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THE SCREWWORM ERADICATION DATA SYSTEM ARCHIVES

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HOUSTON, TEXAS 77058

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PREFACE

For the benefit of persons not associated with the National Aeronautics and Space Administration, the data accumulated during development of the satellite temperature-monitoring system, which served as a basis for the Screwworm Eradication Data System, are described. The main archives consist of daily mean air temperatures (registered to a predetermined grid) and raw radiometric temperature data for the spring and fall of 1975; values are given at 4- and 1-kilometer intervals, respectively, on a grid that includes almost all Mexico except the Yucatan Peninsula and portions south of Tehuantepec. Other items include cloud-free composite infrared and visible images, altitude data in image format, and some historical data. All items are described and some potential uses are listed; all these data are available to the general public.

THE SCREWWORM ERADICATION DATA SYSTEM ARCHIVES

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SUMMARY

This report acquaints potential users with the archives accumulated during 1 year of operation of the satellite temperature-monitoring system during development of the Screwworm Eradication Data System. Brief descriptions of all the kinds of tapes, as well as their potential uses, are presented. Reference is made to other documents that explain the generation of these data.

INTRODUCTION

The Health Applications Group, NASA Lyndon B. Johnson Space Center (JSC)[1] in cooperation with the National Commission of Outer Space of Mexico and the U.S. Department of Agriculture, has developed a unique satellite temperature-monitoring system. Although this system was developed expressly for assisting screwworm eradication control activities, it has furnished data that may be useful to many other projects.

This report is designed to acquaint potential users with the archives accumulated during 1 year of operation of this system. This report concentrates on the bulk of the archives, which consists of computer tapes of daily temperatures and secondary products, but it also describes ancillary materials developed in the same project. Descriptions are sufficiently detailed to enable use of the tapes as received. In addition, extensive references are made to the very detailed reports archived at the Health Applications Office, most of which, as public documents, are normally available in microform through the National Technical Information Service (NTIS)[2].

The great bulk of the archives, here called the main archives, consists of computer-compatible tapes accumulated during two periods of operation in 1975: March 15 through June 27 and October 4 through December 12. All the tapes are derived in some way from the very high resolution radiometer (VHRR) of the improved Tiros operational satellite G (ITOS-G), named NOAA-IV by the National Oceanic and Atmospheric Administration (NOAA).

All data are registered to a common grid (included in the figures), except a few for which coefficients can be furnished for registering the data. The grid is a Lambert conformal conical projection of most of Mexico except the Yucatán Peninsula and a small portion that is south of Tehuantepec.

The most useful data are daily mean air temperatures at a resolution of approximately 4 kilometers over the entire grid. In addition, raw radiometric temperatures, available at a resolution of approximately 1 kilometer, although not registered to a map, may be useful. The main archives also contain important temperature model information (the delta-T field). Other constituents of the main archives are described in detail in the section entitled "Tapes in Main Archives."

Additional archival products are discussed in the section entitled "Other Archived Material." These products include several composite images

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summarizing an extraordinary amount of temperature information; altitude data in image format on computer tapes; photographic images of many data products; some emissivity zone maps; and some historical data on weather, screwworm incidence, and other variables in Texas. Procedures for obtaining copies of these items are provided in the section entitled "Archives Usage."

Herein are some of the first continuous and unique data available for a subcontinental area the size of Mexico and, as such, their usefulness is not yet fully realized. However, some known uses are suggested in the following paragraphs.

Surface mean air temperatures from the main archives can be correlated with all kinds of phenological data; it has not been possible before to measure temperatures at 4-kilometer intervals for correlation with any phenomenon. The detailed effect of temperature on crop maturation can be correlated with these data. Detailed knowledge of temperature can be used to extend data from existing weather stations. Because temperature is also a factor in insect infestations, these data may well be useful for correlating information about infestations in detail.

Other archival products also have a high use potential. In particular, because the composite images summarize a great amount of information, they can be used to delineate ecological zones, to extend seasonal isotherms, etc. (ref. 1). Digital altitude data in image format can also be applicable in performing the same tasks, and emissivity zone images can be useful to persons working with actual soil surface temperature.

TAPES IN MAIN ARCHIVES

This section provides an overview of the procedures used to generate the tapes in the main archives, starting with reception of information from the NOAA-IV satellite. It also includes a brief description of all tapes in these archives.

Data Processing

A full description of the generation of the main archives is beyond the scope of this report and is available in other documents (refs. 2 to 4). Nevertheless, the following description will give some perspective on the steps that led to the production of the tapes in these archives.

Images were received on analog tapes from one of the NOAA receiving stations. The tapes contained VHRR images and certain calibration data recorded directly from the ITOS/NOAA satellite as it passed over Mexico (until line of sight was lost near the Isthmus of Tehuantepec).

The raw analog tapes were digitized nonlinearly to compensate for the foreshortening inherent in the image. At the same time, internal calibrations were applied, as were some atmospheric attenuation factors, and tapes containing corrected radiometric temperatures were produced. These taped images have not been registered to a map; however, because of the nonlinear digitizing, they only need translation in a plane to coincide fairly well with the Lambert conformal map used in this system.

The corrected temperature tapes were registered to a special Lambert conformal map with reference parallels within Mexico (fig. 1) especially prepared for this use. Photographic images, called isothermal images, were prepared from these tapes (their temperature ranges are coded as zones of constant color). Day and night tapes were combined empirically to estimate surface air temperatures. For cases in which clouds covered pixels in both day and night tapes, the delta-T field (temperature model) information was used in combination with data from reporting meteorological stations on the international network.

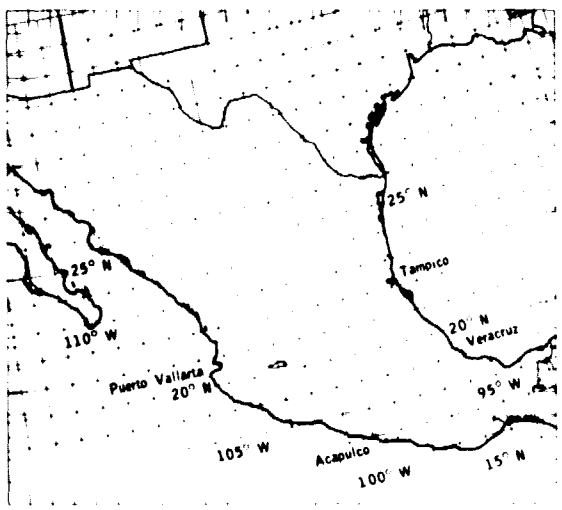

Figure 1.—The grid used in the Screwworm Eradication Data System.

From the isothermal images of mean air temperature, a variety of other products can be prepared. In particular, predictions of screwworm activity were prepared daily and archived.

