

### NOTICES

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#### SUMMARY - HANDBOOK DESCRIPTION

The Environmental Research Institute of Michigan (ERIM) has been collecting infrared imagery with its airborne scanner for several years. Recently, ERIM has been analyzing various backgrounds for the Optical Signatures Program to derive a variety of statistical measures of interest to the designers and users of infrared systems. This handbook contains a summary of the backgrounds analyzed to date as part of this effort. Most of the backgrounds represented in this handbook were imaged on a more-or-less convenience basis, although definite plans were made to include what were considered pertinent background types. While we would be presumptuous to imply that the handbook is complete, even if that goal could be reached in the limited space of this volume, it does contain many of the components that are required to describe a variety of backgrounds.

These components are identified in part by land masses as, for example, mountains and deserts, and perhaps rain forest or jungles; by diurnal variations in background features; by seasonal variations; by scene types, such as cities or urban areas, rural areas, water masses, etc. Many of these components are included in this hardbook. It is our intention to upgrade the handbook by adding to it as other data are available.

In addition to adequate geographical coverage, two other requirements demand attention for the production of useful background information: reasonable spatial resolution and adequate spectral coverage. The spatial resolution is fixed by the information capacity of what we would call general purpose, non-military imagers, such as the ERIM scanners. This criterion fixes the field-of-view of the sensor at about 2 milliradians on a side, providing a ground-print of the order of two to three feet on a side. At competatures in the 270 2007 range, this provides adequate signal-to-noise ratios with the ordinary bandpass filters used in the ERIM scanners.

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The filters used for the imagery in this handbook transmit in the major window regions (described below) between 1 and 15 micrometers, except that between 4.5 and 5.5  $\mu$ m there can be considerable absorption by the atmosphere. We lose nothing by confining our attention to the windows, and, in fact, gain by reducing uncertainty introduced by atmospheric changes. We note often, for example, in some of the data presented in the handbook that because of the 4.5-5.5  $\mu$ m spectral region dependence on the atmosphere, the divergence between the results in that spectral region and those of the spectral region between 8 and 14  $\mu$ m can range from essentially zero to rather large values. The transmission characteristics of the filters used for the data in this handbook are included in Appendix A.

The scenes were chosen to depict certain geographical features, and any inhomogeneity in the scenery is a characteristic of the scene chosen. In the earlier reports of References 1 through 6, selected homogeneous areas were chosen for analysis separately. But here, the scene is kept intact with or without inhomogeneities. By comparing the thermal imagery and the greymaps, the user should easily be able to correlate features in the histograms with inhomogeneities observed in the scenery.

The calibrated (i.e., converted to radiance in watt- $cm^{-2}-sr^{-1}\mu m^{-1}$ , or temperature in °K) signals of every pixel in the analyzed scene are digitized on magnetic tapes which are stored at the ERIM facility. We have analyzed the data in a rather general form for presentation here, but, of course, the data can be handled in any way desired. We have not formatted the tapes for automatic use by any other persons except those who have access to our special programs for computation. However, it is feasible that they could be made available to the public with far less effort than that required to obtain and analyze the data in the first place.

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The substance of the handbook is compiled in Section 3, containing complete packages of background data for different locations, giving all of the statistics and pertinent environmental information. Each package is identified by the name of the scene tabulated in the Master Index and includes the following (except for minor deletions):

- Aerial photo of the scene.
- Thermal image in selected spectral regions.
- Greymap of digitized data.
- Table(s) of scene physical characteristics.
- Various statistical analyses.

The statistics include radiance and temperature histograms, with means and standard deviations; spectral correlations; ellipse "pictures" with tabulations of area, perimeter, and shape distributions; and power spectra. The statistics are described in Section 2 and the data processing details in Appendix B. Appendix A contains a description of the scanners and filters used in collecting the imagery from which the statistical information was obtained. Only those samples from the various reports of References 1 through 6, which are exemplary for a given complete set of conditions, are included. For example, the scanner can be set in two configurations, looking directly downward and looking at ar angle of 35° below the horizon. The difference in results from each type of run is essentially undiscernible in most cases, meaning that the mean and standard deviation of each are nearly the same. Thus, unless the difference is significant, often only one or the other is presented.

Following this discussion is a Master Index to be used as an aid in finding information specific to the needs of the user, and corresponding to various physical and environmental conditions, geographical locations, scenery type, spectral bands, time-of-day or season, etc. Following the Master Index is a Type-of-Background Index set up in matrix form to subdivide the different background types according to the

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diurnal or seasonal cycle. Finally, a Spectral Band Index is included to cover the region in the spectrum from about 1.0  $\mu$ m to about 14.0  $\mu$ m. The different spectral bands covered are 1.0-1.4, 1.5-1.8, 2.0-2.6, 3.0-4.2, 3.5-3.9, 4.5-5.5, and 8.0-14.0  $\mu$ m. The last region, 8.0-14.0  $\mu$ m, was covered with various filters at different  $\Delta\lambda$ 's, designated in the Index merely as 8.0-14.0  $\mu$ m, but specifically delineated in the Handbook within their properly designated bands.

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Since, as was mentioned earlier, the substance of this Handbook was presented in earlier reports, the reader is referred to them (cited in the individual packages) for a more thorou 'h discussion of the statistical features of the various scenes. A few of the common formats are mentioned here, however.

- The greymaps are included to show generally the portion of the scenery analyzed.
- Each histogram includes a Gaussian curve having the same mean and standard deviation as the actual curve, and indicated by circles superimposed over the actual curve.
- The "S" on some of the histograms indicate that saturation has occurred. The digital range of the image signals is between 0 and 255. Because of the difficulty in properly setting amplifier gains, the digital range is sometimes exceeded.

• The ordinate of the power spectra is designated  $(AMPL)^2/(1/M)$  to accommodate multiple curves with different units. For data computed in terms of spectral radiance,

$$AMPL = watt-cm^{-2}-sr^{-1}-\mu m^{-1}$$

and for those computed in terms of temperature, AMPL = °K.

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#### PREFACE

The work described herein was funded by the Optical Signatures Program to support Navy requirements. Project Monitor for this task was Er. Jon Wunderlich, Naval Weapons Center, China Lake, California. Data from infrared (IR) imagery from various terrain and water backgrounds have been collected by the Environmental Research Institute of Michigan (ERIM), analyzed to show their statistical features, and accumulated in a handbook to present an organized set of backgrounds incorporating varied environmental parameters.

The data were collected with ERIM's multispectral scanners, which operate in several wavelength bands in the visible and infrared portions of the electromagnetic spectrum. The imagery were collected with the scanners looking both downward and in a direction 35° below the horizoutal. The statistics are presented in figures and tables, as histograms, means and standard deviations, spectral correlations, ellipses, and power spectra.

In order to keep the handbook to the minimum size necessary to convey the data, and because much of the descriptive material is common to all of the reports from which the data were obtained, the authors deferred to the earlier reports (especially Reference 1) for the material of Section 2 and of Appendices A and B. However, the information essential to the utilization of the data is included in this report.

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#### ACKNOWLEDGEMENTS

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Because of the inclusive nature of the work which incorporates the substance of other tasks and resultant reports, many persons have been involved in the preparation of this handbook. Ms. Abby Liskow deserves special mention for performing the extensive computer operations necessary for the successful completion of the analyses. Dr. J. Robert Maxwell was the initial Project Manager and has contributed invaluably to this report. Dr. Robert E. Sampson has recently assumed the responsibility of Project Manager for the contract which provided the support for this report.

Finally, the most essential task of all was the collection of the data supervised by Mr. Stephen Stewart and performed by flight instrumentation specialists, Mr. Jimmie Ladd and Mr. William Juodawlkis.

The collection of data for the Camp A. F. Hill scenery was supported by the Night Vision Laboratory of the Army's Mobility Equipment Research and Development Command at Ft. Belvoir, Virginia. Data collection for Nellis AFB and Michigan, and the analysis of all the data included in this report, were supported by the Optical Signatures Program, China Lake, California.

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## MASTER INDEX SIGNIFICANT INFORMATION ABOUT VARIOUS SCENES

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Details of these scenes are to be found on the succeeding pages, which are a continuation of this Master Index.

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MASTER INDEX (Cont.)

Scene: Baltimore, MD

Identifier (Date):	Baltimore (5-11-72)
Spectral Bands:	1.0-1.4, 2.0-2.6, 9.3-11.7 μm
Altitude:	2500 ft
IFOV:	2.5 mrad (cross-track); 5.0 mrad (in-track)
Aircraft Ground Speed:	· · ·
Time:	1140
Direct of Flight:	~East
Size of Analyzed Scene:	$5225 \times 4030 \text{ ft}^2$
General Description:	Residential Area
Meteorology:	Clear sky; light haze at 5 Kft; dry

Scene: Black Hills-1, SD

Identifier (Date):	Black Hills-1 (7-22-69)
Spectral Bands:	1.0-1.4, 2.0-2.6, 4.5-5.5, 8.0-13.5 μm
Altitude:	1500 ft
IFOV	3.5 mrad (cross-track); 6.6 mrad (in-track)
Aircraft Ground Speed:	
Time:	1340
Direct of Flight:	East
Size of Analyzed Scene:	1160 x 7140 ft <sup>2</sup>
General Description:	Natural terrain of trees and hills with numerous shadows (forested mountains).
Meteorology:	Visibility >15 mi; clear dary, dry; cloud cover 10%

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Scene: Black Hills-2, SD

Identifier (Date):	Black Hills-2 (7-22-69)
Spectral Bands:	1.0-1.4, 1.5-1.8, 2.0-2.6 µm
Altitude:	1500 ft .
IFOV:	3.5 mrad (cross-track); 6.6 mrad (in-track)
Aircraft Ground Speed:	200 ft-sec <sup>-1</sup>
Time:	1340
Direction of Flight:	East
Size of Analyzed Scene:	$2420 \times 7200 \text{ ft}^2$
General Description:	Forested Mountains
Meteorology:	Visibility >15 mi; clear day, dry; cloud cover 10%

Scene: Camp A. P. H111, VA

Identifier (Date):	Camp A. P. H111 (3-28-78, 3-29-78, 3-30-78)
Spectral Bands:	2.0-2.6, 4.55.5, 8.0-14.0 µm
Altitude:	800 ft
IFOV:	2.0 mrad
Aircraft Ground Speed:	168 ft-sec <sup>-1</sup>
Time:	0930, 1330, 1830, 2330
Direction of Flight:	West
Size of Analyzed Scene:	$1100 \times 1400 \text{ ft}^2$
General Description:	Small stands of leafless deciduous and coniferous trees.
Meteorology:	Clear and dry; sunny during daylight hours; visibility > 30 km; light haze in evening.

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Scene: Flint-1, MI

Identifier (Date):	Flint-1 (9-18-71)
Spectral Bands:	1.0-1.4, 1.5-1.8, 2.0-2.6, 9.3-11.7 µm
Altitude:	1000 ft
IFOV	2.5 mrad (cross-track); 5.0 mrad (in-track)
Aircraft Ground Speed:	$200 \text{ ft-sec}^{-1}$
Time:	1130
Direct of Flight:	~South
Size of Analyzed Scene:	$1600 \times 3980 \text{ ft}^2$
General Description:	Residential Area
Meteorology:	Visibility >10 mi; dry; cloud cover 30-50%

Scene: Flint-2, MI

Identifier (Date):	Flint-2 (9-18-71)
Spectral Bands:	1.0-1.4, 1.5-1.8, 2.0-2.6, 9.3-11.7 µm
Altitude:	1000 ft
IFOV:	2.5 mrad (cross-track); 5.0 mrad (in-track)
Aircraft Ground Speed:	200 ft-sec <sup>-1</sup>
Time:	1155
Direction of Flight:	Southeast
Size of Analyzed Scene:	$1600 \times 4430 \text{ ft}^2$
General Description:	Industrial-Urban Area
Meteorology:	Visibility >10 mi; dry; cloud cover 30-50%

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MASTER INDEX (Cont.)

Scene: Michigan Winter Scene - City

Identifier (Date):	City (4-3-79, 4-4-79)
Spectral Bands:	3.5-3.9, 4.5-5.5, 9.0-11.4 µm
Altitude:	1000 ft (35° depression); 1750 ft (90° depression)
IFOV:	2.5 mrad
Aircraft Ground Speed:	202 $ft-sec^{-1}$
Time:	0600, 1230, 1900, 0030
Direction of Flight:	NNW
Size of Analyzed Scene:	$1650 \times 1750 \text{ ft}^2$
General Description:	Urban Area
Meteorology:	Snow covered ground; air temperature = $-2^{\circ}C$ , 5°C, 4°C, $-2^{\circ}C$ , respectively; cloud cover = 95%, clear, 15%, 60-70%, respectively

Scene: Michigan Winter Scene - Conifers

Identifier (Date):	Conifers (4-3-79, 4-4-79)
Spectral Bands:	3.5-3.9, 4.5-5.5, 9.0-11.4 μm
Altitude:	1000 ft (35° depression); 1750 ft (90° depression);
IFOV:	2.5 mrad
Aircraft Ground Speed:	202 ft-sec <sup>-1</sup>
Time:	0600, 1230, 1900, 0030
Direction of Flight:	NNW
Size of Analyzed Scene:	$1650 \times 1750 \text{ ft}^2$
General Description:	Coniferous Forest
Meteorology:	Snow covered ground; air temperature = -2°C; cloud cover = 95%, clear, 15%, 60-95%, respectively

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Scene: Michigan Winter Scene - Farmland

Identifier (Date):	Farmland (4-3-79, 4-4-79)
Spectral Bands:	3.5-3.9, 4.5-5.5, 9.0-11.4 μm
Altitude:	1000 ft (35° depression); 1750 ft (90° depression)
IFOV:	2.5 mrad
Aircraft Ground Speed:	202 $ft-sec^{-1}$
Time:	0600, 1230, 1900, 0030
Direction of Flight:	NNW
Size of Analyzed Scene:	1650 x 1750 ft <sup>2</sup>
General Description:	Farm Fields
Meteorology:	Snow covered ground; air temperature = $-2^{\circ}C$ , $5^{\circ}C$ , $4^{\circ}C$ , $-2^{\circ}C$ , respectively; cloud cover = $95\%$ , clear, $15\%$ , $60-95\%$ , respectively

Scene: Michigan Winter Scene - Land and Water

Identifier (Date):	Land and Water (4-3-79, 4-4-79)
Spectral Bands:	3.5-3.9, 4.5~5.5, 9.0-11.4 μm
Altitude:	1000 ft (35° depression); 1750 ft (90° depression)
IFOV:	2.5 mrad
Aircraft Ground Speed:	202 ft-sec -1
Time:	0600, 1230, 1900, 0030
Direction of Flight:	NNW
Size of Analyzed Scene:	$1650 \times 1750 \text{ ft}^2$
General Description:	Land and Lake
Meteorology:	Snow covered ground; air temperature = $-2^{\circ}C$ , 5°C, 4°C, $-2^{\circ}C$ , respectively; cloud cover = 95%, clear, 15%, 60-95%, respectively

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Scene: Mill Creek, OK

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Identifier (Date):	Mill Creek (6-30-72)
Spectral Bands:	1.0-1.4, 1.5-1.8, 2.0-2.6, 9.3-11.7 μm
Altitude:	3000 ft
IFOV:	2.5 mrad (cross-track); 5.0 mrad (in-track)
Aircraft Ground Speed:	200 ft-sec <sup>-1</sup>
Time:	0730
Direction of Flight:	Southeast
Size of Analyzed Scene:	$3990 \times 4840 \text{ ft}^2$
General Description:	Mountainous Terrain
Meteorology:	Visibility 30 mi; dry; cloud cover 30%

Scene: Mono Lake, CA

Identifier (Date):	Mono Lake (9-23-68)
Spectral Bands:	1.0-1.4, 2.0-2.6, 4.5-5.5, 8.0-13.5 µm
Altitude:	4000 ft
IFOV:	3.5 mrad (cross-track); 6.6 mrad (in-track)
Aircraft Ground Speed:	200 ft-sec <sup>-1</sup>
Time:	1000
Direction of Flight:	South
Size of Analyzed Scene:	$3100 \times 6760 \text{ ft}^2$
General Description:	Mountains
Meteorology:	Visibility >15 mi; clear and bright; dry

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### MASTER INDEX (Cont.)

Scene: Nellis AFB, NV - Desert and Dry Lake

Identifier (Date):	NEV-C,L H1 (2-25-78, 2-26-78)
Spectral Bands:	2.0-2.6, 3.0-4.2, 3.5-3.9, 4.5-5.5, 9.0-11.4 μm
Altitude:	1000 ft (35° depression)
IFOV:	2.5 mrad
Aircraft Ground Speed:	$200 \text{ ft-sec}^{-1}$
Time:	1100, 1600
Direction of Flight:	East, except NEVC (West)
Size of Analyzed Scene:	1750 x 2700 (desert); 1750 x 1350 (dry lake)
General Description:	Desert and Dry Lake
Meteorology:	<pre>1100 - high, thin, scattered clouds, visibility = 15 miles; 1600 - scattered clouds, light haze, visibility = 35 miles</pre>

### Scene: Nellis AFB, NV - Mountains

Identifier (Date):	NEV-B, F, I, M, N, G1 (2-25-78, 2-26-78)
Spectral Bands:	2.0-2.6, 3.0-4.2, 3.5-3.9, 4.5-5.5, 9.0-11.4 μm
Altitude:	1000 ft (35° depression); 1750 ft (90° depression)
IFOV:	2.5 mrad
Aircraft Ground Speed:	200 ft-sec <sup>-1</sup>
Time:	0930, 1100, 1500
Direction of Flight:	East, except NEVG1 (West)
Size of Analyzed Scene:	$1750 \times 6750 \text{ ft}^2$
General Description:	Mountains
Meteorology:	0930 - high, thin, scattered clouds, 1100 - visibility = 15 miles; 1500 - scattered clouds, light haze, visibility = 35 miles

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### MASTER INDEX (Concluded)

Scene: Pisgah Crater, CA

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Identifier (Date):	Pisgah Crater (10-30-70)
Spectral Bands:	8.0-10.9, 9.4-12.1, 11.3-13.5 μm
Altitude:	1000 ft
IFOV:	3.5 mrad (11.3-13.5); 21 x 28 mrad <sup>2</sup> (8.0-10.9, 9.4-12.1)
Aircraft Ground Speed:	
Time:	0830
Direction of Flight:	South-Southeast
Size of Analyzed Scene:	$6960 \times 820 \text{ ft}^2$
General Description:	Mountains
Meteorology:	Visibility 50 mi; clear and bright; dry; cloud cover 10%
Scene: Port Hueneme, CA	
Identifier (Date):	HUMEl (or HUM1) HUME2 (or HUM2) (3-7-78)
Spectral Bands:	2.0-2.6, 3.0-4.2, 4.5-5.5, 9.0-11.4 µm
Altitude:	1000 ft (35° depression); 1750 ft (90° depression)
IFOV:	2.5 mrad
Aircraft Ground Speed:	202 ft-sec <sup>-1</sup>
Time:	1215, 1420
Direction of Flight:	West
Size of Analyzed Scene:	$6350 \times 2800 \text{ ft}^2$ (HUME1) 1800 x 900 ft <sup>2</sup> (HUME2)
General Description:	Land and water; port facility
Meteorology:	Visibility >15 mi; slight haze; high scattered clouds; water calm; slight

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#### TYPE-OF-BACKGROUND INDEX

This index is intended to direct the reader to background data compiled for different types of scenes and under different temporal conditions, diurnal and seasonal. The breakdown of data into more detailed categories was considered unnecessary because the physical and environmental characteristics are tabulated in each data package in Section 3.

In this index there is a time-of-day versus season matrix for each type of background scene. The reader is referred to the Master Index for the location in the Handbook of material pertinent to the referenced background type.

#### RESIDENTIAL-INDUSTRIAL

Season	Time (Hrs.)				
Bellow	0001-0600	0601-1200	1201-1800	1801-2400	
JanMar.	Michigan	Michigan	Michigan Port Hueneme, CA	Michigan	
AfrJune		Baltimore, MD			
July-Sept.		Flint, Ml			
OctDec.					

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Sagoor	Time (Hrs.)			
364901	6001-0600	0601-1200	1201-1800	1801-2400
JanMar.		Nellis AFB, NV	Nellis AFB, NV	
AprJune		Mill Creek, OK		·
July-Sept.		Mono Lake, CA	Black Hills, SD	
OctDec.		Pisgah Crater, CA		

### DESERT

Contra	Time (Hrs.)			
368501	0001-0600	0601-1200	1201-1800	1801-?400
JanMar.		Nellis AFB, NV	Nellis AFB, NV	
AprJune				
Juły-Sept.				
OctDec.				

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Segran	Time (Hrs.)				
5645011	0001-0600	0601-1200	1201-1800	1801-2400	
JanMar.	Michigan	Michigan	Michigan Port Hueneme, CA	Michigan	
AptJune					
July-Sept.					
OctDec.					

### VEGETATION-RURAL

Saron	Time (Hrs.)				
Jeason	0001-0600	0601-1200	1201-1800	1801-2400	
JanMar.	Camp A.P. Hill, VA Michigan	Camp A.P. Hill, VA Michigan	Camp A.P. Hill, VA Michigan	Camp A.P. Hill, VA Michigan	
AprJune					
July-Sept.			Black Hills, SD		
OctDec.					

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### SPECTRAL BAND INDEX

<u>1.0-1.4 μm</u> Flint-1 Flint-2 Baltimore Mill Creek Black Hills-1 Black Hills-2 Mono Lake

<u>1.5-1.8 μm</u>

Flint-1 Flint-2 Mill Creek Black Hills-2

2.0-2.6 µm

Flint-1 Flint-2 Baltimore Mill Creek Black Hills-1 Black Hills-2 Mono Lake Nellis AFB Port Hueneme-1 Port Hueneme-2 Camp A.P. Hill Michigan

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<u>3.0-4.2 µm</u> Nellis AFB Port Hueneme-1 ine constration de la faith de la strate de la constraire de la constraire de la constraire de la constraire d

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Port Hueneme-2

3.5-3.9 µm

Nellis AFB Michigan

### <u>4.5-5.5 μm</u>

Black Hills-1 Mono Lake Nellis AFB Port Hueneme-1 Fort Hueneme-2 Camp A.P. Hill Michigan

8.0-14.0 µm

Flint-1 Flint-2 Baltimore Mill Creek Black Hills-1 Pisgah Crater Mono Lake Nellis AFB Port Hueneme-1 Port Hueneme-2 Camp A.P. Hill Michigan

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### 1 DATA ANALYSIS - INTRODUCTION

For a large number of years, there has been a great demand for statistical information on backgrounds to be used in a variety of ways, in particular as input to the design and analysis of infrared systems. The Environmental Research Institute of Michigan (ERIM) has for years been collecting infrared imagery with its airborne scanners, calibrated to yield, absolutely, spatially varying radiances from chosen scenery with relatively high spatial resolution. Recent flights have been sponsored through the Optical Signatures Program to Support Navy Requirements. One scanner and its associated equipment are described in Appendix A.

A variety of statistical measures have been derived from the imagery and are presented in this handbook. These include the conventional statistical parameters of means, standard deviations, histograms, Wiener (power) spectra, and spectral correlations as well as new area/ radiance/temperature statistics which are particularly relevant in view of recent advances in sensor and processor technology. Efforts to assess the utility of the various background statistical measures have been reported in various technical reports (References 1-6).

Conventional background statistics have in the past been adequate since in many instances there is a high contrast between the target and background. In such instances, the highest intensity background points determine the highest threshold setting necessary to eliminate all false alarms and the histograms provide estimates of how the detection probability and false alarm rate vary with threshold setting. However, today there is a need for higher-order background statistics because of the increased sophistication of background rejection techniques employed with large detector arrays and imaging or scanning sensors.

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Although the power spectrum is a background statistic which does vary with the spatial distribution of radiances in the scene, it is clearly an inadequate background descriptor for most of today's problems. Small areas of high radiance produce most of the false alarms in today's sensors, and the power spectrum does not distinguish between scenes with many low-intensity areas and those with a few high-intensity areas. This is a well known fact and a result which is evident from the background modeling work of R. Clark Jones and the Working Group on Infrared Backgrounds, WGIRB (Reference 7).

Hence, in addition to the conventional statistics on terrain backgrounds, area/radiance/temperature statistics have been developed as a statistical measure that is more directly useful to the sensor designer in estimating detection probabilities and false alarm rates with today's sensor and processor technology. The statistics developed are the probabilities that regions (of various sizes, shapes, and orientations) will occur in the scene above a specified radiance threshold. The parameters calculated are area, major and minor axes, and the angular orientation for an elliptical figure that is equivalent, in geometric area and ratio of second moments of the region area about its centroid, to each contiguous region above the radiance threshold. The elliptical area is equivalent in spatial area only to each contiguous region above the radiance threshold. Presented in the handbook are histograms of the number of area sizes occurring above preselected thresholds. For most scenes, the number of regions and their areas decreates as the threshold is raised, while the number of small regions above any preset threshold varies from one scene to the next. These area/radiance/temperature statistics are analogous to the more familiar pulse length statistics for one-dimensional records.

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The statistical parameters for the occurrence of areas and intensities in the various background scenes are not only directly useful for estimating sensor performance but may also be useful in special cases in simulating classes of backgrounds. The equivalent ellipses at each threshold can be positioned to simulate the actual scene from which they were derived, or repositioned at random to simulate many scenes having the same area/radiance/temperature statistics. Such simulations of backgrounds reproduce many of the spatial characteristics of the original scene as is shown by example in Figure 1. In this figure, a sample thermal image is reproduced, overlaid by a transparency containing ellipses processed in the analysis from a preselected threshold. Correlations between the ellipses and certain structures in the imagery are evident. The correlations are not as spectacular, however, in the more homogeneous backgrounds. The statistics of the ellipses should match the real scene statistics more and more closely as the threshold for signal detection is raised. However, we have not performed a complete analysis of the correlation between scene characteristics and the simulations representing these scenes.

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The histograms provide probably the greatest amount of information in general about the scene. In the thermal regions of the spectrum they are presented in terms of temperature for comparison among the different spectral regions. The temperatures are obviously only apparent since the emissivity of the surface is less than unity, and furthermore, the atmosphere intervenes to alter the radiation emitted by the surface. Inhomogeneities in the surface radiative properties tend to spread the histogram, while the atmosphere tends to have a quieting effect. The interplay of these two characteristics is evident in the different scenes, particularly in a comparison between the 4.5-5.5 µm and the 8.0-14.0 µm regions. In the shorter wavelength regions, the sun's influence is evident.





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The scanner details are included in Appendix A and the data processing procedures are presented in Appendix B. The remaining sections of this handbook contain the background data that forms the substance of this handbook. The type of data included in this handbook and the form of data presentation is described in Section 2. This section provides the data description and explanation necessary for utilizing the handbook. The substance of the handbook is compiled in Section 3, containing complete packages of background data and pertinent environmental information.

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### DESCRIPTION OF DATA STATISTICS

The multispectral background data selected for inclusion in this report were analyzed to determine the statistics of both radiometric and spatial features. The general data processing principles are presented in Section 2.1 with a more detailed discussion of the procedures included in Appendix B. The remainder of this section is devoted to describing the data and the statistics used to present the data in this handbook. The statistical measures derived from the data are described in Section 2.2; point statistics in Section 2.2.1, and correlative statistics in Section 2.2.2. Three types of correlative statistics are discussed. These include spectral correlations between pairs of bands; area/radiance/ temperature statistics and the development of the equivalent elliptical area concept; and one-dimensional Wiener (power) spectra.

### 2.1 DAIA PROCESSING PROCEDURE

Some preprocessing is required before the scanner data are used to generate scene statistics. First, the high density digital tapes must be converted to computer compatible tapes. Secondly, each channel must be calibrated in temperature or radiance (see Appendix B.2). The data in the near IR channel are converted to equivalent radiance in  $\mu W/cm^2 \cdot sr \cdot \mu m$ and the data in the thermal IR channels are converted to apparent temperature in degrees Kelvin. Next, averaging is employed to reduce oversampling and to equalize any differences in the fields of view of the various detectors (see Appendix B.3). Lastly, calibrated formatted tapes are generated for analysis.

### 2.2 STATISTICS DEFINITIONS

Several sets of statistics have been generated for each of the chosen scenes. These may be broken down into two groups:

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- Point Statistics: Those defined by individual data points in a single channel.
- Correlative and Area Statistics: Those requiring calculation of correlation effects for a scene either in a single channel or between channels.

### 2.2.1 POINT STATISTICS: MEANS AND STANDARD DEVIATIONS

The point statistics generated are the mean and standard deviation for each channel and a histogram of the data value distributions of these channels. In some imagery, to determine the degree of homogeneity that exists, the total scene is broken down into sub-areas and the point statistics generated for these sub-areas as well as for the total area. In practice, the sub-area statistics are generated first and the total area statistics derived from them. Sub-areas are not included in this handbook.

The mean value for area  $\eta$  in Channel J  $(\overline{X(J)}_{\eta})$  is evaluated using

$$\overline{\mathbf{X}(\mathbf{J})}_{\eta} = \frac{1}{N_{\eta}} \sum_{i=1}^{N_{\eta}} \mathbf{x}(\mathbf{J})_{i}$$
(2-1)

where  $x(J)_{i}$  is the data value of pixel i in Channel J and N<sub> $\eta$ </sub> is the total number of data points in the area. Using the same notation, the standard deviation,  $\sigma^{2}(J)_{n}$ , is given by

$$\sigma^{2}(J)_{\eta} = \left(\frac{N_{\eta}}{N_{\eta}-1}\right) \left\{ \left(\frac{1}{N_{\eta}} \sum_{i=1}^{N_{\eta}} x^{2}(J)_{i}\right) - \overline{x(J)_{\eta}^{2}} \right\}$$
(2-2)

At the same time that these statistics are generated, the number of data points having each of the possible data values (0 to 255) is tabulated and this tabulation used to generate histograms for the scene.

2-2

A representative histogram is included in Figure 2. Note that the ordinate of the histogram is probability expressed as fraction of the total number of data points within an interval of the abscissa. In this example case, it is the fraction of the total in a 0.19°K interval.

### 2.2.2 CORRELATIVE AND AREA STATISTICS

Three sets of correlative statistics are generated for the scenes: wavelength correlations, area statistics, and spatial correlations or Wiener spectra. Because of the common factors involved, the wavelength correlations are evaluated at the same time as the means and standerd deviations while the area statistics and Wiener spectra require separate computer codes.

### 2.2.2.1 Wavelength Correlations

The wavelength correlations are determined for all pairs of channels except for those collected at opposite ends of the M-5 scanner which were 90° out of phase. The data for the 1.0-1.4, 1.5-1.8, and 2.0-2.6 µm channels were collected using a three-element InAs detector, the segments of which look at slightly different ground areas at any given time. The 1.0-1.4, 2.0-2.6, and 4.5-5.5 µm data were collected with a threeelement InSb detector. The three channel data were brought into registration at the nadir by applying appropriate time delays to the leading channels (time delays long enough to correct for the 90° phase difference between the two ends of the M-5 scanner could not be generated). Complete registration could not be maintained across the entire scan line because as the scan angle is increased, the projection of the three detector arrays rotates about the center element until at a scan angle of 90° the detector array is aligned in-track rather than cross-track. However the element-to-element registration is 50% or better for angles +20° of nadir.

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The wavelength correlation between two channels, J and K, is defined in terms of a correlation coefficient which is the ratio of the covariance of the two channels to the product of their standard deviations:

$$COR(J,K) = \frac{COV(J,K)}{\sigma(J)\sigma(K)}$$
(2-3)

where COR(J,K) is the correlation coefficient for the two channels,  $\sigma(J)$ and  $\sigma(K)$  their standard deviations, and COV(J,K), the J-K element of the covariance matrix for a given area, is defined as

$$COV(J,K)_{\eta} = \frac{N_{\eta}}{N_{\eta}-1} \left\{ \frac{1}{N_{\eta}} \sum_{i=1}^{N_{\eta}} x(J)_{i}x(K)_{i} - \overline{x(J)_{\eta}} \overline{x(K)_{\eta}} \right\}$$
(2-4)

where all symbols are the same as those of Equations 2-1 and 2-2. The reason for the simultaneous evaluation of Equations 2-2 and 2-4 is obvious: the square of the standard deviation  $\sigma^2(J)$  is the autocovariance or the covariance of a given channel with itself COV(J,J). An example of the correlation coefficients for the infrared channels of the sample area is given in Table 1.

### 2.2.2.2 Area/Radiance/Temperature Statistics

Since means, standard deviations, and histograms do not give any information about the positions of data values in the scene or possible clustering of these values, area statistics have been generated by determining contiguous regions of the scene for which the enclosed points had values greater than some prescribed threshold. Once these regions have been defined, their geometric centroids, areas, and second moments are determined and these parameters used to define a set of equivalent elliptical areas. The output from this procedure is, for each threshold level, a tabulation of distributions in terms of area, perimeter, and shape of the pictured ellipses.
# TABLE 1. STATISTICS OF THE AFTERNOON SCENE

Number of Subregions = 1 Pixel Subarea<sup>\*</sup> Divisions at: 1 855 Line Subarea<sup>\*</sup> Divisions at: 1 704 Line Increment Used = 1 Pixel Increment Used = 1 Correlation Channels: 2 (2.0 - 2.6  $\mu$ m) 4 (4.5 - 5.5  $\mu$ m) 5 (8.0 - 14.0  $\mu$ m)

Correlation	2	4	5
2	1.000		
٤4	0.782	1.000	
5	0.636	0.882	1.000

Channels	2	4	5
Mean	6,2356E+01	2,8569E+02	2.8654E+02
St. Dev.	2.4785E+01	2.2922E+00	2.7390E+00
Total Points	597800.	597800.	597800.

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\* The term subarea refers to the original analyses in which the total area was subdivided into subareas. In the handbook samples, subarea and total area are equivalent. The line and pixel numbers are evident from the greymap dimensions.

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The semi-major and semi-minor axes of the equivalent ellipses are taken coincident with the principal axes of the regions they represent. If  $I_x^c$  and  $I_y^c$  are the second moments of a region about the centroid and  $I_{xy}^c$  its product moment, all of which are calculated as if the plane figures are massive and have moments of inertia<sup>\*</sup>, the angle of rotation of the principal axes relative to a fixed x-y coordinate system is given by

$$\alpha = \frac{1}{2} \tan^{-1} \left\{ \frac{2 \mathbf{I}_{xy}^{c}}{\mathbf{I}_{y}^{c} - \mathbf{I}_{x}^{c}} \right\}$$
(2-5)

where  $\alpha$  is in radians. The second moments of the region about the principal axes are then given by

$$I_{x'} = \left(\frac{I_{x}^{c} + I_{y}^{c}}{2}\right) + \left(\frac{I_{x}^{c} - I_{y}^{c}}{2}\right) \cos 2\alpha - I_{xy}^{c} \sin 2\alpha$$
(2-6)

and

$$I_{y'} = \left(\frac{I_{x}^{c} + I_{y}^{c}}{2}\right) - \left(\frac{I_{x}^{c} - I_{y}^{c'}}{2}\right) \cos 2\alpha + I_{xy}^{c} \sin 2\alpha$$

Since the area and the second moments of an arbitrary region cannot be simultaneously matched using an ellipse, equality is demanded between the geometric areas and the <u>ratios</u> of the principal moments. If the semimajor and semi-minor axes of the ellipse are defined as a and b, respectively, and the a-axis is aligned with the larger of the principal axes of the region, these equalities give

$$a^{2} = \frac{A}{\pi} \sqrt{\frac{I_{1}}{I_{2}}}$$
 (2-7)

and

$$b^2 = \frac{A}{\pi} \sqrt{\frac{I_2}{I_1}}$$

cf. Mathematical Statistics, S. S. Wilks, John Wiley & Sons, 1962.

2-7



where A is the area of the region and  $I_1$  and  $I_2$  are the moments given by Equation 2-6, with  $I_1 > I_2$ . If  $I_y$ , of Equation 2-6 is the larger of the moments, the a-axis of the ellipse is oriented at an angle  $\alpha$  with respect to the fixed x-axis; if  $I_x$ , is larger, the a-axis is at an angle  $\alpha + \pi/2$ . An example of the equivalent elliptical areas generated for the 8.0-14.7 µm channel of the sample area is shown in Figures 3 and 4. These figures represent the areas found for data values exceeding the specified threshold where  $\sigma$  is the standard deviation, i.e., 2.74°K, and the threshold is defined as the mean plus the specified multiple of  $\sigma$ . The mean is 286°K.

#### 2.2.2.3 Wiener (Power) Spectra

The last of the correlative statistics generated are Wiener spectra which give information about the spatial frequency content of the images. The Wiener spectrum for a stationary process is defined as the Fourier transform of the autocorrelation function. In one dimension this is

$$S(k_{x}) = \int_{-\infty}^{\infty} \exp(-2\pi i k_{x} x) R(x) dx \qquad (2-8)$$

where  $S(k_x)$  is the Wiener or power spectrum,  $k_x$  the spatial frequency, and R(x) the autocorrelation function. R(x) is itself defined as the expectation value of the product of scene data values times the corresponding values for the scene when displaced by x:

$$R(x) = E \{f(X)f(X + x)\}$$
(2-9)

where E represents the expectation value of the argument. The Wiener spectrum may be evaluated without first determining the autocorrelation function if the integral

$$\int_{-\infty}^{\infty} |\mathbf{x}\mathbf{R}(\mathbf{x})| d\mathbf{x} \qquad (2-10)$$

is bounded, which is usually the case for non-periodic data with zero mean. In this case, it may be shown that [Reference 8]



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Area: Camp A.P. Hill (Wavelength = 8.0 - 14.0 μm) Temperature Threshold = Mean + 3.00 σ Mean = 286.54 Kelvin Std. Dev. = σ = 2.74 Kelvin

FIGURE 4. EQUIVALENT ELLIPTICAL AREAS - AFTERNOON

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 $S(k_x) = \lim_{x_2 \to x_1} (x_2 - x_1) \rightarrow \infty \left| \int_{x_1}^{x_2} f(x) e^{x_1 - 2\pi i k_x x_1} dx \right|^2$  (2-11)

so that the Wiener spectrum is, in the limit, the modulus squared of the Fourier transform of the scene. Written in terms of the discrete Fourier transform, this equation becomes

$$S(j) = \frac{\Delta x}{(N-1)} \left| \sum_{\ell=0}^{N-1} f(\ell) \exp(-2\pi i j \ell/N) \right|^2 \qquad (2-12)$$

where N is the total number of points being transformed, i the square root of -1, and the spatial frequency  $k_{\chi}$ , evaluated only at integer values of j, is given by

$$k_{x} = \frac{j}{N\Delta x}$$
(2-13)

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where x is the displacement between successive data points.

It may be seen from Equation 2-12 that the Wiener spectrum S(j) is symmetric about j=N/2 since

$$\exp(-2\pi i(N-j)\ell/N) = \exp(+2\pi i j\ell/N) \qquad (2-14)$$

Hence

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S(N-j) = S(j) for j=1, 2, ..., N/2 (2-15)

and only the first half of the Wiener spectrum needs to be evaluated. The calculated frequency range is then

$$\frac{1}{N\Delta x} \leq k_{x} \leq \frac{1}{2\Delta x}$$
(2-16)

One-dimensional Wiener spectra are evaluated both cross-track (along scan line) and in-track (parallel to the aircraft flight paths). These are average spectra since Equation 2-12 was used to transform individual "lines" of data and the transforms have been averaged over a number of

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"lines". Since the Fourier transform algorithms are substantially less expensive if the number of points transformed is a power of 2, only 2<sup>n</sup> points (n was mostly 9, so 2<sup>n</sup>=512) are used for both the cross-track and in-track "lines" of data. The middle 512 scan lines are averaged to obtain the cross-track Wiener spectra; a number of along-track lines (usually 25) equally spaced across the image are averaged to obtain the in-track Wiener spectra. Examples of in-track and cross-track Wiener spectra for the sample area are shown in Figures 5 and 6. The units of power density are (°K)<sup>2</sup>/cycle per meter for the bands above 3 µm and (µW/cm<sup>2</sup>·sr·µm)<sup>2</sup>/cycle per meter for the bands below 3 µm.

Because of the multi-modal nature of many of the background scenes, Wiener spectra are limited, as mentioned in Section 1, in their description of false alarms. They are, however, a traditional method of producing spatial phenomena mathematically, and show trends which are helpful in an overall appraisal of a background scene, especially in relation to other scenes.

#### 2.3 DATA UTILIZATION

The data co \_ained in Section 3 were collected over a period of several years for a variety of purposes. There exists a variety of problems to which data of this type are directly applicable. In some cases, data may be completely appropriate (right wavelength, time, etc.) to a particular problem. While in other situations, it will be desirable to use the data included herein for problems for which the measurements are not directly analogous. For these cases, an estimate may be obtained by extrapolation from or interpolation between the data packages of Section 3. For example, estimates of the background characteristics at wavelengths other than the precise wavelengths at which the measurements were made are possible using the filter characteristics of the scanner included in Appendix A and considering atmospheric effects. In the thermal bands, blackbody curves should be used to extrapolate to the wavelength of interest, whereas in the near infrared wavelengths, the solar spectrum is used.





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POWER SPECTRA - AFTERNOON

\*\*Power spectral density is  $(\mu W - cm^{-2} - sr^{-1} - \mu m^{-1})^2 / cycle/meter$  for the 2.0 to 2.6  $\mu m$  band, and  $(K)^2 / cycle/meter$  for the 4.5 to 5.5 and 8.0 to 14.0  $\mu m$  bands.

FIGURE 6. POWER SPECTRA - AFTERNOON (IN-TRACK)

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In both cases, the variation in the scene emissivity and reflectivity with wavelength will introduce some uncertainty. Additionally, detailed atmospheric measurements were not made and some uncertainty will exist due to atmospheric effects. However, if one recognizes the uncertainties involved due to these effects, an estimate of the background characteristics at conditions other than those included in Section 3 is feasible. The accuracy of the estimate will depend on both the closeness of desired data conditions to those included herein and the specific background and conditions from which the interpolation is made. as induction of the second

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#### PHYSICAL DESCRIPTIONS AND STATISTICAL DATA FOR VARIOUS SCENES

3

This Section is composed of data packages from the different scenes from which imagery was obtained under various environmental, diurnal, and seasonal conditions. Each package contains the following in this order.

- 1. Tables giving the pertinent environmental, geographical, and temporal data concerning the scene; and physical data on the area of coverage, spectral coverage, spatial resolution, flight direction, and depression angle (from the horizontal) of the scanner look direction.
- 2. Aerial photograph of the scene.
- 3. Scanner imagery of the scene in various spectral bands.
- 4. Greymaps of the imagery in selected spectral bands, designating the chosen areas of coverage for which the statistics were calculated. Scanner line numbers are shown on the side of the map and pixel numbers in the scan line on the top or bottom. Scanner line and pixel numbers are used to identify the location of the data in the imagery. See Appendix B for additional details. Because of vertical-to-horizontal asymmetry of scale in the line printer which creates the greymaps, picture sizes are not to scale. The dimensions and scanner line and pixel numbers are included on the picture to identify the area represented.
- 5. Histograms of selected portions of the imagery showing temperature and/or radiance distributions of scene elements (pixels) for various spectral bands. Histograms are reported as probability expressed as fraction of data points in a temperature interval as a function of temperature for wavelengths above 3 µm and as fraction of data points in a radiance interval as a function of radiance for wavelengths below 3 µm.

3.0-1

- 6. Tables showing means and standard deviations for various spectral bands, along with correlations of the data between pairs of spectral bands. The total number of points (pixels) to which these values correspond are tabulated.
- 7. Selected ellipse statistics in two forms: distributions of ellipses in terms of area, perimeter, and shape factor\*, and actual ellipses "pictures" representing the events from which the ellipses were calculated. See Section 2 for description of ellipse representations. In the ellipse pictures, the scanner line numbers corresponding to those on the greymaps are prefixed with an "L"; the pixel numbers are prefixed with a "P". Thus, line 50 is L50, pixel 75 is P75.

