength table file is given in Table 4-3.

Table 4.1. List of current sample group wavelength table.

Data Sample Number	Table Number*			
	1	2	3	4
			μm	
1	.415	.418	8.25	.418
2	.434	.435	8.75	.435
3	.454	.454	9.25	.454
4	.473	.473	9.75	.473
5	.494	.492	10.25	.492
6	.514	.512	10.75	.512
7	.535	.533	11.25	.533
8	.557	.554	11.75	.554
9	.579	.577	12.25	.577
10	.602	.599	12.75	.599
11	.625	.623	13.25	.623
12	.649	.648	13.75	.648
13	.673	.673		.673
14	.699	.700		.700
15	.725	.720		.720
16	.732	.736		.736
17	.751	.756		.756
18	.771	.775		.775
19	.790	.794		.794
20	.809	.813		.813
21	.827	.833		.833
22	.846	.852		.852
23	.864	.871		.871
24	.882	.890		.890
25	.900	.909		.909
26	.918	.928		.928
27	.936	.947		.947
28	.954	.966		.966
29	.971	.984		.984
30	1.000	1.017		1.017
31	1.019	1.038		1.038
32	1.038	1.058		1.038
33	1.056	1.079		1.079
34	1.074	1.100		1.100

*Table 1. 1974-75 reflective FSS data
Table 2. 1976-79 reflective FSS data
Table 3. 1974-81 thermal FSS data
Table 4. 1980-81 reflective FSS data

Table 4.1. List of current sample group wavelength tables (con't.).

Data Sample Number	Table Number		
	1	2	3	4
		μm	
35	1.105	1.135	1.135
36	1.149	1.185	1.185
37	1.191	1.234	1.234
38	1.231	1.283	1.283
39	1.325	1.325	1.325
40	1.375	1.375	1.375
41	1.425	1.425	1.425
42	1.475	1.475	1.475
43	1.525	1.525	1.525
44	1.575	1.575	1.575
45	1.625	1.625	1.625
46	1.675	1.675	1.675
47	1.725	1.725	1.725
48	1.775	1.775	1.775
49	1.825	1.825	1.825
50	1.875	1.875	1.875
51	1.925	1.925	1.925
52	1.975	1.975	1.975
53	2.025	2.025	2.025
54	2.075	2.075	2.075
55	2.125	2.125	2.125
56	2.175	2.175	2.175
57	2.225	2.225	2.225
58	2.275	2.275	2.275
59	2.325	2.325	2.325
60	2.375	2.375	2.375

Table 4.2. Format of wavelength table file that LARSPEC software system uses.

Columns	Parameter	Format
	Table Identifier Card	
1-2	Card Identifier - 'TB'	A2
3	- Blank -	-
4-6	Table Number	I3
7	- Blank -	-
8-10	Number of samples	I4
11	- Blank -	-
12-19	Minimum wavelength	F8.4
20	- Blank -	-
21-28	Maximum wavelength	F8.4
29	- Blank -	-
30-32	Wavelength units -06 = μm -03 = mm -02 = cm -09 = nm -10 = angstroms	I3
33	- Blank -	-
34-80	Descripter Information	11A4,A3
	Band Center Wavelength Cards	
1-2	Card identifier - 'CN'	A2
3	- Blank -	-
4-75	Band Center wavelengths in order	9F8.4
	Band Start Wavelength Cards	
1-2	Card identifier - 'ST'	A-2
3	- Blank -	-
4-75	Band start wavelengths	9F8.4
	Band End Wavelength Cards	
1-2	Card Identifier - 'EN'	A2
3	- Blank -	-
4-75	Band End Wavelengths	9F8.4

5. References

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