Description

The tapes described in the following paragraphs (and in table I) are in the JSC Universal format (app. A) unless otherwise noted. Detailed format and data content information may be obtained from references 3 and 4.

Engineering units (EU) tape.—Both day and night passes containing full-scale unregistered data are available. The data have been calibrated and corrected for atmospheric attenuation, an average emissivity correction has been applied to the data, and certain nonlinear geometric distortions have been removed from the data. These data consist of encoded temperature information at a 0.5-K resolution.

DK1 rollout tape.—This tape contains day- and night-pass infrared data together with visible day-pass data for a single day. The data have been registered and compressed (4 to 1 in both scan line and pixel directions). The data consist of encoded temperature information at a 0.5-K resolution.

Rainfall (ORC) tape.—This tape consists of six registered images.

TABLE I.—Tapes in the Main SEDS Archives

Nomenclature and content	*No. of tapes accumulated during -*	
	Spring, 1975 (3-15 to 6-27)[a]	*Fall, 1975 (10-4 to 12-12)*
Rainfall (ORC) - Contains the following images: Rainfall Ground truth (TGT) Delta-T[b] Met. station Data quality Night cloud	104	70
Screwworm (OWC) - Contains the following images: Short-term growth Long-term growth Crop moisture index growth Degree day growth Screwworm growth Daily mean air temperature[b] Number of days satellite data Short-term data quality	104	70
Engineering units[b] - Contains full-scale unregistered data required for building isothermal[c] images.	171	70
DK1 rollout (day, night) - Contains compressed infrared data.	None	≈120
Data base[b] - Contains the following data-base information: Short-term mean air temperature Long-term mean air temperature Long-term crop moisture index Degree day sum	104	70

[a]Engineering units tapes were accumulated from 3-15 to 9-2.

[b]Most generally useful tapes or type of data.

[c]Require coefficients for registration; available from R. Spaulding, Ground Data Systems Division, JSC.

1. Rainfall — This map consists of the output (five classes) from the Screwworm Eradication Data System (SEDS) maximum-likelihood classifier using day visible and day infrared information supplied as inputs. The five classes represent geographic areas that were cloud-free or had varying degrees of cloud cover for the day satellite pass.

2. Ground truth — This map is a representation of ground-truth temperatures for a particular day (daily mean air temperatures). The data are derived from a combination of manually input ground-truth information for selected locations (meteorological stations) and satellite-derived temperature profile information. The data consist of encoded temperatures.

3. Delta-T — This map consists of the satellite-derived temperature profile information referenced previously. The data consist of encoded temperature information.

4. Meteorological station — This map consists of meteorological zones used as inputs to the two maps listed in items 2 and 3.

5. Data quality — This map contains information on the type of information used in the computation of the temperature estimations for each day. Specifically, it shows whether satellite data or ground-truth data were used for each pixel in the image.

6. Night cloud — This map distinguishes between data (geographic areas) that were used for temperature estimations from the night pass and data that were not.

Screwworm tape.—This tape consists of eight registered images. The first five maps consist of screwworm-growth-potential information based on temperature or moisture or both. References 3 and 4 contain details.

1. Short-term growth
2. Long-term growth
3. Crop moisture index (CMI) growth
4. Degree day growth
5. Screwworm growth
6. Daily mean air temperature — This map consists of encoded temperature information based directly on available satellite information and on the ground-truth map for areas where satellite information was not available because of cloud cover, etc.
7. Number of days of satellite data — This map defines the number of days of satellite information for the data-collection period (normally 14 days).
8. Short-term data quality — This map indicates the quantity of satellite and ground truth data for the previous 4 days.

Data-base tape.—This tape consists of five registered images. The data-base tape is not in Universal format.

1. Short-term mean air temperature (STMAT) — This map represents the sum of the daily mean air temperatures for the last 4 days.
2. Long-term mean air temperature (LTMAT) — This map represents the sum of the daily mean air temperatures for the last 14 days.
3. Long-term crop moisture index (LTCMI) — This map represents the sum of the crop moisture indices for the last 14 days.
4. Degree day sum (DDSUM) — This map represents a quantitative measure of the heat absorption above a baseline value for the last 14 days.
5. Data-quality channel (DQC) — This is a specialized image that relates to the quality of data. It is not likely to be useful.

OTHER ARCHIVED MATERIALS

The items discussed in this section are fewer in number than the main archives; however, some could prove very useful.

Composite Images

During the preparation of emissivity zone maps (ref. 2), several cloud-free composite images were prepared. For the infrared images and for a series of days in a given season, the highest temperatures for each pixel were selected to form a composite image. Because clouds are nearly always considerably colder than land surface or surface covering, this process usually results in a cloud-free composite. Similarly, cloud-free visible composites, which can be useful, can be made by using the lowest value for each pixel. These images can serve as the base for wide-area temperature models (ref. 1) and can probably be used

to extend isothermal maps in greater detail than normally available (ref. 1). Used in concert[3], they serve as a unique base for a zone discriminator (ref. 1), much as they were originally used to derive emissivity zone maps (ref. 2). A cloud-free composite is presented in figure 2.