In some cases one will note a discrepancy between the number of ellipses tabulated in the "Distribution" table which follows each ellipse picture and the apparent number of ellipses in the corresponding figure. There are several reasons for these occurrences among which the following are the chief ones. When obvious, glaring noise spikes were encountered, they were erased from the pictures, but were nevertheless tabulated by the computer program. This occurred only in two cases which are designated on the appropriate figures and tables. Another cause is the merging of small ellipses which appear as one. Finally, probably the major cause is the fact that the Calcomp plotting routine apparently simply drops ellipses which are below a certain size. Therefore, when this discrepancy occurs, it happens mainly to the smallest values in the tabulation, which covers no more than a half dozen pixels

Shape Factor =  $\frac{\text{Perimeter}/2\pi}{\pi}$  $(area/\pi)^{1/2}$ 

For a circular area, the shape factor would achieve its minimum value of unity.

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or so. Since the tapes containing the analyzed data can be made available at cost, these minutely detailed results can be retrieved by persons interested in them.

 One-dimensional power (Wiener) spectra, both in the direction of flight and across the flight line, for various spectral bands. These are called respectively the in-track and crosstrack spectra. See Section 2 for description of power spectra.

Table 2 and Figure 7 are included here to help the reader understand how the energy in a scene is distributed among selected bands. One may discern from them how the signals in different spectral regions relate to each other. Precise correlations cannot be obtained from them, however, because of the host of meteorological and physical factors which come into play. They might be used, though, to infer some generalized qualitative behavior in the histogiams. Table 2, for instance, shows the sunlight radiance reflected from a diffuse terrain element on line 1, and the radiance emitted from it on line 2, in the various bands indicated. From the calculated ratios, it is seen that reflected sunlight predominates in the 2.0-2.6 µm band, can be equally as effective as thermal radiation at 3.5-3.9  $\mu$ m, and diminishes in effectiveness beyond. One important factor which is not included in Table 2 is the possible strong spectral variability of the emissivity of terrain material which could affect the ratios greatly. The emissivity used for Table 2 was nominally 0.9. Figure 7 shows the relative amounts of radiation in the selected thermal bands as affected by absorption in the atmosphere.

Thermal (T)

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IRRADIANCE vs THERMAL RADIANCE AT THE CENTER OF DIFFERENT CHANNELS  $(W-cm^{-2}-ster^{-1}-\mu m^{-1})$ 2.0-2.6 im <u>3.5-3.9 μm</u> <u>4.5-5.5 μm</u> <u>9.0-11.4 μm</u>  $3.97 \times 10^{-6}$ 7.15 x  $10^{-5}$  $2.55 \times 10^{-5}$ 2.59 x  $10^{-7}$ Sun (S)  $1.30 \times 10^{-7}$  $4.03 \times 10^{-5}$  $7.80 \times 10^{-5}$  $9.87 \times 10^{-4}$ 

TABLE 2. COMPARISON OF REFLECTED SOLAR

Ratio (T/S)	с <b>Н</b>	1/550	1.6/1	19.7/1

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## BALTIMORE Data

Wavelength Bands:

1.0-1.4 μm, 2.0-2.6 μm, 9.3-11.7 μm

IFOV: 2.5 mrad (cross-track); 5.0 mrad (in-track)

Altitude: 2500 ft

Depression Angle: 90°

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Time: 1130 hrs

Flight Direction: East

Ground Speed: ~200 ft-sec<sup>-1</sup>

<u>Area Covered (Approx.)</u>: 5200 ft long x 4000 ft wide (1.0-1.4 μm, 2.0-2.6 μm) 6250 ft long x 4000 ft wide (9.3-11.7 μm)

Meteorology: Clear sky; light haze at 5k it; dry conditions







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BALTIMORE, MARYLAND

\*Histograms

Spectral Bands: 1.0 - 1.4 µm 2.0 - 2.6 µm 9.3 - 11.7 µm

\* Circles define a Gaussian curve with the same nean and standard deviation as the actual histogram. An "S" on some curves indicates saturation. Because of limits on gain settings some values may exist beyond the digital limits of 0 and 255, the digital dynamic range of the data processing.





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### BALTIMORE, MARYLAND

Means and Standard Deviations for Spectral Bands Correlations Between Spectral Bands<sup>\*</sup>

Spectral Bands: Channel 2: 1.0 - 1.4 μm (μW-cm<sup>-2</sup>-sr<sup>-1</sup>-μm<sup>-1</sup>) Channel 4: 2.0 - 2.6 μm (μW-cm<sup>-2</sup>-sr<sup>-1</sup>-μm<sup>-1</sup>) Channel 5: 9.3 - 11.7 μm (°K)

## 3.1-1.0

These data were obtained with the M-7 scanner. The 1.0-1.4 and 2.0-2.6  $\mu$ m data are in spatial registration, but the 9.3-11.7  $\mu$ m data were processed separately and are not in spatial registration with the 1.0-1.4 and 2.0-2.6  $\mu$ m data. Hence, spectral correlation coefficients have not been determined between the 9.3-11.7  $\mu$ m data and either the 1.0-1.4  $\mu$ m or 2.0-2.6  $\mu$ m data.

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Number of Subregions =	1			
Pixel Subarea Divisions	at	: 1		645
Line Subarea Divisions	at:	1		500
Line Increment Used = 1				
Pixel Increment Used =	1			
Correlation Channels:	2 4 5	(1.0 (2.0 (9.3	-	1.4 μm) 2.6 μm) 11.7 μm)

Correlation	2	4	
2	1,000		
4	0.084	1.000	
	•		

Channels	2	4	5
Mean	2.1332E+03	7.8471E+01	2.9913E+02
St. Dev.	7.7751E+02	4.3876E+01	5.8879E+00
Total Points	269610	269610	322500

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BALTIMORE, MARYLAND

Ellipse Statistics

Spectral Bands: 1.0 - 1.4 μm 9.3 - 11.7 μm



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# BALTIMORE DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

SQUARE	ME	TERS	FREQUENCY
			,
16.0	τu	20.0	0
20.0	TO	25.0	46
25.0	10	30.0	17
30.0	10	35.0	0
35.0	10	40.0	16
40.0	tu	45,0	12
45.0	۲n	50,0	0
50.0	TO	75.0	12
75.0	10	100.0	8
100.0	то	150.0	2
150.0	TO	200.0	4
200.0	ŤŪ.	250.0	2
250.0	TÖ	300.0	0
300.0	10	400.0	0
400.0	TŪ	500.0	1
0	/ER	500.0	0

Threshold = Mean + 2.13  $\sigma$ Wavelength = 1.0 - 1.4  $\mu$ m Mean = 2133.18  $\mu$ W-cm<sup>-2</sup>-sr<sup>-1</sup>- $\mu$ m<sup>-1</sup>  $\sigma$  = 777.51  $\mu$ W-cm<sup>-2</sup>-sr<sup>-1</sup>- $\mu$ m<sup>-1</sup>

TOTAL NUMBER OF ELLIPTICAL AREAS = 120

**VERIM** 

260 FEATURES WITH AREAS LESS THAN16,00 SO, METERS WERE ALSO RECOGNIZED

	BY PERIMETER			BY SHAPE			
ME	TER	s	FEL	ET	FRFQUENCY	SHAPE FACTOR	FREQUENCY
0	10	7	0 TI	. 22	0	0.0 TH 1.0	1
7	10	10	22 10	1 32	0	1.0 TO 1.1	0
10	10	12	32 TI	1 39	0	1.1 10 1.2	15
12	TO	14	39 TI	45	0	1.2 10 1.3	6
14	to	16	45 10	52	1	1.3 TO 1.4	51
10	TO	17	52 TI	0 <u>55</u>	ō	1.4 TO 1.5	11
17	10	50	55 T	6 65	8	1.5 10 1.6	10
20	TO	22	65 T	0 72	0	1.6 10 1.7	20
22	10	24	72 1	0 78	26	1.7 TU 1.8	10
24	10	26	78 T	0 85	0	1.8 TO 1.9	6
26	in .	28	85 T	0 91	-21	1.9 10 2.0	6
28	10	30	91 T	0 98	Ō	2.0 10 2.4	6
30	10	32	98 T	0 104	16	2.4 10 2.6	U
32	to	39	104 T	0 127	15	2.6 10 2.8	2
19	to	45	127 1	0 147	6	2. A TU 3.0	0
45	TO	55	147 T	0 140	13	3.0 10 3.5	0
55	τ <u>ο</u>	71	180 T	0 232	7	3.5 10 4.0	Û
71	in	100	232.1	11 328	5	4.0 TI) 4.5	0
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BALTIMORE

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

SQUARF METERS	BY AREA FREQUENCY	Threshold = Mean + 3.40 $\sigma$ Wavelength = 1.0 - 1.4 $\mu$ m Mean = 2133.18 $\mu$ W-cm <sup>-2</sup> -sr <sup>-1</sup> - $\mu$ m <sup>-1</sup>
16.0 $10$ $20.0$ $20.0$ $10$ $25.0$ $25.0$ $10$ $30.0$ $30.0$ $10$ $30.0$ $30.0$ $10$ $30.0$ $35.0$ $10$ $30.0$ $35.0$ $10$ $40.0$ $40.0$ $10$ $45.0$ $40.0$ $10$ $45.0$ $45.0$ $10$ $50.0$ $50.0$ $10$ $150.0$ $150.0$ $10$ $200.0$ $200.0$ $10$ $250.0$ $250.0$ $10$ $300.0$ $300.0$ $10$ $500.0$ $300.0$ $10$ $500.0$	0     0       0     0       0     1       0     1       0     0       0     3       0     3       0     3       0     1       0     0       0     3       0     0       0     0       0     0       0     0       0     0       0     0       0     0       0     0	σ = 777.51 μW-cm <sup>-2</sup> -sr <sup>-1</sup> -μm <sup>-1</sup>

TOTAL NUMBER OF ELLIPTICAL AREAS =

12 FEATURES WITH AREAS LESS THAN16.00 SR. METERS WERE ALSO RECOGNIZED

9

BY PERIMETER			BY SHAPE			
METER	S	FFET		FREQUENCY	SHAPE FACTUR	FREDUENCY
0 TD	7	0 T/)	22	Û	0.0 10 1.0	0
7 10	10	22 TU	32	0	1.0 TU 1.1	0
10 TO	12	32 10	39	0	1.1 70 1.2	1
12 10	14	39 TO	45	0	1,2 10 1,3	1
14 10	16	45 TO	52	0	1.3 TO 1.4	1
16 TO	17	52 TU	55	0	1.4 10 1.5	1
17 10	20	55 TO	65	0	1.5 19 1.6	Ż
20 10	22	65 TU	72	0	1.6 TH 1.7	2
22 10	24	72 10	78	1	1.7 70 1.8	Ī
24 10	26	78 10	85	Ŭ	1.8 TE 1.9	0
26 TO	28	85 TO	91	-0	0.5 07 9.1	U
28 10	30	91 70	98	0	2.0 10 2.4	υ
30 10	32	98 T()	104	0	2.4 10 2.6	o
2 10	39	104 10	127	2	2.6 10 2.8	0
39 10	45	127 10	147	1	2 A TO 3.0	0
45 10	55	147 10	180	1	3,0 TU 3,5	0
55 10	71	180 10	232	4	3.5 10 4.0	0
71 10	100	232 10	328	0	4.0 TU 4.5	0
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# DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		,	
SQUARE METF	BY RS	ARFA FREQUENCY	Threshold = Mean + 3.32 $\sigma$ Wavelength = 9.3 - 11.7 $\mu$ m
			Mean = 299.13 Kelvin
			$\sigma$ = 5.89 Kelvin
16.0 TU	20.0	<i>,</i> 0	· •
0.0 TU	25.0	46	
25.0 TU	30.0	17	
30.0 T()	35.0	0	
35.0 TU	40,0	15	
40.0 TO	45.0	11	
45.0 10	50.0	0	
50.0 TU	75.0	12	
75.0 10	100.0	8	
100.0 TU	150.0	2	
550.0 10	200.0	4	
200.0 10	250.0	5	
250.0 10	300.0	0	
300.0 TU	400.0	0	
400.0 10	500.0	1	
11758	500.0	0	

TOTAL NUMBER OF ELLIPTICAL AREAS = 118

262 FEATURES WITH AREAS LESS THAN16.00 SQ. METERS WERE ALSO RECOGNIZED

BY PERIMETER			BY SHAPE			
METEN	5	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 TO	7	0 TQ	22	0	0.0 10 1.0	1
7 10	10	22 10	32	0	1.0 70 1.1	ō
10 10	12	32 10	39	0	1.1 10 1.2	15
15 10	14	39 70	45	0	1.2 10 1.3	6
14 TO	16	45 10	52	t	1.3 70 1.4	řs
16 10	17	52 10	55	ō	1.4 10 1.5	11
17 10	20	55 TU	65	Å	1.5 70 1.6	10
20 10	22	65 10	72	0	1.6 10 1.7	19
22 10	24	72 10	7 R	26	1.7 10 1.8	9
24 10	26	78 TO	85		1.8 10 1.9	
26 10	28	85 TO	91	21	0.5 () 9.1	Å
28 10	30	91 10	98	0	0 5 1 5 1	
30 10	32	98 111	104	16	2.4 10 2 6	0
32 10	39	104 10	127	13	26 10 28	ž
39 10	45	127 10	1 /1 7			, 0
45 TO	55	147 10	180	13	3 0 70 3.5	ں د
55 10	71	180 TO	212		<b>τ</b> 5 τη μο	•
71 70	100	212 10	1.28	7 42		
ELVER	100	6 9 6 10 1	120	2		



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# DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

BY AREA			Threshold = Mean + 3.90 $\sigma$		
SQUARE METER	15	FREQUENCY	Wavelength = 9.3 - 11.7 µm		
			Mean = 299.13 Kelvin		
			$\sigma = 5.89$ Kelvin		
16.0 TO	20.0	0			
20.0 10	25.0	6			
25.0 TU	30.0	2			
30.0 10	35.0	0			
35.0 10	40.0	1			
40.0 10	45.0	1			
45.0 TO	50.0	0			
50.0 TO	75.0	3			
75.0 TO	100.0	2			
100.0 TU	150.0	1			
150.0 TO	200.0	2			
200.0 10	250.0	1			
250.0 TO	300,0	0			
300.0 TU	400.0	0			
400.0 TU	500.0	0			
OVER	500.0	0			

TOTAL NUMBER OF ELLIPTICAL AREAS = 19

35 FEATURES WITH AREAS LESS THAN16.00 SR. METERS WERE ALSO RECOGNIZED

BY PERIMETER					HY SHAPE	
METER	9	FFET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 10	,	0 TO	22	0	0.0 TU 1.0	O
7 10	10	22 10	32	0	1.0 TO 1.1	1
10 TO	12	32 10	39	0	1.1 10 1.2	1
12 10	14	39 TU	45	0	1.2 10 1.3	1
14 TO	16	45 TO	52	0	1.3 10 1.4	4
16 10	17	52 TH	55	0	1.4 TU 1.5	5
17 10	20	55 TO	65	2	1.5 10 1.6	4
20 10	22	o5 10	72	0	1.6 TO 1.7	1
61 SS	24	72 10	78	3	1.7 10 1.8	1
24 10	26	78 10	85	ō	1 8 10 1.9	2
26 10	28	45 TO	91	2	1.9 11 2.0	U
28 10	30	41 TO	9.P	ō	2 0 10 2 4	1
30 10	32	9A (1)	104	1	2.4 11 2.4	0
32 10	39	104 10	127	4	2.6 10.2.8	n
39 10	45	127 10	147	0	2 A TH 3.0	3
45 TO	55	147 10	140	1	3.0 TU 3.5	v
55 TO	71	160 10	232	4	3.5 TH 4.0	ŋ
71 10	100	232 10	328	2	4.0 10 4.5	n

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Power Spectra

Spectral Bands: 1.0 - 1.4 µm 2.0 - 2.6 µm 9.3 - 11.7 µm








# BLACK HILLS, SOUTH DAKOTA<sup>\*</sup>

### Pertinent Scene and Flight Information

(Date of Flight: 22 July 1969)

\* For specific discussions of these and associated data for this scenery, refer to Reference 1.

#### BLACK HILLS-1 Data

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 Wavelength Bands:

 1.0-1.4 μm, 2.0-2.6 μm, 4.5-5.5 μm, 8.0-13.5 μm

 IFOV: 3.5 mrad (cross-track); 6.6 mrad (in-track)

 Altitude:
 1500 ft

 Depression Angle:
 90°

 Time:
 1330 hrs

 Flight Direction:
 East

 Ground Speed:
 ~200 ft-sec<sup>-1</sup>

 Area Covered (Approx.):
 1150 ft wide x 7100 ft long (1.0-1.4 μm, 2.0-2.6 μm, 4.5-5.5 μm)

 1150 ft wide x 7200 ft long (8.0-13.5 μm)

#### BLACK HILLS-2 Data

Wavelength Bands: 1.0-1.4 μm, 1.5-1.8 μm, 2.0-2.6 μm <u>1FOV</u>: 3.5 mrad (cross-track); 6.6 mrad (in-track) <u>Altitude</u>: 1500 ft <u>Depression Angle</u>: 90° <u>Time</u>: 1330 hrs <u>Flight Direction</u>: East <u>Ground Speed</u>: ~200 ft-sec<sup>-1</sup> <u>Area Covered (Approx.)</u>: 2400 ft wide x 7200 ft long <u>Meteorology</u>: Visibility > 15 mi; clear day, dry; cloud cover 10%



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VISIBLE REGION (.50 -.52  $\mu$  m) SCANNER IMAGERY OF BLACK HILLS (IN LEIU OF AERIAL PHOTOGRAPH)



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1.0 - 1.4 µm



1.5 - 1.8 µm



2.0 - 2.6 µm

LINE SCAN IMAGES PRODUCED FROM THE VARIOUS INFRARED CHANNELS OF BLACK HILLS-2









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#### BLACK HILLS, SOUTH DAKOTA

Histograms\*

Spectral	Bands:	1.0 -	1.4 µm
		1.5 -	1.8 µm
		2.0 -	2.6 µm
		4.5 -	5.5 µm
		8.0 -	13.5 µm







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#### BLACK HILLS, SOUTH DAKOTA

Means and Standard Deviations for Spectral Bands Correlations Between Spectral Bands

Spectral Bands: 1.0 - 1.4 µm (µW-cm<sup>-2</sup>-sr<sup>-1</sup>-µm<sup>-1</sup>) 1.5 - 1.8 µm (µW-cm<sup>-2</sup>-sr<sup>-1</sup>-µm<sup>-1</sup>) 2.0 - 2.6 µm (µW-cm<sup>-2</sup>-sr<sup>-1</sup>-µm<sup>-1</sup>) 4.5 - 5.5 µm (°K) 8.0 - 13.5 µm (°K)

<sup>&</sup>lt;sup>\*</sup>The Black Hills-1 data were collected with an M-5 scanner with thermal calibration plates in part of the scanner field-of-view. The  $8.0-13.5 \mu m$  detector and the 1.0-1.4, 2.0-2.6,  $4.5-5.5 \mu m$  detectors were on opposite ends of the scanner and are not in spatial registration. Hence, spectral correlation coefficients have not been determined between the  $8.5-13.5 \mu m$  data and the 1.0-1.4, 2.0-2.6, or  $4.5-5.5 \mu m$  lata.

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#### BLACK HILLS-1

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Number of Subregions = 1 Pixel Subarea Divisions at: 1 311 Line Subarea Divisions at: 10 732 Line Increment Used = 1 Pixel Increment Used = 1 Correlation Channels: 2 (1.0 - 1.4  $\mu$ m) 4 (2.0 - 2.6  $\mu$ m) 5 (4.5 - 5.5  $\mu$ m) 12 (8.0 - 13.5  $\mu$ m)

Correlation	2	4	5
2	1.000		
4	0.505	1.000	
5	-0.166	0.498	1.000

Channels	2	4	5	12
Mean	1.79902+03	1.0556E+02	2.9456E+02	2.9395E+02
St. Dev.	6.1770E+02	5.5347E+01	2.3389E+00	2.3831E+00
Total Points	224130	224130	224130	425630

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### BLACK HILLS-2

Number of Subregions =	1				
Pixel Subarea Divisions	s at	::	1	64	5
Line Subarea Divisions	at	:	2	728	3
Line Increment Used = 1	L				
Pixel Increment Used =	1				
Correlation Channels:	3	(1.5	; -	1.8	μ <b>m)</b>
	5	(1.0	) –	1.4	μm.)
	7	(2.0	) -	2.6	μm)

Correlation	3	5	7
3	1.000		
5	0.743	1.000	
7	0.908	0.518	1.000

Channels	3	5	7
Mean	4.4721E+02	1.6027E+03	9.0510E+01
St. Dev.	1.5485E+02	4.6380E↔C2	3.8712E+01
Total Points	468915	46891.1	468915

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## BLACK HILLS, SOUTH DAKOTA

Ellipse Statistics

Spectral Bands: 1.0 - 1.4 μm 1.5 - 1.8 μm 8.0 - 13.5 μm

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#### BLACK HILLS-1

### DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		87	ARFA	Threshold = Mean + 2.52 $\sigma$
SQUAFE	HETER	83	FREQUENCY	Wavelength = $1.0 - 1.4 \mu m$
				Mean = $1799.05 \mu\text{W-cm}^{-2} - \text{sr}^{-1} - \mu\text{m}^{-1}$
11.0	10	15.0	22	$a = 617.70 \text{ m}/(a = 2 \text{ m}^{-1})$
15.0	TO	20.0	23	ο - οτλιλο ρω-ciii -sr -μiii
20.05	10	25.0	13	
25.0	10	30.0	9	
30.0	<b>T</b> ()	35.0	7	
35.0	10	40.0	8	
40.0	TO	45.0	7	
45.0	<b>T</b> ()	50.0	2	
50.0	10	75.0	7	
75.0	10	100.0	4	
100.0	TO	150.0	7	
150.0	10	200.0	3	
200.0	τu	250.0	1	
250.0	τo	300.0	2	
300.0	<b>T</b> O	400.0	1	
400.0	10	500.0	0	
nv	VER	500.0	0	
TOTAL NUMBE	R OF E	LLIPTICAL A	RFAS = 116	

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132 FEATURES WITH AREAS LESS THAN11.00 SD. METERS WERE ALSO RECOGNIZED

BY PERIMETER			BY CHAPE			
METER	9	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 10	7	0 Tu	22	0	0.0 T() 1.0	0
7 10	10	22 10	12	0	9_0 T() 1.1	0
10 10	12	32 10	39	0	1.1 70 1.2	17
12 10	14	49 TO	45	0	1.2 TU 1.3	16
14 TO	16	45 TO	52	11	1.3 TO 1.4	25
16 10	17	52 10	55	0	1.4 11 1.5	17
17 10	20	55 10	65	16	1.5 10 1.6	8
	22	5 10	72	23	1.6 TO 1.7	1.0
20 10	24	72 10	78	Ő	1.7 TO 1.8	5
26 11	24	78 10	85	Ä	1.8 10 1.9	4
24 10	20	85 TO	01	4	0.5 UT 9.1	5
20 10	10	01 10	0 A	q	P. S OT 0 S	4
20 10	30		100	11	2.4 10 2.6	2
ייו ענ חד כד	10	100 10	127		8.5 117 8.5	0
20 10	л с.	100 10	107	2	2 B 10 3 0	0
15 10	4)	127 10	190	ž	3.0 TU 5.5	1
43 10	22	147 11	373	7	3 5 10 4 0	Q
55 10	11		2 1/ 7 - H	0	4 0 11 4 5	0
11 10	100	637 10	320	7	UVER 4.5	0
OVER	100	10 V F R	250	4		•



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#### BLACK HILLS-1

# DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	6)	ARFA	Threshold = Mean + 3.00 $\sigma$
SUHARE METE	H <b>S</b>	FALOUENCY	Wavelength = 1.0 - 1.4 µm
			Mean = 1799.05 µW-cm <sup>-</sup> -sr <sup>-1</sup> -pm <sup>-1</sup>
11.0 TU	15.0	8	$\sigma = 617.70 \text{ mW} \text{ cm}^{-2} \text{ sm}^{-1} \text{ mm}^{-1}$
15,0 TU	20.0	1	
20.0 10	25.0	Ż	
25.0 10	30.0	4	
30.0 10	35.0	1	
35.0 TU	40-0	ò	
40.0 10	45.0	2	*
45.0 10	50.0	ò	
50.0 TO	75.0	ž	
75.0 10	100.0	с б	
100.0 10	150 0	ŏ	
150.0 10	200.0	ů.	
200.0 10	250.0		
250.0 10	300.0	0	
300.0 10	400 0	Ň	
400.0 10	500 0	0	
	500 O	v	
• / • F •	200.0	U	

TOTAL NUMBER OF ELLIPTICAL AREAS - 21

33 FEATURES WITH AREAS LESS THAN 11,00 SO, HETERS WERE ALSO RECOGNIZED

	84 PERIMETER				BY SHAPF		
METER	5	FEFY		FREQUENCY	SHAPE FACTUR	FREUTENCY	
0 10	7	0 70	55	0	0.0 TO 1.0	n	
7 10	10	55 TO	32	n	1.0 10 1.1	0	
10 10	51	32 10	39	0	5.1 07 1.2	5	
12 10	14	39 11)	45	0	1,2 10 1.5	0	
14 10	10	45 TI)	52	<u> </u>	1.3 11 1.4	4	
16 TO	17	52 10	55	õ	1.4 10 1.5	3	
17 10	20	55 10	65	1	1.5 10 1.6	,	
20 10	ڊ د	65 111	72	3	1.6 10 1.7	3	
55.10	24	77 TO	78	0	1.7 1.1.8	1	
24 10	26	78 711	85	Þ	1 A T() 1 4	i	
26 11	28	AS TO	91	- 1	1.9 10 2.0	1	
28 10	30	91 10	94	0	2 0 14 2 4	1	
30 10	32	98 TO	104	1	2 4 10 2.6	n	
32 10	39	104 10	127	2	2.6 10 2.8	0	
<b>19</b> IO	45	127 10	147	1	2 8 TO 3.0	0	
45 10	55	147 TH	IAD	2	5.0 TIL 5.5	0	
55 10	71	180 TU	532	0	3, 5, 10, 4,0	0	
71 TU	100	535 10	328	U	4.0 111 4.5	i)	
OVER	100	OVEN	438	•	- OVER # 5	٥	



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## BLACK HILLS-1

## DISTRIBUTION OF ELECTPTICAL AREAS GREATER THAN THRESHOLD

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	ti Y	841 A	Threshold # Mean + 2.50 o
BUUAHE HETE	H 13	I REQUENCY	Wavelength = 8.0 - 13.5 pm
			Mean = 293,95 Kclvin
6.0 10	10.0	()	
10.0 10	15.0	62	ø ¤ 2.38 Kelvin
15.0 10	20.0	31	
20.0 10	25.0	29	
15,0 10	30.6	11	
30.0 10	\$5.0	11	
35,0 10	40.0	- b	
40.0 10	41 * , 0	8	
45,0 10	50.0	7	,
56,0 10	7 . 0	37	
75,6 10	100.9	11	
100,0 10	150.0	h	
150,0 TO	200.0	2	:
240.0 10	250.0	ų	
250,0 10	300.0	1	
300.0 10	400.0	0	
440,0 10	500.0	1	
OVER	500.0	3	

TOTAL NUMBER OF ELLIPTICAL APEAS - 214

291 FEATURED WITH AREAD LEAS THAN 4.00 BO, METERS WERE ALSO RECOGNIZED

	BY PEPIMETER				BA BHABE		
метен	9	( FET		FREQUENCY	. SHAPE FACTOR	FREQUENCY	
0 11)	7	<b>Λ</b> Τυ	72	0	0.0 10 1.0	υ	
1 10	10	22 10	32	U	1.0 10 1.1	0	
10 10	12	12 TO	39	0	1,1 10 1.2	11	
12 10	14	39 10	45	4	1,7 10 1.3	16	
14 10	16	45 10	52	Ú	1.3 TU 1.4	29	
16 10	17	52 10	55	40	1.4 70 1.5	37	
17 10	20	55 30	6'5	35	1.5 10 1.6	32	
20 11)	22	65 10	72	Û	1.6 TO 1.7	25	
22 10	24	72 10	7 11	25	1.7 10 1.8	20	
24 10	26	78 TU	A5	14	1.8 10 1.9	12	
26 10	28	85 10	21	0	1.9 10 2.4	6	
26 10	3.0	91 10	0A	19	2.0 10 2.4	15	
30 10	32	98 TO	104	0	2.4 10 2.6	2	
32 10	19	104 10	127	24	2.6 10 2.6	2	
39 10	45	127 10	147	7	2.8 10 3.0	0	
45 10	55	147 10	140	20	3.0 10 3.5	2	
55 10	71	180 10	232	11	3.5 TU 4.0	3	
71 10	100	232 10	<b>39A</b>	- ĥ	g r T) 4.5	0	
	1 4 4	1	1 10	6.3	TIVEN IN S	٥	



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### BLACK HILLS-1

### DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	BY	ARFA,	Threshold = Mean + 3.50 $\sigma$
SQUARE P	ETERS	FREDUENCY	Wavelength = 8.0 - 13.5 µm
8.0 TU 10.0 TU 15.0 TU 20.0 TU 25.0 TU 35.0 TU 40.0 TU 45.0 T 50.0 TU 100.0 TU 100.0 TU 200.0 TU	) 10.0 ) 15.0 ) 20.0 ) 25.0 ) 30.0 ) 35.0 ] 40.0 ) 50.0 ) 75.0 () 100.0 () 150.0 () 200.0 () 250.0	0 7 5 1 2 3 2 1 0 4 0 1 0 0	Waverength = 8.0 - 13.5 μm Mean = 293.95 Kelvin σ = 2.38 Kelvin
250_0 1 300_0 T 400_0 T	() 500,0 () 400,0	1	
	R 500,0	1	

TOTAL NUMBER OF ELLIPTICAL AREAS -

47 FLATURES WITH ARFAS LESS THAN 8.00 SO. METERS WERE ALSO RECOGNIZED

28

BY PERIMETER					BY SHAPE		
METER	9	FFET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 10	7	0 10	22	0	0,0 TO 1.0	0	
7 10	10	22 10	32	0	1.0 10 1.1	0	
10 10	12	32 10	39	0	1.1 10 1.2	5	
12 10	14	19 10	45	2	1.2 10 1.3	1	
10 10	16	45 10	52	0	1.3 10 1.4	3	
14 10	17	52 10	ςς	Ž	1.4 10 1.5	4	
17 10	20	55 TO	15	ž	1.5 10 1.6	1	
20 10	22	45 10	72	õ	1.6 10 1.7	2	
20 10	- e 6 - 5 n	73 10	74.	, ž	1.7 10 1.3	2	
24 10	24	78 10	45	ĩ	1.8 10 1.4	4	
24 10	70		0.1	õ	1.9 10 2.0	5	
26 10	<u>~</u> 0			2	2.0 10 2.4	5	
25 10	10	9 TH	40	E 0	2 4 10 2.6	Ō	
30 11	30	45 11	104	0	2 4 T() 2 B	õ	
35 10	59	194 10	177	3	5 6 70 X 0	2	
34 T.O.	4',	15/ 10	147	<i>i</i> ?	2.5 10 3.0	<u> </u>	
45 10	55	147 T()	180	3	5.0 10 3.5	U	
55 10	71	180 TI)	535	ć	3,5 10 4.0	0	
71 10	100	232 10	328	1	4,0 TO 4,5	0	
0VER	100	OVER	328	2	OVER 4,5	0	



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BLACK HILLS-2

#### DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		1	BY AREA	Threshold = Mean + 2.42 $\sigma$
SOUARE	METERS			110 C31010 - Medit + 2,42 0
o to the			T NEUDENCI	Wavelength = $1.0 - 1.4 \mu m$
				Mean = $1602.71 \mu\text{W}-\text{cm}^{-2}-\text{sr}^{-1}-\mu\text{m}^{-1}$
11.0	70	15.0	30	-2 -1 -1
15.0	10	20,0	20	σ = 463.80 μW-cm ~-sr '-μm '
50.0	TO	25.0	6	
25.0	10	30.0	7	
30.0	τu	35.0	6	
35.0	τu	40.0	6	
40.0	10	45.0	7	
45.0	10	50.0	1	
50.0	τ()	75.0	16	
75.0	TO 1	00.0	12	
100.0	10 1	50.0	9	
150.0	בירי	200.0	4	
500.0	TO 2	250.0	2	
250.0	TO 3	500.0	1	
300.0	TO 4	100.0	5	
400.0	10 5	560.0	3	
٥v	ER 5	0.00	8	

TOTAL NUMBER OF ELLIPTICAL AREAS = 143

▶ - 如此这些感觉,这一次是我们的变形的那些干酪的**的复数,**们都是不能能够能够和我们就能到了这些人的,我们也能是非常能够不能。""你们,你们也没有我们可以

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50 FEATURES WITH AREAS LESS THAN11.00 SQ. METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPE		
METER	5	FFET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
υ το	7	0 T()	22	0	0.0 10 1.0	o	
7 10	10	25 TU	32	0	1.0 TU 1.1	U	
10 10	12	32 10	39	0	1 1 10 1.2	27	
15 10	14	39 TH	45	0	1.2 10 1.3	25	
14 TO	16	45 10	52	27	1.3 10 1.4	23	
16 10	17	52 TH	55	0	1.4 10 1.5	13	
17 10	20	55 TU	65	16	1.5 10 1.6	10	
20 10	55	65 TO	72	6	1.6 10 1.7	12	
55 TO	24	72 10	78	4	1.7 10 1.8		
24 TO	26	78 TO	85	8	1.5 10 1.9	ů	
26 TO	28	85 TH	91	1	1.9 10 2.0		
28 10	30	91 TO	QH	7	2.0 10 2.4	11	
30 TO	32	98 T()	104	6	2.4 10 2.6		
35 10	39	104 TO	127	14	2.6 10 2.8	τ. 	
39 10	45	127 10	347	6	2.8 111 3.0	õ	
45 10	55	147 TO	180	11	3.0 10 3.5	ĩ	
55 TO	71	180 10	232	13	3.5 10 4.0	ò	
71 10	100	232 10	328	4	4.0 10 4 5	1	
OVER	100	NVER	328	20	OVER 4.5	ů ů	



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### BLACK HILLS-2

### DISTRIBUTION OF ELLIFTICAL AREAS GREATER THAN THRESHOLD

			8 Y	ARFA	Threshuld = Mean + 3.29 σ
SQUARE	METERS			FREDUENCY	Wavelength = $1.0 - 1.4 \mu m$
					Mean = $1602.71  \mu W - cm^{-2} - sr^{-1} - \mu m^{-1}$
11.0	τo	15.0		1	$\sigma = 463.80 \text{ uW-cm}^{-2} - \text{sr}^{-1} - \text{um}^{-1}$
15.0	10	20.0		ž	
20.0	10	25.0		1	
25.0	10	30.0		1	
30,0	to	35.0		1	
35.0	<b>T</b> O	40.0		ò	
40.0	10	45.0		ź	
45.0	to	53.0		0	
50.0	10	75.0		2	
75.0	10	100.0		1	
100.0	τα	150.0		1	
150.0	to .	200.0		1	
200.0	TO	250.0		Ó	
250.0	TO .	300.0		0	
300.0	10	400.0		9	
400.0	TO TO	500.0		0	
. av	FR	500.0		0	

TOTAL NUMBER OF ELLIPTICAL AREAS =

6 FEATURES WITH AREAS LESS THAN11.00 SQ. HETERS WERE ALSO RECOGNIZED

13

BY PERIMETER					8Y SHAPF		
METER	8	FFET		FREQUENCY	SHAPE FACTUR	FREQUENCY	
0 10	7	0 T.D	22	0	0.0 TO 1.0	0	
7 10	10	55 IU	32	0	1.0 TU 1.1	0	
10 10	12	32 TH	19	0	1 1 70 1.2	Ũ	
15 10	14	37 11	45	0	1.2 111 1.3	4	
14 10	16	45 TO	52	0	1.3 10 1.4	4	
16 10	17	52 10	55	0	1.4 TO 1.5	S	
17 10	20	55 TO	65	3	1.5 10 1.6	1	
01 05	55	65 TO	72	0	1.6 TO 1.7	0	
01 55	14	72 10	78	1	1.7 10 1.8	0	
24 11	26	78 TO	85	1	1 N TH 1.9	0	
59 IU	28	85 TU	9,	· 0	1.9 TO 2.0	1	
28 10	30	91 TO	9,0	1	2 0 11 2 4	ī	
30 10	30	98 10	104	1	2.4 TH 2.6	0	
35 10	39	104 TH	127	3	2.6 10 2.8	0	
39 10	45	127 10	147	0	2 8 TO 3 0	0	
45 10	55	147 10	130	1	3,0 TO 3,5	0	
55 10	71	180 TU	232	Ŷ	3,5 TH 4,0	0	
71 10	100	232 10	328	2	4.0 10 4.5	C	
OVER	100	OVER	328	0	OVER 4.5	n	



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BLACK HILLS-2

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DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	87 /	AREA	Threshold = Mean + 2.82 $\sigma$
SQUARE METER	5	FREQUENCY	Wavelength = $1.5 - 1.8 \mu m$ Mean = 447.21 $\mu W$ -cm <sup>-2</sup> -sr <sup>-1</sup> - $\mu m$ -1
11.0 TO	15.0	23	σ = 154.85 μW-cm <sup>-2</sup> -sr <sup>-1</sup> -μm <sup>-1</sup>
20.0 TD	25.0	11	
25.0 TO	30.0	<b>q</b> 11	
30.0 TI)	35.0	3	
35.0 TU	40.0	1	
40,0 TO	50.0	8	
50.0 TD	75.0	19	
75.0 TU	100.0	11	
100.0 TO	150.0	2	
150.0 TU	200.0	š	
200.0 10	250.0	i	
250.0 TU	300.0	Ĵ	
300.0 TU	400.0	Ĩ	
400±0 TU (IVER	500.0	8	
TOTAL NUMBER OF E	LLIPTICAL ARE	EAS = 135	The second click t ZED
46 FEATURES	WITH AREAS	LESS THANII	OO SQ. HETERS WERE ALSU RECUGNIZED

					br anart		
		BY PERIME	IC K	FREQUENCY	SHAPE FACTOR	FREQUENCY	
METERS 0 TO 7 TO 10 TO 12 TO 14 TO 16 TO 20 TO 24 TO 24 TO 24 TO 26 TO 32 TO 34 TO 35 TO 36 TO 37 TO 37 TO 38 TO 38 TO 39 TO 45	70246702468029551	FEET 0 T() 27 T() 39 T() 39 T() 45 T() 52 T() 55 T() 72 T() 78 T() 78 T() 98 T() 104 T() 127 T() 147 T() 147 T()	22 39 55 55 55 78 908 1077 11 1232	FREQUENCY 0 0 22 0 8 5 5 5 5 5 7 10 8 14 15	SHAPE       FACTOR         0.0       TO       1.0         1.0       TO       1.1         1.1       TO       1.2         1.2       TO       1.3         1.3       TO       1.4         1.4       TO       1.4         1.5       TO       1.6         1.4       TO       1.4         1.5       TO       1.6         1.6       TO       1.7         1.7       TO       1.7         1.8       TO       1.7         1.7       TO       2.0         2.0       TO       2.0         3.0       TO       3.0         3.0	FRFONENCY 0 22 20 11 16 14 14 14 14 14 14 14 14 14 14 14 14 14	
55 TO 71 TO OVER	100 100	252 TH DVFR	378 378	12 15	8.8 FC 4.5 NVFR 4.5	1	

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## BLACK HILLS-2

## DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	BY	ARFA	Threshold = Mean + 3.18 $\sigma$
SQUARE HET	ER3	FREQUENCY	Wavelength = 1.5 - 1.8 µm
			Mean = 447.21 $\mu$ W-cm <sup>-2</sup> -sr <sup>-1</sup> - $\mu$ m <sup>-1</sup>
11.0 TU	15.0	Q	$\sigma = 154.85 \ \mu W - cm^{-2} - sr^{-1} - \mu m^{-1}$
15.0 10	20.0	6	
20.0 10	25.0	4	
25.0 10	30.0	2	
30.0 10	35.0	3	
35.0 10	40.0	2	
40.0 TO	45.0	2	
45.0 TO	50.0	0	
50.0 TU	75.0	6	
75.0 TD	100.0	2	
100.0 TO	150.0	2	
150.0 TU	200.0	3	
200.0 10	250.0	1	
250.0 TO	300.0	0	
300.0 10	400.0	0	
400 0 10	500 0	2	
	500.0	3	

TOTAL NUMBER OF ELLIPTICAL AREAS =

31 FEATURES WITH AREAS LESS THAN11.00 SQ. METERS WERE ALSO RECUGNIZED

47

BY PERIMETER		BY SHAPE				
METER	5	FFET		FREQUENCY	SHAPE FACTUR	FREQUENCY
0 10	7	0 10	22	O	0.0 10 1.0	n
7 70	ť	22 10	32	0	1.0 TO 1.1	0
1 10	10	32 10	10	0	1.1 10 1.2	,
10 10	16	20 10	45	0	1.2 10 1.5	9
	14	34 TO	20	Å	1.3 10 1.4	7
14 10	10		- 16 - 16	0	1.4 10 1.5	3
16 10	17	57 10	50	0	15 10 1.5	6
17 IU	20	55 111	65	0	1 6 T() 1 7	i,
20 10	55	65 10	72	0		1
22 TO	24	72 TO	78	3	1.7 10 1.0	بر د
24 10	26	78 TO	85	/1	1.8 10 1.9	
26 10	28	85 10	91	-1	1.9 10 2.0	1
28 10	30	91 TD	98	2	2.0 10 2.4	4
30 10	32	48 T()	104	!	2,4 TH 2,6	1
12 10	19	104 10	127	4	2.6 TH 2.8	0
36 10	15	127 111	107	3	2.K TO 3.0	1
37 10	61		160	u .	3,0 11 3.5	0
45 10	כר	147 10	373	-	N.S. TO 4.0	0
55 TO	$\alpha$	100 10	C 16	3	4 0 TO 4.5	0
71 10	103	232 10	325	4		0
UAFB	1.00	0764	328	0		1.

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### BLACK HILLS, SOUTH DAKOTA

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Power Spectra

Spectral Bands: 1.0 - 1.4 μm 1.5 - 1.8 μm 2.0 - 2.6 μm 4.5 - 5.5 μm 8.0 - 13.5 μm















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CAMP A.P. HILL, VIRGINIA\*

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Pertinent Scene and Flight Information

(Dates of Flights: 28,29,30 March 1978)

<sup>\*</sup> For specific discussions of these and associated data for this scenery refer to Reference 5. Note also that in the A.P. Hill data approximately 10 vehicle targets are located in the area. In the following statistics most of the features remaining above the highest radiance and temperature thresholds are targets.

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	Morning		Afternoon
Wavelength Bands:	2.0-2.6 иш, 4.5-5.5 иш, 8.0-14.0 иш	Wavelength Bands:	2.0-2.5 µm, 4.5-5.5 µm, 8.0-14.0 µm
IFOV:	2.0 mrad	IFOV:	2.0 mrad
Depressio:: Angle:	٥٥٩	Depression Angle:	90°
Altitude:	800 ft	Altitude:	800 ft
Time:	<b>6530 hrs</b>	Time:	1330 hrs
Flight Direction:	West	Flight Direction:	West
Sround Speed:	168 ft-sec <sup>-1</sup>	Ground Speed:	168 ft-sec <sup>1</sup>
Area Covered (Approx.):	1100 ft long	Area Covered (Approx.):	1100 ft long
	1400 ft wide		1400 ft w1de
Weather:	Clear	Veather:	Clear
	Evening		Midnight
Wavelength Bands:	4.5-5.5 µm, 8.0-14.0 µm	Wavelength Bands:	4.5-5.5 um, 8.0-14.0 um
IFOV:	2.0 mrad	IFOV:	2.0 mrad
Depression Angle:	90°	Depression Angle:	000
Altitude:	800 ft	Altitude:	800 ft
Time:	1830 hrs	Time:	2330 hrs
Flight Direction:	West	Flight Direction:	West
Ground Speed:	168 ft-sec <sup>-].</sup>	Grourd Speed:	168 ft-sec <sup>1</sup>
Area Covered (Approx.):	ll00 ft long	Area Covered (Approx.):	1600 ft long
	802 ft wide		800 ft wide
Neather:	Clear to slight haze	Weather:	Clear

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PERTINENT INFORMATION ABOUT DIURNAL CAMP A.P. HILL, VIRGINIA DATA



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AERIAL PHOTOGRAPH OF CAMP A. P. HILL TEST AREA. Photo image in reversed left-to-right for compatibility with imagery scan direction.