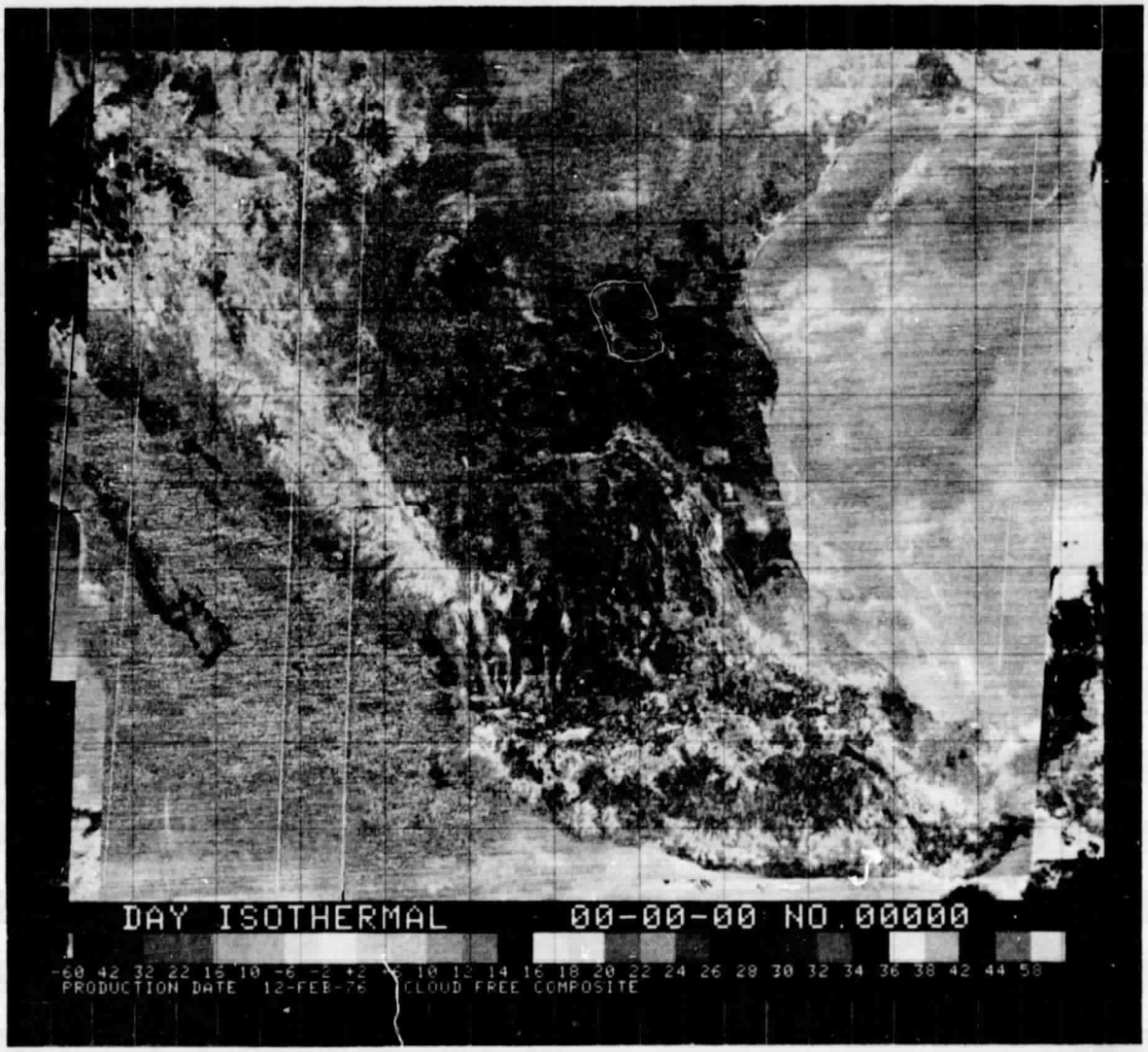

Figure 2.—A composite visible image for spring.

Altitude Data

For reducing raw radiometric data to mean air temperatures, altitude data were encoded in digital image form by using the following relationship.

$$\text{Altitude (meters)} = 25 \times (\text{coded value}) - 100$$

A tape containing these data can be used in the same manner as the composite images described previously and can be used in concert with them.

[3]One visible image, one day infrared image, and one night infrared image; perhaps all these for several seasons in a multichannel image format.

Photographic Images

Most of the data produced by the SEDS on tapes were also converted to color-coded images. Although, for the most part, these images cannot be used in a quantitative way, they may be helpful for understanding the meaning of various tape products. Although these images are included in the archives, it is recommended that no major use be made of them. Sample products are included in figures 3 and 4. Photographs are not indexed by the NTIS.

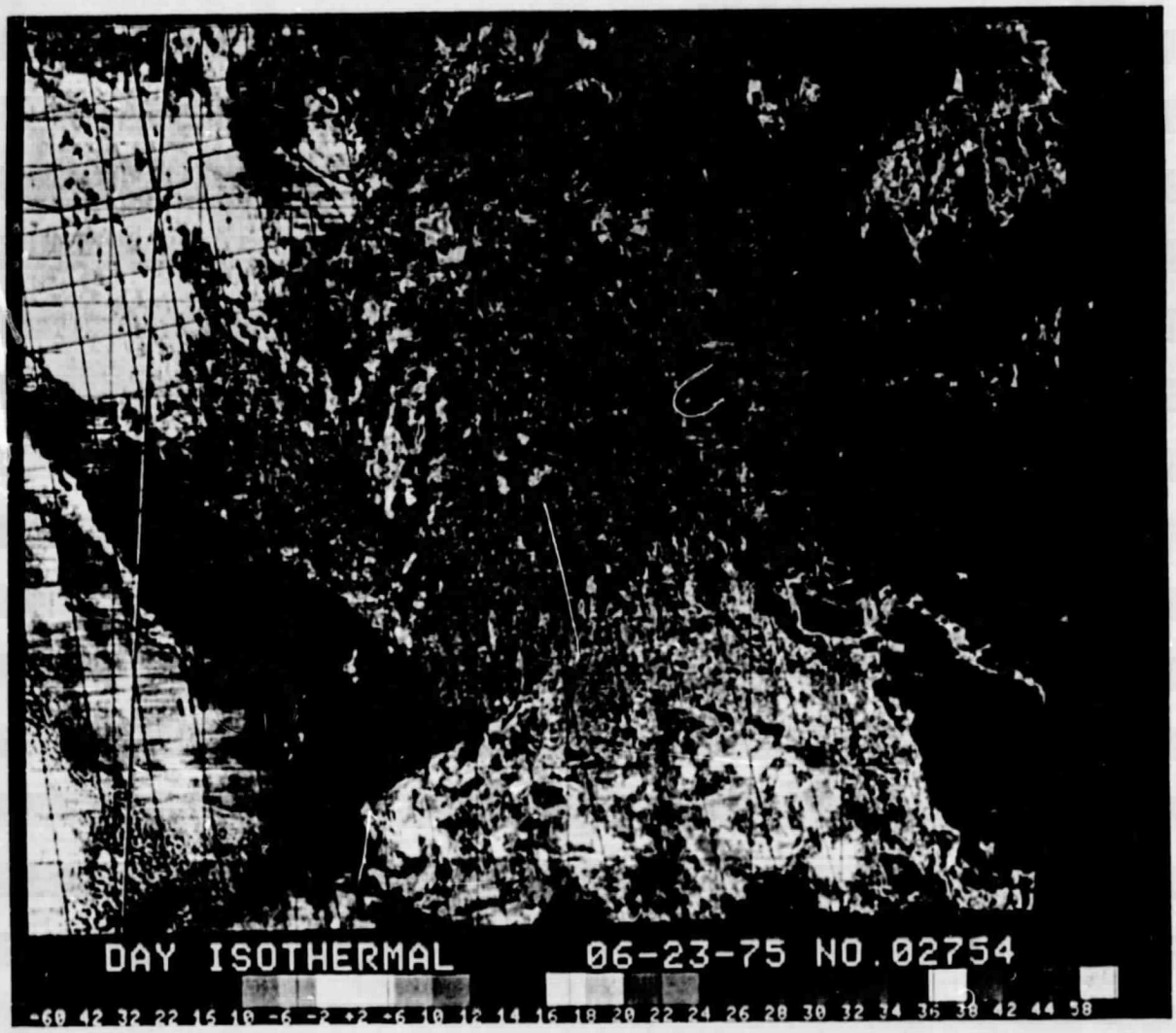

Figure 3.—A color-coded temperature image of an exceptionally cloud-free day.

Historical Data Base

As part of the system evaluation, certain historical data were collected for portions of Texas within the grid. Included were screwworm infestation reports, weather parameters, and various other data, all of which have been compiled and printed in a large report (ref. 5); the data are also available on computer tapes in formats described in the same reference.

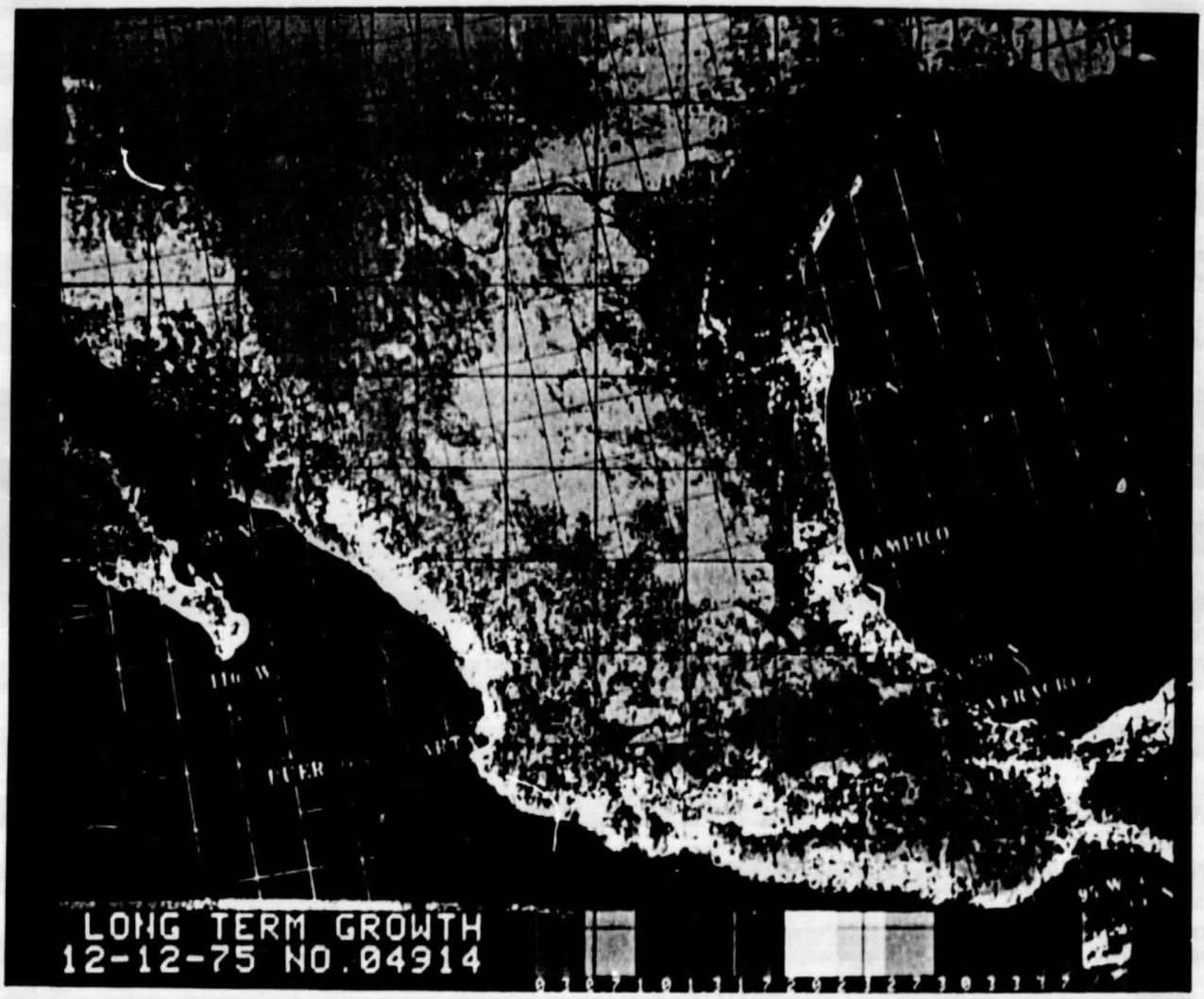

Figure 4.—A color-coded long-term-temperature-potential image.

Emissivity Zone Images

In a procedure adequately described elsewhere (ref. 2), thermal infrared emissivity zone images were made of the entire grid. These images may be useful to certain specialists concerned with the conversion of effective black-body radiation temperatures to actual surface temperatures. These images are preserved on digital tapes.

ARCHIVES USAGE

All materials are available through the NTIS. The main archives and the photographs are stored at the JSC, but the remaining materials will be stored at the NTIS.

System and Content Familiarization

The first step in using these data is to become familiar with the system that produced them. References 2 and 3, the fundamental documentation of the entire system, should be studied; both documents are available from the NTIS.

In many cases, it may be helpful to discuss the contents of these archives with persons directly involved in their development. The staff and collaborators of the Health Applications Group will be pleased to discuss these matters with any potential user. Long distance calls can be made to area code 713, 483-5406 (FTS 525-5406), to Dr. Charles Barnes or other members of the staff. In certain cases, visits to the premises of the Health Applications Group can be arranged.

Ordering Procedure

Directions for specifying precisely the materials to be ordered are provided in the following paragraphs.

Main archives.—For rainfall (ORC), screwworm (OWC), engineering unit, DK1 rollout, and data-base tapes, request the desired tape for a given day. The NTIS will have the tape copied at the JSC and forwarded directly. For the engineering unit tapes, request the registration coefficients at the same time; this information can be obtained from archives of the Ground Data Systems Division (reference: Robert Spaulding).

Composite images and altitude data on digital tapes.—At present, all composite images are archived on a single tape in LARSYS-2 format (app. B), together with the altitude data. This tape will be copied on request from the NTIS. If demand is sufficient, this tape will be maintained on file in the NTIS.

Photographic images.—As noted previously, photographic images of the main archives have little quantitative use. They may be examined on the premises of the Health Applications Group by prearrangement with the Group.

Emissivity zone map on digital tape.—Emissivity zone data for spring and summer 1975 are combined onto a single digital tape in Universal format. The tape is maintained at the NTIS and will be copied on request.

Historical data base.—Historical data are reproduced in reference 5, which is available on microfiche from the NTIS. The data are also available on tapes in several formats as specified in the same document. It is imperative that the document be thoroughly understood before tapes are ordered. Tapes are in the custody of the Health Applications Group (reference: Lorrain Giddings).