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GREYMAP OF CAMP A.P. HILL AREA - AFTERNOON (Time: 1.330,  $\wedge \lambda$ ; 4.5-5.5 µm)

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GREYMAP OF CAMP A.P. HILL AREA - MIDNIGHT (Time: 2330,  $\lambda\lambda$ : 4.5-5.5 µm)

### CAMP A. P. HILL, VIRGINIA

Histograms\*

Spectral Bands: 2.0 - 2.6 μm 4.5 - 5.5 μm 8.0 - 14.0 μm

<sup>\*</sup> Circles define a Gaussian curve with the same mean and standard deviation as the actual histogram. An "S" on some curves indicates saturation. Because of limits on gain settings some values may exist beyond the digital limits of 0 and 255, the digital dynamic range of the data processing.



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#### CAMP A.P. HILL, VIRGINIA

Means and Standard Deviations for Spectral Bands

Correlations Between Spectral Bands\*

Spectral Bands: Channel 2: 2.0 - 2.6  $\mu m (\mu W - cm^{-2} - \epsilon r^{-1} - \mu m^{-1})$ Channel 4: 4.5 - 5.5 µm (°K) Channel 5: 8.0 - 14.0 µm (°K)

Because of the relatively small temperature changes in the scenery, there is a nearly linear relationship between the temperature and radiance statistics for the thermal channels. It is pertinent, therefore, to compute correlations between radiance and temperature channels.

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# STATISTICS OF THE MORNING SCENE

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Number of Subregions = .	1			
Pixel Subarea Divisions	at	:: ]	l.	855
Line Subarea Divisions a	at	: 1	L	700
Line Increment Used = 1				
Pixel Increment Used = 1	1			
Correlation Channels:	2 4 5	(2.0 (4.5 (8.0	-	2.6 μm) 5.5 μm) 14.0 μm)

Correlation	- 2	4	5
2	1.000		
4	0.841	1.000	
5	0.760	0,905	1.000

Channels	2	4	5
Mean	5.9364E+01	2.8377E+02	2.8344E+02
St. Dev.	2.7030E+01	2.5920E+00	2.3146E+00
Total Points	589260.	589260,	589260.

STATISTICS OF THE AFTERNOON SCENE

Number of Subregions = 1 Pixel Subarea Divisions at: 1 855 Line Subarea Divisions at: 1 704 Line Increment Used = 1 Pixel Increment Used = 1 Correlation Channels: 2  $(2.0 - 2.6 \ \mu\text{m})$ 4  $(4.5 - 5.5 \ \mu\text{m})$ 5  $(8.0 - 14.0 \ \mu\text{m})$ 

Correlati	on 2	4	5	•
2	1.000			
4	0.782	1.000		
5	0.636	0.882	1.000	
Channels	2		4	

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Mean	6.2356E+01	2.8569E+02	2.8654E+02
St. Dev.	2.4785E+01	2.2922E+00	2.7390E+00
Total Points	597800.	597800.	597800.

### STATISTICS OF THE EVENING SCENE

Number of Subregions = 1 Pixel Subarea Divisions at: 344 855 Line Subarea Divisions at: 1 700 Line Increment Used = 1 Pixel Increment Used = 1 Correlation Channels: 4 (4.5 - 5.5 µm) 5 (8.0 - 14.0 µm)

Correlation	4	5
4	1.000	
5	0.767	1.000
Channels	4	5
Mean	2.8289E+0	2 2.8116E+02
St. Dev.	1.1683E+0	0 1.7043E+00
Total Pts.	357700.	357700.

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# STATISTICS OF THE MIDNIGHT SCENE

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Number of Subregions = 1 Pixel Subarea Divisions at. 384 895 Line Subarea Divisions at: 1 1000 Line Increment Used = 1 Pixel Increment Used = 1 Correlation Channels: 4 (4.5 - 5.5 µm) 5 (8.0 - 14.0 µm)

4	5
1.000	
0.669	1.000
	4 1.000 0.669

Channels	4	5
Mean St. Dev.	2.8200E+02 1.2626E+00	2.7950E+02 1.5362E+00
Total Pts.	504357.	504357.



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Ellipse Statistics\*

Spectral Bands: 2.0 - 2.6 μm 4.5 - 5.5 μm 8.0 - 14.0 μm

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## MORNING

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		BY AREA	Threshold = Mean + 1,50 σ
SQUARE M	ETEHS	FREQUENCY	Wavelength = $2.0 - 2.6 \mu m$
0.6 TU 5.0 TU 10.0 TU 20.0 TU 25.0 TU 30.0 TU 35.0 TU 35.0 TU 35.0 TU 45.0 TU 50.0 TU 150.0 TU 200.0 TU 200.0 TU 200.0 TU 300.0 TU 300.0 TU	5.0 10.0 15.0 20.0 30.0 30.0 40.0 40.0 40.0 40.0 50.0 100.0 150.0 200.0 750.0 500.0 500.0	485 249 1429 353443231235	Mean = 59.36 μW-cm <sup>-2</sup> -sr <sup>-1</sup> -μm <sup>-1</sup> σ = 27.03 μW-cm <sup>-2</sup> -sr <sup>-1</sup> -μm <sup>-1</sup>
Dvt R	500.0	5	

TOTAL MINIBER OF ELLIPTICAL AREAS = 666

925 FEATURES WITH AREAS LESS THAN 0,60 BQ, METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY BHAPF		
HETT	45	FLLT		FREQUENCY	SHAPE FACTOR FREQUE		
0 TO	7	0 T.U	55	302	0.0 10 1.0	ø	
7 10	10	22 IU	32	96	1.0 10 1.1	0	
10 TO	12	32 10	39	42	1.1 10 1.2	19	
15 10	14	39 10	45	31	1.2.10.1.3	17	
14 10	16	45 TO	52	22	1.3 10 1.4	108	
16 10	17	52 10	55	4	1.4 10 1.5	<b>5</b> .0	
17 10	20	55 10	65	24	1 5 10 1 6	A 4	
20 10	35	65 10	72	1 1	1 6 10 1 7	11,7 11 4	
22 10	24	72 10	78	15	4 7 10 1 4	44	
24 10	26	78 10	85		<b>F A 10 1</b>	74	
26 10	28	65 10	91	· · ·		10	
28 10	30	91 10	QA	, Н		30	
30 10	12	90 10	104	5 0	5 H TO 5 A	10	
32 10	10	164 70	137	14	2 4 10 E 10 5 4 10 5 4	10	
10 10	45	+27 10	107	,,,		12	
45 10		4/17 10	147	11 1	2.0 11 3.0	10	
43 (U Er ()		147 10	110	12	3.0 10 3.5	16	
22 10	1	100 TU	235	14	3.5 10 4.0	13	
11 10	100	<b>5</b> 35 10	359	6	4.0 YU 4.5	3	
OVER	100	OVER	328	25	CIVEN 4 5	17	



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Area: Camp A.P. Hill (Wavelength =  $2.0 - 2.6 \mu m$ ) Radiance Threshold = Mean +  $2.50 \sigma$ Mean =  $59.36 \mu W - cm^{-2} - sr^{-1} - \mu m^{-1}$ Std. Dev. =  $\sigma$  =  $27.03 \mu W - cm^{-2} - sr^{-1} - \mu m^{-1}$ EQUIVALENT ELLIPTICAL AREAS - MORNING

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# MORNING

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	4	Y ARFE	Threshold = Mean + 2.50 $\sigma$
SQUARE ME	TERS	FREQUENCY	Wavelength = 2.0 - 2.6 µm
0.6 10	5.0	. 117	Mean = $59.36 \text{ yW} \text{ cm}^{-2} \text{ sm}^{-1} \text{ ym}^{-1}$
5.0 TU	10.0	11	$- mean = 55,50 \mu m - cm - 57 - \mu m$
10.0 70	15.0	4	$a = 27.03 \text{ where }^2 \text{ sc}^{-1} \text{ where }^{-1}$
15.0 TU	20.0	2	$0 = 27.00 \mu$ M-Cm = 57 = $\mu$ m
50°0 IO	25.0	0	
25.0 10	30.0	1	
30.0 10	35.0	0	
35.0 TO	40.0	1	
40.0 TH	45.0	0	
45.0 10	50.0	1	
50.0 TU	75.0	Ô	
75.0 TU	100.0	9	
100.0 10	150.0	Ő	
150.0 TO	200.0	0	
200.0 TO	250.0	0	
250.0 70	300.0	Ő	
300.0 10	400.0	ņ	
400.0 TO	506.0	0	
OVER	500.0	i.	

211 FEATURES WITH AREAS LESS THAN 0.60 SD. METERS WERE ALSO RECOGNIZED

		HY PERTM	F T F D		:	
					57 (57)	4 P F
METE	<b>₹\$</b>	Ftft		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 10	7	0 T <u>1</u>	22	74	0.0 TU 1.0	0
7 <u>to</u>	10	55 IU	32	23	1.0 1.1	0
10 [0	12	\$2 TH	39	7	5.1 57 1.2	é
12 TO	14	39 TU	45	в	1.2 1.1 1.5	ĩ
14 TO	16	45 TO	52	5	1.3 70 1.4	12
16 TO	17	52 TO	55	2	1.4 10 1.5	н.
17 10	20	55 TO	65	1	1.5 TU 1.6	1 .
50 TU	22	65 TH	72	3	1.5 10 1.7	22
55 10	24	72 TU	78	3	1.7 10 1.8	14
54 T()	59	78 T(I	85	2	1.8 TI) 1.9	7
26 TO	85	85 TU	91	-1	1.9 TU 2.0	
28 T()	30	91 TU	98	i	2.0 10 2 4	15
30 fri	32	98 T(I	104	i	2 8 11 2 6	1 1
35 10	39	104 11)	127	2	2 6 T(1 2 B	4
39 10	45	127 10	147	<b>1</b> ·	2 8 TU % 0	
45 10	55	147 10	180	1		3
55 T.N	71	180 11	232	i		1
71 10	100	232 10	325	0	3∎3 152 4∎V α Λ ΥΠ α Ε	U 1
OVER	100	<b>NVFR</b>	328	-		1



rea: Camp A.P. Hill (wavelength = 4.5 = 5.5  $\mu$ m) Temperature Threshold = Mean + 2.50  $\sigma$ Mean = 283.77 Kelvin Std. Dev. =  $\sigma$  = 2.59 Kelvin EQUIVALENT ELLIPTICAL AREAS - MORNING

3.3-32

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MORNING

DISTRIBUTIONS OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

- <b>247</b> " <b>19</b> 63 (	8 Y	AREA	Threshold = Mean + 2.50 $\sigma$
SQUARE MET	ERS	FREQUENCY	Wavelength = 4.5 - 5.5 µm
0.6 TU 5.0 TU 10.0 TU 20.0 TU 20.0 TU 25.0 TO 30.0 TO 35.0 TU 40.0 TO 45.0 TU 50.0 TO 150.0 TU 200.0 TO 250.0 TU 300.0 TO 400.0 TU	5.0 10.0 20.0 25.0 30.0 35.0 40.0 40.0 50.0 75.0 100.0 150.0 250.0 250.0 300.0 400.0 500.0	267 50 18 10 7 3 2 3 2 3 3 2 3 3 2 2 0 0 0 0 0 0	Mean = 283.77 Kelvin σ = 2.59 Kelvin
UTER	200.0	Q	

TOTAL NUMBER OF ELLIPTICAL AREAS = 372

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205 FEATURES WITH AREAS LESS THAN 0.60 SQ. HETERS WERE ALSO RECOGNIZED

BY PERIMETER

#### BY SHAPE

HETERS		FEET		FREQUENCY	SHAPE FACTUR	FREQUENCY
0 10	7	0 TO	22	165	0.0 TO 1.0	n
7 10	10	22 TU	32	50	1.0 10 1.1	ů
10 10	12	32 10	39	28	1 1 70 1 2	17
12 10	14	39 TO	45	27	1 3 10 1 2	17
14 10	16	45 TO	52	0		17
16 10	17	52 10	55	, ,		<u>80</u>
17 10	20	55 10	45	0 21	1.4 10 1.5	49
20 TO	22	65 TO	72	£ 3	1.5 14 1.6	15
22 10	24		76	0	1.6 10 1.7	39
24 10	24		70	2	1.7 10 1.8	
24 10	20	78 10	82	8	1.8 TU 1.9	24
20 10	28	85 TO	91	6	1.9 TU 2.0	19
20 10	50	91 TO	98	2	2.0 TU 2.4	36
30 TU	32	98 TU	104	2	2.4 10 2.6	9
32 TO	39	104 TO	127	8	2.6 TU 2.8	S
39 TU	45	127 TO	147	9	2.8 TU 3.0	ś
45 TO	55	147 TO	180	2	3.0 10 3.5	, Á
55 10	71	160 TO	232	<u> </u>	3.5 TD 4.0	1
71 10	100	232 10	328	6		2
OVER	100	DVER	328	6	OVER 4.5	2 1



Area: Camp A.P. Hill (Wavelength =  $4.5 - 5.5 \mu$ m) Temperature Threshold = Mean +  $3.00 \sigma$ Mean = 232.77 Kelvin Std. Dev. =  $\sigma$  = 2.59 Kelvin EQUIVALENT ELLIPTICAL AREAS - MORNING

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	BA	AREA	Threshold = Mean + $3.00 \sigma$
SQUARE MET	ERS	FREQUENCY	Wavelength = $4.5 - 5.5 \mu m$
0.6 TU 5.0 TU 10.0 TU	5.0 10.0 15.0	174 22 8	Mean = 283.77 Kelvin σ = 2.59 Kelvin
15.0 TU 20.0 TU 25.0 TO	20.0 25.0 30.0	3 2 2	
30.0 TI) 35.0 TU 40.0 TU	35.0 40.0 45.0	0 0 0	
45.0 TU 50.0 TU 75.0 TU	50.0 75.0 100.0	0 0 0	
100.0 TU 150.0 TU 200.0 TU	150.0 200.0 250.0	0 0 0	
250.0 TU 300.0 TU 400.0 TU DVER	300,0 400,0 500,0 500,0	0 0 0	
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DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

TOTAL NUMBER OF ELLIPTICAL AREAS = 211

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131 FEATURES WITH AREAS LESS THAN 0.60 SQ. METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPE		
М	ETEF	ks *	FEET		FREQUENCY	SHAPE FACTUR	FREQUENCY
0	τn	7	0 TU	22	101	0.0 10 1.0	0
7	10	10	22 70	32	44	1.0 TO 1.1	Ō
10	10	12	32 TU	39	14	1.1 10 1.2	9
12	10	14	39 TU	45	8	1.2 10 1.3	8
14	10	16	45 TU	52	11	1.3 TO 1.4	42
16	10	17	52 10	55	1	1.4 TO 1.5	28
17	10	20	55 TU	65	10	1.5 10 1.6	24
20	10	22	65 TO	72	6	1.6 TU 1.7	29
22	10	24	72 10	78	4	1.7 TU 1.8	18
24	TO	26	78 TU	85	Ó	1.8 TO 1.9	17
26	TO	28	85 TO	91	2	1.9 10 2.0	11
85	10	30	91 10	98	ĩ	2.0 10 2.4	21
30	10	32	98 TO	104	2	2.4 10 2.6	
32	10	39	104 TU	127	ĩ	2.6 TO 2.6	Š.
39	10	45	127 10	147	ī	2.8 10 3.0	ŏ
45	TO	55	147 TO	180	i	3.0 TU 3.5	i
55	TO	71	180 TO	232	ò	3.5 TÜ 4.0	ò
71	TO	100	232 10	328	õ	4.0 10 4.5	ů
Ö	LR	100	OVER	328	õ	OVER 4.5	Ő

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### MORNING

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	BA	AREA	Threshold = Mean + 2.50 $\sigma$
BQUARE METE	ERS	FREQUENCY	Wavelength = 8.0 ~ 14.0 µm
0.6 TU 5.0 TU 10.0 TU 15.0 TU 20.0 TU 25.0 TU 30.0 TU 35.0 TO 40.0 TU 45.0 TU 50.0 TU 100.0 TO 150.0 TO	5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0 150.0 200.0	FREQUENCY 319 59 15 14 5 3 4 0 2 1 4 2 1 4 2 1	wavelength = 8.0 - 14.0 μm Mean = 283.44 Kelvin σ = 2.31 Kelvin
250.0 TO	250,0 300.0	0	
300.0 TU 400.0 TO	400.C 500.0	0	
DVEN	500.0	Δ.	

TOTAL NUMBER OF ELLIPTICAL AREAS - 429

311 FEATURES WITH AREAS LESS THAN 0.60 SQ. METERS WERE ALSO RECOGNIZED

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BY PEHIMETER						BY SHAPE		
ME T	F E R	8	FEET	r	FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 1	0	7	0 10	22	198	0.0 TU 1.0	0	
7 1	r 0	14	01 SS	32	56	1.0 TU 1.1	ò	
10 1	0	15	32 10	39	29	1.1 10 1.2	18	
15 1	0	14	39 TU	45	30	1.2 10 1.3	15	
14 1	10	16	45 10	52	18	1.3 10 1.4	76	
16 T	10	17	52 TU	55	5	1.4 70 1.5	5/	
17 1	0	20	55 10	65	15	1 5 7(1 1 6	50	
20 1	0	22	65 10	72	15	1 6 10 1 7	. 27	
1 55	0	24	72 10	78	7	1 7 T() 1 R	47	
24 1	0	26	78 10	85	<i>k</i>	1 A T() 1 A	<i>e i</i> 11	
25 T	0	28	85 10	91	ů,	1.0 10 1.7	23	
28 1	0	30	91 10	Q.A.		3.4 10 2.0	20	
30 T	n i	12		104	0	2.0 10 2.4	55	
ζ2 r	n	ία	10/1 10	107	4	2.4 19 2.6	15	
10 1	n in	17	104 10	107	10	. 5*0 IN 5*8	8	
15 1	0	43	121 10	147	5	2,8 TU 3,0	6	
42 1	0	22	147 TO	180	2	3.0 10 3,5	4	
22 1	0	71	180 1()	232	6	3.5 10 4.0	6	
71 T	0	100	<b>535</b> 10	328	ĥ	4.0 TU 4.5	5	
0¥£	R	100	DVER	328	4	OVER 4.5	1	

**<u>ERIM</u>** 



Area: Camp A.P. Hill (Wavelength =  $8.0 - 14.0 \mu m$ ) Temperature Threshold = Mean +  $3.00 \sigma$ Mean = 283.44 Kelvin Std. Dev. =  $\sigma$  = 2.31 Kelvin EQUIVALENT ELLIPTICAL AREAS - MORNING

3.3-38

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### MORNING

#### DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

**BY AREA** Threshold = Mean + 3.00  $\sigma$ SQUARE METERS FREQUENCY Wavelength =  $8.0 - 14.0 \mu m$ 0.6 10 5.0 214 Mean = 283.44 Kelvin 5.0 10 10.0 15 10.0 10 4  $\sigma$  = 2.31 Kelvin 15.0 15.0 TU 20.0 4 20.0 10 0.25 0 25.0 10 30.0 1 30.0 TO 35.0 0 35.0 TU 0 40.0 40:0 10 45.0 0 45.0 10 50.0 Û 50.0 TU 75.0 O 75.0 TO 100.0 Q 100.0 10 150.0 0 150.0 Ta 200.0 0 200.0 10 250.0 0 250.0 TU 300.0 0 300.0 10 400.0 ٥ 400.0 TO 500.0 0 OVER 500.0 ۵

TOTAL NUMBER OF ELLIFTICAL AKFAS -238

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100

OVER

326

229 FEATURES WITH AREAS LESS THAN 0,60 SQ. METERS WERE ALSO RECOGNIZED

HY SHAPE BY PERIMETER METERS FEET FREQUENCY SHAPE FACTOR FREQUENCY 0.0 TO 1.0 1.0 TO 1.1 0 10 0 TO 7 22 141 0 7 10 10 22 10 32 43 ð 10 TO 1,1 10 1,2 12 32 10 39 12 10 1.2 TO 1.3 1.3 TO 1.4 15 10 14 39 TU 45 11 26 14 10 16 45 TU 52 58 5 16 TO 17 TO 17 52 TO 55 4 1.4 10 1.5 36 20 55 TO 65 1,5 TU 1,6 20 Ô 20 10 22 65 TU 72 4 1.6 TO 1.7 31 22 10 24 72 TŬ 78 1.7 10 1.8 1 15 24 10 26 78 TU 85 1.8 TU 1.9 8 3 26 TO 28 85 TO 1.9 10 2.0 9 91 1 28 TO 30 TO 30 91 TO 98 2.0 10 2.4 15 1 32 98 TO 104 2 2.4 TU 2.6 6 32 10 39 104 TO 127 2.6 TU 2.8 0 1 127 TU 39 10 147 2.8 10 3.0 45 2 2 45 TU 55 147 TU 180 2 3.0 10 3.5 1 55 TO 71 180 TO 232 3,5 10 4.0 0 0 100 71 10 358 4.0 10 4.5 535 IO ۵ Û OVER 4.5

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# AFTERNOON

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	BY A	REA	Threshold = Mean + 2.00 $\sigma$
SQUARE HETERS	3	FREQUENCY	Wavelength = $2.0 - 2.6 \mu m$
0.6 TU 5.0 TO 10.0 TO 15.0 TU 20.0 TO 25.0 TU 30.0 TU 30.0 TU 35.0 TU 40.0 TU 50.0 TU 100.0 TU 200.0 TU 200.0 TU 250.0 TO 300.0 TO 300.0 TO 400.0 TO 0VER	5.0 10.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0 150.0 250.0 250.0 250.0 500.0 500.0	237 25 9 7 4 2 2 4 2 1 5 2 1 1 2 1 1 2 1 1 2 1 0	Mean = σ2.36 μW-cm <sup>-2</sup> -sr <sup>-1</sup> -μm <sup>-1</sup> σ = 24.79 μW-cm <sup>-2</sup> -sr <sup>-1</sup> -μm <sup>-1</sup>

TOTAL NUMBER OF ELLIPTICAL AREAS = 308

BY PERIMETER

541 FEATURES WITH AREAS LESS THAN 0,60 SQ, METERS WERE ALSO RECOGNIZED

#### BY SHAPE

METER	s '	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 TO	7	0 TO	22	158	0.0 TO 1.0	1
7 10	10	22 TO	32	42	1.0 TO 1.1	0
10 TO	12	32 10	39	20	1.1 TO 1.2	2
12 10	14	39 TO	45	10	1.2 10 1.3	8
14 TO	16	45 TO	52	10	1.3 TO 1.4	61
16 10	17	52 TO	55	2	1.4 10 1.5	35
17 10	20	55 TO	65	6	1.5 10 1.6	20
20 10	22	65 TO	72	6	1.6 TO 1.7	40
22 10	24	72 10	78	2	1.7 TO 1.8	29
24 10	26	78 10	85	ŝ	1.8 70 1.9	12
26 10	28	85 TO	91	ī	1.9 10 2.0	16
28 10	30	91 10	98	4	2.0 TU 2.4	34
30 10	32	98 10	104	2	2.4 10 2.6	7
32 10	39	104 TO	127	5	2.6 TO 2.8	8
39 10	45	127 10	147	3	2.8 10 3.9	8
45 TO	55	147 10	180	7	3.0 TO 3.5	9
55 10	71	180 10	232	Ś	3.5 TU 4.0	ŝ
71 10	100	232 10	328	6	4.0 10 4.5	5
UVER	100	OVER	328	14	OVER 4 5	10



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AFTERNOON

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		BY AREA	Threshold = Mean + 3.00 σ
SUUARE	HETERS	FREQUENCY	Wavelength = 2.0 - 2.6 $\mu$ m
0.6 5.0 15.0 25.0 35.0 40.0 45.0 50.0 100.0 150.0 200.0 250.0 300.0 400.0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	TU     5.0 $TO$ 10.0 $TO$ 15.0 $TO$ 25.0 $TU$ 30.0 $TU$ 30.0 $TU$ 30.0 $TU$ 30.0 $TU$ 30.0 $TU$ 40.0 $TU$ 50.0 $TU$ 50.0 $TU$ 250.0 $TU$ 500.0 $TU$ 500.0 $TU$ 500.0	33 3 1 2 0 1 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0	$Mean = 62.36 \ \mu W - cm^2 - sr^1 - \mu m^{-1}$ $\sigma = 24.79 \ \mu W - cm^2 - sr^1 - \mu m^{-1}$
ŰŸ	CK 200°0	0	

TOTAL NUMBER OF ELLIPTICAL AREAS - 43

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83 FEATURES WITH AREAS LESS THAN 0,60 SG, METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPE		
METER	8	FZET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 TO	7	0 <b>T</b> O	22	22	0.0 10 1.0	c	
7 10	10	55 IO	32	5	1.0 TO 1.1	0	
10 TO	12	32 TO	39	3	5.1 07 1.2	Ó	
12 10	14	39 TU	45	2	1.2 10 1.3	ů.	
14 TO	16	45 10	52	2	1.3 10 1.4	9	
16 10	17	52 TO	55	ž	1.4 10 1.5	Å	
17 10	20	55 TO	65	1	1.5 TU 1.6	ž	
20 16	22	65 10	72	ò	1.6 TO 1.7	Ä	
22 10	24	72 TO	78	ő		ĩ	
24 10	26	78 10	85	ů.	4 8 70 1 9	ر ۱	
26 10	28	85 10	01	0		1	
28 10	30	91 10	08	0		2	
30 10	12		104	5		2	
32 10	10	10/1 10	1 7 7	ů,		0	
30 30	37	104 10	121	U.	2.0 10 2.0	3	
34 10	45	12/ 10	147	1	2.8 10 3.0	1	
45 TO	55	147 TO	180	1	3,0 TO 3,5	1	
55 TO	71	180 TO	232	1	3,5 TO 4,0	1	
71 10	100	232 TU	328	3	4.0 10 4.5	0	
UVER	100	OVER	328	0	OVER 4.5	0	



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### AFTERNOON

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

BY AREA Threshold = Mean + 2.50  $\sigma$ BUUARE METERS FREQUENCY Wavelength = 4.5 - 5.5 um0.6 TO 5.0 222 Mean = 285.69 Kelvin 5.0 TO 10.0 33 10.0 TO 15.0 11  $\sigma = 2.29$  Kelvin 15.0 10 20.0 4 20.0 TU 25.0 TU 25.0 5 ŝ 30.0 30.0 TO 35.0 0 35.0 TU 40.0 TU 40.0 1 45 . 0 1 45.0 TO 50.0 1 50.0 TO 75.0 3 75.0 TO 100.0 1 100.0 TO 150.0 Ô 150.0 TO 200,0 Û 200.0 70 250.0 0 250.0 TU 300.0 Ô 300.0 TC 400.0 0 400.0 TO 500.0 0 OVER 500,0 ð

TOTAL NUMBER OF ELLIPTICAL AREAS = 287

199 FEATURES WITH AREAS LESS THAN 0.60 SQ. METERS WERE ALSO RECOGNIZED

BY PERIMETER BY SHAPE. METERS FEET FREQUENCY SHAPE FACTOR FREQUENCY 0 TO 7 0.0 TU 1.0 0 10 22 136 0 7 TO 22 10 32 1.0 TO 1.1 10 44 ٥ 39 10 TO 17 SI 12 32 10 30 1.1 TO 1.2 21 39 1.2 TO 1.3 1.3 TO 1.4 1.4 TO 1.5 22 57 14 10 45 9 52 14 TO 45 TO 16 14 16 TO 17 TO 17 52 TU 4 38 1.5 TU 1.6 1.6 TO 1.7 1.7 TO 1.8 27 27 27 20 55 TU 65 13 20 TO 22 65 TO 72 4 55 IQ 24 72 10 78 4 55 TO 1.9 23 12 24 10 26 78 10 85 0 1,8 26 10 28 65 TO 91 6 2 1.9 28 10 30 91 10 98 2,0 10 2,4 17 2.4 TO 2.6 2.6 TO 2.8 30 10 32 Ĵ 3 48 TO 104 11 104 TU 127 TO 32 10 39 127 4 39 TO 45 147 4 2.8 10 3.0 1 55 71 147 TO 180 TO 3.0 TU 3.5 3.5 TU 4.0 45 TÜ 180 3 1 55 TG 232 3 3 71 10 100 232 10 328 4.0 TU 4.5 3 1 OVER 328 ž 100 OVER OVER 4,5 ٥

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Area: Camp A.P. Hill (Wavelength =  $4.5 - 5.5 \mu m$ ) Temperature Threshold = Mean +  $3.50 \sigma$ Mean = 285.69 Kelvin Std. Dev. =  $\sigma$  = 2.29 Kelvin EQUIVALENT ELLIPTICAL AREAS - AFTERNOON

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## AFTERNOON

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		BY AREA	Threshold = Mean + $3.50 \sigma$
SQUARE H	ETERS	FREQUENCY	Wavelength = $4.5 - 5.5 \mu m$
0.6 TU 5.0 TO 10.0 TO 15.0 TU 20.0 TU 25.0 TU 30.0 TO 35.0 TO 40.0 TO 50.0 TO	5.0 10.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0	35 2 0 1 1 0 0 0 0 0 0 0	Mean = 285.69 Kelvin $\sigma$ = 2.29 Kelvin
75.0 TU 100.0 TU 150.0 TU 200.0 TU 250.0 TO 300.0 TO 400.0 TO OVER	100.0 150.0 200.0 250.0 300.0 400.0 500.0 500.0	0 0 0 0 0 0 0 0	

TOTAL NUMBER OF ELLIPTICAL AREAS = 39

BY PERIMETER

28 FEATURES WITH AREAS LESS THAN 0.60 SQ. METERS WERE ALSO RECOGNIZED

BY SHAPE

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HETERS	•	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 T 0	7	0 TO	22	22	0.0 10 1.0	0
7 10	10	07 SS	32	5	1.0 10 1.1	Ő
10 10	15	32 TO	39	6	1.1 10 1.2	i i
12 10	14	39 10	45	i	1.2 10 1.3	6
14 10	16	45 TO	52	2	1.3 10 1.4	, a
16 10	17	52 10	55	ō	1.4 10 1.5	Ś
17 10	20	55 TO	65	Ō	1.5 10 1.6	
20 TO	25	65 TO	72	ō	1.6 10 1.7	2
22 10	24	72 TO	78	Ĩ	1.7 10 1.8	5
24 10	26	78 TO	85	ŏ	1.8 10 1.9	0
26 TO	28	85 TO	91	õ	1.9 10 2.0	ŏ
07 8S	30	91 TO	98	Ō	2.0 TO 2.4	ů.
30 10	32	98 TO	104	Ō	2.4 TO 2.4	1
32 10	39	104 TO	127	õ	2.6 TO 2.8	i
39 10	45	127 10	147	2	2.8 10 3.0	1
45 10	55	147 10	180	ō		
SS 10	71	180 10	212	ň		
71 to 1	00	212 10	124	õ		v
OVER 1	00	OVEN	138	ŏ	4,0 10 4,3 Over 4 e	Ű
	••	UVEN	264	v	UVER 4,3	0



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Area: Camp A.P. Hill (Wavelength =  $8.0 - 14.0 \mu m$ ) Temperature Threshold = Mean +  $2.50 \sigma$ Mean = 286.54 Kelvin Std. Dev. =  $\sigma$  = 2.74 Kelvin EQUIVALENT ELLIPTICAL AREAS - AFTERNOON



**AFTERNOON** 

TOTAL NUMBER OF ELLIPTICAL AREAS - 421

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342 FEATURES WITH AREAS LESS THAN 0.60 SQ. HETERS WERE ALSO RECOGNIZED

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BY PERIMETER					BY SHAPE		
HETE	R5 <sup>1</sup>	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 TO	7	· 0 TU	22	217	0.0 TO 1.0	0	
7 10	10	0T 5S	32	64	1.0 TO 1.1	0	
10 10	12	32 TO	39	38	1.1 10 1.2	22	
12 10	14	39 10	45	21	1.2 10 1.3	10	
14 10	16	45 10	52	14	1.3 70 1.4	70	
16 10	17	52 10	55	5	1.4 70 1.5	ÅQ	
17 10	20	55 10	45	11		0 V A L	
20 10	22	65 10	72			40	
22 10	24	73 10		,	1.6 10 1.7	40	
24 10	54		/0	2	1.7 10 1.8	19	
24 10	20	76 10	a >	4	1.8 TU 1.9	18	
20 10	20	85 TU	91	3	1,9 TO 2,0	14	
26 TO	30	91 TO	96	3	2,0 TO 2,4	41	
30 TO	32	98 TO	104	3	2.4 TO 2.6	11	
35 10	39	104 TO	127	4	2.6 10 2.8	4	
39 10	45	127 TO	147	4	2.8 10 3.0	2	
45 10	55	147 TO	180	5	3.0 10 3.5	Ā	
55 10	71	180 TO	232	ŝ	3.5 TO 4.0	ï	
71 10	100	232 10	328	Ā	4.0 TO 4.5	5	
OVER	100	OVER	328	2	OVER 4.5	Č	

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Area: Camp A.P. Hill (Wavelength = 8.0 - 14.0 m) Temperature Threshold = Mean +  $3.00 \sigma$ Mean = 286.54 Kelvin Std. Dev. =  $\sigma$  = 2.74 Kelvin EQUIVALENT ELLIPTICAL AREAS - AFTERNOON

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# EVENING

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		BΥ	AREA	Threshold = Mean + 2.00 $\sigma$
SQUARE	METERS		FREQUENCY	Wavelength = $4.5 - 5.5 \mu m$
0.6 5.0 10.0 25.0 30.0 35.0 45.0 50.0 75.0 100.0 200.0 250.0 300.0	10     10	5.0 10.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0 200.0 250.0 300.0 400.0 400.0	311 35 10 2 3 2 0 1 1 1 0 0 1 1 0 0 0 0 0 0 0	waverengtn = 4.5 - 5.5 μm Mean = 282.89 Kelvin σ = 1.17 Kelvin
400.0 Dy	TU YER 9	500.0	0 1	

TOTAL NUMBER OF ELLIPTICAL AREAS = 367

611 FEATURES WITH AREAS LESS THAN 0.60 SQ, METERS WERE ALSO RECOGNIZED

BY VERIMETER					BY SHAPE		
METER	5	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 10	7	0 TO	22	171	0.0 TU 1.0	0	
7 10	10	22 T()	32	75	1.0 TO 1.1	0	
10 10	12	32 TO	39	25	1.1 10 1.2	8	
15 10	14	39 10	45	17	1.2 TU 1.3	11	
14 TO	16	45 TU	52	14	1.3 TU 1.4	61	
16 T()	17	52 TO	55	3	1.4 TU 1.5	20	
17 10	20	55 TO	65	15	1.5 TO 1.6	15	
20 10	22	65 TU	72	4	1.6 TU 1.7	52	
22 10	24	72 10	78	11	1.7 10 1.8	30	
24 10	56	78 TU	85	4	1.8 TU 1.9	19	
01 05	85	85 TO	91	3	1.9 10 2.0	33	
28 10	30	91 TO	98	5	2.0 10 2.4	61	
30 10	32	98 10	104	2	2.4 TÜ 2.6	17	
32 10	39	104 10	127	7	2.6 TU 2.8	10	
39 10	45	127 10	147	2	2.8 TU 3.0	7	
45 10	55	147 10	180	1	3.0 10 3.5	12	
55 10	71	180 10	232	2	3.5 10 4.0	5	
71 10	100	232 10	328	ĩ	4.0 TU 4.5	1	
OVER	100	OVER	328	4	OVER 4.5	5	

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Area: Camp A.P. Hill (Wavelength =  $4.5 - 5.5 \mu$ m) Temperature Threshold = Mean +  $3.00 \sigma$ Mean = 282.89 Kelvin Std. Dev. =  $\sigma = 1.17$  Kelvin EQUIVALENT ELLIPTICAL AREAS - EVENING

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# EVENING

# DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		BY	AREA	Threshold = Mean + 3.00 $\sigma$
SQUARE	METERS		FREQUENCY	Wavelength = $4.5 - 5.5 \mu m$
SQUARE 0.6 5.0 10.0 15.0 25.0 35.0 40.0 40.0 45.0 50.0 100.0 150.0 200.0 250.0 300.0	HETERS         TO         TO	<b>S.0</b> <b>10.0</b> <b>20.0</b> <b>23.0</b> <b>30.0</b> <b>30.0</b> <b>30.0</b> <b>30.0</b> <b>40.0</b> <b>45.0</b> <b>75.0</b> <b>100.0</b> <b>150.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>200.0</b> <b>2</b>	FREQUENCY 11 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Wavelength = 4.5 - 5.5 μm Mean = 282.89 Kelvin σ ≈ 1.17 Kelvin
0\	ER	500.0	. 0	

TOTAL NUMBER OF ELLIPTICAL AREAS = 14

2 FEATURES WITH AREAS LESS THAN 0.60 SQ, METERS WERE ALSO RECOGNIZED

#### BY PERIMETER

#### BY SHAPE

METLR	\$	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 10	7	0 TO	22	5	0.0 70 1.0	0
7 10	10	22 TU	32	5	1.0 TU 1.1	0
10 TO	12	32 10	39	0	1.1 TO 1.2	5
12 10	14	39 10	45	1	1.2 10 1.3	3
14 10	16	45 10	52	1	1.3 10 1.4	3
16 TO	17	52 10	55	0	1.4 TU 1.5	2
17 10	20	55 TO	65	1	1.5 10 1.6	2
20 10	25	65 TU	72	Q	1.6 TU 1.7	õ
22 10	24	72 TU	78	0	1.7 10 1.8	0
24 10	26	78 TO	85	5	1.6 10 1.9	Ó
26 TU	28	85 TO	91	0	1.9 10 2.0	i
01 8S	30	91 TO	98	0	2.0 10 2.4	ò
30 10	32	98 TU	104	c	2.4 10 2.6	0
32 10	39	104 10	127	Ō	2 6 10 2 8	Ó
39 10	45	127 10	147	ò	2.8 TU 3.0	ò
45 10	55	147 10	180	ō	3.0 10 3.5	0
55 TO	71	180 10	232	Ō	3.5 TU 4.0	Ő
71 10	100	232 10	328	Ó	4.0 10 4.5	õ
OVER	100	OVER	328	i	OVER 4.5	ĩ



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# - EVENING

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	BY AREA	Threshold = Mean + 2.00 σ
SQUARE METERS	FREQUENCY	Wavelength = $8.0 - 14.0 \mu m$
0.6       TU       5.         5.0       TU       10.         10.0       TU       15.         15.0       TU       20.         20.0       TU       25.         25.0       TU       30.         30.0       TU       35.         35.0       TU       45.         45.0       TU       50.         50.0       TU       75.         75.0       TO       100.         100.0       TU       150.         150.0       TU       150.         20.0       TU       250.	PREGUENCY         0       237         0       39         0       19         0       4         0       2         0       1         0       1         0       1         0       1         0       1         0       2         0       1         0       2         0       1         0       2         0       0	Wavelength = 8.0 - 14.0 μm Mean = 281.16 Kelvin σ = 1.70 Kelvin
250.0 TU 300. 300.0 TU 400.	0 0 0 1	
300.0 TO 400. 400.0 TO 500.	0 1	
Uter DUV.	v 0	

TOTAL NUMBER OF ELLIPTICAL AREAS = 311

165 FEATURES WITH AREAS LESS THAN 0,60 SQ, METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPE		
METER	3	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 TO	7	0 T U	22	146	0.0 TU0	0	
7 TO	10	22 TO	32	61	1.0 10 1.1	0	
10 TO	12	36 10	39	21	1 1 10 1 2	16	
01 51	14	39 TU	45	15	1.2 10 1.3	25	
14 TO	16	45 TO	52	13	1.3 TO 1.4	74	
16 TO	17	57 TO	55	5	1.4 TU 1.5	42	
17 10	20	55 TO	65	9	1.5 10 1.6	27	
OT 05	22	65 TO	72	2	1.6 10 1.7	41	
22 10	24	72 10	78	2.	1.7 TU 1.8	20	
24 10	56	78 TO	85	ŝ	1.8 TU 1.9	11	
26 10	28	85 TO	91	7	1.9 10 2.0	7	
0T 85	30	91 TO	9.8	i	2.0 10 2.4	22	
50 10	32	98 TO	104	7	2.4 10 2.6		
12 10	39	104 10	127	3	2-6 10 2-8	ģ	
19 10	45	127 10	107	ĩ	2 A TO 3.0	4	
15 10	55	147 TO	180	2	3.0 10 3.5	2	
55 10	71	180 10	212	- +	3.5 T() 4 0	1	
	100	212 10	128	i		2	
INFE	100		158	5		1	
D	***	UVER	364	3	UTEN 443	3	



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# EVENING

DISTRIBUTION OF ELEPTICAL AREAS GREATER THAN THRESHOLD

	8 Y	AREA	Threshold # Mean + 2,50 g
SJUARE METE	RS	FREQUENCY	Wavelength - 8.0 - 14.0 µm
0,6 YG 5,0 TG 10,0 TG 15,0 TG 20,0 TG 20,0 TG 30,0 TG 35,0 TG 45,0 TG	5,0 10,0 15,0 20,0 25,0 30,0 30,0 40,0 50,0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Mean = 281,18 Kelvin a = 1,70 Kelvin
50.0 TU 75.0 TU 100.0 TU 150.0 TU 250.0 TU 250.0 TU 300.0 TU 400.0 TU UVFK	75,0 100,0 150,0 200,0 250,0 300,0 400,0 500,0 500,0		

TOTAL NUMBER OF ELLIPTICAL AREAS - 25

BY PEHIMETER

20 PEATURES WITH AHEAS LESS THAN 0,40 BC, METTHS WENT ALSO RECOUNTED

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HETER	5	FEET		FREQUENCY	BHAPL FACTOR	FREQUENCY
0 10	7	0 T()	22	14	0.0 10 1.0	Q
7 14	10	22 10	32	5	1.0 10 1.1	L
10 10	51	32 10	39	2	1.1 10 1.2	4
12 10	14	39 10	4'5	1	1.7 10 1.1	1
14 10	16	45 10	4.2	0	1.1 10 1.4	6
16 10	47	52 TO	55	6	1.4 10 1.5	5
17 10	20	55 TU	65	i	1.5 10 1.6	7
20 10	22	65 10	72	ō	1.6 10 1.7	7
22 10	24	72 10	78	Ó	1.7 10 1.0	1
24 10	26	78 10	A5	ò	1.6 10 1.9	i i
26 70	28	#5 TO	91	0	1.7 10 2.0	Ô
28 10	30	91 10	σA	Ó	2.0 10 2.4	Ô
*o 10	32	98 10	104	0	2.4 11) 2.6	Ó
32 10	39	104 10	127	Ó	2.6 10 2.8	1
39 10	45	127 10	1 4 7	ů.	2.6 10 3.0	0
45 10	66	147 10	100	õ	8.0 10 3.5	0
55 10	71	180 TO	2 12	ō	<b>1</b> . 1 <b>1</b> 0 <b>4</b> .0	õ
71 10	100	212 1/1	126	5	4.0 10 4.4	ò
OVER	100	EVER	328	Ő	UVIH 11.5	õ



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MIDNIGHT

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	BY	AREA	Threshold = Mean + $1.50 \sigma$
SQUARE METER	9	FREQUENCY	Wavelength = $4.5 - 5.5 \mu m$
0.6 TU 5.0 TU 16.0 TU 15.0 TU 20.0 TU 20.0 TU 35.0 TU 35.0 TU 40.0 TU 40.0 TU 40.0 TU 100.0 TU 100.0 TU 200.0 TU 200.0 TU 200.0 TU 300.0 TU	5.0 10.0 15.0 25.0 30.0 35.0 40.0 45.0 50.0 150.0 250.0 250.0 300.0 500.0 500.0	422 30 4 5 1 3 1 0 0 3 1 3 0 0 1 1 1	Mean = 282.00 Kelvin $\sigma$ = 1.26 Kelvin
OVER	500.0	L	