CONCLUDING REMARKS

A large archive of daily satellite data of Mexico and the southwestern United States was accumulated during operation of the Screwworm Eradication Data System. Included are daily mean air temperatures, 4- and 14-day temperature summations, effective radiometric temperatures by day and by night, and other such data.

In addition, other materials were generated that can have wide use outside the screwworm program. These materials include digitally coded altitude maps, composite infrared images, cloud-free composite visible images, thermal infrared emissivity zone maps, and a historical data base of information pertinent to the screwworm problem. All these materials are likely to have uses far beyond their original applications in the screwworm program. For example, the composite images are likely to furnish a unique basis for temperature modeling.

Most of the materials mentioned previously consist of digital tapes with data at 4-kilometer grid points over most of Mexico and the southwestern United States, excluding only the Yucatán Peninsula, extreme southern portions, and northern Baja California from Mexico.

All these data are being made available through the NTIS so that they will be easily accessible to the scientific community. They should find wide use in climatology, meteorology, and many other fields.

Lyndon B. Johnson Space Center
National Aeronautics and Space Administration
Houston, Texas, December 15, 1976
178-57-81-01-72

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4. Screwworm Eradication Data System (SEDS) Applications Program Documentation, Part II. Aeronutronic Ford Corporation, July 1976 (JSC-10019).

5. Giddings, L. E.: The Anomaly Data Base of Screwworm Eradication. LEC-7922, Lockheed Electronics Co., Inc., Oct. 1976 (JSC-11156).

APPENDIX A

JSC UNIVERSAL FORMAT FOR COMPUTER-COMPATIBLE TAPES

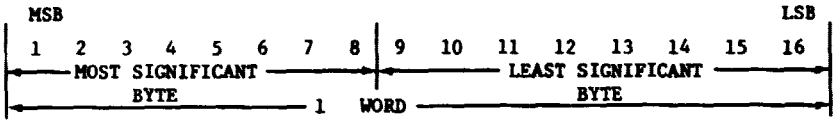
Most tapes taken from the main archives will be furnished in the JSC Universal format described in the following excerpt from an Aeronutronic Ford document[4].

[4]Lyndon B. Johnson Space Center: Aeronutronic Ford Corp., Earth Resources Data Format Control Book, Vol. 1, Revision A, 1974 (JSC internal document, restricted distribution).

6.0.1 IMAGERY DATA UNIVERSAL FORMAT

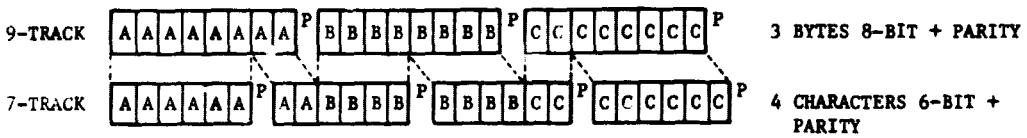
General Ground Rules

- Tape will be 9-track, 800 BPI, (or 556 BPI) odd parity CCT or 7-track*
- 8 bits = 1 byte
- Basic word size in header = 2 bytes
- Word format will be as follows:



- Binary Data is right justified in the field defined.
- The header record is the first record on a tape.
- The header record is fixed length equal 3060 bytes.
- Data following the header will be arranged by data sets, where a data set is defined as the ancillary data and all of the video data for one scan line for all active channels.
- Data sets will be recorded in variable length physical records, not to exceed 3000 bytes of information per record. Note, since 3000 bytes is not compatible with the word lengths of all computers, the computer generating the tape will add a sufficient number of fill zeros to the end of the data to make the record length divisible by 32, 36, 48, and 60 bits (180 bytes). Therefore, it is possible to have a max physical record length of 3060 bytes, but under no condition will data exceed 3000 bytes.
- Data sets will be packed into consecutive physical records of equal length. Under no condition will a data set begin in the middle of a physical record unless the data set can be completed in that record. If two or more records are needed for the data set, the data set will be divided but under no condition will the data for a video channel begin in the middle of a physical record unless the data for that video channel can be completed in that record. Consequently, data sets which are lengthy will be divided so that the ancillary block and video data from an integral number of channels will be in one record and remaining video data will follow in succeeding records with an integral number of channels per record. Fill zeros will be supplied at the ends of the records as required to satisfy the equal length constraint noted above.

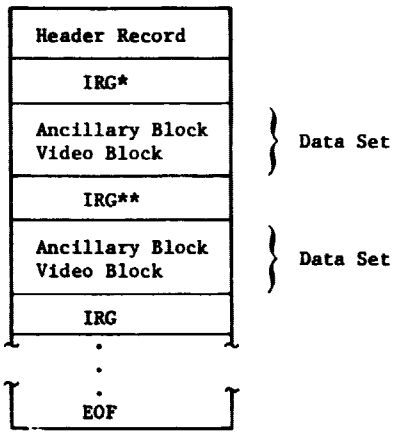
* The universal tape format was designed as though only 9-track tapes would be written and read. If a 7-track tape output is required, the information given in the universal format as 8-bit bytes is translated into 6-bit characters. This is accomplished by converting three 8-bit storage bytes in a serial binary mode into four 6-bit characters and writing them onto the 7-track tape together with parity.



6.0.1 IMAGERY DATA UNIVERSAL FORMAT (CONTINUED)

General Ground Rules (Continued)

- o If multiple data runs are on the same tape, the runs are separated by an EOF. Each run will have its own header.
- o If a run is not completed on a tape, two EOF's are written on the tape and a new header is then written on the next tape.
- o When a run is completed and no other run follows on that tape three EOF's are written.
- o All data in the header record and ancillary blocks will be in binary unless otherwise noted.
- o The tape format will be as follows:



* IRG = Inter Record Gap - always follows the header record.

** An IRG may appear between the ancillary block and the video block so that the recording of a data set requires more than one physical record; or a physical record may contain two or more data sets, not separated by any IRG. See ground rules above and data set description following for criteria determining the placement of IRG's.