TOTAL NUMBER OF ELLIPTICAL AREAS - 486

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\*\* \* ERIM

1234 FEATURES WITH ARFAS LESS THAN 0.60 SQ. METERS WERE ALSO RECOGNIZED

#### BY SHAPE

BY PERIMETER				BY SHAPE		
METER	5	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 TO 7 TO 10 TO 12 TO 14 TO 14 TO 16 TO 17 TO 20 TO 22 TO	7 10 12 14 16 17 20 22 24	0 T0 22 T0 32 T0 39 T0 45 T0 52 T0 55 T0 65 T0 72 T0	22 39 55 55 78	259 78 33 23 10 7 16 5 6	0.0 TU 1.0 1.0 TO 1.1 1.1 TU 1.2 1.2 TU 1.3 1.3 TU 1.4 1.4 TU 1.5 1.5 TU 1.6 1.6 TU 1.7 1.7 TU 1.8	0 9 86 48 29 70 31 21
24 TU 26 TO 28 TO 30 TO 32 TO 39 TO 45 TU 55 TO 71 TO aver	26 28 30 32 39 45 55 71 100 100	78 TU 85 TU 91 TU 98 TU 104 TO 127 TO 147 TO 180 TO 237 TO 0VER	65 91 98 104 127 147 180 232 328 328	5 4 5 4 3 5 4 3 5 12	1,4 TU 2.0 2.0 TU 2.4 2.4 TO 2.6 2.6 TU 2.6 2.6 TU 3.0 3.0 TU 3.5 3.5 TU 4.0 4.0 TU 4.5 TVFR 4.5	30 63 18 11 11 16 4 3 18



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Area: Camp A.P. Hill (Wavelength =  $4.5 - 5.5 \mu m$ ) Temperature Threshold = Mean +  $2.50 \sigma$ Mean = 282.00 Kelvin Std. Dev. =  $\sigma$  = 1.26 Kelvin EQUIVALENT ELLIPTICAL AREAS - MIDNIGHT

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## MIDNIGHT

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		BY	AREA	Threshold = Mean + 2.50 $\sigma$
SQUARE	METERS		FREQUENCY	Wavelength = 4.5 - 5.5 $\mu m$
0.6 5.0 15.0 25.0 35.0 40.0 50.0 150.0 150.0 250.0 150.0 250.0 300.0 200	TO     TO <td>5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0 150.0 200.0</td> <td>7 3 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>Mean = 282.00 Keivin σ = 1.26 Kelvin</td>	5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0 150.0 200.0	7 3 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Mean = 282.00 Keivin σ = 1.26 Kelvin
	-		-	

TOTAL NUMBER OF ELLIPTICAL AREAS - 12

بالمراجع

7 FEATURES WITH AREAS LESS THAN 0.60 SQ. METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPE		
METER	15	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 TO	7	0 10	22	2	0.0 TO 1.0	0	
7 TO	10	22 TU	32	5	1.0 TO 1.1	0	
10 TO	12	32 TU	39	2	1.1 10 1.2	2	
12 10	14	39 TU	45	ĩ	1.2 10 1.3	1	
14 10	16	45 TO	52	õ	1.3 70 1.4	3	
16 TU	17	52 10	55	ĩ	1.4 10 1.5	Ĵ	
17 10	20	55 10	65	ō	1.5.10 1.6	ī	
20 10	22	65 10	72	Ō	1.6 10 1.7	i	
22 10	24	72 10	78	<u>0</u>	1.7 TU 1.8	Ő	
24 10	26	78 10	85	å	1.8 TU 1.9	ŏ	
26 10	28	85 TO	01	ő	1.9 10 2.0	ŏ	
28 10	10	91 TH	0.A	ň	2.0 10 2.4	ň	
30 10	12	98 TO	104	ŏ	2.4 10 2.6	ŏ	
12 10	19	104 TO	127	ő	2.6 10 2.8	ŏ	
10 10	45	127 10	1 / 7	Ň	2 6 10 3 6	ő	
as 10		167 10	180	ŏ	3 0 70 3.5	Ň	
55 10	71	147 10	212	Ň		Ň	
33 10	100		535	v 		V A	
F1 10	100	636 IU	250	v.			
OVER	188	INVER.	528	I	UVER 0.5	1	
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## MIDNIGHT

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

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		R	Y ARFA	Threshold = Mean + 2.00 $\sigma$
SQUARE	HETERS		FREQUENCY	Wavelength = $8.0 - 14.0 \mu m$
0.6 5.0 10.0 15.0 20.0 25.0	T0 T0 T0 T0 T0 T0	5,0 10,0 15,0 20,0 25,0	219 30 9 6 5	Mean = 279.50 Kelvin σ = 1.54 Kelvin
30.0 35.0 40.0 45.0 50.0 75.0	TO TO TO TO TO TO	35.0 40.0 45.0 50.0 75.0	1 2 1 3 1	
100.0 150.0 200.0 250.0 300.0 400.0	TO TU TO TU TU TO ER	150.0 250.0 250.0 300.0 400.0 500.0	0 0 1 0 0 1	

TOTAL NUMBER OF ELLIPTICAL AREAS - 281

187 FEATURES WITH AREAS LESS THAN 0.60 SO. METERS WERE ALSO RECOGNIZED

	HY PERIMETER					BY SHAPE		
М	ETER	5	F	EET		FREQUENCY	SHAPE FACTOR	FRFQUENCY
0	10	7	0	10	22	132	0.0 TU 1.0	0
	10	10	22	TU	32	56	1.0 TO 1.1	0
10	10	12	32	TO	39	15	1.1 10 1.2	16
12	10	14	39	ŤÖ	45	19	1.2 10 1.3	15
14	TO	16	45	TO	52	11	1.3 10 1.4	82
16	10	17	52	tõ	55	i,	1.4 TO 1.5	29
17	to	20	55	10	65	ĩ	1.5 10 1.6	25
20	TO	22	65	tn	72	i	1.6 10 1.7	21
22	to	24	12	10	78	5	1.7 TU 1.8	20
34	in	26	78	TO	85	<u> </u>	1.0 10 1.9	ĨĨ
3.	10	20	86	10	65		1 9 711 2.0	
20	10	10	07	10	71	5	2 0 TI 2.4	21 -
20	10	30	41	10	40	Ĕ		10
30	10	26	49		104	<u> </u>		10
35	TO	- 34	104	10	127	2	2.0 10 2.0	3
39	10	45	127	TU	147	6	5°N IO 3°0	4
45	TO	55	147	10	180	2	3.0 TU 3.5	0
55	10	71	180	10	232	2	3.5 TU 4.0	<b>ن</b>
71	10	100	232	10	328	3	4.0 TU 4.5	3
	URU	1			158	Č.	OVER A.S	1



Area: Camp A.P. Hill (Wavelength =  $8.0 - 14.0 \mu m$ ) Temperature Threshold = Mean +  $3.00 \sigma$ Mean = 279.50 Kelvin Std. Dev. =  $\sigma$  = 1.54 Kelvin EQUIVALENT ELLIPTICAL AREAS - MIDNIGHT



TOTAL NUMBER OF ELLIPTICAL AREAS =

BY PERIMETER

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4 FEATURES WITH AREAS LESS THAN 0,60 SQ, METERS WERE ALSO RECOGNIZED

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#### BY SHAPE

METER	89	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCI
0 10	7	0 TO	22	3	0.0 TU 1.0	0
7 10	10	22 TU	32	2	1.0 TO 1.1	Ó
10 10	12	32 10	19	ī	1.1 10 1.2	2
12 10	1 4	19 10	45	ī	1.2 10 1.3	ī
14 10	14	45 10	82			;
14 10	10	47 10 63 TO	76	0		5
10 10	1/		12	•		E 1
17 10	20	22 10	67	U	1.7 10 1.0	1
20 10	2.2	65 TO	72	0	1.6 10 1.7	0
22 10	24	72 TO	78	0	1.7 TU 1.8	0
24 10	26	76 TU	85	0	1.8 TU 1.9	1
26 TO	28	85 TO	91	0	1.9 TU 2.0	0
28 10	30	91 TO	98	0	2.0 10 2.4	0
30 10	12	98 10	104	Ő	2.4 10 2.6	Ó
12 10	10	104 10	127	ň	2.4 10 2.8	ň
10 10	45	137 10	1.07	ň		Ň
37 10			147			Ň
45 10	22	147 10	100	U	3.0 10 3.3	U U
22 10	- 71	180 TO	232	0	3,5 10 4,0	0
71 TO	100	535 10	359	0	4.0 10 4.5	0
OVER	100	OVEN	320	0	NVER 4.5	Ô

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CAMP A. P. HILL, VIRGINIA

Power Spectra

Spectral Bands: 2.0 - 2.6 μm 4.5 - 5.5 μm 8.0 - 14.0 μm



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\*\* Power spectral density is  $('K)^2/cycle/meter$  for the 4.5 to 5.5 and 8.0 to 14.0  $\mu$ m bands. Area: CAMP A.P. HILL IN-TRACK Wavelength = 4.5-5.5 (+), 8.0-14.0 (X) ł SPATIAL FREQUENCY (CYCLES/M) POWER SPECTRA - EVENING Ĩ L 2\_01×1 6-01×1 EOIXI 201×1 РОМЕВ SPECTRAL DENSITY++

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# FLINT, MUCHIGAN\*

Pertinent Scene and Flight Information (Date of Flight: 18 September 1971)

\* For specific discussions of these and associated data for this scenery, refer to Reference 1.

#### FLINT-1 Data

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Wavelength Bands: $1.0-1.4 \ \mu m$ ,  $1.5-1.8 \ \mu m$ ,  $2.0-2.6 \ \mu m$ ,  $9.3-11.7 \ \mu m$ IFOV: $2.5 \ mrad$  (cross-track);  $5.0 \ mrad$  (in-track)Altitude: $1000 \ ft$ Depression Angle: $90^{\circ}$ Time: $1130 \ hrs$ Flight Direction:Ground Speed: $200 \ ft-sec^{-1}$ Area Covered (Approx.): $1600 \ ft \ wide \ x \ 4000 \ ft \ long$ Meteorology:Visibility > 10 mi; dry; cloud cover 30-50%

### FLINT-2 Data

Wavelength Bands: $1.0-1.4 \ \mu m$ ,  $1.5-1.8 \ \mu m$ ,  $2.0-2.6 \ \mu m$ ,  $9.3-11.7 \ \mu m$ IFOV: $2.5 \ mrad$  (cross-track);  $5.0 \ mrad$  (in-track)Altitude: $1000 \ ft$ Depression Angle: $90^{\circ}$ Time: $1200 \ hrs$ Flight Direction:SoutheastGro ind Speed: $200 \ ft-sec^{-1}$ Area Covered (Approx.): $1600 \ ft$  wide x 4500 ft longMeteorology:Visibility > 10 mi; dry, cloud cover 30-50%

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Histograms\*

Spectral	Bands:	1.0 -	1.4 µm
		3.5 -	1.8 µm
		2.0 -	2.6 µm
		9.3 -	11.7 µm



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Wave:ength = 9.3 - 11.7 Mean = 297.00 Std. Dev. = 3.18

Area: FLINT-2

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## FLINT, MICHIGAN

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Means and Standard Deviations for Spectral Bands Correlations Between Spectral Bands<sup>\*</sup>

Spectral Bands:	Channel 2:	1.0 - 1.4 $\mu m \ (\mu W - cm^{-2} - sr^{-1} - \mu m^{-1})$
	Channel 3:	1.5 - 1.8 $\mu m$ ( $\mu W$ -cm <sup>-2</sup> -sr <sup>-1</sup> - $\mu m$ <sup>-1</sup> )
	Channel 4:	2.0 - 2.6 $\mu m (\mu W - cm^{-2} - sr^{-1} - \mu m^{-1})$
	Channel 5:	9.3 - 11.7 µm (°K)

\* Because of the relatively small comperature changes in the scenery, there is a nearly linear relationship between the temperature and radiance statistics for the thermal channels. It is pertinent, therefore, to compute correlations between radiance and temperature channels.

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فاستعقال والمعاد

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## FLINT-1

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Number of Subregions = 1		
Pixel Subarea Divisions	at: 1	645
Line Subarea Divisions a	t: 10	806
Line Increment Used = 1		
Pixel Increment Used = 1		
Correlation Channels:	2 (1.0 - 3 (1.5 - 4 (2.0 - 5 (9.3 -	1.4 μm) 1.8 μm) 2.6 μm) 11.7 μm)

2	3	4	5	
1.000				
0.392	1.000			
0.303	0.603	1.000		
-0.455	0.048	0.177	1.000	
	2 1.000 0.392 0.303 -0.455	2 3 1.000 0.392 1.000 0.303 0.603 -0.455 0.048	2 3 4 1.000 0.392 1.000 0.303 0.603 1.000 -0.455 0.048 0.177	2 3 4 5 1.000 0.392 1.000 0.303 0.603 1.000 -0.455 0.048 0.177 1.000

Channels	2	3	4	5
Mean	1.2728E+03	1.7316E+02	3.5843E+01	2.9443E+02
St. Dev.	3.6425E+02	8.2745E+01	1.0386E+01	3.1403E+00
Total Points	514065	514065	514065	514065



#### FLINT-2

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Number of Subregions = 1 Pixel Subarea Divisions at: 1 645 Line Subarea Divisions at: 10 896 Line Increment Used = 1 Pixel Increment Used = 1 Correlation Channels: 2 (1.0 - 1.4  $\mu$ m) 3 (1.5 - 1.8  $\mu$ m) 4 (2.0 - 2.6  $\mu$ m) 5 (9.3 - 11.7  $\mu$ m)

Correlation	2	3	4	5
2	1.000			
3	0.718	1.000		
4	0.489	0.634	1.000	
5	-0.437	-0.180	-0.036	1.000

Channels	2	3	4	5
Mean	7.8997E+02	2.3997E+02	3.9247E+01	2.9700E+02
St. Dev.	3.0508E+02	7.7870E+01	1.3748E+Cl	3.1768E+00
Total Points	572115	572115	572115	572115

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## FLINT, MICHIGAN

Ellipse Statistics

Spectral Bands: 1.0 - 1.4 μm 9.3 - 11.7 μm





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# FLINT-1

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

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Threshold = Mean + 2.00  $\sigma$ 

Wavelength =  $1.0 - 1.4 \mu m$ 

Mean =  $1272.84 \mu W - cm^2 - sr^1 - \mu m^{-1}$  $\sigma = 364.25 \mu W - cm^2 - sr^{-1} - \mu m^{-1}$ 

BY SHAPE

HY AREA

SQUAR	E ME	TERS	E RENGENC
0.0	11	100.0	157
100.0	1.1	200.0	2
200.0	10	546.0	I
500.0	10	1609.9	ر. ا
1000.0	10	1500.0	() ()
1500.0	10	2006.0	1
2000.0	10	2500.0	Ó
2500.0	10	3000.0	0
3000.0	To	4600.0	0
4600.0	10	5000.0	n
5600.0	111	6000.0	0
6600.0	10	8500.0	0
8661.0	10	10000.0	0
10000.0	1.1	15 100.0	0
15400.0	10	20000.0	ņ
20030.0	10	10000.0	ŋ
10600.1	1.1	anann a	0
40000-0	10	160000.0	0
ſ+	V F. G	160005.0	0

TOTAL NUMBER OF ELLIPTICAL AREAS -

HA BENTHELLS

METERS	FFFT		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 10 5	0 0 T O	164	176	0.0 70 1.0	1
50 10 10	0 160 10	320	11	1.0 TO 1.1	9
100 10 15	u 328 10	492	2	1.1 10 1.2	н
150 10 20	n //02 Tri	656	ĩ	1.2 10 1.3	9
200 10 25	0 656 16	# <b>7</b> (1	0	1.3 71 1.4	2.0
260 10 50	u 420 10	0A/I	0	1.4 10 1.5	12
7 JU 10 30	6 0vd 10	1146	ó	1.5 10 1.6	14
250 10 27	A CLASS TO	1412	ő	1.6 10 1.7	17
330 T1 49	0 1710 10	1 1 1 1	Ň	1.7 10 1.8	18
000 11 19 6 a 8 1 a 6 6		1.116.0	0	1.8 10 1.9	11
- 300 In 00		2204	ů 0	1.9 11 2.0	22
	0 1989 19	16.24	0	5.6 10 2 2	20
700 10 NO	0 2240 DO	2007.0	1	2 2 10 2 4	1.5
800 11 90	1 2020 IV	6.0.36	0	5 9 70 2 6	A
400 14 100	1) 2003 IV	26.90	Ŭ,		2
1000 13 150	0 3280 11	19937 197	0		
1240 11 140	a 3937 fr	4493	0		L L
1400 17 160	0 //5+5-10	5207	0	3.0 10 3.3	ć
1044 14 593	0 5240 FG	5551	n	3.5 10 4.0	e
11/10 210	a nots		0	14VER 4.0	1


		RY ARFA	Threshold = Mean + 3.00 $\sigma$
SQUARE ME	TERS	FREQUENCY	Wavelength = $1.0 - 1.4 \mu m$
n.n 10	100.0	16	Mean = 1272.84 uW-cm <sup>-2</sup> -sr <sup>-1</sup> -um <sup>-1</sup>
100.9 TU	500.0	ń	$a = 361.25 \text{ where}^{-2} \text{ cm}^{-1} \text{ cm}^{-1}$
200.0 10	500.0	0	0 - 304.25 μw-cm -5r -μm
500.0 10	1000.0	1	
1000.0 10	1500.0	0	
1500.0 10	2000.0	0	
2000.0 10	2500.0	<u>0</u> .	
2500.0 10	3000.0	0	
3000.0 10	4009.0	Q	
4000.n TU	5000.0	0	
5000.0 10	6480.0	0	
6000.0 10	8000.0	0	
8000.0 10	10000.0	0	
10000.0 10	15000.0	0	
15008.9 10	20000.0	0	
50000.0 10	40000.0	0	
40000.0 10	80900.0	0	
80400.0 10	160000.0	0	
<b>NVER</b>	160000.0	0	

FLINT-1 DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

			BY PF	81.F	ារូន		
нг	TER	5	r	FET		FREQUENCY	SHAP
0 1	0	50	0	τo	164	12	e.,
50 1	10	100		10	3 <b>7</b> Å	n	1.0

MF	TE	<b>?</b> 5	1	TEET		FREQUENCY	SHAPE FACTUR	FREQUENCY
0	10	50		to	164	12	0.0 TO 1.0	C
50	10	100	164	10	328	4	1.0 76 1.1	4
100	TO	150	328	TD.	422	0	1.1.10.1.2	2
150	1n	200	497	10	656	0	1.2 10 1.3	1
200	1n	250	656	10	820	0	1.3 TO 1.4	5
250	17	300	820	Th	984	ò	1.4 10 1.5	ì
300	17	550	DAU	10	114A	• 0	1.5 10 1.6	ŝ.
350	10	400	1148	10	1312	ō	1.6 11 1.7	n
100	10	500	1312	to	1640	i	1.7 10 1.8	υ
500	Th	600	1640	TO	1468	Ó	1.8 10 1.9	Û
600	17	700	1968	TO.	2296	Ö	0.5 11 4.1	1°
700	10	800	2296	TO	2024	ŏ	5.5 01 9.5	ź
800	17	900	2624	10	2052	Ö	2.2 10 2.4	2
900	TO.	1000	2052	10	3240	0	2.4 10 2.6	- U
1000	10	1200	120.0	TIT	3937	0	8.5 11 2.8	0
1200	Th	1400	3937	10	1503	0	2.4 TO 3.4	1
1/100	13	1600	8555	th	5219	0	3.1 11 3.5	è
1600	10	2000	5240	10	6361	0	3.5 11 4.0	0
ÖV	15.9	2100		IFH	6501	e	1115 4.0	1

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Area: FLINT-1 (Wavelength =  $9.3 \sim 1^{1}.7 \mu m$ ) Temperature Threshold = Mean +  $2.50 \sigma$ Mean = 294.43 Kelvin Std. Dev.  $\sigma$  = 3.14 Kelvin EOUIVALENT ELLIPTICAL ARTAS

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## FLINT-1

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DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		inresnoid = mean + 2.50 $\sigma$
SQUARE METERS	FREQUENCY	Wavelength = 9.3 - 11.7 $\mu m$
0.0 70 100.0	271	Mean = 294.43 Kelvin
100.0 10 200.0	4	
200.0 10 500.0	4	$\sigma$ = 3.14 Kelvin
500.0 10 1000.0	1	
1600.010 1500.0	0	
1500.0 10 2000.0	0	
2000.0 10 2500.0	<b>n</b> ·	
2500.0 10 - 5000.0	0	
3600.0 10 ///000.0	1	
400n.n TO 5000.0	0	
5000.0 10 6000.0	n	
6660.n TÚ 8000.0	0	
8000.0 10 10000.0	0	
10000.0 TO 15000.0	0	
15000.0 10 20000.0	0	
20600.0 T/J //////.0	0	
40000.0 TH 80000.0	ò	
80000.9 10 160000.0	Ó	
NVER 160000.0	Ő	

TOTAL NUMBER OF ELLIPTICAL AREAS = 281

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#### BY PERIMETER BY SHAPE METERS FFET FREQUENCY SHAPE FACTOR FREQUENCY 50 0 10 0 TO 164 269 0.0 10 1.0 Ü 100 50 TO 164 Th 328 5 1.0 TO 1.1 1 100 10 150 328 TO 492 11 1.1 10 1.2 27 150 TA 500 492 TO 656 1 1.2 TO 1.3 33 200 TH 250 656 TO 850 1 1.3 10 1.4 44 300 250 TO 017 058 1.4 10 1.5 984 0 24 300 11 350 984 TO 1148 C 1.5 10 1.6 51 350 TH 400 1149 10 1312 0 1.6 10 1.7 27 400 TH 500 1312 10 1640 1.7 70 1.8 0 24 500 10 600 1640 10 1968 0 1.8 TR 1.9 11 600 11 700 1968 TO 5539 1.9 77 2.0 0 11 700 10 2296 10 800 2024 2.0 10 2.2 0 15 2624 10 800 TT 900 2952 1 5.5 10 5.4 4 900 TO 1000 2952 10 3240 0 5.4 TO 2.6 0 3250 TO 1000 th 1500 3457 0 5.6 10 5.8 1 1200 10 1400 3937 16 0593 0 12.8 10 3.0 1 1400 TO 1600 150; T: 5249 0 3.0 Tu 3.5 U 1600 10 2000 5269 10 6551 3.5 10 4.0 0 0 OVER 2000 INVER. 6561 Ô DVER 4.0 1

3.4-27



Area: FLINT-1 (Wavelength 9.3 - 11.7  $\mu$ m) Temperature Threshold = Mean + 3.00  $\sigma$ Mean = 294.43 Kelvin Std. Dev. =  $\sigma$  = 3.14 Kelvin SQU(V/LENT ELLIPTICAL AREAS



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#### FLINT-1

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	B	Y AFEA	Threshold = Mean + 3.00 $\sigma$
SOUARE NE	TFAS	FREDHE CY	Wavelength = $9.3 - 11.7 \mu m$
0.0 10	100-0	4 R	Mean = 294.43 Kelvin
100.0 10	200.0	2	2 14 Kaluin
200.0 19	500.0	1	$\sigma = 3.14$ Kelvin
500.0 10	1000.0	1	
1000.0 10	1500.0	0	ł
1500.0 10	2000.0	n	
2000 0 10	2500.0	ຄໍ	
2500.0 10	3000.0	1	
3000.0 TJ	4000.0	0	
4000.0 13	5000.0	ń	
· 5000.0 10	6000.0	0	
6600.0 10	8000.0	0	
8600.0 10	10000.0	0	
10000.0 10	15000.0	0	
15000.0 30	21000.0	0	
20000.0 10	40000.0	0	
40000.0 10	snorn.n	0	
80000.1 10	160000.0	0	
OVER	160000.0	0	
MATAT MINRER OF 1	FLETPTTCAL AREA	5 m 55	

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BY SHAPE

METE	RS	FEFI	r	FREUMENCY	SHAPE FACTUR	FREAMENCY
0 10	50	0 T/)	164	40	0.0 10 1.0	ð
50 10	100	164 1.1	3211	3	1.0 70 1.1	1
100 10	150	328 TO	472	n	1.1 70 1.2	3
150 10	200	492 TO	656	3	1.2 Th 1.3	11
200 10	250	656 10	826	0	1.3 TO 1.4	9
250 10	300	820 10	914	0	1.4 TO 1.5	6
300 10	550	OAN TH	1175	<sup>0</sup>	1.5 10 1.6	5
350 17	100	11/10 1/1	1312	Ö	1.6 10 1.7	6
400 10	500	1312 10	1640	Ō	1.7 10 1.8	5
500 10	600	1640 10	1958	0	1.8 TO 1.9	5
600 10	700	1968 10	22.0	0	1.9 10 5.0	Û
700 1:1	600	2296 10	2620	0	5.0 10 5.5	1
800 TO	900	2024 10	2452	1	2.2 10 2.4	1
910 10	1000	2952 10	30.0.1	Ó	5.4 10 5.6	1
1000 10	1200	3239 1:	3937	<b>)</b>	8.6 TO 2.8	Ċ.
1200 17	1200	70 7 11	11535	Q	2.4 Th 3.0	Ŭ
1/100 10	1000	4505 TH	5,2 113	0	3.0 10 3.5	1
1600 17	2000	5749 14	6591	Ô	3.5 11 4.0	0
OVER	2000	OVER.	6551	Q	IVER 4.0	1



Area: FLINT-2 (Wavelength = 1.6 - 1.4  $\mu$ m) Radiance Threshold = Mean + 2.85  $\sigma$ Mean = 789.97  $\mu$ W-cm<sup>-2</sup>-sr<sup>-1</sup>- $\mu$ m<sup>-1</sup> Std. Dev. = 305.08  $\mu$ W-cm<sup>-2</sup>-sr<sup>-1</sup>- $\mu$ m<sup>-1</sup> EQUIVALENT ELLIPTICAL AREAS

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### FLINT-2

### DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		BY	AREA	Threshold = Mean + 2.85 $\sigma$
SQUARE	METERS		FREQUENCY	Wavelength = 1.0 - 1.4 $\mu$ m
 4.0 5.0 15.0 25.0 30.0 30.0 40.0 45.0 50.0 100.0 150.0 200.0 250.0 300.0 40.0	TU TO TO TO TO TO TO TO TO TO TO TO TO TO	5.0 10.0 25.0 35.0 40.0 50.0 75.0 100.0 250.0	29 52 23 4 3 4 3 0 2 2 2 3 3 0 0 1 3 0 0 1	Mean = 789.97 μW-cm <sup>-2</sup> -sr <sup>-1</sup> -μm <sup>-1</sup> σ = 305.08 μW-cm <sup>-2</sup> -sr <sup>-2</sup> -μm <sup>-1</sup>
1) V	C.M.	500.0	1	

TOTAL NUMBER OF ELLIPTICAL AREAS = 135

BY PERIMETER

427 FEATURES WITH AREAS LESS THAN 4.00 SQ. HETERS WERE ALSO RECOGNIZED

#### BY SHAPE

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ME	TER	\$	FEFT		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 .	TO I	7	0 10	22	10	0.0 10 1.0	12
7	ោ	10	22 TO	32	16	1.0 TO 1.1	1
10	10	12	32 10	39	14	1.1 70 1.2	17
12	10	14	39 TO	45	27	1.7 10 1.3	9
14	10	16	45 10	52	14	1.3 TO 1.4	19
16	TO	17	52 10	55	6	1.4 TO 1.5	16
17	TO	20	55 10	65	9	1.5 70 1.6	13
20	TO.	22	65 TO	72	4	1.6 10 1.7	10
22	10	24	72 10	78	2	1.7 70 1.8	5
24	10	26	74 TU	85	6	1.8 TU 1.9	10
26	10	28	85 TO	91	-1	1.9 70 2.0	7
28	TO:	30	91 TO	98	ŏ	2.0 10 2.4	9
30	10	32	98 TU	104	2	2.4 10 2.6	1
32	10	39	104 TO	127	6	2.6 TO 2.8	1
39	TO	45	127 10	147	3	2.8 TU 3.0	1
45	10	55	147 TO	180	Ž	3.0 TO 3.5	Ō
55	10	71	180 10	232	2	3.5 10 4.0	S
71	10	100	232 10	328	4	4.0 10 4.5	ž
ÓV	ĒR	100	OVER	328	7	TIVER 4.5	ō

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#### FLINT-2

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	6 Y	ARFA	Threshold = Mean + 3.75 $\sigma$
SQUARE ME	TERS	FREQUENCY	Wavelength = 1.0 - 1.4 $\mu$ m
4.0 TO 5.0 TO 10.0 TO 20.0 TO 20.0 TO 20.0 TO 30.0 TO 35.0 TO 40.0 TO 45.0 TO 50.0 TO 100.0 TO 100.0 TO 200.0 TO	5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 150.0 150.0 200.0 250.0 300.0 300.0 50.0 0 50.0 300.0 50.0 300.0 50		Mean = 789.97 μW-cm <sup>-2</sup> -sr <sup>-1</sup> -μm <sup>-1</sup> σ = 305.08 μW-cm <sup>-2</sup> -sr <sup>-1</sup> -μm <sup>-1</sup>
TOTAL NUMBER OF	ELLIPTICAL AREA	5 = 29	

131 FEATURES WITH AREAS LESS THAN 4.00 SQ. METERS WERE ALSO RECUGNIZED

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BY PERIMETER BY SHAPE METERS FEFT FREQUENCY SHAPE FACTOR FREQUENCY 0 10 7 0 16 22 32 6 0.0 TU 1.0 7 10 10 22 TO 1.0 TO 1.1 1 10 10 12 32 TO 39 5 1,1 TO 1,2 12 10 14 39 TO 45 2 1.2 TU 1.3 1.3 TO 1.4 14 10 16 45 TO 52 Ô 16 TO 1.4 TU 1.5 1.5 TU 1.6 17 52 10 55 2 0 0 65 72 17 TO 20 55 10 22 24 20 10 65 TD 1.6 TO 1.7 1.7 TO 1.0 1.8 TO 1.9 22 10 72 10 78 1 24 10 26 78 TO 85 2 91 26 10 28 85 TO 1,9 10 2,0 28 10 30 2.0 TO 2.4 2.4 TO 2.6 91 10 98 3 32 39 30 10 98 TO 104 0 127 32 10 104 TO 1 5.6 TO 2.8 39 TO 45 TO 45 55 127 10 147 2.8 10 5.0 1 3.0 TU 3.5 3.5 TU 4.0 147 TO 180 0 55 10 71 180 10 232 1 71 10 100 232 10 328 0 4.0 TO 4.5

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Area: FLINT-2 (Wavelength =  $9.3 - 11.7 \mu m$ ) Temperature Threshold = Mean +  $4.50 \sigma$ Mean = 297.00 Kelvin Std. Dev. =  $\sigma = 3.18$  Kelvin EQUIVALENT ELLIPTICAL AREAS

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ण्डात्र विक्रियनी स्वयं के यह अवता भारत र जन्मकी अहां की दीवती की दीवता र र र जन्म का की किहीवकी ही दिनिया र सक

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	I	BY AREA	Threshold = Mean + 4.50 $\sigma$
SQUARE H	ETERS	FREQUENCY	Wavelength = 9.3 - 11.7 µm
4.0 TU 5.0 TU 10.0 TU 10.0 TU 20.0 TO 20.0 TO 20.0 TU 30.0 TU 35.0 TO 40.0 TU 50.0 TU 50.0 TU 150.0 TU 200.0 TU 250.0 TU 300.0 TU	5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0 150.0 260.0 300.0 400.0	106 185 68 44 22 16 24 10 11 10 43 15 32 7 8 3 6	Mean = 297.00 Kelvin σ = 3 18 Kelvin
NVER	500.0	7	

TOTAL NUMBER OF ELLIPTICAL AREAS - 618

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1843 FEATURES WITH ARFAS LESS THAN 4.00 SQ. METERS WERE ALSO RECUGNIZED

	•	BY PERIME	ETER		BY SI	HAPE
HETER	85	FEET		FREQUENCY	SHAPE FACTUR	FREQUENCY
0 TO	7	0 T()	22	0	0.0 TU 1.0	0
7 10	10	22 TO	32	58	1.0 70 1.1	0
10 TO	12	32 TO	39	59	5.1 07 1.1	63
15 10	14	39 TO	45	101	1.2 10 1.3	45
14 TO	16	45 T()	52	28	1.3 10 1.4	63
16 TO	17	52 10	55	24	1.4 TO 1.5	46
17 10	20	55 to	65	55	1.5 19 1.6	56
20 TO	55	65 TO	72	22	1.6 70 1.7	51
55 TU	24	72 10	78	12	1.7 70 1.8	31
24 10	26	78 14	85	15	1.8 10 1.9	26
26 10	28	85 TO	91	11	1.9 11 2.0	32
28 10	30	91 TO	98	11	2.0 70 2.4	84
30 TÜ	32	98 TO	104	8	2.4 10 2.6	31
32 10	39	104 TO	127	39	2.6 10 2.8	24
35 10	45	127 TO	147	14	2 A TU 3.0	ี 8
45 10	55	147 TO	190	25	3.0 10 3.5	39
55 TO	71	180 TO	232	39	3.5 TH 4.0	10
71 10	100	232 TU	328	43	4.0 10 4.5	4
OVER	100	OVER	328	54	OVER 4 5	5

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#### FLINT, MICHIGAN

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Power Spectra

Spectral Bands: 1.0 - 1.4 μm 1.5 - 1.8 μm 2.0 - 2.6 μm 9.3 - 11.7 μm





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Į, ERIM MICHIGAN WINTER SCENES\* CITY <u>.</u> CONIFERS - # \_\_\_\_\_ FARMLAND LAND AND WATER Pertinent Scene and Flight Information (Dates of Flights: 3,4 April 1979) Ć For specific discussions of these and associated data for this scenery, refer to Reference 6. ▲ 注 モノ

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# <u> YERIM</u>

PERTINENT INFORMATION ABOUT DIURNAL MICHIGAN WINTER SCENE DATA

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	Pre-Davn			Naon
Wavelength Bands:	4.5-5.5 µm, 9.0-1		Wavelength Bands:	3.5-3.9 µm, 4.5-5.5 µm, 9.0-11.4 µm
IFOV-	2.5 mrad		:vov:	2.5 mrad
	90°Depression	35° Depression		90° Depression 35° Depression
Altitude:	1750 ft	1000 ft	Altitude:	1750 fc 1000 fc
Time:	0535-0605 hrs		Tine:	1230-1305 hrs
Flight Direction:	MAK		Flight Direction:	MNN
(round Speed:	202 ft-sec <sup>-1</sup>		Ground Speed:	202 ft-sec <sup>-1</sup>
Area Covered (Ap; rox.):	: 1650 ft long		Area Covered (Approx.):	1650 ft long
	2800 ft wide			2800 ft wide
	(1750 ft wide)*			(1750 ft wide)*
Type of Area Analyzed:	<pre>4 types: city; l sition; conifers;</pre>	and-to-water tran- farmland	Type of Area Analyzed:	<pre>4 types: city; land-to-water tran- sition; conifers; farmland</pre>
Meteorol.3gy:	Snow cover≓95% cloud cover≔95%	nd; air terp=-2°C;	Meteorology:	Snow covered ground; air temp=5°C; cloud cover: clear
	Sunset			Midnight
Wavelength Bands:	4.5-5.5 1.21, 9.0-1	1.4 19	Wavelength Bands:	4.5-5.5 µm, 9.0-11.4 µm
IFOV:	2.5 <b>mra</b> đ		IFOV:	2.5 rrad
	90° Depression	35° Depression		90 Depression 35° Depression
Altitude:	1750 ft	1000 ft	Altitude:	1750 ft 1000 ft
Time:	1900-1930 hrs		Time:	0030-0120 hrs
Flight Direction:	, NNN		Flight Direction:	MXN
Ground Speed:	202 ft-sec <sup>-1</sup>		Crcund Speed:	202 ft-sec <sup>-1</sup>
Area Covered (Approx.):	: 1650 ft long		Area Covered (Approx.):	16 <sup>5</sup> 0 ft long
	2800 ft wide			2800 ft vide
	(1750 ft wide)*			(1750 ft wide)*
Type of Area Analyzed:	4 types: city; l sition; conifers;	and-to-water tran- farmland	Type of Area Analy: Ed:	4 types: city; land-to-water tran- sition; conifers; farmland
Meteorology:	Snow covered grou cloud cover=15%	nd, air temp <sup>#4°</sup> C,	Meteorclogy:	Snow covered ground; air temp≖-2°C; cloud cover=60% - 95%
* In this table, the ast	cerisk applies to t	he victh of the scene f	or which the statistics ar	e calculated. This is about 63%

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AERIAL PHOTOGRAPH - FARMLAND

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MICHIGAN WINTER SCENE IMAGERY - PRE-DAWN (90<sup>0</sup> Depression)

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¢. Farmland MICHIGAN WINTER SCENE IMAGERY - SUNSET (90<sup>0</sup> Depression) Conifers 9.0 - 11.4 µm 4.5 - 5.5 μm Ę, Land & Water City 

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(All scenes are 2825 ft wide by 1650 ft long.)



CONIFERS



FARMLAND

FIGURE 9. MICHIGAN WINTER SCENE GREYMAPS - PRE-DAWN

3.5-12



FIGURE 10. MICHIGAN WINTER SCENE GREYMAPS - NOON

3.5-13





ERIM MICHIGAN WINTER SCENE - CITY 2 Histograms Spectral Bands: 3.5 - 3.9 µm 4.5 - 5.5 µm  $9.0 - 11.4 \ \mu m$ Circles define a Gaussian curve with the same mean and standard deviation as the actual histogram. An "S" on some curves indicates saturation. Because of limits on gain settings some values may exist beyond the digital limits of 0 and 255, the digital dynamic range of the data processing. 3.5-16





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#### CITY - PRE-DAWN

Number of Subregions: 1 Line Increment Used: 1 Pixel Increment Used: 1 Correlation Channels: 10 (4.5 - 5.5 µm) 12 (9.0 - 11.4 µm)

#### 90° Depression

Pixel Subarea Divisions At:	123	523
Line Subarea Divisions At:	1	385

Correlation	10	12
10	1.000	
12	0.818	1.000

Channels	10	12
Mean	2.7515E+02	2.7507E+02
Standard Deviation	2.2520E-01	3.9349E-01
Total Points	154000.	1.54000.

#### 35° Depression

Pixel Subarea Divisions At:	123	523
Line Subarea Divisions At:	1	211

Correlation	10	12
10	1.000	
12	0.797	1.000

Channels	10	12
Mean	2.7513E+02	2.7499E+02
Standard Deviation	1.8358F-01	3.1458E-01
Total Points	84400.	84400.

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Number of Subregion.	1				
Line Increment Used.	1				
Pixel Increment Used:	1				
Correlation Channels:	8	(3.5	-	3.9 µm	i)
	10	(4.5	-	5.5 µm	i)
	12	(9.0		<b>11.</b> 4 µ	m)

90°	Depression
-----	------------

Pixel	Subarea	Division	s At:	123	523
Line	Subarea	Divisions	At:	1	385

Correlation	8	10	12
8	1.000		
10	0.364	1.000	
12	0.441	0.600	1.000

Channels	8	10	12
Mean	2.8380E+02	2.7805E+02	2.7905E+02
Standard Deviation	6.2127E+00	2.0422E+00	2.7589E+00
Total Points	154000.	154000.	154000.

#### 35° Depression

Pixel Subarea Divisions At:123523Line Subarea Divisions At:1211

Correlation	8	10	12
8	1.000		
1.0	0.268	1.000	
12	0.442	0.465	1.000

Channels	8	10	12
Mean	2.8527E+02	2.787OE+02	<b>?.7974E+</b> 02
Standard Deviation	5.3784E+00	2.1785E+00	2,94 <b>1.9E+</b> 00
Total Points	83600.	83600.	83600.

#### CITY - SUNSET

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Number of Subregions:	1
Line Increment Used:	1
Pixel Increment Used:	1
Correlation Channels:	10 (4.5 - 5.5 μm)
	12 (9.0 - 11.4 µm)

#### 90° Depression

Pixel Subarea Divisions At:	123	523
Line Subarea Divisions At:	1	385

Correlation	10	12
10	1.000	
12	0.703	1.000

Channels	10	12
Mean	2.7560E+02	2.7559E+02
Standard Deviation	3.5060E-01	4.9331E-01
Total Points	154000.	154000.

## 35° Depression

Pixel Subarea Divisions At:	123	523
Line Subarea Divisions At:	1	211

Correlation	10	12
10	1.000	
12	0.711	1.000

Channels	10	12
Mean	2.7556E+02	2.7536E+02
Standard Deviation	2.9188E-01	4.3698E-01
Total Points	84400.	84400.

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#### CITY - MIDNIGHT

Number of Subregions:	1
Line Increment Used:	1
Pixel Increment Used:	1
Correlation Channels:	10 (4.5 - 5.5 μm)
	$12 (9.0 - 11.4 \mu m)$

#### 90° Depression

Pixel Subarea Divisions At:	123	523
Line Subarea Divisions At:	1	385

Correlation	10	· 12
10	1.000	
12	0.707	1.000

Channels	10	12
Mean	2.7514E+02	2.7500E+02
Standard Deviation	1.7298E-01	2.7871E-01
Total Points	154000.	154000.

## 35° Depression

Pixe]	L Subarea	a Divisions	s At:	123	523
Line	Subarea	Divisions	At:	1	211

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 Correlation
 10
 12

 10
 1.000
 12

 12
 0.786
 1.000

Channels	10	12
Mean	2.7515E+02	2.7498E+02
Standard Deviation	2.0678E-01	3.4865E-01
Total Points	84400.	84400.

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#### MICHIGAN WINTER SCENE - CITY

Ellipse Statistics

Spectral Bands: 3.5 - 3.9 μm 4.5 - 5.5 μm 9.0 - 11.4 μm

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Threshold = Mean + 0.35  $\sigma$ Wavelength =  $4.5 - 5.5 \mu m$ Mean = 275.15 Kelvin  $\sigma = 0.23$  Kelvin

197 TOTAL NUMBER OF ELLIPTICAL AREAS -

250.0

300.0

400.0

500.0

500.0

200.0 10

250.0 10

300.0 TO

400.0 10

OVER

1018 FEATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

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BY SHAPE BY PERIMETER FREQUENCY METERS FREQUENCY SHAPE FACTOR FEET 0.0 TU 1.0 0 0 10 7 0 10 22 ۵ 7 10 22 10 32 0 1.0 TU 1.1 J 10 39 0 1.1 10 1.2 2 10 10 12 35 10 ٩٣ 1,2 10 1.3 12 12 TO 14 TO 39 10 14 11 1,3 10 1,4 7 52 16 45 10 ۵ 1.4 10 1.5 9 16 10 17 52 10 55 18 15 8 1,5 10 1.6 17 10 20 55 TO 65 24 1.6 10 1.7 25 10 52 65 TC 72 29 1,7 10 1.8 29 24. 72 10 78 0 55.10 24 10 78 10 85 1,8 10 1.9 14 26 16 1.9 10 2.0 12 85 10 91 10 26 10 36 2.0 10 2.4 44 59 10 30 91 10 98 11 2.4 10 2.6 13 30 10 32 98 TO 104 1 2.6 10 2.8 4 32 10 39 104 TO 127 25 39 10 127 10 2.8 10 3.0 45 147 11 6 55 147 TO 180 3,0 10 3.5 Ŷ 45 10 11 5 2 3.5 TU 4.0 55 10 71 180 10 535 5 4.0 10 4.5 328 71 10 100 525 10 10 OVER 4.5 B OVER 100 OVEN 328 18



## CITY - PRE-DAWN

#### DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	BY	AREA
SQUARE METE	RS	FREDUENC
8.0 TO	10.0	3
10.0 10	15.0	5
. 15.0 TO	20.0	0
20.0 TD	25.0	n
25.0 tu	30.0	0
30.0 TU	35.0	0
35.0 TU	40.0	0
40.0 TO	45.0	õ
45.0 TO	50.0	ő
50.0 TO	75.0	ő
75.0 TO	100.0	ő
100.0 10	150.0	ő
150.0 10	200.0	ň
200.0 TI	250.0	0
250.0 10	300-0	ő
300.0 TO	400.0	0
400.0 TI	500.0	Ň
OVER	500.0	Õ

Threshold = Mean + 2.87  $\sigma$ Wavelength = 4.5 - 5.5  $\mu$ m Mean = 275.15 Kelvin  $\sigma$  = 0.23 Kelvin

TOTAL NUMBER OF ELLIPTICAL AREAS -

360 FLATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSD RECOGNIZED

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HY PERIMETER					BY SHAPE		
METER	15	FELT		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 TD	7	0 TO	22	0	0.0 10 1.0	٥	
7 10	10	22 TD	35	0	1.0 TO 1.1	Ó	
10 10	12	37 10	39	ō	1 1 10 1 2	ŏ	
01 51	14	39 TO	45	ō		0	
14 10	16	45 10	52	õ		0	
16 10	17	52 10	55	Ň			
17 10	20	55 TO	45	2		1	
20 10	22	45 10	73	2	1,5 10 1,6	U	
22 10	2/1 -	73 10	76	2	1.6 10 1.7	Ç	
	2.		10	v	1.7 10 1.8	1	
	<i>с</i> 0		85	1	1,8 TU 1,9	1	
20 10	85	85 T()	91	1	1.9 10 2.0	0	
28 10	30	91 10	48	1	2.0 10 2.4	5	
50 TO	32	96 10	104	0	2.4 10 2.6	ő	
0T 58	39	104 TO	127	0	2.6 10 2.8	ŏ	
39 10	45	127 10	147	ň		ů	
45 10	55	147 TO	180	ů A		0	
55 10	71	180 10	212	ŏ	3.0 (1) 3.3	9	
71 10	100	212 TO	128	~		() ()	
nviu	100	E 3F - T() 	570	U .	4,0 10 4,5	0	
UTEN	100	UVER	240	0	OVER 4.5	0	

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## CITY - PRE-DAWN

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	8 Y	AREA
SQUARE METE	R 8	FREQUENCY
8.0 TO	10.0	36
10.0 TG	15.0	56
15.0 TU	20.0	36
20.0 TU	25.0	40
25.0 10	30.0	13
30.0 10	35.0	19
35.0 TO	40.0	12
40.0 TU	45.0	8
45.0 TU	50.0	3
50.0 T()	75.0	17
75.0 10	100.0	12
100.0 10	150.0	12
150.0 TO	0.015	4
200.0 10	250.0	5
250.0 TU	300.0	1
300.0 T()	400.0	5
400.0 TO	500.0	0
OVER	500.0	6

Threshold = Mean + 0.50  $\sigma$ Wavelength = 9.0 - 11.4  $\sigma$ m Mean = 275.07 Kelvin  $\sigma$  = 0.39 Kelvin

TOTAL NUMBER OF ELLIPTICAL AREAS -

602 FEATURES WITH AREAS LESS THAN 8.00 SD. METERS WERE ALSO RECOGNIZED

282

BY PERIMETER BY SHAPE METERS FEET FREQUENCY SHAPE FACTOR FREQUENCY 0 TO 22 72 7 0 10 0 0.0 TU 1.0 2 7 10 1.0 10 1.1 10 01 55 1 0 32 TO 39 TO 39 45 10 10 12 1.1 10 1.2 1 2 15 10 14 16 1.2 10 1.3 20 14 10 16 45 10 52 Ó 1.3 TO 1.4 18 57 TO 55 TO 55 65 72 16 10 17 27 .4 10 1.5 11 1 17 10 20 27 1.5 TO 1.6 21 01 05 01 55 22 65 10 13 1.6 10 1.7 2% 24 72 10 78 10 0 1.7 1.8 28 24 10 1.9 26 78 10 1.8 10 85 15 21 26 10 85 85 10 91 9 10 2.0 17 18 28 10 30 91 10 28 2.0 10 2.4 51 52 30 10 98 10 32 104 2.4 10 2.6 2 16 32 10 6 10 2.8 34 104 TH 127 42 2 16 127 10 39 10 45 147 15 2.A TO 3.0 3 45 10 55 10 55 71 147 10 180 24 3.0 10 3.5 15 180 10 232 12 3.5 T(1 4.0 5 21 25 4. N TU 4.5 71 10 100 232 TO 328 1 328 DVER 100 **OVER** OVER 4.5 8

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## CITY - PRE-DAWN

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

BY AREA SQUARE NETERS FREQUENCY 8.0 TD 10.0 0 10.0 TD 15.0 Ó 15.0 TO 20.0 1 20.0 10 25.0 25.0 TU \$0.0 0 30.0 10 35.0 Ô 35.0 TO 40.0 0 40.0 T0 45.0 0 45.0 TH 50.0 0 50.0 TO 75.0 0 75.0 TO 100.0 0 100.0 10 150.0 0 150.0 10 200.0 1 250.0 200.0 10 0 250.0 10 300.0 0 300.0 10 400.0 0 400.0 TO OVER 500.0 ٥ 500.0 2

Threshold = Mean + 2.03  $\sigma$ Wavelength = 9.0 - 11.4  $\mu$ m Mean = 275.04 Kelvin  $\sigma$  = 0.39 Kelvin ista di seconda di seco

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TOTAL NUMBER OF ELLIPTICAL AREAS =

15 FEATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

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BY SHAPE BY PERIMETER METERS FFET FREQUENCY SHAPE FACTUR FREQUENCY 0.0 TO 1.0 0 TO 0 0 TO 7 0 22 7 10 10 55 IU 32 1.5 TO 1.1 0 Û. 1.1 10 1.2 10 TO 12 32 TO 39 0 0 15 10 14 39 TU 45 0 1.2 TU 1.3 0 14 10 16 45 TU 52 0 1.3 TO 1.4 52 TO 55 TO 65 TU 1.4 10 1.5 55 16 10 17 0 1.5 TO 1.6 17 10 20 65 0 55 TU 1.7 20 10 72 1 1.6 72 TU 22 10 24 78 0 1.7 TO 1.8 ٥ 24 10 26 78 10 85 0 1.8 10 1.9 ٥ 85 TU τU 26 TO 28 41 1.9 2.0 1 10 2.4 25 10 91 10 98 2.0 30 0 1 2.4 10 2.6 98 TO 30 TO 32 104 0 TO 2.8 32 10 39 104 TO 151 0 6,5 0 2.8 10 3.0 39 10 45 127 10 147 0 ۸ 55 147 180 0 3.0 10 3.5 15 10 T0 71 3.5 10 4.0 535 55 10 180 TO 0 4,0 10 4,5 71 10 328 0 100 232 TH 0 OVER 4.5 OVER 100 DVER 328 3 ۵



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#### CITY - NOON

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	8 Y	AREA
SQUARE NETER	29	FREQUENCY
8.0 TO	10.0	21
10,0 TO	15.0	26
15.0 10	20.0	-13
20.0 10	25.0	8
25.0 TU	30.0	2
30.0 TO	35.0	6
35.0 70	40.0	6
40.0 TO	45.0	Ś
45.0 TO	50.0	5
50.0 TO	75.0	11
75.0 TO	100.0	
100.0 10	150.0	5
150.0 TO	200.0	4
200.0 10	250.0	1
250.0 10	300.0	ż
300.0 TO	400.0	ż
400.0 TO	500-0	ō
OVER	500.0	5

TOTAL NUMBER OF ELLIPTICAL AREAS = 127

BY PERIMETER

259 FLATURES WITH AREAS LESS THAN 8.00 SQ. HETERS WERE ALSO RECUGNIZED

BY SHAPE

Threshold = Mean + 2.00  $\sigma$ Wavelength = 3.5 - 3.9  $\mu$ m

Mean = 283.80 Kelvin

 $\sigma$  = 6.21 Kelvin

NETER	3	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 TO	7	0 TU	55	0	0.0 10 1.0	0
7 10	10	22 10	32	0	1.0 TO 1.1	0
10 10	12	32 TO	39	0	1.1 10 1.2	2
12 10	14	39 TO	45	Ś	1.2 10 1.3	7
14 TD	16	45 10	52	õ	1.3 TO 1.4	4
16 10	17	52 10	55	10	1.4 10 1.5	7
17 10	20	55 10	65	19	1.5 10 1.6	14
20 10	22	65 TO	72	9	1.5 10 1.7	12
22 10	24	. 72 10	78	0	1.7 70 1.8	50
24 TO	26	78 10	85	7	1.8 10 1.9	<b>9</b>
26 TO	28	85 TO	91	6	0.5 07 9.1	8
28 TO	30	91 10	98	5	2.0 10 2.4	20
30 10	32	98 TO	104	ō	2.4 10 2.6	5
32 10	39	104 TO	127	13	2.6 10 2.8	ź
39 10	45	127 10	147	9	2.8 TO 3.0	ž
45 10	55	147 10	180	13	3.0 10 3.5	7
55 10	71	180 TO	212		3.5 10 4.0	4
71 10	100	232 70	328	ģ	4.0 TO 4.5	2
OVER	100	<b>ÖYER</b>	328	13 '	OVER 4.5	- Z



# CITY - NOON

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	87	ARFA	Threshold = Mean + 3.50 $\sigma$		
SQUARE METE	RS	FREQUENCY	Wavelength = 3.5 - 3.9 µm		
6.0 TO 10.0 TO 15.0 TO 20.0 TO 25.0 TO 30.0 TO 35.0 TO 40.0 TO 50.0 TO 50.0 TO 100.0 TO 100.0 TO 200.0 T	10.0 15.0 20.0 25.0 30.0 35.0 40.0 50.0 75.0 100.0 250.0 300.0 250.0 300.0 500.0	2 7 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Mean = 283.80 Kelvin σ = 6.21 Kelvin		
	• •				

TOTAL NUMBER OF ELLIPTICAL AREAS # 24

35 FEATURES WITH AREAS LESS THAN 8,00 SQ. METERS WERE ALSO RECOGNIZED

BY PERIMETER					TER	8	BY SHAPE		
ME	TER	9	F	EET		FREQUENCY	SHAPE FAC	TUR FREQUENCY	
0	ta.	7	0	<b>1</b> 0	25	0	0.0 TO 1.	.0 0	
7	10	10	55	10	32	0	1.0 TO 1.	.1 0	
10	TO -	12	32	TO	39	0	1.1 10 1	.2 1	
12	10	14	39	τo	45	0	1.7 10 1	.3 0	
14	10	16	45	ŧο –	52	0	1.3 TU 1	.4 5	
16	<b>T</b> O	17	52	τo	55	5	1.4 TO 1	.5 3	
17	tn -	20	55	10	65	3	1.5 10 1	.6 2	
20	TO .	22	65	10	72	1	1.6 TO 1	.7 2	
22	10	24	• 12	to	76	Ö	1.7 10 1	.8 3	
24	10	56	78	10	85	· 1	1.8 10 1	.9 2	
26	<b>T</b> O	28	85	τu	91	ĩ	1.9 10 2	0 1	
28	10	30	91	TO	98	1	5 01 0.5	4 3	
30	10	32	<b>Q</b> B	t0	104	ò	2.4 10 2	.6 0	
32	τo	39	104	10	127	0	2.01 9.5	.8 1	
39	<b>T</b> ()	45	127	10	147	4	2 A TO 3	.0 0	
45	10	55	147	T ()	180	4	3 0 70 3	.5 0	
55	10	71	180	10	232	1	3.5 10 4	.0 1	
71	10	100	232	TO	328	3	4.0 TO 4	5 0	
0	/Ł R	100	ÖV	FR	328	ō	OVER 4	.5 0	



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## CITY - NOON DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		BY	AREA
SQUARE H	ETERS		FREQUENCY
8.0 10	) 10.0		17
10.0 TE	) 15.0		31
15.0 TC	0.05 (		19
20.0 TC	) 25.0		17
25.0 TO	) 30.0		6
30.0 TO	35.0		o
35.0 T(	) 40.0		4
40.0 TO	) 45.0		7
45.0 TU	) 50.0		4
50.0 T(	1 75.0		12
75.0 10	) 100.0		7
100.0 T(	150.0		4
150.0 10	200.0		3
200.0 TI	) 250.0		3
250.0 Tt	300.0		0
300.0 T(	) 400.0		0
400.0 TO	500.0		0
OVE	8 500.0		5

Threshold = Mean + 2.53  $\sigma$ Wavelength = 4.5 - 5.5  $\mu$ m Mean = 278.05 Kelvin  $\sigma$  = 2.04 Kelvin

TOTAL NUMBER OF ELLIPTICAL AREAS = 148

230 FEATURES WITH AREAS LESS THAN 8.00 SR. METERS WERE ALSO RECOGNIZED

UT PERIMETER					BY SHAPE		
METER	9	FEET		FREQUENCY	SHAPE FACTUR	FREQUENCY	
<b>0 1</b> 0	7	0 TH	22	0	0.0 TO 1.0	2	
7 10	10	55 IO	32	0	1.0 TO 1.1	0	
10 TO	12	32 TO	39	O	1.1 TO 1.2	0	
12 10	14	39 10	45	1	1.2 10 1.3	5	
14 10	16	45 YO	52	0	1.3 TO 1.4	4	
16 10	17	52 10	55	12	1.4 TO 1.5	7	
17 TO	20	55 70	65	11	1.5 70 1.6	32	
20 10	22	65 TO	72	19	1.6 TO 1.7	7	
<b>55 1</b> 0	24	72 10	78	* 0	1.7 10 1.8	17	
24 10	- 26 '	78 TO	85	13	1.8 T() 1.9	8	
26 10	28	85 TO	91	5	1.9 TO 2.0	5	
28 TU	30	91 TO	98	11	2.0 TO 2.4	30	
30 TO	32	98 10	104	ō	2.4 10 2.6	7	
32 TO	39	104 TO	127	16	5.6 TU 2.8	5	
39 TO	45	127 10	147	13	2.8 TO 3.0	7	
45 TU	55	147 TO	180	16	3.1 10 3.5	4	
55 10	71	160 TO	232	11	3.5 TO 4.0	3	
71 10	100	232 10	328	10	4.0 TO 4.5	1	
OVER	100	OVER	328	10 '	OVER 4.5	4	


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### CITY - NOON DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	BY	AREA
SQUARE M	ETFRS	FREQUENCY
8.0 TU	10.0	5
10.0 10	15.0	Š
15.0 70	20.0	Ä
20.0 10	25.0	2
25.0 TO	30.0	2
30.0 TO	35,0	2
35,0 10	40,0	3
40.0 TO	45.0	5
45.0 10	50.0	2
50.0 TO	75_0	1
75.N TU	100.0	1
100.0 10	150.0	1
150.0 TU	200.0	0
500.0 IC	250.0	0
250.0 TO	300.0	0
300.0 10	0 400.0	0
400.0 10	) 500.0	Ó
OVER	500.0	0

Threshold = Mean + 3.29  $\sigma$ Wavelength = 4.5 - 5.5  $\mu$ m Mean = 278.05 Kelvin  $\sigma$  = 2.04 Kelvin taihate aki dhaadhataa aaraada dadda diidhiddiidhiddii isaa daha shira ah. aaraan dii fidaha dhaada i

TOTAL NUMBER OF ELLIPTICAL AREAS = 34

109 FEATURES WITH ARFAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

BY PERIMETER				TER	BY SHAPE		
ME	TER	5	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0	10	7	0 T()	22	0	0.0 70 1.0	2
7	10	10	55 IO	32	0	1.0 TU 1.1	0
10	10	12	32 10	39	0	1.1 10 1.2	0
12	10	14	39 10	45	3	1.2 TO 1.3	ź
14	10	16	45 10	52	ī	1.3 10 1.4	5
16	10	17	52 10	54	5	1.4 10 1.5	Ś
17	10	20	55 TU	65	š	1.5 10 1.6	Å
20	10	62	65 10	72	Ĩ	1-6 10 1-7	2
22	TO .	24 .	72 10	78	0	1.7 10 1.8	ĩ
24	TO	26	78 10	85	ž	1 8 TO 1.9	;
26	in.	28	85 10	91	2	1.9 10 2.0	4
28	10	30	91 10	98	Ę	2 0 10 2 4	ĩ
30	τn	ŝž	98 TO	104	õ	2 4 10 2.6	õ
12	10	10	104 10	127	u u		0
19	to	45	127 10	4 # 7	1		ů
<u> </u>	10	55	107 10	180			ő
5	TO.	71		210	2		0
	10	100	100 IU 212 TO	- 16	2		0
1	111	100	() Se ()	370	· ·		0
0.4	1.1	100	UVER	570	Q	1/VER 4.5	0



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# CITY - NOON DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

.

	θY	AREA	Threshold = Mean + 2.82 $\sigma$
SQUARE METE	RS	FREQUENCY	Wavelength ≈ 9.0 - 11.4 µm
8.0 T() 10.0 T() 15.0 T() 20.0 T() 25.0 T() 35.0 T() 35.0 T() 40.0 T() 45.0 T() 59.0 T() 75.0 T() 100.0 T() 200.0 T() 200.0 T() 300.0 T()	10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0 150.0 250.0 300.0 40.0 40.0	17 34 19 13 4 6 3 4 3 7 2 3 1 1 0	Mcan = 279.05 Kelvin σ = 2.76 Kelvin
400.0 TO 07FR	500.0	6 1	

TOTAL NUMBER OF ELLIPTICAL AREAS = 119

207 FEATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

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BY PERIMETER	
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BY PERIMETER					BY SHAPE		
METER	8	FELT		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 10	7	0 TO	55	0	0.0 TO 1.0	o ·	
7 10	10	55 10	32	0	1.0 TO 1.1	Õ	
10 10	12	32 10	39	0	1.1 10 1.2	ō	
15 10	14	39 TO	45	3	1.2 10 1.3	ĩ	
14 10	16	45 TO	52	0	1.3 10 1.4	á	
16 TO	17	52 TO	55	7	1.4 10 1.5	Ś	
17 10	20	55 10	65	18	15 10 1 6	12	
CT 05	22	65 TO	72	7	1 6 10 1 7	10	
22 10	24 .	72 10	78	ò	1 7 10 1 8	10	
24 10	20	78 TO	85	16	18 70 19	10	
20 10	58	85 10	91	8	1 9 70 2 0	7	
01 8S	30	91 TO	98	6		24	
30 10	32	98 TU	104	ő		6 U	
35 10	39	104 10	127	14	5 4 70 2.0		
39 TO	45	127 10	1 # 7	5		11	
45 10	55	147 10	180			2	
55 10	71	180 10	212	۲ د م	3.0 10 3.3		
71 10	100	343 10	228	<b>1</b> 0	5.5 10 4.0	e	
	100	E26 111	טיקוב מריד	4 ·	4.0 TO 4.5	1	
UTEN	100	114.1 11	م ہے ج	r.	OVER 4,5	1	



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# CITY - NOON

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DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	ĐY	ARFA	Threshold = Mean + 3.57 σ
SQUARE METE	R S	FREQUENCY	Wavelength = 9.0 - 11.4 µm
8.0 TO 10.0 TO 15.0 TO 20.0 TO 25.0 TO 30.0 TO 35.0 TO 45.0 TO 45.0 TO 50.0 TO 75.0 TO 100.0 TO 100.0 TO 250.0 TO 250.0 TO 300.0 TO	10.0 15.0 20.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0 150.0 200.0 300.0 400.0	5 6 2 5 1 3 1 6 1 1 2 0 0 0 0 0	Mean = 279.05 Kelvin σ = 2.76 Kelvin
OVER	500.0	õ	

TOTAL NUMBER OF ELLIPTICAL AREAS = 29

210 FEATURES WITH AREAS LESS THAN 5.00 SQ. METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPE		
METER	9	FFET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 T 0	7	0 TO	22	0	0.0 T() 1.0	o	
7 TO	10	22 T()	32	Q	1.0 TO 1.1	0	
10 10	12	32 10	39	C	1,1 10 1,2	0	
12 10	14	39 10	45	0	1.2 TO 1.3	0	
14 10	16	45 TO	52	0	1.3 TO'1.4	1	
16 10	17	52 10	55	2	1.4 TO 1.5	0	
17 10	20	55 10	65	4	1.5 10 1.6	5	
20 10	22	65 TO	72	2	1.6 TO 1.7	4	
22 10	24.	77 10	78	ō	1.7 TO 1.8	3	
24 10	26	78 10	A.5	1	1.8 TO 1.9	4	
26 10	28	85 TO	91	1	1.9 10 2.0	2	
28 10	30	91 10	98	4	2.0 10 2.4	7	
	12	98 10	104	0	2 4 10 2.6	2	
32 70	10	10/1 10	1 2 7	7	2.6 10 2.8	0	
30 10	116	107 70	1/17	2	2.8 10 3.0	0	
97 (C) 46 TO	6	1/17 10	100	2	3.0 10 5.5	1	
	7.	147 10	212	5	3.5 10 4.0	. 0	
	11		2,72	5		0	
/1 10	100	636 10	320	č		ő	
UVER	100	UVER	250	0	1)Y( 44)	Ŷ	



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SQUARE METERS	FREQUENCY
8.0 T0   10.0     10.0 T0   15.0     15.0 T0   20.0     20.0 T0   25.0     25.0 T0   30.0     30.0 T0   35.0	11 27 8 7 3 4
35.0 TO   40.0     40.0 TO   45.0     45.0 TO   50.0     50.0 TO   50.0     50.0 TO   100.0     100.0 TO   150.0     150.0 TO   200.0     200.0 TO   250.0     250.0 TO   200.0     300.0 TO   400.0     40.0 TO   500.0     40.0 TO   500.0	3 0 7 3 5 2 0 0 0 0 1

Threshold = Mean + 2.00  $\sigma$ Wavelength = 4.5 - 5.5  $\mu$ m Mean = 275.60 Kelvin  $\sigma$  = 0.35 Kelvin տաներաներին էլերանաներություն են հանձնաներան անձնաներերություն անձնաներություններությունները համանաներին են ան

TOTAL NUMBER OF ELLIPTICAL AREAS = 85

114 FEATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPE		
METER	9	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 10	7	0 TO	22	0	0.0 TU 1.0	0	
7 10	10	22 TO	35	0	1.0 TO 1.1	ò	
10 TO	12	32 10	39	0	1.1 10 1.2	ĩ	
15 LO	14	39 T()	45	5	1.2 10 1.3	7	
14 10	16	45 10	52	õ	1 3 10 1.4	7	
16 10	17	52 10	55	Å	1 4 10 1 5	,	
17 10	20	55 TU	65	11		10	
20 10	22	65 TO	72	10	4 4 T() 4 7	10	
22 10	24	72 10	78	16		0	
74 10	26		95	Š		15	
26 10	24		0.5	. (	1.8 10 1.9	3	
20 10	20	07 (1)	41	8	1.9 10 2.0	4	
	30	41 10	48	3	<b>2,</b> 0 TO 2,4	11	
50 10	32	98 TO	104	o	2,4 TO 2,6	0	
35 10	39	104 TO	127	5	2.6 10 2.8	3	
39 10	45	127 10	147	4	2.8 TO 5.0	. 2	
45 TD	55	147 10	100	4	3.0 10 3.5	1	
55 to	71	180 TH	535	3	3.5 TU 4.0	1	
71 10	100	232 TO	328	7	4-0 10 4-5	i	
UVER	100	OVER	328	8	OVER 4.5	2	



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### CITY - SUNSET DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	B۲	AREA	Threshold = Mean + 3.71 o
SQUARE HETF	RS	FREQUENCY	Wavelength = 4.5 - 5.5 µm
			Mean = 275.60 Kelvin
8.0 TO	10.0	3	
10.0 70	15.0	1	o = 0.35 Kelvin
15,0 10	20.0	ž	
2C.0 TO	25.0	2	
25.0 10	30.0	n	
30,0 10	35.0	õ	
35.0 10	40.0	ů.	
40.0 10	44.0	ŏ	
45.0 TO	50.0	ñ	
50.0 TG	75.0	0	
75.0 TU	100.0	ĩ	
100.0 10	150.0	ò	
150.0 TO	200.0	ĩ	
201.0 10	250.0	0	
250.0 TO	300.0	õ	
300.0 10	400.0	0	
400.0 TO	500-0	õ	
OVER	500.0	ŏ	

TOTAL NUMBER OF ELLIPTICAL AREAS = 10

19 FEATURES WITH AREAS LESS THAN 8.00 SG. METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPE		
METER	3	FFET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
O TC	7	0 T.O	55	5	0.0 10 1.0	0	
7 TU	10	22 TO	32	Û	1.0 TU 1.1	0	
10 10	12	32 10	39	0	1.1 10 1.2	Ó	
12 10	14	39 TO	45	0	1.2 10 1.3	ō	
14 10	16	45 TO	52	O	1.3 TO 1.4	2	
16 10	17	52 10	55	2	1.4 10 1.5	0	
17 10	20	55 TO	65	-	1.5 10 1.6	ž	
20 10	55	65 TO	72	ī	161017	0	
22 10	24	72 10	73	6	1 7 70 1 8	ž	
24 TO	26	78 TO	85	ï	1 8 70 1 9	5	
26 10	20	85 10	91	0	19 10 2.0	6	
28 10	30	91 10	98	0		ò	
30 10	32	96 10	104	ů 0	2 4 10 2 6	Ň	
32 10	34	104 TO	127	ž	2 6 10 2 8	,	
39 10	45	127 10	147	0			
45 10	55	147 10	180	õ		Ň	
5 10	7 1	180 10	212	õ		•	
71 10	100	212 10	1 J L			4	
0116	100	outo	158	1		U	
0124	100	UVER	360	1	U7ER 4.5	0	



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### CITY - SUNSET DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	BY	AREA	Threshold = Mean + 1.69 J
SQUARE HETE	RS	FREQUENCY	Wavelength = 9.0 - 11.1 µm
8.0 TQ 10.0 TQ 15.0 TQ 20.0 TQ 25.0 TQ 30.0 TQ 35.0 TQ 45.0 TQ 50.0 TQ 50.0 TQ 100.0 TQ 150.0 TQ 250.0 TQ 200.0 TQ	10.0 15.0 20.0 30.0 35.0 40.0 50.0 75.0 100.0 150.0 200.0 250.0	8 18 17 5 1 4 6 3 3 1 3	Mean = 275.59 Kelvin o = 0.49 Kelvin
300.0 TO 400.0 TO OVER	400.0 500.0 500.0	1 1 1	
DTAL NUMBER OF EI	LLIPTICAL ARE	\S = 83	

171 FEATURES WITH AREAS LESS THAN 8.00 SD. METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPE		
HETERS	3	FFET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 T O	7	0 T()	55	0	0.0 10 1.0	0	
ריד ל	10	0T 55	32	0	1.0 TU 1.1	Ç	
10 TO	12	35 10	39	0	1.1 TO 1.2	1	
12 TO	14	39 TO	45	7	1.2 10 1.3	7	
14 10	16	45 TO	52	0	1.3 10 1.4	5	
16 TO	17	52 TO	55	Š	1.4 10 1.5	ī	
17 TO	50	55 TO	65	6	1.5 10 1.6	ů	
20 10	55	65 TO	72	ŝ	1.6 10 1.7	10	
07 55	24.	72 10	78	0	1 7 10 1.8	16	
24 10	26	78 TO	85	7	1 A TU 1.9	11	
26 TO	28	85 TU	91	7			
28 TO	30	91 10	96	ц ц	201024	Å	
30 10	32	OB TO	10	0		1/ X	
32 15	39	104 10	127	10	5 4 T() ) A	5	
39 10	45	127 10	1.17	10		1	
45 10	55	147 10	180	5		0	
55 10	71	180 10	212	5	1,0 U J,J	2	
71 10	100	313 10	234	4	3,5 10 4,0	1	
	100	ese 10	370 70	3	4.0 10 4.5	2	
0464	100	OVER	250	11	OVER 4,5	3	

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#1151日の「豊富な経験である」「おようなななない」はないになります。 第15日日本の「豊富な経験である」「おようななない」はないになった。 第15日本の「豊富な経験である」「おようななない」は、「おようなない」は、「おようなない」は、「おようなない」である。

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Contraction (Contraction)

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# CITY - SUNSET DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	BA	AREA	Threshold = Mean + $3.00 \text{ o}$		
SQUARE MET	ERS	FREQUENCY	Wavelength = 9.0 - 11.4 $\mu m$		
8.0 TO 10.0 TO 15.0 TO 20.0 TO 25.0 TO 30.0 TO 40.0 TO	10.0 15.0 20.0 35.0 35.0 40.0 45.0	1 7 2 1 0 1 0	Mean = 275.59 Kelvin σ = 0.49 Kelvin		
45.5 T() 50.0 T() 75.0 T() 100.0 T() 150.0 T() 200.0 T() 250.0 T() 300.0 T() 400.0 T() 0VER	50.0 75.0 100.0 250.0 250.0 300.0 400.; 500.0	0 0 0 0 0 0 0 0 0 0			

TOTAL NUMBER OF ELLIFTICAL AREAS =

BY PERIMETER

28 FEATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

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#### BY SHAPE

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METE	88	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
<b>0</b> 10	7	0 10	55		0.0 70 1.0	0
7 70	10	22 TO	32	Ö	1.0 10 1.1	ů
10 TO	51	32 10	39	Ő	1.1 10 1.2	Ť
15 10	14	39 TO	45	Ó	1.2 10 1.3	ò
14 10	16	45 10	52	0	1 3 10 1.4	ž
16 T.D	17	52 TO	55	1	1.4 10 1.5	ž
17 10	20	55 TÖ	65	4	1.5 10 1.6	ź
CT 05	22	65 TN	77	3	1.6 10 1.7	0
22 10	24.	72 10	78	õ	1 7 10 1 8	ĩ
24 10	26	78 10	Å5	õ	1 A T(1 1 9	i i
26 10	28	85 10	91	2	1.9 10 2.0	ĩ
28 (1)	30	S1 TO	98	ĩ	2.0 10 2.4	i
30 10	32	98 10	104	õ	2.4 10 2.5	
32 10	39	104 7()	127	ĩ	2.6 10 2.8	ŏ
34 10	45	127 10	147	0	2 A T() 3.0	0
45 10	55	147 10	180	õ	<b>X</b> 0 <b>Y</b> () <b>X</b> 5	õ
55 TO	71	180 10	232	à	1.5 10 4.0	ŏ
71 10	100	232 10	328	ō	4 0 10 4.5	ŏ
DVER	100	DVE0	126	ň		v A

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Apply a transmission



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Area: CITY - Midnight (Wavelength =  $4.5 - 5.5 \mu m$ ) Temperature Threshold = Mean +  $1.50 \sigma$ Mean = 275.14 Kelvin Std. Dev. =  $\sigma$  = 0.17 Kelvin

EQUIVALENT ELLIPTICAL AREAS

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# CITY - MIDNIGHT DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

			-		
	BY	ARFA	Threshold = Mean + $1.50$		
SQUARE METI	ENS	FREQUENCY	Wavelength = 4.5 - 5.5 μm		
8.0 10	10.0	24	Mean = 275.14 Kelvin		
10.0 TO 15.0 TO	15.0 20.0	31	$\sigma = 0.17$ Kelvin		
20.0 T() 25.0 T()	25.0	- - 			
30.0 TO	35.0	 R			
40.0 T()	45.0	4			
45.0 TO	50.0 75.0	4 10			
75.0 TU 100.0 TO	100.0	6 3			
150.0 TO 200.0 TO	200.0 250.0	2			
250.0 TO 300.0 TO	300.0	1			
400.0 T()	500,0 500,0	0			
	200.0	3			

TOTAL NUMBER OF ELLIPTICAL AREAS = 137

881 FEATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

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BY PERIMETER					BY SHAPE		
METER	9	FFET		FREQUENCY	SHAPE FACTUR	FREQUENCY	
0 T O	7	0 10	22	0	0.0 TO 1.0	1	
7 10	10	22 10	32	1	1.0 TU 1.1	0	
10 10	51	32 10	39	ō	1.1 10 1.2	0	
01.51	14	39 T()	45	3	1.2 10 1.3	6	
14 10	16	45 TO	52	o	1.3 TU 1.4	5	
16 10	17	52 10	\$5	17	1.4 10 1.5	4	
17 10	20	55 10	55	11	1.5 TU 1.6	16	
20 10	22	65 10	72	- ÷	1 6 10 1.7		
22 10	24	72 10	78	0	17 TO 1.8	15	
24 10	26	78 TO	A5	15	1 A TO 1.9	ι,	
26 10	28	85 TO	01	7		11	
26 10	30	91 10	98	7	2 0 10 2.4	21	
30 10	12	98 10	104		<b>5</b> 4 <b>1</b> 0 <b>2</b> 4	10	
12 10	10	10/1 10	1.27	14	7.4 10 7.0 7.4 TO 7.0	1.7	
39 10	45	127 10	147	1 7		4	
45 10	66		147	12		4	
40 10	73	. 14/ 111	190	10	3.0 10 3.5	2	
55 10	/1	170 10	252	5	3.5 (0 4.0	5	
71 10	100	52 10	358	12	4.0 10 4.5	2	
OVER	100	OVER	328	16	OVER 4,5	5	



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1999年 - 東部会

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### CITY - MIDNIGHT

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्यत्र हे ता कहीत पत्र कि त्या कर कि <mark>विक्रियत्र के किसे करता कि अधि कि तो कि सिद्धि कि कि कि कि कि कि कि कि के क</mark>ि कि के कि

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	BA	AREA	Threshold = Mean + $3.63$ c		
SQUARE METE	RS	FREQUENCY	Wavelength = 4.5 - 5.5 µm		
8.0 TO 10.0 T() 15.0 TO 20.0 Tu	10.0 15.0 20.0 25.0	6 3 4 3	Mean = 275.14 Kelvin σ = 0.17 Kelvin		
25.0 T() 30.0 T() 35.0 T() 40.0 T() 45.0 T()	30.0 35.0 40.0 45.0	0 1 0 0			
50.0 TU 75.0 TO 100.0 TO 150.0 TO	75.0 100.0 150.0	0 0 0			
200.0 T() 250.0 T() 300.0 T() 400.0 TO	250.0 300.0 400.0 500.0	0 0 0 0			
NVER TAL NUMBER OF E	500.0 LLIPTICAL ARE	0 AS = 17			

TOTAL NUMBER OF ELLIPTICAL AREAS =

106 FEATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPE		
METERS		FEET		FREQUENCY	SHAPE FACTUR	FREQUENCY	
0 T()	7	0 10	52	0	0.0 TU 1.0	0	
7 10	10	22 10	32	0	1.0 TO 1.1	0	
10 TO	12	32 10	39	0	1.1 TO 1.2	0	
12 10	14	39 10	45	2	1.2 TU 1.3	2	
14 TO	16	45 TO	52	0	1.3 TO 1.4	0	
16 10	17	52 TO	55	1	1.4 TO 1.5	1	
17 TO	20	55 TU	65	3	1.5 TO 1.6	2	
20 10	22	65 TU	72	1	1.6 10 1.7	0	
22 10	24	72 10	78	ō	1.7 TO 1.8	5	
24 10	56 .	78 Tu	85	1	1.8 TO 1.9	S	
26 10	28	85 10	91	Š	1.9 10 2.0	0	
28 10	30	91 TO	98	0	2.0 TO 2.4	0	
30 10	32	98 10	104	Ó	2.4 TO 2.6	2	
32 10	39	104 10	127	0	2.6 10 2.8	0	
39 10	45	127 TU	147	1	2.8 10 3.0	1	
45 TO	55	147 10	i A O	2	3.0 TO 3.5	2	
55 10	71	180 TO	232	1	3,5 10 4.0	0	
71 10	100	232 10	328	ō	4.0 TO 4.5	0	
OVER	100	OVER	328	0 1	OVER 4.5	0	

ERIM P 323 P 523 P123 L**1** 1659 ft 1 L 384 - 1750 ft -Area: CITY - Midnight (Wavelength = 9.0 - 11.4 µm) . Temperature Threshold = Mean + 1.50  $\sigma$ Mean = 275.00 Kelvin Std. Dev. =  $\sigma$  = 0.28 Kelvin EQUIVALENT ELLIPTICAL AREAS Ċ 3.5-74

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# CITY - MIDNIGHT

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	84	AREA	Threshold = Mean + 1.50 $\sigma$
SQUARE MET	ERS	FREQUENCY	Wavelength = 9.0 - 11.4 µm
8.0 TU 10.0 TO 55.0 TO 20.0 TU 25.3 TU 30.0 TU 35.0 TU 40.0 TO 45.0 TU 45.0 TU 75.0 TU 106.0 TU 106.0 TU 200.0 TU 250.0 TU 250.0 TO	10.0 :5.0 25.0 30.0 35.0 40.0 45.0 50.0 100.0 150.0 200.0 300.0 400.0	22 32 16 9 6 11 4 3 7 5 4 1 2 2 0	Mean = 275.00 Kelvin σ = 0.28 Kelvin
QVER	500.0	5	

TOTAL NUMBER OF ELLIPTICAL AREAS = 132

354 FLATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

AY PERIMETER					BY SHAPE		
METE	ĸs	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 10	7	0 TO	22	0	0.0 TO 1.0	0	
7 10	10	CT 55	32	0	1.0 10 1.1	ň	
10 TO	12	32 10	39	0	1.1 10 1.2	ő	
1ā TO	14	39 10	45	11	1.2 10 1.4	12	
14 TO	15	45 T()	52	0	1.3 TO 1.4		
16 TO	17	52 10	55	6	1 (I T() 1 5	<b>7</b>	
17 10	20	55 T()	65	13	1 5 10 1 6	10	
01 05	22	65 TO	72 .	15		10	
22 10	24 .	72 TO	78	ō	1 7 10 1 8	15	
24 TO	26	78 70	85	Š	1.0 1.0	17	
01 65	20	85 10	91	á	1,6 10 1,4	11	
28 10	30	91 10	98	и и		č	
30 10	32	OT AP	164	-		96	
32 10	19	104 10	127	21	2.4 10 2.0	0	
39 70	45	127 10	147			4	
45 10	55	147 10	180	12		5	
55 10	71	180 10	212	1.3	3.0 10 3.5	4	
71 10	100	חל כוכ	124	16	3.5 10 4.0	2	
	100	E 2 C 10	370	, , , , , , , , , , , , , , , , , , ,	4.0 10 4,5	1	
υτιπ	100		120	17	OVER # S	"	

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### CITY - MIDNIGHT

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	HY	AREA	Threshold = Mean + 2.50 (		
SQUARE METE	84.	FREQUENCY	Wavelength = 9.0 - 11.4 µm		
8.0 TU 10.0 TO 15.0 TO 20.0 TO 25.0 TO 30.0 TO 35.0 TO 40.0 TO 45.0 TO 50.0 TO 50.0 TO 150.0 TO 150.0 TO 200.0 TO 250.0 TO 300.0 TO 300.0 TO 400.0 TO 400.0 TO	10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0 150.0 250.0 300.0 400.0 500.0		Mean = 275.00 Kelvin o = 0.28 Kelvin		
(**	200.0	-			

TOTAL NUMBER OF ELLIPTICAL AREAS = 13

37 FEATURES WITH AREAS LESS THAN 8.00 SQ. HETERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPE		
METER	9	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 10	7	0 TO	22	0	0.0 TU 1.0	0	
7 10	10	22 10	32	0	1.0 TO 1.1	0	
10 10	12	32 10	39	Ó	1.1 10 1.2	1	
12 10	10	39 10	45	0	1.2 TO 1.3	1	
14 10	16	45 10	52	Û	1.3 TU 1.4	1	
16 10	17	52 10	55	1	1.4 10 1.5	0	
17 10	20	55 10	65	4	1.5 TO 1.6	2	
20 10	22	65 T()	72	2	1.6 10 1.7	1	
22 10	24	72 10	78	ō	1.7 TO 1.8	3	
24 10	26	78 10	85	1	1 A TO 1.7	0	
26 10	28	85 10	91	0	1.9 TU 2.0	5	
28 TU	30	91 TD	39	0	2.0 10 2.4	1	
30 TO	32	98 10	104	0	2.4 TO 2.6	0	
32 to	19	104 10	127	2	2.6 10 2.8	0	
39 10	45	127 10	147	õ	2.8 10 3.0	. 0	
45 TO	55	147 10	180	1	3.0 10 3,5	1	
55 TO	71	180 TO	232	ō	3.5 10 4.0	0	
71 10	100	212 10	328	ō	4.0 10 4.5	0	
OVER	106	DVER	126	ż'	OVER 4.5	0	

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### MICHIGAN WINTER SCENE - CITY

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Power Spectra

Spectral Bands: 3.5 - 3.9 μm 4.5 - 5.5 μm 9.0 - 11.4 μm

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#### MICHIGAN WINTER SCENE - CONIFERS

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Histograms\*

Spectral Bands: 3.5 - 3.9 μm 4.5 - 5.5 μm 9.0 - 11.4 μm

\*Circles define a Gaussian curve with the same mean and standard deviation as the actual histogram. An "S" on some curves indicates saturation. Because of limits on gain settings some values may exist beyond the digital limits of 0 and 255, the digital dynamic range of the data proc ssing.



















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## MICHIGAN WINTER SCENE - CONIFERS

Means and Standard Deviations for Spectral Bands Correlations Between Spectral Bands

Spectral Bands:	Channel 8:	3.5 - 3.9 µm (°K)
	Channel 10:	4.5 - 5.5 (Pa (PK)
	Channel 12:	9.0 ~ 11.4 µm (°K)



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## STATISTICS OF THE CONIFERS (PRE-DAWN) SCENE

Number of Subregions:	1
Line Increment Used:	1
Pixel Increment Used:	1
Correlation Channels:	10 (4.5 - 5.5 μm) 12 (9.0 - 11.4 μm)

## 90° Depression

-	Pixel Subarea Divisions At:	123	523
	Line Subarea Divisions At:	1	385

Correlation	10	12
10	1.000	
12	0.658	1.000

Channels	10	12
Mean	2.7486E+02	2.7466E+02
Standard Deviation	9.7860E-02	1.7563E-01
Totel Points	154000.	154000.

## 35° Depression

Pixel	Subarea	Divisions	At:	123	523
Line S	Subarea	Divisions	At:	1	211

Correlation	10	12
10	1.000	
12	0.553	1.000

Channels	10	12
Mean	2.7483E+02	2.7466E+02
Standard Deviation	7.0218E-02	1.3288E-01
Total Points	84400.	84400.

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#### STATISTICS OF THE CONIFERS (NOON) SCENE

Number of Subregions: 1 Line Increment Used: 1 Pixel Increment Used: 1 Correlation Channels: 8 (3.5 - 3.9 µm) 10 (4.5 - 5.5 µm) 12 (9.0 - 11.4 µm)

#### 90° Depression

Pixel	. Subarea	Divisions	At:	123	523
Line	Subarea	Divisions A	t:	1	385

Correlation	8	10	12
8	1.000		
10	0.169	1.000	
12	0.188	0.611	1.000

Channels	8	10	12
Mean	2.8177E+02	2.7758E+02	2.7868E+02
Standard Deviation	3.6689E+00	6.3410E-01	9.3872E-01
Total Points	153200.	153200.	153200,

## 35° Depression

Pixel Subarea Divisions At: 123 523 Line Subarea Divisions At: 1 211

Correlation	8	10	12
8	1.000		
10	0.206	1.000	
12	0.228	0.640	<b>1.00</b> 0

Channels	8	10	12
Mean	2.8505E+02	2.7869E+02	2.8003E+02
Standard Deviation	2.8419E+00	5.3734E-01	8.3943E-01
Total Points	83600.	83600.	83600.

## STATISTICS OF THE CONFIERS (SUNSET) SCENE

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10 (4.5 - 5.5 μm)
12 (9.0 - 11.4 µm)

# 90° Depression

Pixel Subarea Divisions At:	123	523
Line Subarea Divisions At:	1	385

Correlation	10	12
10	1.000	
12	0.768	1.000

Channels	10	12
Mean	2.7540E+02	2.7544E+02
Standard Deviation	1.6557E-01	2.6030E-01
Total Points	154000.	154000.

# 35° Depression

Pixel Subare	a Divisions At:	123	523
Line Subarea	Divisions At:	1	211

 Correlation
 10
 12

 10
 1.000
 12

 12
 0.793
 1.000

Channels	10	12
Mean	2.7543E+02	2.7537E+02
Standard Deviation	1.3133E-01	2.2989E-01
lotal Points	84400.	84400.

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## STATISTICS OF THE CONIFERS (MIDNIGHT) SCENE

Number of Subregions:	1
Line Increment Used:	1
Pixel Increment Used:	1
Correlation Channels:	10 <b>(4.5 - 5.5</b> μm)
	12 (9.0 - 11.4 μm)

## 90° Depression

Pixel Subarea Divisions At:	123	523
Line Subarea Divisions At:	1	385

Correlation	10	12	
10	1.000		
12	0.837	1.000	

Channels	10	12
Mean	2.7498E+02	2.7476E+02
Standard Deviation	<b>1.3947E-01</b>	2.3721E-01
Total Points	154000.	154000.

## 35° Depression

Pixel	. Subarea	a Divisions	At:	123	523
Line	Subarea	Divisions	At:	1	211

Correlation	10	12
30	1.000	
12	0.814	1.000

Channels	10	12
Mean	2.7500E+02	2.7472E+02
Standard Deviation	1.0951E-01	<b>1.9783</b> F-01
Total Points	84400.	84400.