TABLE 6.0.1-1 UNIVERSAL FORMAT IMAGERY HEADER RECORD

BYTE NO.	DESCRIPTION	NO. OF BYTES
1-32	Computing System ID - EBCDIC	32
	Computing System producing this tape, i.e., ERIPS, PREPROC., PRODUCTION, etc.	
33-52	Tape Library ID - EBCDIC	20
53-60	Sensor ID - EBCDIC	8
	S192, MSS, ERTS, etc.	
61-63	Date of this tape generation	
	Day of month - Binary	1
	Month Number - Binary	1
	Year - Last 2 digits - Binary	1
64	Tape Sequence ID - Binary first tape reel = 1	1
65-66	Mission No. - Binary	2
67-68	Site - Binary	2
69	Line - Binary	1
70	Run - Binary	1
71-72	Orbit - Binary	2
73-80	Time of first scan in this job	
	Tenths of millisec - Binary	2
	Seconds - Binary	1
	Minutes - Binary	1
	Hours - Binary	1
	Day of month - Binary	1
	Month Number - Binary	1
	Year - Last 2 digits - Binary	1
	Contents of these bytes should remain constant throughout job.	
81-88	Channels active in this job - up to 64 channels, 1 BIT/CH starting left to right (MSB to LSB), 1 - active, video data always appears in the order indicated here.	8
89	Processing flag	1
	0 = Raw Data 1 = Processed data from computing system	
90	No. of channels in this job	1

TABLE 6.0.1-1 UNIVERSAL FORMAT IMAGERY HEADER RECORD (Continued)

Header Record (Continued)

BYTE NO.	DESCRIPTION	NO. OF BYTES
91	No. of bits in a picture element	1
92-93	Byte location of start of video data within scan.	2
94-95	Byte location of start of first calibration area within the scan.	2
96-97	No. of video elements per scan within a single channel.	2
98-99	No. of calibration elements in the first calibration area within the scan in a single channel.	2
100-101	Physical record size in bytes This number must be a multiple of 180 bytes.	2
102	No. of channels per physical record This field refers to the second and subsequent records within the recording of a data set. Bytes 1785-1786 give the number of channels of data in the first record of a data set. if no. elements per channel greater than 3K this field will equal 0.	1
103	No. of physical records per scan per channel. This field is used only when the no. of elements per channel is greater than 3K. Otherwise it is equal to 0.	1
104	No. of records to make a complete data set.	1
105-106	Length of ancillary block in bytes	2
107	Data Order Indicator 0 = Video ordered by channel. 1 = Video ordered by pixel	1
108-109	Start Pixel No. Number of the first pixel per scan on this tape referenced to original image. The first pixel in the original image is pixel number one.	2
110-111	Stop Pixel No. Number of the last pixel per scan on this tape referenced to original image.	2

TABLE 6.0.1-1 UNIVERSAL FORMAT IMAGERY HEADER RECORD (Continued)

BYTE NO.	DESCRIPTION	NO. OF BYTES
112-239	A_o Coefficient (2 bytes* per channel)	128
240-367	E_o Exponent (2 bytes* per channel)	128
368-495	A_1 Coefficient (2 bytes* per channel)	128
496-623	E_1 Exponent (2 bytes* per channel)	128
	To convert parameter value (C) to engineering units (Y) $Y = A_o * 10^{E_o} + C * A_1 10^{E_1}$	
624-687	Color Code Information	64
	1 Byte/Channel in same order as 'Channel Active on this Tape' Indicator. 0 = Not Active 1 = Red 2 = Green 3 = Blue	
688-751	Scale Factor	64
	1 Byte/Channel in same order as 'Channel Active on this Tape' Indicator.	
752	Offset Constant	1
753	Word size of generating computer	1
	Gives size of smallest quantity in bits that machine can write on tape.	
754-1777	Wavelength of Each Channel	1024
	8 Bytes per limit, 16 Bytes per channel EBCDIC wavelength will be specified in milli-microns.	
1778	Number of Data Sets per Physical Record	1
1779-1780	Address of start of second calibration within scan. If the scan has only one calibration area, this field will contain zeros.	2
1781-1782	Number of calibration elements in the second calibration area within the scan in a single channel. If the scan has only one calibration area, this field will contain zeros.	2

*Most significant bit is a sign bit: 0 = +, 1 = -. Remaining 15 bits are straight binary.

TABLE 6.0.1-1 UNIVERSAL FORMAT IMAGERY HEADER RECORD (Continued)

BYTE NO.	DESCRIPTION	NO. OF BYTES
1783	Calibration source indicator LSB = second calibration area LSB + 1 = first calibration area 0 = low calibration source data present 1 = high calibration source data present	1
1784	Fill Zero	1
1785-1786	Number of channels in the first physical record of the data set	2
1787-1788	Total number of bytes per scan per channel	2
1789-1790	Pixel skip factor - the quantity to be added to the number of the last pixel processed to yield the number of the next pixel to be processed; 1 = process every pixel, 2 = process every second pixel, etc.	2
1791-1792	Scan skip factor - the quantity to be added to the number of the last scan processed to yield the number of the next scan to be processed; 1 = process every scan, 2 = process the second scan, etc.	2
1793-2940	General Information Information in EBCDIC generated to satisfy user requirements. Content will be unique for each user and will depend not only on the sensor but also on the specifications of the user for whom the tape is generated. Bytes for which user specifies no requirement will contain fill zeros.	
1793-2184	Fill zeros	758
2185-2550	General Annotation byte assignments for ERIPS (Not Supplied by PDP)	366
2185-2484	User Comments	300
2485-2488	Fill zeros	4
2489-2496	Latitude of pixel 1 of registered image	8
2497-2504	Longitude of line 1 of registered image	8
2505-2512	Latitude scale factor - Deg/Pixel	8
2513-2520	Longitude scale factor - Deg/Pixel	8
2521-2550	Fill zeros	30
2551-2642	General Annotation byte assignments for CYBER 73 at JSC.	92
2643-2758	Fill zeros.	116

TABLE 6.0.1-1 UNIVERSAL FORMAT IMAGERY HEADER RECORD (Continued)

BYTE NO.	DESCRIPTION	NO. OF BYTES
2759-2940	General Annotation Byte Assignments for the Production Film Converter	
2759*	n Thousand scan lines per frame - Binary	1
2760-2789*	Job ID - EBCDIC	30
2790-2792*	Altitude in meters - Binary	3
2793-2794*	Ground speed in meters per second - Binary	2
2795*	Scan Type - Binary 0 = Linear 1 = Smoothed	1
2796*	Angle of Arc in degrees - Binary	1
2797*	Camera - Binary 0 = 70 mm 1 = 5-Inch	1
2798*	Input Device - Binary 0 = 9-TRK 1 = HDT	1
2799*	Truncation - Binary 0 = 2 LO order bits 1 = 2 HI order bits 2 = NO	1
2800-2807*	Channels requested 1 Bit/Channel up to 64 total channels - Binary	8
2808*	Processing Mode - Binary 0 = Serially 1 = Concurrently	1
2809-2873	Overlay Image Factors - Binary $A_0, A_1, A_2, \ldots A_n$ Where n = Channel number up to 64. A_o is the overall factor. There is an implied decimal point to the left of the least significant decimal digit; if the MSB = 1, the number is negative; if = 0, positive.	65

If values for A are not provided, the default value of A shall be "1" when processing color, "1/n" when processing gray shade, and A_o shall be "0" for both. Then the resultant light intensity for pixel P with input light intensity C for channel n is related by:

$$P = A_o + (A_1C_1 + A_2C_2 + \ldots + A_nC_n).$$

*Required for Image Processing Calculations.