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#### MICHIGAN WINTER SCENE - CONIFERS

Ellipse Statistics

Spectral Bands: 3.5 - 3.9 μm 4.5 - 5.5 μm 9.0 - 11.4 μm isto controctions to static static structure during why should be added by the distribution of the static structure of some static structure of the 
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# CONIFERS (Pre-Dawn) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	βY	AREA	Threshold = Mean + 1.71 o
SQUARE ME	TERS	FREQUENCY	Wavelength = 4.5 - 5.5 $\mu$ m
8.0 TO 10.0 T() 15.0 T() 20.0 T() 25.0 T() 30.0 T() 35.0 T() 40.0 T() 45.0 T()	10.0 15.0 20.0 25.0 35.0 40.0 45.0 50.0	34 45 21 13 5 2 4 0 4	Mean = 274.86 Kelvin σ = 0.10 Kelvin
50.9 TO 75.0 TO 100.0 TU 150.0 TO 200.0 TO 250.0 TO 300.0 TO 400.0 TO UVER	75,0 100,0 150,0 200,0 300,0 400,0 500,0 500,0	2 1 2 0 1 0 1 1	

TOTAL NUNBER OF ELLIPTICAL AREAS = 136

2043 FLATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

o o o Multiceitation. No coloridade la constructione en o diferenza da construction de la construction de la c

BY PERIMETER			BY SHAPE			
METER	9	FEET		FREQUENCY	SHAPE FACTOR	FREQUÊNCY
0 TO	7	e TO	22	0	0.0 TO 1.0	0
7 10	10	01 SS	32	o	1.0 TO 1.1	ò
10 TN	12	32 TO	39	0	1.1 TO 1.2	ž
12 10	14	39 T()	45	9	1.2 10 1.3	9
14 TO	16	45 TO	52	0	1.3 10 1.4	Ś
16 TO	17	52 10	55	18	1.4 TO 1.5	ć
17 10	20	55 10	65	14	15 18 1.6	14
01 05	26	65 TO	72	17		14
22 TO	24	72 10	78	1	17 10 1 8	11
24 10	26	78 10	ÅŠ	15	1 B T() 1 9	
26 TO	28	85 TO	91	11		10
28 10	30	91 10	QA	13	3 0 TO 3 4	10
30 10	32	98 T()	104	'n		33
32 10	19	10/ 10	1 3 7			11
10 10	45	137 70	1.07	18		4
15 70	20		147	10	2.4 10 3.0	ć
65 10		147 10	140	4	3,0 10 3,5	5
33 10	/1	180 10	232	4	3,5 TO 4.0	5
/1 10	100	535 10	358	1 ,	4.0 10 4.5	2
UVER	100	OVFR	328	6	OVER 4.5	1



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CONIFERS (Pre-Dawn) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

BY AREA			Threshold = Mean + 3.25 $\sigma$		
SQUARE MET	'ERS	FREQUENCY	Wavelength = 4.5 - 5.5 µm		
8.0 TU 10.0 TO 15.0 TO 20.0 TO 25.0 TO 30.0 TO 35.0 TO 40.0 TO 45.0 TO 50.0 TO 100.0 TO 150.0 TO 200.0 TO 200.0 TO 200.0 TO	10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0 150.0 200.0 250.0 300.0	REQUENCY 3 7 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Wavelength = 4.5 - 5.5 μm Mean = 274.86 Kelvin σ = 0.10 Kelvin		
400.0 TO OVER	500.0 500.0	0 0			

TOTAL NUMBER OF ELLIPTICAL AREAS =

BY PERIMETER

SI FEATURES WITH AREAS LESS THAN 8.00 SQ. HETERS WERE ALSO RECOGNIZED

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BY SHAPE

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out, and its watched state.

METER	9	FFET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 T O	7	0 T()	22	0	0.0 TU 1.0	0
7 10	10	22 TO	32	0	1.0 TO 1.1	Ō
10 TO	12	32 TO	39	0	1.1 70 1.2	0
15 10	14	39 TO	45	2	1.2 10 1.3	Ż
14 10	16	45 TO	52	ō	1.3 TO 1.4	0
16 TQ	17	52 TO	55	ē	1.4 10 1.5	2
17 10	20	55 TO	65	š	1.5 10 1.6	5
20 10	52	65 10	72	ĩ	1 6 10 1.7	0
55 IU	24	72 10	78	õ	1.7 10 1.8	ž
24 10	- 35	78 10	85	, 2	1.8 TÜ 1.9	1
50 TO	58	85 TO	91	ō	1.7 10 2.0	í
28 10	30	91 10	98	2	2.0 10 2.4	2
30 10	32	98 TO	103	0	2.4 TU 2.6	1
32 10	39	104 TO	127	1	2 6 10 2.8	;
39 17	45	127 10	1 4 7	ò	2 A T() L 0	
45 Tu	55	147 TO	140	ő	3 0 70 3 5	õ
55 10	71	180 TO	212	ů,	151040	ŏ
71 10	100	232 70	128			0
0768	100		1.76	1		ů,
CT CH	1 U U	UVER	240	U	UVER 4.5	0



Area: Conifers (Wavelength = 9.0 - 11.4 µm mperature Threshold = Mean +  $1.56 \sigma$ Mean = 274.66 Kelvin Std. Dev. =  $\sigma$  = 0.18 Kelvin .QUIVALENT ELLIPTICAL AREAS - PRE-DAWN

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CONIFERS (Pre-Dawn) DISTRIBUTION ()F ELLIPTICAL AREAS GREATER THAN THRESHOLD

	84	AREA	Threshold = Mean + $1.56 \text{ o}$
SQUARE HETE	RS	FREQUENCY	Wavelength = 9.0 - 11.4 µm
8.0 TU 10.0 TO 15.0 TO 20.0 TU 25.0 TU 30.0 TU 35.0 TU 40.0 TU 50.0 TU 50.0 TU 50.0 TU	10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0	FREQUENCY 33 48 24 12 4 6 4 4 4 0 5	wavelength = 9.0 ~ 11.4 μm Mean = 274.66 Kelvin σ = 0.18 Kelvin
150.0 TO 150.0 TO 250.0 TO 300.0 TO 400.0 TO OVER	200.0 250.0 300.0 400.0 500.0	2 1 0 1 0	

TOTAL NUMBER OF ELLIPTICAL AREAS = 149

902 FEATURES WITH AREAS LESS THAN 8.00 SO. METERS WERE ALSO RECOGNIZED

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BY PERIMETER			BY SHAPE			
METER	5	FEET		FREQUENCY	SHAPE FACTOR FREQUE	
0 T 0	7	0 10	22	0	0.0 TO 1.0	0
7 10	10	22 10	32	0	1.0 TO 1.1	0
10 TO	12	32 10	39	0	1.1 10 1.2	3
12 10	14	39 T()	45	13	1.2 TO 1.3	17
14 TO	16	45 TO	52	0	1.3 10 1.4	12
16 10	17	52 TO	55	25	1.4 10 1.5	
17 10	20	55 10	65	26	1.5 10 1.6	17
01 05	22	65 10	72	16	1.6 TO 1.7	18
22 10	24	72 TC	78	0	1.7 TO 1.8	19
24 10	26	78 TO	85	11	1.8 TO 1.9	0
26 10	28	85 10	91	6	1 9 TU 2 0	Ś
28 10	30	91 10	98	ž	2.0 TO 2.4	22
30 TO	3,2	98 10	104	2		, ,
32 10	39	104 10	127	16	2 6 10 2.8	,
39 10	45	127 10	147	7	5 A TU 3 0	
45 TO	55	147 10	180	7	<b>X</b> 0 TO <b>U</b> 5	<u>د</u>
55 10	71	180 10	512	'n	3.5 10 4.0	ź
71 + 10	100	242 10	158			
UVER	100	OVED	328	- ·		с. 0



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# CONIFERS (Pre-Dawn) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

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BY AREA			Threshold = $Mean + 3.12 \sigma$		
SQUARE METE	P 5	FREQUENCY	Wavelength = 9.0 - 11.4 $\mu m$		
8.0 TO 10.0 TU 15.0 TO 20.0 TO 25.0 TO 35.0 TO 40.0 TO 45.0 TO 50.0 TO 50.0 TO 100.0 TO	10.0 15.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0 150.0	3 0 0 0 0 0 0 0 0 0 0 0 0	Mean = 274.66 Kelvin o = 0.18 Kelvin		
150,0 TO 200,0 TO 250,0 TO 300,0 TO 400,0 TO OVER	210.0 250.0 300.0 400.0 500.0 500.0	0 0 0 0 0 0			

TOTAL NUMBER OF ELLIPTICAL AREAS =

25 FEATURES WITH AREAS LESS THAN 8,00 SQ. METERS WERE ALSO RECOGNIZED

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HY PERIMETER			BY SHAPE			
ME7E	R 5	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 10	7	0 T()	22	0	0.0 10 1.0	U
7 10	10	22 TO	32	0	1.0 70 1.1	Ö
10 10	12	32 10	39	n	1.1 70 1.2	Ō
12 10	14	39 10	45	2	1.2 10 1.3	2
14 10	16	45 TO	52	ō	1.3 70 1.4	ō
16 10	17	52 10	55	1	1.4 10 1.5	ő
17 10	20	55 10	45	0	1.5 10 1.6	1
20 10	22	65 10	72	ĩ	1.6 10 1.7	ó
22 TO	24	. 72 10	78	0	1.7 11 1.8	1
24 TO	26	78 TO	ŔŠ	Ő	1.8 TO 1.9	ó
26 10	28	85 TO	91	õ	1.9 TO 2.0	ő
28 TO	30	91 10	98	ō	2.0 10 2.4	ñ
30 10	32	98 TO	104	ò	2.4 10 2.6	Ő
32 10	39	104 TO	127	õ	8.5 UT 6.5	õ
39 10	#5	127 10	1/17	0	2.8 TU 3.0	õ
45 TO	55	147 10	180	0	3 0 70 3.5	ò
55 TA	71	180 TO	232	0	3.5 TO 4.0	ň
71 10	100	212 10	128	ő	4 0 10 4 5	0
<b>NVEP</b>	100	010	1 18			0



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### CONIFERS (Noon) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	<b>8</b> Y	AREA	Threshold = Mean + 1.65 $\sigma$		
SQUARE HETE	H S	FREQUENCY	Wavelength = 3.5 - 3.9 µm		
6.0 TO 10.0 TO 15.0 TO 20.0 TO 25.0 TO 30.0 TO 35.0 TO 40.0 TO 40.0 TO 44.0 TO 44.0 TO 45.0 TO 150.0 TO 200.0 TO	10.0 15.0 20.0 35.0 35.0 40.0 50.0 100.0 150.0 200.0 200.0 200.0 200.0 500.0 500.0	42 51 10 4 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Mean = 28] 77 Kelvin σ = 3.67 Kelvin		

TOTAL NUMBER OF ELLIPTICAL AREAS = 108

3898 FEATURES WITH AREAS LESS THAN A.OO SQ. HETERS WERE ALSO RECOGNIZED

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		BY PERIME	TER	BY SHAPE		
METF	59	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 10	7	0 TO	22	0	0.0 TO 1.0	0
7 10	10	22 TO	32	0	1.0 TO 1.1	Ő
0 10	12	32 10	39	ō	1.1 10 1.2	Ň
2 10	14	39 TO	<b>4</b> 5	ŭ	1.2 10 1.3	ů
4 10	16	45 TO	52	0	1.3 (1) 1.4	2
6 TO	17	52 10	\$5	1	1 / 10 1 5	0
7 TO	20	55 10	45	15	1 5 70 1 4	• 1
0 10	22	AS TO	72	20		13
22 10	24.	72 10	78	20		4
	24	76 10	10		1.7 10 1.6	14
14 10 14 10	20		n 7 0 1	18	1.5 10 1.9	10
	20	05 (1)	91	1.5	1.9 10 2.0	4
0 10	50	91 TO	98	8	2.0 10 2.4	40
50 TU	32	98 T()	104	0	2.4 TU 2.6	3
82 TO	39	10/ 10	127	8	2.6 10 2.8	3
39 10	45	. 127 10	147	2	2.9 10 3.0	2
<b>15 1</b> 0	55	147 10	180	4	3.0 TU 3.5	4
55 TO	71	160 TO	232	1	3.5 TO 4.0	0
71 10	100	232 10	325	ī ,	4.0 10 4.5	õ
OVER	100	OVER	328	0	OVER 4.5	ŏ



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### CONIFERS (Noon) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	8 Y	ARFA	Threshold = Mean + 2.00 $\sigma$		
SQUARE HE	TERS	FREQUENCY	Waveleng	th = 3.5	- 3.9 μm
_			Mean = 28	81.77 Ke)	vin
8.0 TU	10.0	7			
10.0 TO	15.0	4	$\sigma = 3.67$	Kelvin	
15.0 TO	20.0	0			
20.0 TU	25,0	0			
25.0 TO	30.0	0			
30.0 TO	35.0	0			
35.0 TO	40.0	0			
40.0 TO	45.0	0			
45.0 TO	50.0	0			
50.0 TO	75.0	0			
75.0 TU	100.0	0			
100.0 TO	150.0	0			
150.0 TO	200.0	0			
500 0 10	250.0	0			
250,0 T()	300.0	0			
300.0 TO	400.0	0			
400.0 TU	500.0	0			
OVER	500,0	0			
TOTAL NUMBER OF	ELLIPTICAL AREA	s = 11			
1670 FEATURE	S WÌTH AREAS	LESS THAN 8.00	SQ. METERS	WERE ALSO	RECUGNIZED

		BY PERIME	TER	BY SHAPE		
METER	8	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 10	7	0 10	22	0	0.0 TU 1.0	0
7 10	10	55 TU	32	o	1.0 TO 1.1	0
10 TU	12	32 TO	39	0	1.1 70 1.2	0
12 10	14	39 10	45	0	1.2 TO 1.3	0
14 TO	16	45 TO	52	0	1.3 10 1.4	0
16 TO	17	57 10	55	1	1.4 10 1.5	0
17 10	20	55 TO	65	4	1.5 10 1.6	1
20 10	22	65 10	72	3	1.6 TU 1.7	1
01 55	24	07.57	78	0	1.7 10 1.8	3
24 10	5.6	78 TO	85	2	1 A TO 1.9	0
26 10	28	85 10	91	1	1.9 TU 2.0	1
28 10	30	91 TO	98	0	2.0 10 2.4	5
30 10	32	98 T()	104	0	2.4 10 2.6	0
32 10	39	104 10	127	0	2.6 10 2.8	0
39 10	45	127 10	147	0	2 A TO 3.0	0
45 TO	55	147 10	180	0	3 0 11 3 5	0
55 10	71	180 10	232	0	3.5 10 4.0	0
71 10	100	232 10	378	0	4 n TH 4.5	0
UNER	100	OVER	1 7 A	A 1	OVER / S	0



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### CONIFERS (Noon) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

+ 2.17 σ - 5.5 μm

		BA	AREA	Threshold = Mean + 2
SQUARE	METER	RS	FREQUENCY	Wavelength = 4.5 - 5
				Mean = 277.58 Kelvin
8.0	<b>T</b> O	10.0	22	
10.0	10	15.0	34	$\sigma = 0.63$ Kelvin
15.0	TO	20.0	18	
. 20.0	TO	25.0	4	
25.0	10	30.0	ç	
30.0	τő	35.0	ú	
35.0	TO	40.0	1	
40.0	TO	45.0	i	
45.0	<b>T</b> O	50.0	i	
50.0	tú	75.0	2	
75.0	10	100.0	ō	
100.0	10	150.0	1	
150.0	Tũ	200.0	ò	
200.0	10	250.0	Ó	
250.0	τú	300.0	0	
300.0	TO	400.0	()	
400.0	TU	500.0	0	
0)	/ER	500.0	0	
			_	

TOTAL NUMBER OF ELLIPTICAL ARFAS = 93

406 FEATURES WITH AREAS LESS THAN 8.00 SR. METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPF		
METERS	3	FEET		FREQUENCY	SHAPE PACTOR	FREQUENCY	
0 TD	7	ñ T()	22	. 0	0.0 TO 1.0	0	
7 TO	10	22 TO	32	0	1.0 TÚ 1.1	0	
10 10	12	32 10	39	0	1.1 TO 1.2	1	
12 10	14	39 TO	45	8	1.2 TO 1.3	11	
14 10	16	45 10	52	Ö	1.3 TO 1.4	15	
16 10	17	52 10	\$5	25	1.4 TO 1.5	7	
17 10	20	55 10	65	16	1.5 TU 1.6	15	
20 10	22	65 10	72	9	1.6 TO 1.7	14	
22 10	24 .	72 10	78	0	1.7 10 1.8	11	
24 10	26	78 TO	85	9	1.A TO 1.9	3	
01 65	28	85 10	91	3	1.9 TO 2 0	5	
01 8S	30	91 10	98	7	2.0 10 2.4	8	
30 TO	32	98 TO	104	Ŭ	2.4 TU 2.6	2	
32 10	39	104 TO	127	8	8.5 01 4.5	0	
39 10	45	127 10	147	3	2.8 TD 3.9	0	
45 10	55	147 10	180	2	3.0 10 3.5	1	
55 10	71	180 TU	232	2	3.5 10 4.0	Ō	
71 10	100	232 TO	128	ō	4 0 10 4.5	0	
UVER	100	OVER	378	1	OVER 4.5	0	



CONIFERS (Noon) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

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	BY A	REA	Threshold = Mean + 2.79 $\sigma$
SQUARE HETER	18	FREQUENCY	Wavelength = 4.5 - 5.5 $\mu$ m
8,0 T() 10.0 T() 15.0 T() 20.0 T() 25.0 T() 30.0 1() 35.0 T() 40.0 T() 45.0 T() 50.0 T() 75.0 T()	10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0	3 3 1 0 0 0 0 0 0	Mean = 277.58 Kelvin σ = 0.63 Kelvin
109.0 TO 150.0 TO 200.0 TO 250.0 TO 300.0 TO 409.0 TO OVER	150.0 200.0 250.0 300.0 400.0 500.0 500.0		

67 FEATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

BY PERIMETER

## BY SHAPE

METERS	3	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 T()	7	0 10	22	0	0.0 TU 1.0	0
7 10	10	22 10	32	Ō	1.0 TU 1.1	0
10 10	12	32 10	τü	0	1.1 10 1.2	0
12 10	14	19 10	<i>.</i> <i>.</i> <i>.</i>	1	1.2 10 1.3	2
14 10	16	45 10	52		1.3 10 1.4	1
14 10	17	52 TO	55	4	1.4 10 1.5	0
17 70	20	55 TO	45	ō	1.5 TO 1.6	3
20 10	20	AS TO	72	ĩ	1.6 10 1.7	0
2 10	2/	73 10	78	â	1.7 70 1.8	1
26 10	24	70 10	05	ő	1.8 TO 1.9	Ō
24 17	20	45 10	01	ĩ	0.5 01 9 1	0
20 10	20		91	1	2 0 10 2.4	i
20 11	20	91 10	10/	1	2 4 10 2.6	Ō
50 10	32		104	0	26102.8	0
52 111	59	194 10	1.07	D	18 TO 3 6	ŏ
39 TO	45	121 10	147	U	7 0 10 3.0	ò
45 10	55	147 10	180	0		0
55 TO	71	180 TO	525	0	5.7 10 4.0	0
71 10	100	232 10	328	0 (		0
OVER	100	OVER	328	0	11464 4.2	U



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CONIFERS (Noon) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

BY ARFA		Threshold = Mean + 2.07 $\sigma$		
FR	OUENCY	Wavelength = $9.0$	- 11.4 µm	
FR 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0 200.0 250.0	30 28 13 6 1 1 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Wavelength = 9.0 Mean = 278.68 Kel o = 0.94 Kelvin	- ]].4 μm vin	
300.0 400.0 500.0	0			
400,0 500,0	0			
500.0	0			
	BY ARFA FRE 10.0 15.0 20.0 25.0 30.0 35.0 40.0 50.0 75.0 100.0 150.0 200.0 250.0 300.0 250.0 50.0	BY ARFA FREQUENCY 10.0 30 15.0 28 20.0 13 25.0 6 30.0 6 35.0 1 46.0 1 45.0 4 50.0 0 75.0 0 100.0 0 150.0 0 200.0 0 250.0 0 250.0 0 250.0 0 50.0 0 5	BY ARFA         Threshold = Mean           FREQUENCY         Wavelength = 9.0           Mean = 278.68 Kel           10.0         30           15.0         28           20.0         13           25.0         6           30.0         6           35.0         1           40.0         6           35.0         1           45.0         4           50.0         0           150.0         0           250.0         0           300.0         0           50.0         0           50.0         0           50.0         0           50.0         0           50.0         0           50.0         0           50.0         0           50.0         0           50.0         0           50.0         0           50.0         0           50.0         0           50.0         0           50.0         0           50.0         0           50.0         0           50.0         0           50.0	

TOTAL NUMBER OF ELLIPTICAL AREAS =

500 FEATURES WITH AREAS LESS THAN 8,00 SQ. METERS WERE ALSO RECUGNIZED

89

BY SHAPE BY PEPIMETER SHAPE FACTOR FREQUENCY FREQUENCY HETERS FEET 0 10 22 12 0.0 TO 1.0 0 0 10 7 0 1.0 TO 1.1 0 7 70 10 22 TO 0 1.1 10 1.2 1 10 TO 12 32 10 39 0 12 9 2 39 10 12 10 14 45 10 1.2 10 1.3 52 1.3 TU 1.4 0 45 TO 14 10 16 1.4 10 1.5 16 10 17 52 TO 55 20 15 8 1,5 10 1.6 17 TO 20 55 TO 65 16 1.6 10 1.7 20 TO 22 65 TU 72 10 24 72 10 0 7 1,7 10 1.8 18 78 55 IO 1.8 TU 1.9 1.9 TU 2.0 7 24 TO 26 78 TU 85 u 91 26 10 28 85 TO 3 2.0 10 2.4 13 28 10 30 91 10 98 4 ō 98 T() 194 0 5.4 10 5.6 30 TU 35 0 5.6 TU 2.8 127 32 10 T0 39 104 13 2.A TU 3.0 0 39 10 45 ·127 TO 147 2 3.0 TU 3.5 0 147 10 45 10 55 180 4 Ô 71 3.5 10 4.0 55 10 232 0 180 TO 4.0 10 4.5 0 232 10 71 10 100 328 0 OVER 4.5 0 UVER 100 **NVER** 358 0

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CONIFERS (Noon) DISTRIBUTION OF ELLIPTICAL AREAS GREATEP THAN THRESHOLD

- 11.4 um

· ·	BY AREA		AREA	Threshold = Mean + 2.71 $\sigma$	
ş	QUARE	METER	8	FREQUENCY	Wavelength = $9.0 - 11.4$ us
1	6.0 T 10.0 T 15.0 T 20.0 T 25.0 T 35.0 T 40.0 T 45.0 T 50.0 T 50.0 T 50.0 T 25.0 T	TO TO TO TO TO TO TO TO TO TO TO TO TO	<pre> 10.0 15.0 20.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0 150.0 200.0 35.0 40.0 40.0 45.0 40.0 45.0 40.0 45.0 40.0 40</pre>	PREIJOENCY 2 1 0 0 0 0 0 0 0 0 0 0 0 0 0	Mean = 278.68 Kelvin σ = 0.94 Keivin
ι	400.0 1 OVE	TU EH R of E	509.0 500.0 LLIPTICAL AR	0 0 EAS = 3	

TOTAL NUMBER OF ELLIPTICAL AREAS =

59 FEATURES WITH AREAS LESS THAN 8.00 SG. METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPF		
METERS	5	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 TO	7	0 TO	22	0	0.0 10 1.0	0	
7 10	10	0T 55	32	0	1.0 TO 1.1	0	
10 TU	12	32 10	39	0	5.1 UT 1.1	0	
12 10	14	49 TO	45	1	1.2 10 1.3	1	
14 10	16	45 10	52	ō	1.3 10 1.4	1	
16 10	17	52 10	55	2	1.4 10 1.5	0	
17 10	20	55 10	65	0	1 5 10 1.6	1	
20 TO	22	65 TU	72	0	1 6 TO 1.7	0	
22 10	24	72 10	78	ō	1 7 10 1.8	0	
24 10	26	78 .0	85	ō	1.8 TU 1.9	0	
26 10	28	85 70	91	0	0.5 CT 9.1	0	
28 10	30	91 TO	98	0	2,0 TU 2,4	0	
30 10	32	98 TO	104	Ó	2.4 10 2.6	0	
32 10	39	104 10	127	ō	2.6 TO 2.8	0	
39 10	45	127 10	147	ō	2.8 TO 3.0	0	
45 10	55	147 10	180	ō	3.0 TO 3.5	Û	
55 10	71	180 TO	232	0	3,5 10 4.0	0	
71 10	100	232 10	328	ú.	4,0 TO 4,5	0	
OVER	100		328	o .	DVER 4.5	0	

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### CONIFERS (Sunset) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		ВY	AREA	Threshold = Mean + $2.00$		
. sa	UARE METE	RS	FREQUENCY	Wavelength = $4.5 - 5.5 \mu m$		
1 1 2 3 3 4 4 4 5 7 10 15 20 25	8.0 TU 0.0 TU 5.0 TU 0.0 TU	10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 75.0 100.0 250.0 200.0	19 39 10 11 2 5 3 2 4 2 1 0 1	Mean = 275.40 Kelvin σ = 0.17 Kelvin		
40	0.0 TU OVER	500.0 500.0	1			

TOTAL NUMBER OF ELLIPTICAL ARFAS = 103

505 FEATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECUGNIZED

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BY PERIMETER					BY SHAPE		
METER	3	FFET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
<u>ο τ</u> ο	7	0 TO	22	0	0.0 70 1.0	1	
7 10	10	27 T()	35	1	1.0 70 1.1	j	
10 TO	12	32 1()	39	0	1.1 10 1.2	ž	
12 10	14	39 10	45	6	1.2 10 1.3	ŝ	
14 10	16	45 T()	52	1	1.3 TO 1.4	11	
16 TI)	17	52 10	ς,	18	1.4 10 1.5	•;	
17 10	20	55 10	65	19	1.5 10 1.6	15	
20 TO	22	65 10	72	14	1.6 10 1.7	8	
22 10	24 -	12 10	78	0	1 7 TO 1 B	13	
24 10	26	78 TO	85	Å	1 8 10 1 9	A	
26 10	28	85 TO	91	ŭ	1 9 7(1 2 0	1)	
28 TO	30	91 TO	ČA	2		10	
30 10	12	GR TO	104	0	3 /1 70 6	10	
12 10	10	100 10	4.77			-	
19 10	15	117 10	107	:	2.0 10 2.0	3	
J 7 10		101 00	147	<u>1</u>	2.4 10 3.0	e	
43 111	כר גר	147 10	180	/	3,0 10 3,5	3	
75 10	11	160 T()	232	4	3,5 T() 4,0	2	
71 10	100	535 JU	328	5	4,0 TO 4,5	0	
OVER	100	OVER	378	4	OVER 4.5	Ú	



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### CONIFERS (Sunset) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

-	BY AREA	Threshold = Mean + 3.24 o
SQUARE HETE	RS FREQUEN	<b>cy</b> Wavelength = 4.5 - 5.5 µm
		Mean = 275.40 Kelvin
8.0 TO	10.0 1	
10.0 TO	15.0 2	$\sigma = 0.17$ Kelvin
15.0 TO	20.0 3	
20.0 10	25.0 0	
25.0 10	30.0 0	
50.0 TU	35.0 0	
35.0 TU	40.0 0	
40.0 TO	45.0 0	
45.0 T()	50.0 0	
50.0 TO	75.0 0	
75.0 TD	100.0 1	
100.0 TO	150.0 0	
150.0 TU	200.0 0	
500 <b>.</b> 0 10	250.0 0	
250.0 TU	300.0 0	
300.0 TO	410.0 1	
400.0 TU	500.0 0	
OVER	500.0 0	

TOTAL NUMBER OF ELLIPTICAL AREAS =

21 FEATURES, WITH AREAS LESS THAN 8.00 80. METERS WERE ALSO RECUGNIZED

8

BY PERIMETER				BY SHAPE		
METER	\$	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 10	7	0 ΤΟ	22	0	0.0 TO 1.0	0
7 10	10	22 10	32	<b>0</b> •	1.0 TO 1.1	0
10 TO	51	32 TU	39	ō	1.1 10 1.2	0
12 10	14	39 10	45	Ō	1.2 10 1.3	1
14 TO	16	45 10	52	0	1.3 TO 1.4	Ō
16 10	17	52 10	55	1	1.4 10 1.5	Ó
17 10	20	55 10	65	ž	1.5 10 1.6	1
01 05	22	65 TO	72	ō	1.6 10 1.7	ž
01 55	24	72 TU	78	ō	1.7 TU 1.8	0
24 10	26	78 TO	65	ہے	1.8 10 1.9	Ó
01 65	28	85 TU	91	0	1.9 10 2.0	e
28 10	30	91 10	98	Ō	2.0 TO 2.4	2
30 10	32	98 TO	104	0	2.4 10 2.6	1
11 57	39	104 TL	127	1	8,5 01 6,5	0
39 10	45	127 TU	147	ō	2.8 T( 3.0	0
45 TO	55	147 TU	180	ō	3.0 10 3.5	1
55 10	71	180 TO	535	ō	3,5 10 4,0	ō
71 TO	100	232 TU	328	0	4.0 10 4.5	0
OVER	100	OVED	7 78	-	OVER DE	0



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Area: Conifers (Wavelength =  $9.0 - 11.4 \mu m$ ) Temperature Threshold = Mean +  $1.50 \sigma$ Mean = 275.44 Kelvin Std. Dev. =  $\sigma$  = 0.26 Kelvin EQUIVALENT ELLIPTICAL AREAS - SUNSET

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# CONIFERS (Sunset)

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	8 Y	AREA	Threshold = Mean + 1.50 ຕ		
SQUARE METE	RS.	FREQUENCY	Wavelength = 9.0 - 11.4 $\mu$ m		
			Mean = 275.44 Kelvin		
8.0 TO	10.0	12			
10.0 TU	15.0	56	o = 0.26 Kelvin		
15.0 70	20.0	29			
20.0 TO	25.0	20			
25.0 TO	30.0				
30.0 10	35.0	6			
35.0 TO	40.0	7			
40.0 TO	45.0	8			
45.0 TU	50.0	6			
50.0 TO	75.0	15			
75.0 TU	100.0	5			
100.0 TO	150.0	6			
150.0 TO	200.0	0			
500°U 10	250.0	1			
250.0 TU	300.0	0			
300.0 10	400.0	3			
400.0 TO	50α.0	1			
DAEK	500.0	2			

TOTAL NUMBER OF ELLIPTICAL AREAS - 202

542 FEATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECUGNIZED

HA DEBIMELLEB					BY SHAPE		
METER	8	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 TO	7	0 ΤΟ	22	0	0_0 TO 1.0	2	
7 10	10	01 SS	32	1	1.0 70 1.1	1	
10 TN	12	32 TO	39	0	1.1 10 1.2	11	
12 10	14	37 10	45	21	1.2 10 1.3	25	
14 TO	16	45 TO	52	0	1.3 10 1.4	27	
16 TD	17	52 10	55	36	1.4 10 1.5	9	
17 TO	20	55 TO	65	19	1.5 10 1.6	26	
01 0S	22	65 TO	72	22	1.6 10 1.7	18	
01 55	24 .	72 10	78	0	1.7 TO 1.8	21	
24 10	26	78 TO	85	15	1.8 TU 1.9	16	
26 10	85	85 11)	91	16	1.9 TO 2.0		
01 8S	30	91 10	98	A	2 0 10 2.4	20	
30 th	32	98 10	104	0	2.4 TO 2.6	6	
32 10	39	104 10	127	16	2 6 T() 2.8	5	
59 TO	45	127 10	147	11		, ,	
45 TO	55	147 10	180	12		r X	
55 10	71	180 TO	212	Â		0	
71 10	100	252 10	328	8 .	<i>a</i> 0 TD <i>a</i> 5	2	
OVES	100	OVER	378	9	OVER 4.5	3	

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 CONIFERS (Sunset) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	84	ARFA	Threshold = Mean + 3.00 $\sigma$
SQUARE METE	R 8	FREQUENCY	Wavelength = 9.0 - 11.4 µm
8-0 T()	10.0	2	Mean = 275.44 Kelvin
10.0 TO 15.0 TO	15.0	2	σ = 0.26 Kelvin
20.0 TU 25.0 TO	25.0	0	
30.0 TO 35.0 TO	35.0 40.0	0 0	
40.0 TO 45.0 TO 50.0 TO	45.0	0	
75.0 TO	100.0	0	
150.0 TU 200.0 TU	200.0 250.0	o O	
250.0 TU 300.0 TU	300.0	1 0	
400.0 TO OVER	500.0 500.0	0 0	

TOTAL NUMBER OF ELLIPTICAL AREAS =

23 FEATURES WITH AREAS LESS THAN 8.00 SQ. HETERS WERE ALSO RECUGNIZED

9

BY PERIMETER BY SHAPE HETERS FEFT FREQUENCY SHAPE FACTOR FREQUENCY 0 TU 7 TO 7 0 10 22 0 0.9 TU 1.0 ٥ 10 55 TO 32 0 1.0 TO 1.1 0 39 45 10 TO 12 32 TO 0 1.1 10 1.2 0 12 10 14 39 10 0 1.2 10 1.3 0 14 TO 16 45 T() 52 0 1.3 TO 1.4 1 16 10 17 52 TO 55 19 1,5 1.4 1 1 20 22 24 26 17 10 55 TO 1.5 10 1.6 65 2 01 05 65 TO 72 1 1.6 TO 1.7 2 1,7 01 SS TO 1.8 72 10 78 0 Ô 24 TQ 7 A th A5 1.8 TO 1.9 1 26 10 28 85 TO 91 1.9 10 2.0 0 0 10 32 91 10 28 10 49 5.0 10 2,4 1 2.4 TU 2.6 2.6 TU 2.8 30 10 98 TU 104 0 1 39 164 10 127 32 10 1 1 39 10 45 151 TO 147 0 2.8 TU 3.0 0 55 71 45 10 147 10 180 3.0 TO 3.5 1 ٥ 55 10 180 10 232 3,5 TU 4,0 1 0 100 71 10 01 SES 328 4.0 10 4.5 0 0 OVER . 190 **DVER** 378 OVER 4.5 ŧ 0

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CONIFERS (Midnight) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD accult in the life of a

	θY	ARFA	Threshold = Mean ، 1.40 o
SQUARE METE	RS	FREQUENCY	Wavelength = 4.5 - 5.5 $\mu$ m
8.0 TG 10.0 TO 15.0 TU 20.0 TU 25.0 TO 30.0 TU 35.0 TU 40.0 TU 40.0 TU 40.0 TU 40.0 TU 50.0 TU 200.0 TU 200.0 TU 200.0 TU 200.0 TU	10.0 15.0 20.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0 150.0 250.0 250.0 400.0 500.0	54 63 22 11 6 3 0 1 0 0 0 3 0 0 0 0 0 0 0 0 0 0 0 0	Mean = 274.98 Kelvin σ = 0.14 Kelvin
UVER	500.0	(°	

TOTAL NUMBER OF ELLIPTICAL AREAS = 103

2422 FEATURES WITH AREAS LESS THAN 8,00 SQ. METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPE		
METER	9	FEET		FREQUENCY	SHAPE FACTUR	FREQUENCY	
0 10	7	0 T()	22	0	0.0 TU 1.0	0	
7 10	10	0T SS	32	Ó	1.0 TO 1.1	0	
10 TO	12	37 10	39	0	1.1 10 1.2	ż	
12 TO	14	39 TO	45	15	1.2 10 1.3	17	
14 10	16	45 TO	52	ð	1.3 TU 1.4	12	
16 10	17	52 TÚ	55	29	1.4 TO 1.5	3	
17 10	20	55 10	65	36	1.5 10 1.6	20	
10 10	22	65 10	72	18	1.6 10 1.7	1 3	
07 55	24	72 10	78	0	1.7 10 1.8	31	
24 10	26	78 TO	85	9	1.8 T() 1.9	10	
56 10	28	85 TU	91	15	1.9 10 2.0	10	
28 10	30	91 10	95	6	2.0 10 2.4	26	
30 10	32	98 10	104	ō	2.4 10 2.6	10	
32 10	34	104 10	127	22	8.5 97 6.5	ä	
39 10	45	127 TO	147	2	2.8 TO 3.0	2	
45 10	55	14 10	180	7	3.0 10 3.5	2	
55 fg	71	180 10	212	ò	3.5 T() 4 O	1	
71 10	100	212 10	328	ĩ	4 0 10 4 5		
OVEN	100		138	-		0	



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CONIFERS (Midnight) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		нү	ARFA	Threshold = Mean + 2.00 $\sigma$
	SQUARE HETERS	i	FREQUENCY	Wavelength = 4.5 - 5.5 µm
-	8.0 70 10.0 10 15.0 TU 20.0 TU 25.0 TO 30.0 TU 35.0 TO 35.0 TO 45.0 TO 50.0 TO 150.0 TO 200.0 TO 250.0 T	$ \begin{array}{c} 10.0\\ 15.0\\ 25.0\\ 30.0\\ 35.0\\ 40.0\\ 50.0\\ 150.0\\ 150.0\\ 250.0\\ 40.0\\ 50.0\\ 250.0\\ 40.0\\ 50.0\\ $		Mean = 274.98 Kelvin σ = 0.14 Kelvin
	<		v	

TOTAL NUMBER OF ELLIPTICAL AREAS -

139 FLATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

7

HY PERIMETER					BY SHAPE		
METER	5	FEFT		FREQUENCY	SHAPE FACTOR	FREQUENCY	
6 TO	7	0 TO	22	0	0.0 70 1.0	0	
7 tu	10	22 TO	32	0	1.0 TU 1.1	0	
10 TU	12	37 10	39	0	1.1 70 1.2	0	
15 10	14	39 TU	45	0	1.2 10 1.3	0	
14 TO	16	45 TO	52	0	1.3 10 1.4	0	
16 10	17	52 10	55	Ō	1.4 10 1.5	ů	
17 10	20	55 TO	65		1.5 10 1.6	,	
11 65	2.5	65 TO	72	3	1.6 10 1.7	1	
01 55	24	72 10	78	õ	1 7 10 1 8	1	
24 10	55	78 10	85	0	1 8 10 1 9	1	
26 10	28	85 TE	91	0	191020	1	
28 10	50	91 10	8.9	0		;	
30 10	32	98 10	: 64	ň	241226	1	
32 11	39	104 10	127	1	2.4 10 2 8	;	
39 -1)	<b>4</b> 5	127 10	147	i		, A	
45 10	55	1/17 10	140	;		¢	
55 TD	71	180 10	212	1	5.0 19 5.5	0	
71 10	100	100 10	210	0	5.5 0 4.0	0	
0140	100	() ()	) r' D	U .	4.5 70 4.5	0	
UNEN	100	<u>tive</u> r	328	Q	QVER 4.5	0	



CONIFERS (Midnight) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	BY	ARFA	Threshold = Mean + 1.19 o
SQUARE METERS		FREQUENCY	Wavelength = 9.0 - 11.4 µm
0.0.7		_	Mean = 274.76 Kelvin
8,0 TO 10,0 TO 15,0 TO	10.0 15.0	45 80	$\sigma$ = 0.24 Kelvin
20.0 TO	25.0	32	
30.0 TU 35.0 TU	35.0	11 5	
40.0 TO 45.0 TO	45.0 50.0	5	
50.0 T() 75.0 T() 100 0 T()	75.0	12	
150.0 TO 200.0 TO	200.0 250.0	1	
250.0 TO 300.0 TO	300.0	1 0	
400.0 TO Over	500.0 500.0	0 1	

TOTAL NUMBER OF ELLIPTICAL AREAS = 262

1188 FEATURES WITH AREAS LESS THAN 8,00 SQ. WETERS WERE ALSO RECOGNIZED

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BY PERIMETER					BY SHAPE		
METE	RS	FEET		FREQUENCY	SHAPE FACTUR	FREQUENCY	
0 10	7	0 10	22	0	0.0 10 1.0	0	
7 10	10	22 10	32	Ó	1.0 TO 1.1	0	
10 10	12	32 10	19	ō	1,1 10 1.2	4	
12 TD	14	39 10	45	13	1.2 TO 1.5	17	
14 10	16	45 TO	52	0	1.3 10 1.4	17	
16 10	17	52 10	55	31	1.4 10 1.5	10	
17 10	20	55 to	65	45	1.5 10 1.6	30	
01 05	22	65 TO	72	25	1.6 10 1.7	32	
01 55	24.	72 70	78	0	1.7 TO 1.8	37	
24 10	26	78 TO	85	27	1 A TO 1.9	15	
26 10	28	85 TU	91	20	1.9 10 2.0	25	
28 10	30	91 70	98	16	2 0 10 2.4	45	
30 10	32	98 TO	104	0	2.4 TO 2.0	9	
32 10	39	104 10	127	29	2.6 10 2.8	8	
39 10	45	127 10	147	16	2.8 10 3.0	5	
45 10	55	147 TO	180	17	3.0 10 3.5	Ś	
55 10	71	180 TO	212		3.5 10 4.0	ź	
71 10	1 0 0	242 10	128	10	4.0 10 4.5	2	
OVER	100	DVER	328	7 '	OVER 4.5	1	

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CONIFERS (Midnight) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD ulu - Alli La

	84	AREA	Thre∍hold ≈ Mean + 1.50 o
SQUARE HETER	8	FREQUENCY	Wavelength = 9.0 - 11.4 pm
8.0 TO 19.0 TO 15.0 TO 20.0 TO 25.0 TO 30.0 TO	10.0 15.0 20.0 25.0 30.0	5 5 1 1 1	Mean = 274.76 kelvin σ = 0.24 Kelvin
35.0 TO 40.0 TD 45.0 TO 50.0 TO	40.0 45.0 50.0 75.0	0	
75.0 TU 100.0 TU 150.0 TU 200.0 TU	100.0 150.0 200.0 250.0		
250,0 TO 300,0 TO 400,0 TO 0VER	300.0 400.0 500.0 500.0		

TOTAL NUMBER OF ELLIPTICAL AREAS =

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199 FEATURES WITH AREAS LESS THAN 8.00 SR. METERS WERE ALSO RECUGNIZED

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NY PERIMETER				BY SHAPE		
METER	8	FEET		FREQUENCY	SHAPE FACTUR	FREQUENCY
0 TO	7	0 TO	22	O	0.0 TO 1.0	0
7 10	10	22 T()	32	0	1.0 10 1.1	Ó
10 TO	51	32 10	39	0	5.1 07 1.1	1
12 TO	14	39 T()	45	3	1.2 10 1.3	ż
14 TO	16	45 70	52	0	1.3 TU 1.4	2
16 10	17	52 10	55	2	1.4 10 1.5	ō
17 10	<b>2</b> 0	55 10	65	2	1.5 TU 1.6	i
20 10	25	55 10	72	1	1.6 10 1.7	0
0T 55	24	72 TO	78	ō	1.7 10 1.8	3
24 TO	26	78 TO	85	2	1.8 10 1.9	1
56 TU	28	85 10	91	1	0.5 UT P.1	2
0T 85	30	91 10	98	0	2.0 10 2.4	1
30 10	32	92 10	104	0	2.4 10 2.6	1
35 10	39	104 10	127	2	2.6 TU 2.8	ò
39 10	45	127 TO	147	ī	2.8 10 5.0	ò
45 10	55	147 TO	180	0	3.0 10 3.5	ĩ
55 10	71	180 TD	232	Ō	3.5 TU 4.0	ò
71 10	100	232 10	328	ĩ	4 0 10 4 5	0
INVER	100	OVEL	7.54	<i>.</i> .		~

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MICHIGAN WINTER SCENE - CONIFERS

Power Spectra

Spectral Bands: 3.5 - 3.9 μm 4.5 - 5.5 μm 9.0 - 11.4 μm




















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### MICHIGAN WINTER SCENE - FARMLAND

Means and Standard Deviations for Spectral Bands

Spectral Bands:	Channel 8:	3.5 -	3.9 µm	(°K)
	Channel 10:	4.5 -	5.5 µm	(°K)
	Channel 12:	9.0 -	<b>11.4</b> µm	(°K)

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### FARMLAND - PRE-DAWN

Number of Subregions:	1
Line Increment Used:	1
Pixel Increment Used:	1
Correlation Channels:	10 (4.5 – 5.5 µm)
	12 (9.0 - 11.4 μm)

## 90° Depression

Pixel Subarea	Divisions At:	123	523
Line Subarea D	ivisions At:	1	385

Correlation	10	12
1.0	1.000	
12	0.765	1.000

Channels	10	12
Mean	2.7455E+02	2.7407E+02
Standard Deviation	1.4660E-01	2.2202E-01
Total Points	154000.	154000.

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## 35° Depression

Pixel	L Subarea	a Divisions	s At:	123	523
Line	Subarea	Divisions	At:	1	211

Correlation	10	12
10	1.000	
12	0.840	1.000

Channels	10	12
Mean	2.7445E+02	2.7407E+02
Standard Deviation	1.5195E-01	2.4940E-01
Total Points	84400.	84400.

# FARMLAND - NOON

Number of Subregionu:	1				
Line Increment Used:	1				
Pixel Increment Used:	1				
Correlation Channels:	8	(3.5	-	3.9	um)
	10	(4.5	-	5.5	um)
	12	(9.0	-	11.4	µm)

90° Depression		
Pixel Subarea Divisions Ac:	123	523
Line Subarea Divisions At:	1	385

Correlation	8	10	12
8	1.000		
10	0.174	1.000	
12	0.266	0.607	1.000

Channels	8	10	12
Mean	2.7966E+02	2.7662E+02	2.7723E+02
Standard Deviation	4.2649E+00	9.4517E-01	1.2254E+00
Total Toints	153200.	153200.	153200.

երիսուին, են չել շննարչունը է են երանակությունը երանությունը։ Դես են երանության են են են երանակությունը։ Լես են

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### 35° Depression

Pixel Subarea Divisions At: 123 523 Line Subarea Divisions At: 1 211

Channels	8	10	12
Mean	2.8104E-02	2.7736E+02	2.77915+02
Standard Deviation	3.4479E+00	1.0462E+00	1.4930E+00
Total Points	83600.	83600.	83600,

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#### FARMLAND - SUNSET

Number of Subregions: 1 Line Increment Used: 1 Pixel Increment Used: 1 Correlation Channels: 10 (4.5 - 5.5 µm) 12 (9.0 - 11.4 µm)

90° Depression		
Pixel Subarea Divisions At:	123	523
Line Subarea Divisions At:	1	385

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ા અડસાંક તે બોહ જોવ સોકરનાં દેન્ તો તે તે તે કોશીય વિવેસિતોપ્રાંન કે આવે કે આવે છે. તે સોક્સોની પ્રતિ મે આપ્રે

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Correlation	10	12
10	1.000	
12	0.744	1.000

Channels	10	12
Mean	2.7501E+02	2.7479E+02
Standard Deviation	2.8952E-01	4.0305E-01
Total Points	154000.	154000.

35° De	pression
--------	----------

Pixe!	L Subarea	a Divisions	s At:	123	523
Line	Subarea	Divisions	At:	1	211

Correlation 10 12 10 1.000 0.844 12 1.000

Channels	10	12
Nean	2.7502E+02	2.7470E+02
Standard Deviation	2.9582E-01	4.5508E-01
Total Points	84400.	84400.

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#### FARMLAND - MIDNIGHT

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Number of Subregions:	1
Line Increment Used:	1
Pixel Increment Used:	1
Correlation Channels:	10 (4.5 - 5.5 μm)
	12 (9.0 - 11.4 µm)

## 90° Depression

Pizel Subarea Divisions At:	123	523
Line Subarea Divisions At:	1	385

Correlation	10	12
10	1.000	
12	0.871	1.000

Channels	10	12
Mean	2.7466E+02	2.7416E+02
Standard Deviation	2.2886E-01	3 6454E-01
Total Points	154000.	154000.

## 35° Depression

Pixel Subarea Divi	sions At: 123	523
Line Subarea Divis	ions At: 1	211

Correlation	10	12
10	1.000	
12	0.905	1.000

Channels	10	12
Mean	2.7475E+02	2.7433E+02
Standard Deviation	1.9049E-01	3.2901E-01
Total Points	84400.	84400.

ERIM MICHIGAN WINTER SCENE - FARMLAND Histograms\* Spectral Bands: 3.5 - 3.9 µm 4.5 ~ 5.5 µm 9.0 ~ 11.4 µm \* Circles define a Gaussian curve with the same mean and standard A line in the second deviation as the actual histogram. An "S" on some curves indicates saturation. Because of limits on gain settings some values may exist beyond the digital limits of 0 and 255, the digital dynamic range of the data processing. 3.5-178 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_









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### MICHIGAN WINTER SCENE - FARMLAND

Power Spectra

Spectral Bands: 3.5 - 3.9 μm 4.5 - 5.5 μm 9.0 - 11.4 μm

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\*\* Power Spectral Density is ("K)<sup>2</sup>/cycle/meter for 4.5 to 5.5 µm and 9.0 to 11.4 µm bands.

POWER SPECTRA - MICHIGAN WINTER SCTYE: MIDNIGHT - (ANGLE: 35 DEG.) - CROSS-TRACK

3.5-212



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#### MICHIGAN WINTER SCENE - LAND & WATER

Histograms\*

Spectral Bands:  $3.5 - 3.9 \ \mu m$  $4.5 - 5.5 \ \mu m$  $9.0 - 11.4 \ \mu m$ 

3.5-214

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<sup>\*</sup> Circles define a Gaussian curve with the same mean and standard deviation as the actual histogram. An "S" on some curves indicates saturation. Because of limits on gain settings some values may exist beyond the digital limits of 0 and 255, the digital dynamic range of the data processing.









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ERIM ٦ MICHIGAN WINTER SCENE - LAND & WATER ; Means and Standard Deviations for Spectral Bands ٩ Correlations Between Spectral Bands Spectral Bands: Channel 8: 3.5 - 3.9 µm (°K) Channel 10: 4.5 - 5.5 µm (°K) 1 Channel 12: 9.0 - 11.4 µm (°K) đ Ć 3.5-233

#### LAND & WATER - PRE-DAWN

Number of Subregions: 1 Line Increment Used: 1 Pixel Increment Used: 1 Correlation Channels: 10 (4.5 - 5.5 µm) 12 (9.0 - 11.4 µm)

## 90° Depression

Pixel Subarea Divisions At:	123	523
Line Subarea Divisions At:	1	385

Correlation	10	12
10	1.000	
12	0.654	1.000

Channels	10	12
Mean	2.7505E+C2	2.7487E+02
Standard Deviation	1.1105E-01	1.7481E01
Total Points	154000.	154000.

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## 35° Depression

Pixel	l Subarea	a Divisions	s AL:	123	523	
Line	Subarea	Divisions	At:	1	211	

Correlation	16	12	
10	1.000		
12	0.724	1.000	

Channels	10	12
Mean	2.7496E+02	2.7464E+02
Standard Deviation	9,631 <i>6</i> E-02	1,6107E-01
Total Points	844CO.	84400.

3.5-234

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LAND & WATER - NOON

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Number of Subregions:	1	
Line Increment Used:	1	
Pixel Increment Used:	1	
Correlation Channels.	8	(3.5 – 3.9 μm)
	10	(4.5 - 5.5 μm)
	12	$(9.0 - 11.4 \mu m)$

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90° Depression			
Pixel Subarea Divisions At:	123	523	
Line Subarea Divisions At:	1	385	

Correlation	8	10	12
8	1.000		
10	0.313	1.000	
12	0.345	0.793	1.000

Channels	8	10	12
Mean	2.8120E+02	2.7681E+02	2.7747E+02
Standard Deviation	4.1248E+00	1.1984E+00	1.6994E+00
Total Points	153200.	153200.	150200.

# 35° Depression

Pixel Subarca Divisions At: 123 523 Line Subarea Divisions At: 1 211

<b>Correlation</b>	8	10	12
8	1.000		
10	0.5'1	1,000	
12	0,565	0.905	1.000

Channels	8	10	12
Mean	2.7937E+02	2.7623E+02	2.7616E+02
Standard Deviation	3.6773E+00	9.9948E-01	1.5471E+00
Total Points	83600.	83600.	83600.

3.5-235


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#### LAND & WATER - SUNSET

Number of Subregions:	1
Line Increment Used:	1
Pixel Increment Used:	1
Correlation Channels:	10 (4.5 - 5.5 μm)
	12 (9.0 - 11.4 µm)

90° Depression			
Pixel Subarea Divisions At:	123	523	
Line Subarea Divisions At:	1	385	

Correlation	10	12
10	1.000	
12	0.882	1.000

Channels	10	12
Mean	2.7525E+02	2.7512E+02
Standard Deviation	2.6181E-01	4.2969E-01
Total Points	154000.	154000.

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# 35° Depression

Pixel	. Gubarea	Divisions	At:	123	523
Line	Subarea	Divisions /	At:	1	211

Correlation	10	12
10	1.000	
12	0.904	1.000

Channels	10	12
Mean	2.7529E+02	2.7497E+02
Standard Deviation	2.3681E-01	4.8677E-01
Total Points	84400.	84400.

#### LAND & WATER - MIDNIGHT

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**Description** of the second strength of the second s

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- Contraction

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Number of Subregions:	ï
Line Increment Used:	1
Pixel Increment Used:	1
Correlation Channels:	10 (4.5 - 5.5 µա)
	12 (9.0 - 11.4 µm)

#### 90° Depression

Pixel Subarea Divisions At:	123	523
Line Subarea Divisions At:	1	385

.

Correlation	10	12
10	1.000	
12	0.420	1.000

Channels	10	1.2
Mean	2.7496E+02	2.7474E+02
Standard Deviation	7.3608E-02	1.0586E-01
Total Points	154000.	154000.

# 35° Depression

Pixel	Subarea	a Divisions	a At:	123	52.3
Line	Subarea	Divisions	At:	1	211

Correlation	10	12
10	1.000	
12	0.023	1.000

Channels	10 .	12
Mean	2.7491E+02	2.7451E+02
Standard Deviation	5.3676E-02	7.2946E-02
Total Points	84400.	84400.

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#### LAND & WATER - PRE-DAWN DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		8 Y	AREA
SQUAR	E ME	TERS	FREQUENCY
8.0	to	10.0	56
10,0	10	15.0	40
15.0	<b>T</b> O	20.0	25
50.0	Ťί	25.0	13
25.0	T()	30.0	5
30.0	<b>T</b> ()	35.0	6
35.0	10	40.0	3
40.0	10	45.0	1
45.0	tυ	50.0	4
50.0	TO	75.0	14
75.0	τo	100.0	9
100.0	10	150.0	7
150.0	10	200.0	3
500.0	TÜ	250.0	0
250.0	то	300.0	3
300.0	10	400.0	3
400.0	10	500.0	1
01	/ER	500.0	1

Threshold = Mean + 2.15  $\sigma$ Wavelength = 4.5 - 5.5  $\mu$ m Mean = 275.05 Kelvin  $\sigma$  = 0.11 Kelvin

TOTAL NUMBER OF ELLIPTICAL AREAS = 164

747 FEATURES WITH AREAS LESS THAN 8,00 SQ, METERS WERE ALSO RECUGNIZED

BY PERIMETER			BY SHAPE			
METER	8	FFET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 T O	7	0 TO	22	0	0.0 TU 1.0	0
7 10	10	22 10	32	0	1.0 TO 1.1	0
10 TO	12	32 10	39	0	1.1 70 1.2	1
12 TO	14	39 10	45	6	1.2 10 1.3	ż
14 TO	10	45 TO	52	G	1.3 TU 1.4	1
16 10	17	52 10	55	10	1.4 10 1.5	
17 10	20	55 TO	65	15	1.5 10 1.6	13
01 0S	55	65 TO	72	17	1.6 10 1.7	Â
22 10	24	01 57	78	0	1.7 TD 1.8	14
24 10	26	78 TO	A5	14	1.8 TO 1.9	8
26 10	85	85 10	41	6	0.5 01 2.0	
28 10	30	91 111	98	10	2.0 10 2.4	3.4
30 10	32	9A T()	104	0	2.4 TO 2.6	18
32 10	39	104 TO	127	22	2.6 10 2.8	
39 TO	45	127 10	107	8	2.8 10 3.0	, Q
45 TU	55	147 10	140	ÿ	3.0 10 3.5	1
55 TO	71	180 TO	212	Ġ	3.5 TH 4.0	
71 10	100	232 10	328	17 (		ĩ
OVER	100	D/ER	328	27	OVER 4 5	10

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# LAND & WATER - PRE-DAWN DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

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	84	AREA
SQUARE HETER	3	FREQUENCY
8,0 TO -10,0 TO	10.0	1 1
15.0 TU 20.0 TU	20.0 25.0	1
25.0 TU 30.0 TO	30.0 35.0	1
40,0 T() 45.0 T()	40.0 45.0 50.0	1 0
50.0 TO 75.0 TU	75.0 100.0	0
100.0 TO 150.0 TO	150.0	0
250.0 TU 300.0 TU	<pre>257.0 300.0 400.0</pre>	0 0 0
400.0 TU UVER	500.0 500.0	0

Threshold = Mean + 3.71  $\sigma$ Wavelength = 4.5 - 5.5  $\mu$ m Mean = 275.05 Kelvin  $\sigma$  = 0.11 Kelvin

.

TOTAL NUMBER OF ELLIPTICAL AREAS =

34 FEATURES WITH AKEAS LESS THAN 8,00 SQ. METERS WERE ALSO RECUGNIZED

7

BY PERIMETER BY SH	APE
METERS FEET FREQUENCY SHAPE FACTOR	FREQUENC
0.1 07 0.0 0 55 07 0 7 07 0	0
7 TO 10 22 TO 32 0 1.0 TO 1.1	ō
10 10 12 32 10 39 0 1.1 10 1.2	ŏ
12 TO 14 39 TO 45 1 1.2 TO 1.3	ĩ
14 TO 16 45 TO 52 0 13 TO 1.4	ò
16 10 17 52 10 55 0 1 4 10 1 5	Ň
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LAND & WATER - PRE-DAWN DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

			ΗY	AREA
SQUARE	METERS			FREQUENCY
8.0	TO	10.0		25
10.0	TO	15.0		37
15.0	T()	20.0		20
20.0	†ถ	25.0		13
25.0	TO	30.0		6
30.0	TO	35.0		8
35.0	TO	40.0		7
40.0	10	45.0		3
45.0	tu	50.0		5
50.0	70	75.0		9
75.0	TO	100.0		Li I
100.0	TO	150.0		2
150.0	10	200.0		3
200.0	TO	250.0		1
250.0	TO	300.0		1
300.0	tu	400.0		0
400.0	T()	500.0		0
OV	ER.	500.0		3

Threshold = Mean + 2.09  $\sigma$ Wavelength = 9.0 - 11.4  $\mu$ m Mean = 274.87 Kelvin  $\sigma$  = 0.17 Kelvin

TOTAL NUMBER OF ELLIPTICAL AREAS = 144

346 FEATURES WITH AREAS LESS THAN 8,00 SG. METERS WERE ALSO RECOGNIZED

BY PERIMETER			BY SH	1 PF		
METER	3	FFET		FREQUENCY	SHAPE FACTOR	FPEQUENCY
0 1 D	7	ט זינ	22	c	0.0 TO 1.0	0
7 10	10	22 10	12	0	1.0 TO 1.1	0
10 10	12	12 10	29	0	1.1 TU 1.2	2
12 10	14	10 10	45	8	1.2 TO 1.3	10
14 70	16	45 10	52	ō	1.3 10 1.4	6
16 10	17	52 15	55	13	1.4 10 1.5	6
17 10	20	55 10	55	21	1.5 TO 1.6	10
20 10	22	1.5 10	72	15	1.6 10 1.7	12
22 11	24.	72 10	73	c	9.7 TO 1.8	19
24 10	26	76 79	<b>8</b> 5	8	1.8 TU 1.9	10
26 10	28	85 10	\$1	9	1.9 10 2.0	3
26 10	30	91 TD	98	8	2.0 13 2.4	32
	30	99 TO	134	ō	2.4 711 2.6	7
32 10	20	100 10	1 37	16	2.6 10 2.8	B
30 10	45	127 10	127	1.4	2.8 TO 5.0	5
45 10	55	147 10	180	7	3.0 TU 3.5	5
55 TO	71	180 TO	232	, S	3.5 10 4.0	1
71 10	100	212 10	128	10	4.0 10 4.5	1
OVER	100	OVER	328	10	OVER 4.5	3



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## LAND & WATER - PRE-DAWN DISTRIBUTION OF ELLIPTICAL AREAS GREATER 1HAN THRESHOLD

	8 Y	AREA	Threshold = Mean + 3.66 c		
SQUARE METE	R 8	FREQUENCY	Wavelength = 9.0 - 11.4 µm		
8.0 TU 10.0 TU 15.0 TU 20.0 TU 25.0 TU 30.0 TU 35.0 TG 40.0 TU 45.0 TU 50.0 TU 75.0 TU 100.0 TU 150.0 TU 200.0 TU	$     \begin{array}{r}       10.0 \\       15.0 \\       20.0 \\       25.0 \\       30.0 \\       40.0 \\       45.0 \\       50.0 \\       75.0 \\       100.0 \\       250.0 \\       300.0 \\       300.0 \\       400.0 \\       500.0 \\$		Mean = 274.87 Kelvin σ = 0.17 Kelvin		

TOTAL NUMBER OF ELLIPTICAL AREAS =

18 FLATURES WITH AREAS LESS THAN 8.00 SP. METERS WERE ALSO RECOGNIZED

7

BY PERIMETER			BY SHAPE			
METER	9	FEET		FREQUENCY	SHAPE FACTUR	FREQUENCY
0 T D	· 7	0 TU	22	0	0.0 10 1.0	o
7 TO	10	<b>55 1</b> 0	32	0	1.0 10 1.1	0
10 TO	12	32 10	39	0	1.1 10 1.2	0
12 10	14	39 T(1	45	0	1.2 10 1.3	Ġ
14 10	16	45 TO	52	0	1.3 TO 1.4	Ó
16 TO	17	52 10	55	1	1.4 TU 1.5	1
17 TO	20	55 TO	65	0	1.5 TU 1.6	1
20 10	55	65 TO	72	ò	1.6 TO 1.7	ò
0T 55	24	· 72 TO	78	0	1.7 TU 1.8	Ś
24 10	26	78 TO	85	0	1.8 TU 1.9	2
5P 10	85	85 T.C	91	2	1.9 TO 2.0	ĩ
01.85	30	91 TQ	98	1	2.0 10 2.4	Ō
30 10	32	98 TO	104	0	2 4 10 2 6	Q
32 10	39	104 TO	127	3	2.6 TU 2.8	0
39 10	45	127 10	147	ō	2.8 10 3.0	Ó
45 TO	55	147 10	180	0	5.0 10 3.5	Ó
55 10	71	180 10	232	0	3,5 TU 4 (	ċ
71 10	100	232 TO	378	o '	4 0 TU 4 5	0
11V/ D	100	(MCC D	156	, ,		0



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LAND & WATER - NOON DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

SQUARE METER	8¥	ARFA Frequency	Threshold = Mean + 1.83 σ Wavelength = 3.5 - 3.9 μm
8.0 TU 10.0 TU 15.0 TO 20.0 TU 25.0 TU 30.0 TU 35.0 TU 40.0 TU 40.0 TU 40.0 TU 50.0 TU 100.0 TU 150.0 TU 200.0 TU 200.0 TU 350.0 TU 40.0 TU 200.0 TU 200.0 TU 200.0 TU	$   \begin{array}{r}     10.0 \\     15.0 \\     20.0 \\     25.0 \\     30.0 \\     40.0 \\     40.0 \\     40.0 \\     40.0 \\     40.0 \\     40.0 \\     40.0 \\     40.0 \\     40.0 \\     40.0 \\     50.0 \\     300.0 \\     300.0 \\     500.0 \\     500.0 \\     500.0 \\     500.0 \\   \end{array} $	22 29 20 8 1 4 4 3 7 2 1 3 1 0 0 0 0 0 0	Mean = 281.20 Kelvin . σ = 4.12 Kelvin

TOTAL NUMBER OF FLLIPTICAL AREAS = 99

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1890 FEATURES WITH AREAS LESS THAN 8.00 SO, METERS WERE ALSO RECOGNIZED

BY PERIMETER			BY SH	APF.		
METER	8	FFET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 10	7	0 10	22	0	0.0 10 1.0	0
7 10	10	27 TO	32	0	1.0 10 1.1	0
10 10	51	32 10	39	0	5.1 OT 1.1	1
15 10	14	39 10	45	4	1.2 TO 1.3	4
14 10	16	45 10	52	0	1.3 10 1.4	6
16 10	17	52 TO	55	10	1.4 TO 1.5	2
17 10	20	55 TÚ	65	7	1.5 10 1.6	7
20 10	22	65 TO	77	10	1.6 10 1.7	3
22 10	24.	72 10	78	0	1.7 10 1.8	12
24 10	26	78 TO	85	13	1.8 TO 1.9	7
26 10	26	65 T()	91	11	1.9 10 2.0	Ś
28 10	30	91 10	QH		2.0 TO 2.4	36
50 10	32	98 10	104	0	2.4 11 2.6	Ś
12 10	19	104 70	127	15	2.6 10 2.8	ú
39 10	45	127 70	4 / 7	13	281010	
15 10		447 70	107	4 E	2 6 70 3.6	1
55 10	71	147 10	212	ر 4		
71 70	100	101/11	C ) C 7 1 H	υ Γ		1
71 (1)	100	636 10	320	2	4 8 10 4 3	1
OVER	100	D VE R	528	2	11VER 4.5	0



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# LAND & WATER - NOON

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	87	AREA	Threshold = Mean + 3.00 $\checkmark$		
SQUARE METER	28	FREQUENCY	Wavelength = $3.5 - 3.9 \mu m$		
8.0 10	10.0	0	Mean = 281.20 Kelvin		
10.0 T()	15.0	3	$\sigma = 4.12$ Kelvin		
20.0 TU	25.0	<i>e</i> 1			
25.0 TO	30.0	1			
35.0 10	40.0	1			
40.0 TU 45.0 TU	45.0 50.0	0			
59.0 TU	75.0	4	<b>c</b> .		
100.0 TU	100.0	0	· · ·		
150.0 TO 200.0 TO	200.0	0			
250.0 TU	300.0	0			
300.0 TO 400.0 TO	400.0 500.0	C O			
OVER	500.0	0			

TOTAL NUMBER OF ELLIPTICAL AREAS = 13

60 FLATURES WITH ARFAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

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		BY PERIME	BY SHAPE			
METER	5	FFFT		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 10	7	0 T()	22	0	0.0 70 1.0	0
7 10	10	07 SS	32	0	1.0 TU 1.1	0
10 10	12	32 10	39	0	1.1 10 1.2	1
15 10	14	39 TD	45	1	1.2 10 1.3	0
14 10	16	45 10	52	0	1.3 TO 1.4	3
16 10	17	52 TO	55	o	1.4 TO 1.5	0
17 10	20	55 10	65	3	1.5 TU 1.6	j
20 10	52	65 TO	72	ī	1.6 TU 1.7	2
22 10	24	. 72 10	78	Ö	1.7 TO 1.8	1
24 10	26	78 10	85	1	1 A TU 1.9	ō
26 10	28	85 10	91	ō	1.9 10 2.0	0
28 10	30	91 TN	98	0	2.0 TH 2.4	5
30 10	32	98 10	104	0	2.4 10 2.6	1
32 10	34	104 TO	127	2	2.6 10 2.8	Ō
39 TO	45	127 10	147	ō	2 8 TO 5.0	0
45 10	55	147 TO	180	2	3.0 TO 3.5	0
55 TO	71	180 TO	532	3	3.5 T() 4.0	0
71 10	100	232 10	328	0	4.0 T() 4.5	0
OVER	100	<b>NVER</b>	328	0 '	INVER 4.5	0



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# LAND & WATER - NOON DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

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SQUARE	METERS	l	FREQUENCY
8.0	10	10.0	16
10.0	10	15.0	34
15.0	TU	20.0	24
20.0	TO:	25.0	17
25.0	10	30.0	R
30.0	10	35.0	3
35.0	TO	40.0	7
40.0	10	45.0	1
45.0	T()	50.0	5
50.0	τu	75.0	11
75.0	10	100.0	4
100.0	10	150.0	4
150.0	TO	200.0	1
200.0	TO	250.0	1
250.0	to	300.0	0
300.0	10	400.0	1
400.0	<b>T</b> ()	500.0	0
01	/£R	500.0	1

Threshold = Mean + 2.50  $\sigma$ Wavelength = 4.5 - 5.5  $\mu$ m Mean = 276.81 Kelvin  $\sigma$  = 1.20 Kelvin

TOTAL NUMBER OF ELLIPTICAL AREAS = 138

190 FEATURES WITH AREAS LESS THAN 8.00 SO. METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPE		
METERS		FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 10	7	0 T()	22	0	0.0 10 1.0	n	
7 10	10	22 10	32	Ó	1.0 TO 1.1	0	
10 10	12	32 10	39	ō	1.1 10 1.2	Ġ	
12 10	14	39 10	45	12	1.2 TO 1.3	51	
14 10	16	45 TO	52	0	1.3 10 1.4	20	
1. 10	17	52 10	55	18	1.4 TU 1.5	13	
17 10	20	55 10	65	16	1.5 TO 1.6	21	
20 10	22	· 65 TO	72	12	1.6 10 1.7	8	
22 10	24	72 10	78	0	1.7 TO 1.6	13	
2µ ±0	26	78 TO	85	14	1.8 TU 1.9	9	
26 TU	28	85 TU	01	8	1.9 10 2.0	5	
28 10	10	01 70	0A	8	2.0 10 2.4	17	
	12	OR TO	1 0 4	0	2.4 10 2.6	4	
30 10	10	104 10	127	17	2.6 10 2.8	2	
10 10	116	127 10	1 / 7	7	2.8 TO 3.0	2	
45 10	56	127 10 147 TO	140	ż	3.0 10 3.5	, ŝ	
40 IU KC 90	22	147 10	373	7	1 5 TO 4.0	2	
71 7	11		C 76		1 N 75 4 5	, r	
	100	232 10	275		0VER 4.5	í	



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#### LAND & WATER - NOON DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

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	UY AREA				Threshold = Mean + 4	4.15 σ
30	UARE	METERS		FREQUENCY	Wavelength = $4.5 - 1$	5 <b>.</b> 5 μm
					Mean = 276.81 Kelvi	n
	8,0	TO	10.0	4		
1	10.0	TO	15.0	10	$\sigma = 1.20$ Kelvin	
1	15.0	τo	20,0	1		
2	0.0	10	25.0	3		
2	25.0	fn	30.0	3		
2	50.0	TO	35.0	3		
2	\$5.0	to .	40.0	2		
4	40.0	tu	45.0	0		
4	45.0	to	50.0	1		
Ļ	0.0	tu	75.0	5		
I	15.0	10	100.0	0		
1 (	0.00	TO	150.0	0		
15	50.0	10	200.0	n		
50	0,00	tu	250.0	0		
25	50.9	7()	300.0	0		
30	0.00	τej	400.0	0		
4 (	00.00	то	500.0	0		
	(1 <b>v</b>	ER	500.0	0		

29 TOTAL NUMBER OF ELLIPTICAL AREAS =

SB FEATURES WITH ARFAS LESS THAN 8,00 SQ. METERS WERE ALSO RECOGNIZED

BY PERINETER					BY SHAPF		
METER	9	FFET		FREQUENCY	SHAPE FACTOR	FRFQUENCY	
0 TO	7	0 TO	22	0	0.0 10 1.0	С	
7 10	10	22 TO-	35	0	1.0 TO 1.1	0	
10 10	12	32 10	39	0	1.1 TO 1.2	0	
15 10	14	39 10	45	0	1.2 10 1.3	5	
14 TO	16	45 TO	52	Ō	1.3 TO 1.4	ដ	
16 10	17	52 TO	55	5	1.4 TO 1.5	3	
17 10	20	55 TO	65	4	1.5 TO 1.6	5	
01 05	55	65 TN	57	4	1.6 TO 1.7	1	
22 TO	24.	72 TU	78	0	1.7 TO 1.8	6	
24 TO	56	78 TO	85	2	1 8 70 1 9	0	
26 TU	85	85 TO	91	4	1.4 70 2.0	1	
28 10	30	S1 TO	9.8	2	2.0 TO 2.4	3	
30 10	32	98 TO	104	ō	2.4 10 2.6	0	
32 10	39	104 TO	127	ž	2.6 TO 2.8	2	
39 10	45	127 10	147	ō	2 8 TO 3 0	1	
45 10	55	147 10	180	3	3.0 TU 3.5	0	
55 TO	71	180 10	232	2	3.5 TU 4.0	1	
71 10	100	232 10	328	1 (	4 0 TU 4 5	0	
OVER	100	OVER	328	ċ	OVER 4.5	0	

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## LAND & WATER - NOON DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	t	Y ARE	٨
SQUARE METERS			FREQUENCY
S.0 TU 10.0 TO 15.0 TU 20.0 TU 25.0 TU 35.0 TU 35.0 TU 45.0 TU 50.0 TU 50.0 TU 75.0 TU 100.0 TU 250.6 TU 250.6 TU	10.0 15.0 25.0 35.0 35.0 45.0 50.0 75.0 150.0 250.0 250.0		21 53 27 10 8 10 5 7 3 5 4 20
250.0 TU 300.0 Tu 400.0 Tu Over	300.0 400.0 500.0 500.0		1 1 0 1

Threshold = Mean + 2.35 o Wavelength = 9.0 - 11.4  $\mu$ m Mean = 277.47 Kelvin o = 1.70 Kelvin TOTAL NUMBER OF ELLIPTICAL AREAS = 169

275 FEATURES WITH AREAS LESS THAN 8,00 SQ. METERS WERE ALSO RECOGNIZED

BY PERINETER					BY SHAPE		
METER	8	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 10	7	0 TC	22	0	6.0 TU 1.0	0	
7 19	10	22 TO	32	n	1.0 TO 1.1	0	
10 16	12	32 14	30	0	1.1 10 1.2	1	
15,10	:4	57 TU	45	5	1.2 10 1.3	12	
14 10	10	45 16	52	0	1.3 10 1.4	19	
16 1.1	17	52 Tu	55	25	1.4 70 1.5	18	
17 7 7	26	55 TU	65	27	1.5 10 1.6	75	
20 TO	55	65 10	72	18	1.6 10 1.7	10	
22 10	24	72 Tu	7 15	Ó	1.7 10 1.8	18	
24 73	25	78 TT	35	19	1 8 70 1 9	4	
28 74	26	85 10	91	R	1.9 10 2.0	15	
28 10	30	91 14	98	8	2 0 10 2 4	17	
34 TO	32	48 TO	164	0	2.4 10 2.6	11	
32 10	3.9	104 10	1 27	14	2.6 10 2.8	4	
39 T.)	25	127 TO	147	6	2 A TU 3.0	4	
45 10	5'2	147 10	180	11	3.0 10 3.5	2	
55 10	71	ា្រក វ័ព	232	14	3.5 10 4.0	1	
71 10	100	232 10	32B	7	4 0 10 4 5	ź	
9v6 R	100	(iv F R	326	7	OVER 4.5	1	



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## LAND & WATER - NOON DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	8 Y	AREA	Threshold = Mean + 3.79 o		
SQUARE METI	H8	FREQUENCY	Wavelength = $9.0 - 11.4 \ \mu m$		
$\begin{array}{c} 8, 0 & \mathbf{T} 0 \\ 10, 0 & \mathbf{T} 0 \\ 15, 0 & \mathbf{T} 0 \\ 20, 0 & \mathbf{T} 0 \\ 25, 0 & \mathbf{T} 0 \\ 30, 0 & \mathbf{T} 0 \\ 35, 0 & \mathbf{T} 0 \\ 45, 0 & \mathbf{T} 0 \\ 45, 0 & \mathbf{T} 0 \\ 50, 0 & \mathbf{T} 0 \\ 75, 0 & \mathbf{T} 0 \\ 100, 0 & \mathbf{T} 0 \end{array}$	10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0 150.0	3 9 7 2 6 2 1 0 3 1 0	Mean = 277.47 Kelvin σ = 1.70 Kelvin		
159.0 TO 200.0 TO 259.0 TO 399.0 TO 399.0 TO 499.0 TO DVER	200,0 250,0 300,0 400,0 500,0 500,0	1 0 0 0 0			

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TOTAL NUMBER OF ELLIPTICAL AREAS =

89 FEATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

31

BY PERIMETER					BY SHAPF		
METER	S	FEET		FREQUENCY	SHAPE FACTUR	FRFQUENCY	
0 T D	7	0 TO	55	0	0.0 10 1.0	0	
<b>7 1</b> 0	10	67 SS	32	ò	1.0 TO 1.1	0	
10 TO	12	32 10	39	0	1.1 10 1.2	0	
12 10	14	39 TO	45	3	1.2 10 1.3	Ľ	
14 TO	16	45 T()	52	ō	1.3 10 1.4	2	
16 10	17	52 10	55	Ĵ	1.4 10 1.5	1	
17 10	20	55 TO	65	- 6	1.5 10 1.6	i	
20 10	52	65 TO	72	ž	1 6 10 1 7	7	
55 I.U	2.1	07 ST	78	0	1 7 10 1 8	,	
24 TO	59	78 10	85	2	1.8 TU 1.9	1	
26 10	28	85 TO	91	4	1.9 10 2.0	i	
07 8S	30	91 TO	98	0	2.0 10 2.4	i	
30 10	32	96 TO	104	n	2.4 10 2.6	2	
35 10	39	104 TH	127	2	2.6 70 2.8	ō	
39 10	45	. 127 10	147	Ż	2.8 T() 3.0	1	
45 10	55	147 TO	180	1	3.0 TU 3.5	1	
55 TO	71	180 10	232	i	3.5 ID 4.0	0	
71 10	100	01 StS	328	2.	4.0 10 4.5	1	
11VE R	100	OVER	328			Å	



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### LAND & WATER - SUNSET DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

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	BY	AREA	Threshold = Mean + 2.00 $\sigma$		
SQUARE METER	₹S	FREQUENCY	Wavelength = $4.5 - 5.5 \mu m$		
8.0 TU 10.0 TU 15.0 TO 25.0 TO 25.0 TO 35.0 TO 40.0 TU 45.0 TU 50.0 TO 50.0 TO 150.0 TO 150.0 TO	10,0 15.0 20.0 25.0 35.0 40.0 45.0 75.0 100.0 150.0 200.0	10 22 24 8 4 4 4 4 1 15 4 3 2	wavelengtn = 4.5 - 5.5 μm Mean = 275.25 Kelvin σ = 0.26 Kelvin		
250.0 TO	270.0 300.0 405.0	1			
400.0 TO 400.0 TO OVER	400.0 500.0 500.0	2 0 2			

TOTAL NUMBER OF ELLIPTICAL AREAS = 113

191 FEATURES WITH AREAS LESS THAN 0.00 SO, METERS WERE ALSO RECOGNIZED

2

BY PERIMETER					BY SHAPE		
нетен	3	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 T(1	7	0 T()	22	0	0.0 TC 1.0	0	
7 10	10	22 T()	32	0	1.0 TO 1.1	0	
10 10	12	32 10	39	0	1.1 10 1.2	0	
12 10	14	59 TO	45	3	1.2 10 1.3	ě	
14 10	16	45 T()	52	0	1.3 70 1.4	10	
16 10	17	52 TO	55	11	1 4 70 1.5	î,	
17 10	20	55 70	65		1 S TO 1 S	15	
20 10	22	65 TO	72	6	1 A T(1 1 7	11	
22 10	24 .	12 10	79	0		1.0	
24 10	26	76 10	AL.	10	1 8 70 1 9	10	
26 10	28	85 10	01	14		10	
28 10	30	01 TO	08	4		, í	
Kn Til	13	44 10	40	0		15	
1.2 10	10	40 10	104	4.3	2.4 10 2.6	~	
3.6 1.0	די כ ווכ	114 11	101	12	2.6 10 2.8	2	
37 10	45	167 10	147	6	2.A 10 3.0	3	
45 10	<u>, , , , , , , , , , , , , , , , , , , </u>	147 T()	140	7	3,0 TU 3,5	3	
55 T/i	71	180 TH	232	11	3.5 TO 4.0	L	
71 10	100	232 to	328	9	4.0 TO 4.5	0	
UVER	100	OVER	328	В	ENVER 4.5	4	

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# LAND & WATER ~ SUNSET

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	-		6	Y AREA
	SQUARI	E METEI	25	FREQUENCY
and the second	8.0 1(.0 15.0 20.0 25.0 30.0 340.0 45.0 50.0 75.0	T0 T0 T0 T0 T0 T0 T0 T0 T0 T0 T0 T0	10.0 15.0 20.0 30.0 35.0 40.0 45.0 50.0 75.0	3 5 1 0 0 1 0 0
	100.0 150.0 200.0 250.0 300.0 400.0	TU TU TU TU TU TU (FR	150.0 250.0 250.0 300.0 400.0 500.0	

Threshold = Mean + 3.50 o Wavelength = 4.5 - 5.5  $\mu$ m Mean = 275.25 Kelvin o = 0.26 Kelvin ator idda af in side a maraktin allateor atilitati a ta

TOTAL NUMBER OF ELLIPTICAL AREAS \* 13

31 FEATURES WITH AREAS LESS THAN 8,00 SQ. METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPE		
METERS		FFET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 10	7	0 TO	22	Ô	0.0 TO 1.0	o	
7 10	10	01 55	32	0	1.0 70 1.1	Ó	
10 TO	12	32 10	39	Ó	1.1 10 1.2	ò	
12 10	14	39 T()	45	1	1.2 10 1.3	Ś	
14 10	16	45 TC	52	Ö	1.3 TU 1.4	1	
16 10	17	57 10	55	3	1.4 10 1.5	, 0	
17 10	20	55 TO	65	5	1.5 10 1.6	ž	
20 10	22	65 T.O.	72	ī	1 6 10 1.7	r. 1	
55 10	24.	72 10	78	ō	1.7 10 1.8	ó	
24 TO	26	78 TO	85	õ	1 A T() 1.9	ž	
26 11	28	85 10	91	ő	1 9 10 2.0	5	
28 TQ	30	<b>91</b> TO	98	Ň	201024	1	
30 T()	32	98 10	104		5 8 10 2 6		
32 10	59	104 10	127	1	2 4 TI) 2 A	,,	
39 10	45	127 10	147	-		Ŷ	
45 10	54	447 10	180			U	
55 10	71	180 10	212	Č,		0	
21 10	100	313 14	1.76	Ů,	3.5 10 4.0	0	
	100	r 37 10	250	U	4, 0° T() 4,5	0	
015	100	11V} H	320	0	OVER 4.5	0 D	



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#### LAND & WATER - SUNSET DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

Threshold = Mean + 1.76  $\sigma$ Wavelength = 9.0 - 11.4  $\mu$ m

Mean = 275.12 Kelvin

 $\sigma$  = 0.43 Kelvin

			8 Y	AREA
SQUARE	ME	IFRS		FREQUENCY
8.0 10.0 15.0 20.0 25.0 30.0 45.0 50.0 150.0 150.0 150.0 200.0 300.0	TO TO TO TO TO TO TO TO TO TO TO TO	$   \begin{array}{c}     10 \\     0 \\     20 \\     0 \\     25 \\     0 \\     30 \\     0 \\     35 \\     0 \\     40 \\     0 \\     50 \\     0 \\     75 \\     0 \\     100 \\     0 \\     300 \\     0 \\     400 \\     0 $		21 27 22 8 6 7 2 1 3 9 10 5 0 2 2 0
406.0 ()v	TO FR	5ng:0 500.0		1 3

TOTAL NUMBER OF ELLIPTICAL AREAS - 129

192 FEATURES WITH AREAS LESS THAN 8.00 BQ. METERS WERE ALSO RECOGNIZED

BY PERIMETER				8Y 3H	BY SHAPE		
METER	9	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 TO	7	0 70	22	0	0.0 TU 1.0	0	
7 10	10	22 TO	32	0	1.0 TU 1.1	0	
10 10	12	32 10	39	0	1.1 10 1.2	1	
12 10	14	39 10	45	8	1.2 TO 1.3	10	
14 10	16	45 10	52	Ó	1.3 10 1.4	ġ	
16 10	17	52 10	\$5	17	1.4 10 1.5	12	
17 10	20	55 TO	65	17	1.5 10 1.6	21	
20 10	22	65 10	72	12	1.6 10 1.7	15	
01 SS	24 .	01 57	78	0	1.7 10 1.8	11	
24 10	26	76 TO	A 5	13	1.8 10 1.9		
26 10	28	85 10	91	ĩ	19102.0	6	
28 10	30	91 TO	9A	ĩ	2.0 10 2.4	15	
30 10	32	98 TO	104	ò	2.4 10.2.6		
32 10	39	104 70	127	20	2 6 TO 2 8	5	
39 10	45	127 10	147	<u> </u>		1	
45 TO	55	147 10	180	6	3 0 7/1 3 5	1	
55 TO	71	180 10	212	6		1	
71 10	100	212 10	134	4.2		1	
	100	626 10	170	12		1	



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LAND & WATER - SUNSET DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

> Threshold = Mean + 3.00  $\sigma$ Wavelength =  $9.0 - 11.5 \, \mu m$

> > FREQUENCY

0

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0

Mean = 275.12 Kelvin

 $\sigma$  = 0.43 Kelvin

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TO

3.0 10 3.5

4.0 TO 4.5

OVER 4.5

TU 4.0

2.8

3.0

6

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	8 Y	AREA
BOUARE MET	ERS	FREQUENCY
8.0 TU	10.0	2
10.0 TU	15.0	5
≈15.0 TQ	20.0	4
20.0 T()	25.0	1
25.0 TH	30.0	1
30.0 10	35.0	õ
35.0 TU	40.0	Ó
40.0 TO	45.0	ť
45.0 TO	50.0	1
50.0 TU	75.0	1
75.0 TU	100.0	ő
100.0 T()	150.0	0
150.0 10	0.005	0
200.0 70	250.0	ö
250.0 TU	300.0	0
300.0 TO	400.0	0
400.0 TO	500.0	Ő
OVER	500.0	ň

TOTAL NUMBER OF ELLIPTICAL AREAS -

14

26

39 10

45 TO 55 TO

71 10

UVER

29 FEATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

16

BY PERIMETER BY SHAPE METERS FEET FREQUENCY SHAPE FACTOR 0 TO 7 TO 7 0 10 25 0 0.0 TO 1.0 22 TO 32 TO 10 10 32 0 1.0 TO 1.1 10 TO 39 12 0 τŋ 1.2 1. 15 10 14 39 T() 45 Q TO 1.3 1.2 52 55 10 16 45 tn 0 3 10 1.4 16 10 17 52 T() 2 4 τu 1.5 17 TO 50 55 TO 65 3 τ0 1.6 20 10 55 65 TO 72 3 τŪ 7 6 22 10 24 72 10 78 0 10 .8 24 10 26 78 TO 85 2 10 1.9 A 10 10 10 28 0 2 85 10 91 9 2,0 28 TH 30 91 TO 98 Ô 2.4 30 10 37 10 32 39 9 B ΤO 104 0 4 τ0 2.6

1

0

1

2

0

0

127

147

180

535

328

328

104 TO

.127 TO

147 TO

180 10

232 TO

OYER

45

55 71

100

100



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# LAND & WATER - MIDNIGHT DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

			8 ¥	ARFA
SQUARE	METE	RS		FREQUENCY
8.0	10	10.0		9
10.0	70	15.0		.11
15.0	TU	20.05		12
20.0	TO	25.0		8
25.0	10	30.0		>
30.0	10	35.0		2
35.0	TU	46.0		2
40.0	то	45.0		0
45.0	10	50.0		2
50.0	T()	75.0		5
75.0	T1)	100.0		4
100.0	10	150.0		2
150.0	<b>T</b> ()	200.0		2
500.0	1()	250.0		0
250.0	10	300.0		0
300.0	<b>T</b> ()	400.0		1
400.0	<b>T</b> 0	500.0		0
01	(ER	500.0		1

Threshold = Mean + 3.00  $\sigma$ Wavelength = 4.5 - 5.5  $\mu$ m Mean = 274.96 Kelvin  $\sigma$  = 0.07 Kelvin