TABLE 6.0.1-1 UNIVERSAL FORMAT IMAGERY HEADER RECORD (Continued)

BYTE NO.	DESCRIPTION	NO. OF BYTES
2759-2940	General Annotation Byte Assignments for the Production Film Converter (Continued)	
2874*	Color Select - Binary 0 = No Color 1 = Assigned Color 2 = False Color	1
2875*	Image Format - Binary 0 = Single Image 1 = Overlay Images 2 = Abut Images 3 = Offset Images	1
2876*	Repeat of Pixels per Scan - Binary 0 = None 1 = 1 Repeat 2 = 2 Repeat n = n Repeat	1
2877	Repeat of Scan - Binary 0 = None 1 = 1 Repeat 2 = 2 Repeat n = n Repeats	1
2878-2881	Partial Scan - Binary Zeros to indicate full scan Byte 2878-2879 = From Pixel No. Byte 2880-2881 = To Pixel No.	4
2882-2883	Sensor scan rate in scans/second - Binary	2
2884	Pixel Size - Binary	1
2885-2886	Angle of Drift - Binary Byte 2885 = ± Integer Byte 2886 = Fraction	2
2887-2940	Fill zeros	54
2941-3000	ITITLE - User Designated Identification	60
3001-3060	Fill Zeros, makes the record an integral number of computer words. These bytes must <u>never</u> contain data.	60

Data Sets

- The first word (2 bytes) of every record is a counter giving the number of the physical record within the video data set. This is primarily intended for use in data sets that are greater than 3000 bytes long and therefore require more than one physical record for recording. This word will always equal "1" for the first record of a data set.
- The first block of a data set is the ancillary block.
- The length of the ancillary block is variable, with the number of bytes given in the header record.
- Bytes 1 through 4 of the ancillary block will contain the current GMT at the start of this data set recorded in tenths of milliseconds.
- Bytes 5 through 68 will indicate channel status for this scan, one byte per channel, where the LSB = 0 inidcates the channel in sync, and the LSB = 1 indicates the channel not in sync.
- Bytes 69-70 contain the scan line number. This will be an arbitrary but sequential count for each scan line that appears in the data run.
- Bytes 71 through N will be dependent on whether this job contains raw or processed data. (See byte 89 in the header record.) The value of N will be given in bytes 105 and 106 in the header record and will always be equal to or greater than 70.
- If this job contains raw data, bytes 71 through N will contain the housekeeping data channel from the sensor, if one is available.
- A job containing processed data will, in addition to the 70 bytes of ancillary data already described, contain, at a minimum, the following pieces of information:
    - Latitude of the aircraft or of the center of the image from EREP or satellite in binary.
    - Longitude of the aircraft or of the center of the image from EREP or satellite in binary.
    - Altitude in meters recorded in binary.
    - Heading in tenths of a degree.
    - Ground speed in meters per second.
    - Roll - Defined in specific formats, following.
    - Pitch - Defined in specific formats, following.
    - Yaw - Defined in specific formats, following.
    - Sun angle.

  The specific formats for each sensor (following in this section) shall provide where this data will appear in the format.

Data Sets (Continued)

Other parameters may be added, if required, with the length of the ancillary block given in the header.

- Following the ancillary block in each data set will be the video data from all of the active channels for one scan. The video data from all of the active channels for one scan will comprise a video block.

- Video blocks within a data run will always contain the same number of video channels.

- Each video block will be the same number of bytes in length. If video data is not available to fill a block, fill zeros will be added to make it the same length as preceding video blocks.

- Video data less than 8 bits per pixel will be packed, right justified, in an 8-bit byte with zeros added to the left.

- Video data greater than 8 bits per pixel will be packed, right justified, in as many 8-bit bytes as necessary to hold the pixel, with zeros added to the left.

- If this tape contains raw data, the PCM sync words associated with the video data, if any, will be included with the video data on this tape. If this tape contains processed data, no sync words will be present.

- Calibration data that is associated with each scan within each channel will be included, if this tape contains raw imagery data, in the same sequence as it appears in the data stream on the flight tape. If this tape contains processed imagery data, the appearance of the calibration data will depend on the specific sensor requirements and will be specified in the respective format following in this document.

- The combined length of the ancillary block and the video block will determine the relationship between data sets and physical records. Some data runs may contain data sets which are so small more than one can be packed into one physical record. Others may contain data sets which will require a whole physical record for each. Still others may contain data sets which are so long that each data set will require two or more physical records.

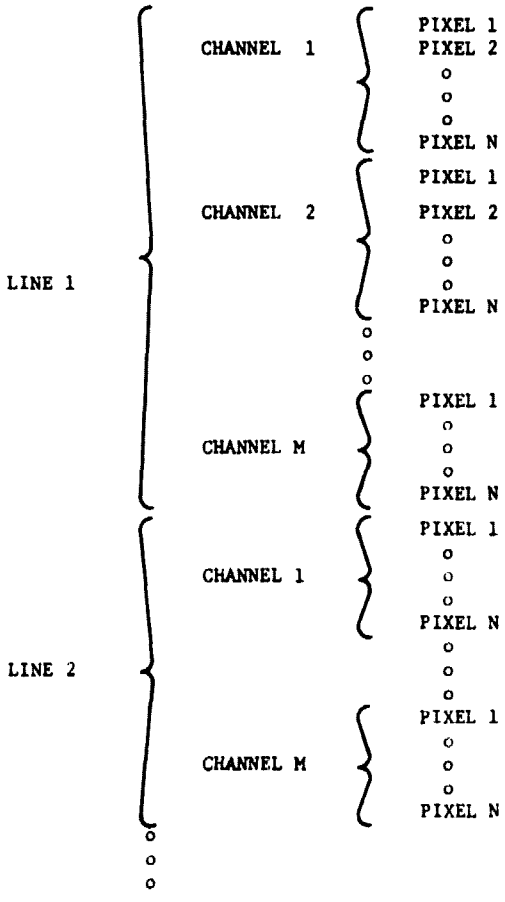
- Data sets will be packed in physical records depending on the length of the data set. The ancillary block will always appear in the first physical record per data set. Following the ancillary block, as many complete channels in this data set will be recorded as will fit in up to 3000 bytes. If the data set is too long to be recorded in one physical record, the second and subsequent records will begin with the next ... e channel in the data set.

- A video channel will not be divided between two records unless a single scan from that channel contains more than 3000 bytes. If a scan from any channel is greater than 3000 bytes in length, then the scan will be divided into as many equal parts as is necessary to allow each part to equal less than 3000 bytes and therefore, fit into a physical record with max length 3000 bytes.

Data Sets (Continued)

- If a video block is divided between more than one record for recording, the number of data channels in the first record may vary from the number of channels in the second and successive records; however, the number of channels in all records following the first per data set will always be the same. The number of channels in the first record and the number in successive records will be given in the header record. In records following the first, if video data is not available so as to allow all records to contain the same number of channels, fill zeros will be added in lieu of the video data in order to make all records the same length. In addition, fill zeros will be added to either the first record or all of the successive records, depending on which is shorter, so as to make all of the records the same length.

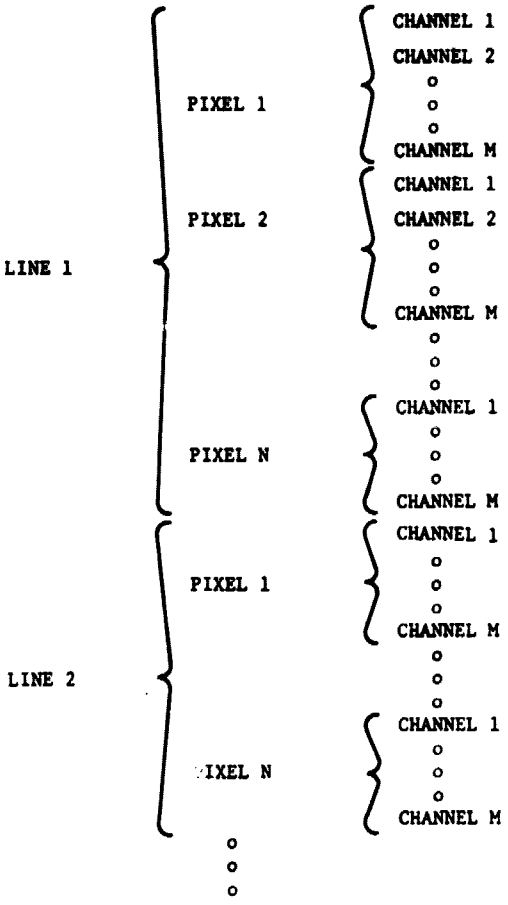
- The normal arrangement of pixels within a scan of data will be by channel. The Universal format* will be as follows:



*If this tape contains raw imagery data, the PCM sync words, if any, that are associated with the data on the flight tape will be included with the data.

Data Sets (Continued)

- When conflicts arise such that channel arrangement of the scan data can not be accomplished, the data will be arranged by pixel. This arrangement will be discouraged. The Universal format* for this arrangement will be as follows:



* If this tape contains raw imagery data, the PCM sync words, if any, that are associated with the data on the flight tape will be included with the data.

APPENDIX B

LARSYS-2 TAPE FORMAT

The composite images are furnished on standard 9-track 800-bit-per-inch (bpi) digital computer tapes. Data are furnished in LARSYS-2 format described in the following excerpt from an Aeronutronic Ford document[5].

[5]Lyndon B. Johnson Space Center: Aeronutronic Ford Corp., Earth Resources Data Format Control Book, Vol. 2, 1973 (JSC internal document, restricted distribution).

7.5 LARSYS Version 2 Tape Format

- 4 types of records
  - a. ID record -- 200 full words fixed length
  - b. Data record - variable length
  - c. End-of-tape records - 200 full words fixed length
  - d. End-of-file records - IBM standard
- 32 bits per word
- 8 bits per byte

7.5.1 ID Record (200 full words fixed length)

Word	Format	Description
ID (1)	Integer	LARS Tape Number (e.g., 1,17,102, etc.)
ID (2)	Integer	File number on this tape
ID (3)	Integer	Run number (8 digits aabbbbcc) aa - last 2 digits of the year data was taken bbbb - running serial number for the year data was taken cc - uniqueness digits for runs which would otherwise have the same run number
ID (4)	Integer	Continuation Code ID (4) = 0 means the first line of data follows this ID record ID (4) = X means that the data following this ID record is a continuation of a flight line started on tape.

Word	Format	Description
ID (5)	Integer	Number of Data Channels (Spectral bands) on tape (30 maximum)
ID (6)	Integer	Number of Data Samples per channels per line
ID (7-10)	Alpha-numeric (4A4)	Flightline Identifications (16 characters)
ID (11)	Integer	Month data was taken
ID (12)	Integer	Day data was taken
ID (13)	Integer	Year data was taken
ID (14)	Alpha-numeric (1A4)	Time data was taken
ID (15)	Integer	Altitude of aircraft
ID (16)	Integer	Ground heading of aircraft
ID (17-19)	Alpha-numeric (3A4)	Date data run was generated on this tape (12 characters)
ID (20-50)	Integer	All zero (to be defined later)
ID (51)	Real	Lower limits in micrometers of first spectral band on tape
ID (52)	Real	Upper limits in micrometers of first spectral band on tape
ID (53)	Real	The suggested value of "C0" calibration pulse
ID (54)	Real	The suggested value of "C1" calibration pulse.
ID (55)	Real	The suggested value of "C2" calibration pulse.
ID (56-200)	Real	Repeat of ID (51-55) for ID (5) channels in order of appearance in Data Records.
ID (51-200)	Real	= 0.0 if Data Channels do not exist

7.5.2 Data Record (Variable number 8-bit bytes)

Byte No.	Description
1-2	Record number
3-4	Roll parameter
5	Channel 1, sample 1
6	Channel 1, sample 2
.	.
.	.
.	.
M+4	Channel 1, sample M
M+5	Channel 1, 0 or dark level (C_o)
M+6	Channel 1, Variance of C_o (VC_o)
M+7	Channel 1, Calibration of source C,
M+8	Channel 1, Variance of C, (VC,)
M+9	Channel 1, Calibration source C_2
M+10	Channel 1, Variance of C_2 (VC_2)
M+11	Channel 2, sample 1
M+12	Channel 2, sample 2
.	.
.	.
.	.
.	.
.	.
(M+6) N+4	Channel N, Variance of C_2 (VC_2)

The value of (M+6) is given in ID (6) and the value of N is given in ID (5).

7.5.3 End of Tape Record

Word	Format	Description
ID(1)	Integer	LARS tape number
ID(2)	Integer	File number on this tape
ID(3)	Integer	Set equal to 0
ID(4)	Integer	Continuation Code
		ID(4) = 0 means end of data ID(4) = X means data in previous file is continued on tape X
ID(5-50)	Integer	All zero (may be defined later)
ID(51-200)	Real	0.0 (may be defined later)

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