TOTAL NUMBER OF ELLIPTICAL AREAS =

238 FEATURES WITH AREAS LESS THAN 8.00 SR. METERS WERE ALSO RECOGNIZED

63

BY PERIMETER					HY SHAPE		
METER	5	FFET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 10	7	0 10	22	0	0.0 TO 1.0	0	
7 10	10	55 TO	32	0	1.0 TU 1.1	0	
10 10	12	32 10	39	0	5.1 07 1.2	Ō	
12 10	14	39 TO	45	Ó	1.2 10 1.3	Ő	
14 TO	16	45 10	52	0	1.3 TO 1.4	3	
16 10	17	52 TO	55	3	1.4 10 1.5	1	
17 10	20	55 TO	65	10	1.5 TU 1.6	ŝ	
20 TO	22	65 TO	72	4	1 6 TO 1.7	5	
22 10	24	72 10	78	0	1 7 10 1.8	, ,	
24 10	26	78 TO	R.S.	Š	1 8 10 1.9	ž	
26 10	28	A5 10	61	ĩ		5	
28 10	30	91 10	O.A	, J 1		1	
30 10	32	08 7/1	10	5	7 4 70 7 K		
12 70	10	404 10	104	7			
30 10		437 70	101	4	2.0 10 2.0	1	
37 111	• ) • :	127 10	147	3	2.6 10 3.0	5	
45 111	22	147 10	140	•	3.0 TU 3.5	6	
55 10	$\overline{\Lambda}$	180 TO	535	5	3.5 10 4.0	2	
71 TA	100	232 TO	328	4	4,0 T() 4,5	0	
UVER	100	OVER	328	7	OVEH 4.5	3	



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## LAND & WATER - MIDNIGHT DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	8 Y	AREA	Threshold - Mean + 4 97 ~
SQUARE METE	КS	FREQUENCY	Wavelength = 4.5 - 5.5 $\mu$ m
8.0 TO 10.0 TO 15.0 TO	19.0 15.0 20.0	1 5	Mean = 274.96 Kelvin σ = 0.07 Kelvin
20.0 TO 25.0 TO	25.0 30.0 35.0	1	
35.0 TO 40.0 TO 45.0 TO	40.0 45.0 50.0	1 0	
59.0 TI) 75.0 TI) 100.0 TC	75.0 100.0 150.0	0	
150.0 TO 200.0 TO 250.0 TO	200.0 250.0 300.0	1 0 0	
300.0 TO 400.0 TO OVER	400.0 500.0 500.9	0 C 0	

TOTAL MOMBER OF ELLIPTICAL AREAS = 11

53 FEATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPF		
METERS		FRET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 TO	7	0 10	22	0	0.0 TU 1.0	0	
7 10	10	22 TO	32	0	1.0 TO 1.1	ò	
10 TO	12	32 16	39	0	1.1 70 1.2	Ó	
12 10	14	39 10	45	Ō	1.2 TO 1.3	1	
14 TO	16	45 10	52	Ő	1.3 TU 1.4	ō	
16 10	17	52 TO	55	1	1.4 10 1.5	ż	
17 10	20	55 10	65	ī	1.5 10 1.6	0	
20 10	22	65 70	72	2	1.6 10 1.7	1	
22 10	24	72 10	78	ō	1.7 10 1.8	ī	
24 10	26	78 TO	AS	4	1.6 YO 1.9	1	
56 10	28	85 10	91	0	0.5 UT 9.1	1	
28 10	30	91 TO	98	ō	2.0 10 2.4	ż	
30 10	32	98 10	104	ō	2.4 10 2.6	ō	
32 10	39	104 10	127	1	2.6 10 2.8	0	
39 10	45	127 10	147	ò	2 8 10 3.0	õ	
45 10	55	147 10	180	i	3.0 1() 3.5	1	
55 t0	71	180 10	232	ō	3.5 () 4.0	0	
71 10	100	232 10	328	0	4.0 10 4.5	ő	
	100	0 - C - C - C - C - C - C - C - C - C -	1.50			Ň	

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LAND & WATER ~ MIDNIGHT DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	RA RA	AREA
SQUARE METER	R 5	FREQUENCY
8.0 TU	10.0	1
10.0 10	15.0	11
15.0 TO	50.0	
20.0 TU	25.0	2
25.0 10	30.0	3
30.0 TO	35.0	۱
35.0 10	40.0	0
40.0 10	45.0	1
45.0 TC	50.0	0
50.0 TO	75.0	4
75.0 TU	100.0	5
100.0 TO	150.0	2
150.0 TO	500.0	0
506°0 10	250.0	0
250,0 TO	300.0	1
300.0 TH	400.0	1
400.0 TU	500.0	0
OVER	500.0	3

Threshold = Mean + 3.00  $\sigma$ Wavelength = 9.0  $\sim$  11.4  $\mu$ m Mean = 274.74 Kelvin  $\sigma$  = 0.11 Kelvin

TOTAL NUMBER OF ELLIPTICAL AREAS =

99 FEATURES WITH ARFAS LESS THAN 8.00 SQ. METERS WERE ALSO RECUGNIZED

41

HY PERIMETER					BY SHAPE		
METERS	i	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 TO 7 TO 10 TO 12 TO 14 TO 16 TO 16 TO 17 TO	7 10 12 14 16 17 20	0 TU 22 TU 32 TU 39 TU 45 TU 52 TU 55 TU	22 32 39 45 55 65	0 0 0 2 5	0.0 TO 1.0 1.0 TO 1.1 1.1 TO 1.2 1.2 TO 1.3 1.3 TO 1.4 1.4 TO 1.5 1.5 TO 1.6	0 1 1 3 3	
20 TO 22 TO 24 TO 26 TO 26 TO 28 TO 30 TO 32 TO	22 24 26 30 32 32	65 TO 78 TO 85 TO 91 TO 98 TO 104 TO	72 78 85 91 98 104 127	6 0 1 3 0 3	1.6 TU 1.7 1.7 TU 1.8 1.8 TU 2.0 2.0 TO 2.4 2.4 TU 2.6 2.6 TU 2.6 2.6 TU 3.0	s 2 3 2 4 3 2 0	
39 T() 45 TO 55 TO 71 TO UVER	45 55 71 100	127 TO 147 TO 180 TO 232 TO OVER	147 180 232 328 328	4 1 4 3 8	3.0 TU 3.5 3.5 TO 4.0 4.0 TU 4.5 OVER 4.5	2 2 4	


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# LAND & WATER - MIDNIGHT DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

Threshold = Mean + 5.15  $\sigma$ Wavelength = 9.0 - 11.4  $\mu$ m

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Mean = 274.74 Kelvin

 $\sigma$  = 0.11 Kelvin

	ßA	AREA
SUUNPE METE	нS	FREQUENCY
5.0 T()	10.0	0
10.0 10	15.0	3
15.0 TO	<b>20.0</b>	0
20.0 10	25.0	1
25.0 TO	30.0	S
30.0 T()	35.0	1
35.0 TU	40.0	0
40.0 TO	45.0	1
45.0 TU	50.0	0
50.0 TU	75.0	5
75.0 79	100.0	0
100.0 TH	150.0	0
150.0 11	200.0	0
200.0 70	250.0	0
250.0 10	300.0	Ŭ
300.6 10	400.0	n
400.0 TO	500.0	С
OVER	500.0	0

TOTAL NUMBER OF ELLIPTICAL AREAS =

19 FEATURES WITH AREAS LESS THAN 8.0) SO. METERS WERE ALSO RECOGNIZED

10

BY PERIMETER					BY SHAPE		
METER	S	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 10	7	0 TO	22	0	0.0 10 1.0	0	
7 10	10	01 55	32	0	1.0 10 1.1	0	
0 10	10	32 10	39	0	1.1 10 1.2	0	
2 10	14	39 10	45	0	1.2 103	0	
4 11)	16	45 10	52	Ō	1.3 10 1.4	0	
6 10	17	52 TG	55	õ	1.4 10 1.5	2	
7 10	20	55 TO	65	2	1.5 10 1.6	2	
0 TO	22	65 10	72	ĩ	1.6 TU 1.7	1	
01 5	24	72 10	78	Ó	1.7 70 1.8	0	
94 10	26	78 10	85	0	1.8 TO 1.9	2	
6 70	28	85 TO	91	0	1.4 10 2.0	Ú	
PB TO	50	91 TO	9.8	1	2.0 TU 2.4	2	
50 10	32	IT AP	194	0	2.4 70 2.6	1	
11 57	39	104 TO	127	3	5.6 TU 2.8	0	
39 TO	45	127 10	141	1	2.8 10 3.0	0	
15 10	55	147 10	140	0	3.0 TU 3.5	0	
5 TU	71	189 TO	232	1	3.5 10 4.0	0	
71 19	100	232 TO	328	1	4.0 10 4.5	0	
DVER	100	OVER	32'1	0	OVER 4-5	0	

3.5-275

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### MICHIGAN WINTER SCENE - LAND & WATER

Power Spectra

Spectral Bands: 3.5 - 3.9 μm 4.5 - 5.5 μm 9.9 - 11.4 μm

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Area: LAND & WATER Wavelength = 3.5-3.9 (+), 4.5-5.5 (×), 9.0-11.4 (⊡) POWER SPECTRA - MICHIGAN WINTER SCENE: NOON - (ANGLE: 35 DEG.) - IN-TR/CK

\*\* Power Spectral Density is (\*K)<sup>2</sup>/cycle/meter for 3.5 to 3.9 µm, 4.5 to 5.5 µm and 9.0 to 11.4 µm bands. e.

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MILL CREEK, OKLAHOMA\*

Pertinent Scene and Flight Information

(Date of Flight: 30 June 1972)

\* For specific discussions of these and associated data for this scenery, refer to Reference 1.

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# MILL CREEK Data

Wavelength Bands:

1.0-1.4 μm, 1.5-1.8 μm, 2.0-2.6 μm, 9.3-11.7 μm

IFOV: 2.5 mrad (cross-track); 5.0 mrad (in-track)

Altitude: 3000 ft

Depression Angle: 90°

Southeast

Time: 0730 hrs Flight Direction:

Ground Speed: ~200 ft-sec<sup>-1</sup>

<u>Area Covered (Approx.)</u>: 4000 ft long x 4800 ft wide <u>Meteorology</u>: Visibility 30 mi; dry; cloud cover 30%

3.6-2





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بيقت مطور لقرائل المترومات

9.3 - 11.7 µm

india menistration

Lauddarlindin dalar

LINE SCAN IMAGES PRODUCED FROM THE VARIOUS INFRARED CHANNELS OF MILL CREEK

3.6-4



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## MILL CREEK, OKLAHOMA

Histograms\*

Spectral Bands: 1.0 - 1.4 μm 1.5 - 1.8 μm 2.0 - 2.6 μm 9.3 - 11.7 μm

3,6-6

Circles define a Gaussian curve with the same mean and standard deviation as the actual bistogram. An "S" on some curves indicates saturation. Because of limits on gain settings some values may exist beyond the digital limits of 0 and 255, the digital dynamic range of the data processing.



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#### MILL CREEK, OKLAHOMA

Means and Standard Deviations for Spectral Bands Correlations Between Spectral Bands

Spectral Bands: Channel 2:  $1.0 - 1.4 \ \mu m \ (\mu W - cm^{-2} - sr^{-1} - \mu m^{-1})$ Channel 3:  $1.5 - 1.8 \ \mu m \ (\mu W - cm^{-2} - sr^{-1} - \mu m^{-1})$ Channel 4:  $2.0 - 2.6 \ \mu m \ (\mu W - cm^{-2} - sr^{-1} - \mu m^{-1})$ Channel 5:  $9.3 - 11.7 \ \mu m \ (^{\circ}K)$ 

<sup>\*</sup>Because of the relatively small temperature changes in the scenery, there is a nearly linear relationship between the temperature and radiance statistics for the thermal channels. It is pertinent, therefore, to compute correlations between radiance and temperature channels.

#### MILL CREEK

Number of Subregions = 1Pixel Subarea Divisions at: 1 645 11 276 Line Subarea Divisions at: Line Increment Used = 1 Pixel Increment Used = 1 2 (1.0 - 1.4 µm) Correlation Channels:  $\begin{array}{c} 1.5 - 1.8 \ \mu\text{m} \\ 4 \ (2.0 - 2.6 \ \mu\text{m}) \\ 5 \ (9.3 - 11.7 \ \mu\text{m}) \end{array}$ 

Correlation	2	3	4	5
2	1.000			
3	0.835	1.000		
4	0.869	0.880	<b>1.00</b> 0	
5	0.052	0.256	0.245	1.000

Channe1s	2	3	4	5
Mean	1.1220E+02	3.5919E+01	4.1767E+00	2.9811E+02
St. Dev.	6,2268E+01	2.0177E+01	2 <b>.9</b> 106 <b>E+0</b> 0	9.7983E-01
Total Points	171570	171570	171570	171570

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DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

HY A;		REA	Threshold = Mean + 2.50 $\sigma$				
SUUARE METERS			FREQUENCY	Wavelength = 1.0 - 1.4 $\mu$ m			
	0. 100. 200.	0 TO 0 TO 0 TO	100 200 500	• 0	139 21	Mean = 112.20 $\mu$ W-cm <sup>-2</sup> - g = 62.27 $\mu$ W-cm <sup>-2</sup> -sr <sup>-1</sup>	sr <sup>-1</sup> -µm <sup>-1</sup> - µm <sup>-1</sup>
1	500.	n 111 n 10	1000	0	S S		<b>F</b>
1 2	500.	n TO 9 TO	2500	9 0	0		
2	500.	0 10 0 10	3000.	0	0 2		
4 5 6	000.000.000	6 10 6 10 6 10	5000, 6000,	.0 , 0	1		•
8 10	600.0 600.0	0 TU 0 TU 0 TU	10000 10000 15000	.0 .0	1		
15	500.1	1 1 Ú 1 TÚ	20000	0	0		
40 80	000 <b>.</b> 0 000.0	1 10 1 10 1 10	80000. 160000.	, G , Q	n 0		
TOTAL	NUMBE	ROFI	LLIPTICAL	AREAS =	180		
			BY PER	THEIGR		BY S	APE
M	rteks	;	FE	ET	FREQUENCY	SHAPE FACTOR	FREQUENCY
0 50	17 10	50	0 T 164 T	1) 164 1) 328	13/1	0.0 T() 1.0	U
100	10	150	32A T	11 492	6	1.1 TO 1.2	9 40
500	tn	250	656 1	0 520 0 520	6 1	1.2 TO 1.5 1.3 TO 1.4	A 05
520	רז	300	820 T	ጣ ዓዳቆ	n	1.4 TO 1.5	

METERS	FEET	FREDHENCY	SHAPE FACTOR	
0 TH - 50	0 TO	164 134	0.0 T(1 1.0	
50 10 100	164 TN	328 26	1.0 TO 1.1	
100 10 150	328 TH	492 6	1.1 Th 1.2	
150 10 200	492 TO	656 6	1.2 Th 1 L	
200 Tr 250	656 10	620 1		
250 TH 300	820 TO	944 0	1.0 10 1.5	
300 10 350	984 TO 1	148 3	1.5 10 1.6	
350 10 400	1148 TO 1	312 0		
400 TA 500	1312 10 1	644 0	1 7 YO 1 A	
500 17 600	1649 TO 1	0		
600 17 700	1968 10 2	290 0		
700 10 800	2296 TO 20	0.24 0		
800 10 900	2624 10 2	95.2 0		
900 10 1000	2052 10 3	24.5 4		
1000 10 1200	2200 10 10	237 0		
1200 10 1000	3947 11 41	197 9 198 0		
1/00 10 1600	4505 10 4	713 U 1101 D	6.9 10 3.9	
1601 10 2000	5040 to 41		5.0 11 5.4	
0000 11 6000			3.5 11 4.0	
0 VE 16 2 10 U	TANKS OF	251 }	UA65 0.6	

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DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

HY ARFA			- Δ	Threshold = Mean + 3.00 $\sigma$			
SOHARE METERS				FREDUENCY	Wavelength = $1.0 - 1.4 \mu m$	1	
	ο.	0 10	100.0		173	Mean = 112.20 $\mu W_{cm}^{-2}$ -sr	·]]
	100.	0 10	200.0		7	- 2 - 1	-1
	200.	n TO	500.0		ż	σ = 62.2/ μW-Cm -sr -μπ	1
	500.	0 10	1000.0		3		
1	000.	0 10	1500.0		0		
i i	500.	0 10	2000-0		ő		
ż	600.	0 TO	2500.0		<u>0</u> ·		
2	500.	0 10	3000-0		0	\$	
3	600.	0 TU	4900-0		0		
4	0.00	0 10	5000-0		õ		
5	000.	n TU	6090.0		Ô		
6	600.	0 10	8000.0		0		
8	000.	0 10	10000.0		0		
10	600	2 10	15000.0		ñ		
15	000.	n tō	20000.0		0		
20	000.	n 10	40000.0		Ô	•	
40	600.	n 11)	ธกลุยล. ด		0		
80	000.	0 10	160000.0		0		
		UNER	160010.0		0		
TCTAL	NUMB	ER OF I	LLIPTICAL ARE	AS =	190		
			ЙА БЕНІА	LTCR		BY SHA	ÞE.
M	TER	S	FFET		FREQUEN	CY SHAPE FACTOR	FREGHENCY
0	n	50	0 T/I	164	169	0.0 70 1.0	0
50	tn.	100	164 TI)	328	11	1.0 10 1.1	0
100	T:	150	329 TO	472	4	1.1 10 1.2	159
150	1n	200	492 10	656	5	1.2 19 1.3	5
200	10	250	656 10	950	0	1.5 1.1.4	19
2:50	Tn	300	820 TO	994	1	1.4 70 1.5	2
300	17	350	984 TO	1148	0	1.5 1.1.0	14
350	TO	400	1148 10	1315	0	1.6 11 1.7	14
100	17	500	1312 10	1645	V	1.7 TO 1.8	ા

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1.8 10 1.9

1.9 10 2.0

2.0 10 2.2

1.5 UT 5.5

5.4 10 5.6 8.5 UT 6.5

2.8 11 3.0

3.0 10 3.5

3.5 TO 4.0

9VEP 4.9

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1649 TO

1968 TO

2296 10

2020 10

2952 TO 3248 TO

3437 10

1543 10

5249 10

**DVER** 

1968

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2052

3240

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4593

\$249

6561

6551

600

700

800

900

500 TO

600 11

700 10

600 10

900 10 1000

1000 TO 1200

1200 10 1400

1400 1-1 1600

1600 TH 2000

0AF8 5000

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Area: MILL CREEK (Wavelength =  $9.3 - 11.7 \mu m$ ) Temperature Threshold = Mean +  $2.50 \sigma$ Mean = 298.11 Kelvin Std. Dev. =  $\sigma$  = 0.98 Kelvin EQUIVALENT ELLIPTICAL AREAS

## 3.6-18

				MILL	CREEK				
C	DIST	RIBUTION	OF	ELLIPTICAL	AREAS	GREATER	THAN TH	RESHOLD	
		ŧ	3Y (	AREA	Th	meshold :	= Mean +	2.50 o	
SQUARE	MEI	FRS		FREQUENC	r Wa	velength	= 9.3 -	11.7 µ	m
	in	100.0		229	Me	ean = 298	.11 Kelv	in	
100 0 1	14)	200.0		16	_	- 0 98 K	alvin		
200.0 1	10	500.0		11	σ	= 0.90 K	ervin		
500.0 1	r.j	1600.0		2					
1600.0 1	ru	1500.0		3					
1500.0	ŧõ –	2000.0		5					
2000.01	Ti)	2500.0		L. L.					
2500.0 1	1.1	3000.0		1.					
3604.1 1	10	aneg <b>.</b> 0		0 0					
4900.0	1+1	5000.0		0					
5000.0	111	6600.0		0					
6000.0	10	8000.0		n •					
8660.0	10	10060.0		v ,					
10000.0	1.)	1906.0		1					
15000.0	10	20000.0		3					
50000.0	10	4000.0		0					
40000.0	111	80000.0		9					
	10 Fil	160000.0		0					
OTAL NUMBER	OF E	LLIPTICAL ARE	AS .	- 206					
				. 0				B4 5"	8 PT
		BA DEM1.	1.1						EDUAT
METERS		P.E.F. 1	•	F RE GI	nf.at A		SHAPE I	46107	P KE GILLAC
0 17	50	0 10	1	164 2	2.3		0.0 10	1 1.0	0 0
50 10 1	00	164 (71)	1	328	55			1 Lat 5 1 2	161
100 10 1	50	328 Th		192	н			1 1 4	
150 10 2	00	495 10		556	3		1.2.1	1 1 4	27
500 10 5	150	656 10	-	45u			1.0 10	11.5	10
250 Th 3	00	820 10		444 4	5		1.5 1	11.0	11
300 11 3	50	984 T7)	1	146	L D		1.5 1	1.7	15
350 10 1	100	1148 10		31C 6.0.0	2		1.7 1	1 1.0	6
400 10 5	500	1312 10	11	040 06 d	1		1.8 T	1 1.9	>
500 10 6	500	1040 10	ן ר	294	i		1.4 1	0.5 (	6
600 11 7	100	1767 IV	2	624	ò		2.0 1	<b>5.</b> 5 0	5
700 10 d	500 500	2620 10		952	0		2.7.7	1 2.4	3
11 CUS 11 1	100	2077 14	- 5	220	1		2.8 T	0.5.6	5
1000 10 13	200	3,240 10	3	437	Û		2.6 1	1 5 8	e .
1200 10 10	100	3937 10	- a	593	0		2.8 1	1 3.0	۲.
1400 10 10	510	49,93 Tr	٤,	245	0		3.0 1	11 5.3	v 1
1600 11 20	190	5249 10	É1	561	0		3.5 1	11 4 <b>6</b> 7	3
OVER 20	000		ú	561	1		ti A (	<b>α.ч</b> ∎V	•.

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Area: Mill CREEK (Wavelength \* 9.3 - 11.7 pm) Temperature Threshold \* Mean + 3.00 o Mean \* 298.11 Kelvin Std. Dev. \* o \* 0.98 Kelvin EQUIVALENT ELLIPTICAL AREAS

3.6-20

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D	ISTRIBUTION	MILL OF ELLIPTICAL	CREEK AREAS GREATER THAN THRESHOLD
SDUARE M	ETFRS	BY AREA FREQUENC	Threshold = Mean + $3.00 \sigma$ Wavelength = $9.3 - 11.7 \mu m$ Hean = 298.11 Kelvin
100.9 10 200.0 10 500.0 10 1000.0 10 1500.0 10 2000.0 10 2500.0 10	5 2000 5 5000 1 100000 1 150000 1 200000 1 200000 1 200000 3 300000	710000000000000000000000000000000000000	σ = 0.98 Kervin
3000.0 TU 4000.0 To 5090.0 To 6000.0 To 8000.0 To 10000.0 To	1 4000.0 1 5000.0 1 6000.0 3 8000.0 1 10000.0 1 15000.0		
15000.9 10 20000.0 10 40000.9 10 80000.9 10 80000.9 10 90F1	) 20000.0 J 40000.0 ) 40000.0 J 100000.0 3 100000.0		

TOTAL NUMBER OF ELLIPTICAL AREAS -

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ERIM ۲ ; MILL CREEK, OKLAHOMA Power Spectra ٩ Spectral Bands: 1.0 - 1.4 μm 1.5 - 1.8 μm 2.0 - 2.6 μm 9.3 - 11.7 μm \$,

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1100 - 11000 - 11000 - 1100 - 1100 - 1100 - 1100 - 1100 -





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#### MONO LAKE Data

Wavelength Bands: $1.0-1.4 \ \mu\text{m}$ ,  $2.0-2.6 \ \mu\text{m}$ ,  $4.5-5.5 \ \mu\text{m}$ ,  $8.0-13.5 \ \mu\text{m}$ IFOV:  $3.5 \ \text{mrad}$  (cross-track);  $6.6 \ \text{mrad}$  (in-track)Altitude: 4000 ftDepression Angle:  $90^{\circ}$ Time: 1000 hrsFlight Direction: SouthGround Speed:  $\sim 200 \ \text{ft-sec}^{-1}$ Area Covered (Approx.): 3100 ft wide x 6750 ft long

<u>Meteorology</u>: Visibility > 15 mi; clear and bright; dry

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# MONO LAKE, CALIFORNIA

Histograms\*

Spectral Bands: 1.0 - 1.4 μm 2.0 - 2.6 μm 4.5 - 5.5 μm 8.0 - 13.5 μm

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\* Circles define a Gaussian curve with the same mean and standard deviation as the actual histogram.





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#### MONG LAKE, CALIFORNIA

Means and Standard Deviations for Spectral Bands Correlations Between Spectral Bande"

Spectral Bands: Channel 2:

1.0 - 1.4  $\mu m$  ( $\mu W - cm^{-2} - \mu r^{-1} - \mu m^{-1}$ ) 2.0 - 2.6  $\mu$  ( $\mu$ W-cm<sup>-2</sup>-sr<sup>-1</sup>- $\mu$ m<sup>-1</sup>) Channel 4: 4.5 - 5.5 µm (°K) Channel 5: Channel 20: 8.0 ~ 13.5 µm (°K)

<sup>\*</sup> The Mono Lake data were collected with an M-5 scanner with thermal calibration plates in part of the scanner field-of-view. The 8.0-13.5 µm detector and the 1.0-1.4, 2.0-2.6, 4.5-5.5 µm detectors were on opposite ends of the scanner and are not in spatial registration. Hence, spectral correlation coefficients were not determined between the 8.0-13.5 µm data and the 1.0-1.4, 2.0-2.6, and 4.5-5.5 µm data.

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م المحاصفي : مالك المحاصفي المحاص

Number of Subregions =	1				
Pixel Subarea Divisiona	i at	: )		311	L
Line Subarea Divisions	at i	: 1(	,	260	j i
Line Increment Used = 1	Į	-			
Pixel Increment Used -	1				
Correlation Channels:	2	(1.0	-	1.4	µm)
	4	(2.0	-	2.6	pm)
	5	(4.5		5.5	µm)

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Correlation	2	4	5
2	1,000		
4	0,892	1,000	
5	0,833	().814	1,000

Channela	2	4	5	20
Maan	2.05348+03	9.4652E+01	2,8552E+02	2.8850E+0z
GL. Dev.	<b>3</b> , 3430E402	<b>1.</b> 68048+01	<b>1.3</b> 413E+00	1,57898400
Total Points	79360	79360	79360	87730

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MONO LAKE, CALIFORNIA

Ellipse Statistics

Spectral Band: 4.5 - 5.5 µm

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Area: MONO LAKE (Wardlength =  $4.5 - 5.5 \mu$ m) Temperature Threshold = Mean + 0.63  $\sigma$ Mean = 285.52 Kelvin Std. Dev. =  $\sigma$  = 3.34 Kelvin EQUIVALENT ELLIPTICAL AREAS

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# MONO LAKE

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

BY AREA			Tireshold = Mean + 0.63 c		
SQUARE METERS		FREQUENCY	Wavelength = $4.5 - 5.5 \mu$		
			Mean = 285.52 Kelvin		
8C.0 TO	100.0	0	- 1 24 Kolvin		
100.0 10	150.0	60	$\delta = 1.34$ Kervin		
150.0 10	200.0	19			
200.0 10	250.0	14			
250.0 10	300.0	8			
300.0 TO	400.0	20			
400.0 '0	5.2.0	15			
OV FR	500.0	40			

TOTAL NUMBER OF ELUCTICAL AREAS = 170

87 FEATURES WITH AREAS LESS THANBO.00 SQ. METERS WERE ALSO RECOGNIZED

		DY PERIME	BY SHAPE			
MET	ERS	FEET		FREQUENCY	SHAPE FACTUR	FREQUENCY
0 1	10 7	0 70	55	0	0.0 TU 1.0	0
7 1	10 10	01 SS	32	U	1.0 10 1.1	Û
10 1	ST 81	35 10	39	0	1.1 10 1.2	31
12 1	14	39 (0	45	0	1,2 10 1,3	39
14 1	10 16	45 TO	52	0	1.3 10 1.4	22
16 1	10 17	52 TO	55	0	1,4 11 1,5	17
17 1	10 20	55 10	65	0	1,5 10 1,6	13
20	10 22	65 10	72	0	1.6 TO 1.7	10
22 1	10 24	72 10	78	Ō	1.7 10 1.8	10
24 1	10 26	78 10	A5	0	1 A TH 1.9	6
26	10 28	85 TO	91	0	1.9 10 2.0	5
58 .	rn 30	91 TO	98	0	2.0 10 2.4	10
30	10 35	98 TO	104	0	2.4 TU 2.6	2
32	10 39	104 TO	127	O	2.6 10 2.8	1
34 '	10 45	127 10	147	30	2 A TO 3 0	Ž
45	10 55	147 10	190	23	3,0 10 5,5	1
55	10 71	180 TO	535	29	3.5 10 4 0	2
71	10 100	232 10	328	32	4 5 TH 4 5	1
άV	ER 100	OVER	328	62	OVER 4.5	د ا



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- 作品語品語語 小品 市内部分 いい 日本 おうてきを加加する 日本語 小品語 医薬 いる美容力 二字 使快快的 時間 一下

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## MONO LAKE

# DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	67	Y AREA	Threshold = Mean + 1.63 $\sigma$
SQUARE METE	R 8	FREQUENCY	Wavelength = 4.5 - 5.5 $\mu$ m
80.0 TU 100.0 TU 150.0 TU 200.0 TU 250.0 TU 300.0 TU 400.0 TU	100.0 150.0 200.0 250.0 300.0 400.0 500.0	0 7 0 3 5 0	Mean = 285.52 Kelvin σ = 1.34 Kelvin
OVER	500.0	8	

TOTAL NUMBER OF ELLIPTICAL AREAS - 23

13 FEATURES WITH AREAS LESS THANBOIDD SD. METERS WERE ALSO RECOGNIZED

	HY PERIMETER			BY SHAPE		
METER	S	FFET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 10	7	0 T()	22	0	0.0 10 1.0	1
7 10	10	22 10	32	0	1.0 10 1.1	0
10 10	51	32 10	39	Ù	1.1 11 1.2	4
12 10	14	39 111	45	õ	1.2 TO 1.3	2
14 10	16	45 10	52	ō	1.3 TU 1.4	2
16 10	17	52 10	55	0	1, 0 10 1,5	2
17 10	20	55 10	65	ō	1.5 10 1.6	3
20 10	22	15 11	72	ō	1.6 10 1.7	5
22 10	24	72 10	78	ō	1.7 TU 1.8	n
24 11	26	78 10	25	ů	1.8 10 1.9	1
26 10	28	P5 10	91	0	1.4 10 2.0	0
28 10	30	91 10	4A	õ	2 0 11 2 4	5
36 10	12	QA T.1	104	0	2. 11 11 2.6	v
12 10	34	104 10	121	i	2.6 10 2.8	0
19 10	45	127 10	107	4	2 P TH 3.0	n
45 10	55	147 10	180	1	1.0 11 1.5	0
55 10	21	180 10	212	i	3.5 10 4.0	0
71 10	100	312 10	1.76	, L	4.0 1 4.5	0
	4 11 12	6 JF 111	1 1 8	11	OVER 4 S	ņ

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MONO LAKE, CALIFORNIA

Power Spectra

Spectral Band: 4.5 - 5.5 µm



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NELLIS AFB, NEVADA\*

Pertinent Scene and Flight Information (Dates of Flights: 25,26 February 1978)

\*For specific discussions of these and associated data for this scenery, refer to References 2 and 3.

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Mountainous Terrain

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Wavelength Bands:	
NEVB: 3.5-3.9 μm NEVF: 3.5-3.9 μm NEVG1: 2.0-2.6 μm NEVI: 2.0-2.6 μm	, 3.0-4.2 μm, 4.5-5.5 μm, 9.0-11.4 μm , 3.0-4.2 μm, 4.5-5.5 μm
NEVM: 3.5-3.9 μm NEVN: 2.0-2.6 μm	, 3.0-4.2 μm, 4.5-5.5 μm, 9.0-11.4 μm
IFOV: 2.5 mrad	
Altitude:	Depression Angle:
NEVB(F,I,M,N) 1000 ft	NEVB(F,1,M,N) 35°
NEVG1 1750 ft	NEVG1 90°
Time:	Flight Direction:
NEVG1: 0930 h NEVF(M,N): 1100 h NEVB(I): 1500 h	rs NEVB(F,1,M,N): East rs NEVG1: West rs
Ground Speed: 200 ft-	sec <sup>-]</sup>
Area Covered (Approx.)	: 1750 it wide x 6750 ft long
Meteorology:	
(2-25-78, AM) - NE High, thin scat	VF(G1) tered clouds; visibility = 15 mi.
(2-25-78, PM) - NE Scattered cloud	VB(1) s; light haze; visibility - 35 mi.
(2-26-78, AM) - NE Bigh overcast:	VM(N) light haze: visibility = 15 mi.

3.8-2

#### Desert Terrain (Including Dry Lake)

Wavelength Bands:

NEVC1: 3.5-3.9 μm NEVH1: 2.0-2.6 μm, 3.0-4.2 μm, 4.5-5.5 μm, 9.0-11.4 μm NEVL: 3.5-3.9 μm

IFOV: 2.5 mrad

Altitude: 1000 ft

#### Depression Aagle: 35°

Time:

Flight Direction:

NEVC1: West

NEVH1(L): East

NEVC1(H1): 1100 hrs NEVL: 1600 hrs

Ground Speed: 200 ft-sec<sup>-1</sup>

Area Covered (Approx.):

NEVC1 (Desert): 1750 ft wide x 3400 ft long

NEVH1(L) (Desert): 1750 it wide x 3400 ft long (Dry Lake): 1750 ft wide x 3400 ft long

Meteorology:

NEVC1 (HL)

High, thin scattered clouds; visibility = 15 mi.

NEVL

Complete cloud cover; light haze; visibility = 35 mi.







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NELLIS AFB, NEVADA

\*Histograms

Spectral	Bands:	2.0 -	2.6 µm
		3.0 -	4.2 µm
		3.5 -	3.9 µm
		4.5 -	5.5 µm
		9.0 -	11.4 µm



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#### NELLIS AFB, NEVADA

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Means and Standard Deviations for Spectral Bands Correlations Between Spectral Bands

Spectral Bands: 2.0 - 2.6  $\mu$ m ( $\mu$ W-cm<sup>-2</sup>-sr<sup>-1</sup>- $\mu$ m<sup>-1</sup>) 3.0 - 4.2  $\mu$ m (°K) 3.5 - 3.9  $\mu$ m (°K) 4.5 - 5.5  $\mu$ m (°K) 9.0 - 11.4  $\mu$ m (°K)

\* Because of the relatively small temperature changes in the scenery, there is a nearly linear relationship between the temperature and radiance statistics for the thermal channels. It is pertinent, therefore, to compute correlations between radiance and temperature channels.

**<u>ERIM</u>** 

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#### MOUNTAINOUS TERRAIN

#### NEVB

Channel:	2 (3.5 - 3.9 µm)
Channel	2
Mean	2.9819E+02
St. Dev.	7.1665E+00
Total Poin	ts 355600

#### NEVF

Correlation Channels: 2  $(3.5 - 3.9 \ \mu\text{m})$ 6  $(9.0 - 11.4 \ \mu\text{m})$ 

Correlation	2	6
2	1.000	
6	0,880	1.000
Channels	2	6
Mean	2.9676E+02	2.8708E+02
Std. Dev.	9.9428±+00	6.5334E+00
Total Points	355600	355600

## NEVG1

Correlation Char	nnels: 1 (2 2 (3 5 (4 7 (9	.0 - 2.6 .0 - 4.2 .5 - 5.5 .0 - 11.	μm) μm) μm) 4 μm)		
Correlation	1	2	5	7	
1	1.000				
2	0,837	1.000			
5	0.793	0.894	<b>1</b> .00	0	
7	0.810	0.890	0.98	3 1.000	
Channels	1	2		5	7
Mean	4.2120E+01	2,9112	E++07	2.8373E+02	2.8506E+02
St. Dev.	2.35801+01	8,8900	E+00	4 67001.+00	6.3500E+00
Total Points	610400	6104	00	610400	610400

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# MOUNTAINOUS TERRAIN (Cont'd)

## NEV I.

<b>Correlation</b>	Channels:	1	(2.0		2.6	μm)
		2	(3.0	-	4.2	μm)
		5	(4.5	-	5.5	μm)

Corr	elation	1	2	5	
	1	1.000			
	2	0.740	1.000		
	5	0.612	0.804	1.000	
Channels		1	2		5
Mean		5.5750E+01	3.000	0E+02	2.9068E+02

St. Dev.	2.3280E+01	7.2800E+00	4,6000E+00
Total Points	349600	349600	349600

#### NEVM

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Channel: 3 (3.5 - 3.9 µm)

Channe1	3
Mean	2.8360E-02
St. Dev.	3.8200E+02
Total Points	349600

## NEVN

Correlation Chan	nnels: 1 (2 2 (3 5 (4 7 (9	.0 - 2.6 .0 - 4.2 .5 - 5.5 .0 - 11.4	µm) µm) µm) 4 µm)		
Correlation	<b>]</b> .	2	5	7	
1	1.000				
2	0.255	1.000			
5	0.413	0.539	1.000	)	
7	0.398	0.565	0.910	1.000	
Channels	1	2		5	7
Mean	1.7300E+01	2.8568	E+02	2.8312E+02	2.8537E+02
St. Dev.	5.2800E+00	3.6500	E+00	<b>1.5000E+0</b> 0	2.2300E+00
Total Points	349600	3496	00	349600	349600

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# DESERT (including Dry Lake)

## NEVC1

· · ···•(	Correlation Char	nels: 2 ( 6 (	(3.5 - 3.9 μm) (9.0 - 11.4 μm)
-	Correlation	2	6
	2	1.000	
·	6	0.335	1.000
	Channels	2	6
	Mean	3.0956E+0	2 2,9875E+02
	St. Dev.	2.4900E+0	0 1.3500E+00
	Total Points	176400	176400

## NEVH1

Correlation Channels: 1 (2.0 - 2.6 µm)(3.0 - 4.2 µm)(4.5 - 5.5 µm)(9.0 - 11.4 µm)

#### Desert

Correlation	1	2	5	7			
1	1.000						
2	0.408	1.000					
5	0.015	0.188	1.00	0			
7	-0.001	0.102	0.58	4 1.000			
Channels	1	2		5	7		
Mean	7,3960E+01	3.0745E+02		2.9502E+02	2.9872E+02		
St. Dev.	1.17508+01	2.7700E+00		2.7700E+0		0.8700E+00	1.2100E+00
Total Points	349600	3496	600	349600	349600		

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# DESERT (including Dry Lake) (Cont'd)

NEVH1 (Cont'd)

Dry Lake						
Correlation	1	2	5	7	-	•
1	1.000					
2	0.737	1.000				
- 5	-0.830	-0.487	1.000	)		
7	-0.935	-0.690	0.902	2 1.000		
Channels	1	2		5	7	
Mean	1.4324E+02	3.1290	E+02	2.9016E+02	2.9194	¥E+02
St. Dev.	2.2090E+01	3.5200	E+00	0.9100E+00	1.5700	)E+00
Total Points	72400	7240	0	72400	7240	00

NEVL

Channel: 3 (3.5 - 3.9 µm)

Desert

Channel	3
Mean	2 <b>.926</b> 0E+02
St. Dev.	2.2100E+00
Total Points	136400

Dry Lake

Channel	3		
Mean	2.8711E+02		
St. Dev.	2.8900E+00		
Total Points	72400		

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NELLIS AFB, NEVADA

Ellipse Statistics

Spectral Bands: 2.0 - 2.6 μπ 3.0 - 4.2 μm 4.5 - 5.5 μm 9.0 - 11.4 μm

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# NEVN

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	6 Y	AREA	Threshold = Mean + 1.50 o
80UARE ME18 8.0 TO 10.0 TO 15.0 TO 20.0 TU 25.0 TO 30.0 TO 35.0 TU 40.0 TU 45.0 TU 50.0 TO 75.0 TO 100.0 TO 150.0 TO 200.0 TO	HY ERS 10.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0 100.0 200.0 250.0	AREA FREQUENCY 286 126 141 69 26 40 7 19 18 36 16 18 13 6	Threshold = Mean + 1.50 $\sigma$ Wavelength = 2.0 - 2.6 $\mu$ m Mean = 17.30 $\mu$ W-cm <sup>-2</sup> -sr <sup>-1</sup> - $\mu$ m <sup>-1</sup> $\sigma$ = 5.28 $\mu$ W-cm <sup>-2</sup> -sr <sup>-1</sup> - $\mu$ m <sup>-1</sup>
250.0 TO 300.0 TO 400.0 TO	300.0 400.0 500.0	2 5 2	
UVER	200*0	12	

TOTAL NUMBER OF ELLIPTICAL AREAS -846

3248 FEATURES WITH AREAS LESS THAN 8,00 SR. METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPE		
METERS		FEET		FREQUENCY	SHAPE FACTUR FREQUE		
0 10	7	0 T(1	22	0	0.0 TU 1.0	0	
7 10	10	22 TO	32	0	1.0 TO 1.1	0	
10 10	12	32 10	39	0	1.1 TU 1.2	18	
12 10	14	39 TO	45	13	1.2 10 1.3	4	
14 10	15	45 TO	52	92	1.3 TO 1.4	111	
16 TO	17	52 TO	55	47	1.4 TO 1.5	5	
17 10	20	55 TO	65	172	1.5 TO 1.6	127	
20 10	52	65 10	72	86	1.6 70 1.7	20	
25 IU	24	72 TO	78	22	1.7 TO 1.8	145	
24 10	26	78 10	85	19	1.8 TO 1.9	19	
26 10	28	85 10	91	48	1 9 70 2.0	52	
28 10	30	91 10	78	29	2.0 10 2.4	145	
30 10	32	98 10	104	28	2.4 TU 2.6	45	
35 10	39	104 TO	127	53	2.6 TO 2.8	7	
39 10	45	127 10	147	38	2.8 10 3.0	22	
45 TO	55	147 10	180	45	3.0 70 3.5	34	
55 TO	71	180 10	232	36	3.5 TO 4.0	19	
71 10	100	535 To	328	40	4.0 10 4.5	18	
DYE R	100		328	78		31	

ERIM ₽523 P123 \_ 1750 ft -L883 \$, 6'50 ft L449 -

**L**15

Area: NEVN (Wavelength = 2.0 - 2.6  $\mu$ m) Radiance Threshold = Mean + 2,50  $\sigma$ Mean = 17.30  $\mu$ W-cm<sup>-2</sup>-sr<sup>-1</sup>- $\mu$ m<sup>-1</sup> Std. Dev. =  $\sigma$  = 5.28  $\mu$ W-cm<sup>-2</sup>-sr<sup>-1</sup>- $\mu$ m<sup>-1</sup> EQUIVALENT ELLIPTICAL AREAS FOR NELLIS MOUNTAINS

NEVN

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		Ð	Y AREA	Threshold = Mean + 2.50
	SQUARE HETER	5	FREQUENCY	Wavelength = $2.0 - 2.6 \mu m$
	8 1 70	10.0	40	$p_{12} = p_{12} = 17.50 \ p_{11} = 0.01 \ p_{11}$
		15 0	115	$a = 5.28 \text{ m}/(-cm^2 - sr^2 - m^2)$
	15 0 10	30 0	145	0 = 0.20 frm=cm = 31 = fm
÷ .	20.0 10	20.0	21	· ·
	25.0 10	30.0	2	
	10.0 TO	35.0	Â	
	35.0 10	40.0	ž	
	40.0 TO	45.0	ĩ	
	45.0 TO	50.0	ĩ	
	50.0 TO	75.0	Ŭ.	
	75.0 10	100.0	1	
	100.0 TO	150.0	Ō	
	150.0 10	200.0	Ō	
	200.0 10	250.0	0	
	250.0 TU	300.0	1	
	300.0 10	400.0	1	
	400.0 TO	500.0	õ	
	OVER	500.0	Ō	
			-	

TOTAL NUMBER OF ELLIPTICAL AREAS = 196

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1089 FEATURES WITH AREAS LESS THAN 8.00 BO. HETERS WERE ALSO RECOGNIZED

BY PERIMETER					<b>FER</b>	8Y 3	BY SHAPE		
NE	TER	9	F	ECT		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0	10	7	0	το	22	0	0.0 TU 1.0	0	
7	10	10	22	าก	32	Ç	1,0 TO 1,1	0	
10	10	12	32	10	39	0	1.1 70 1.2	6	
12	TÖ	14	39	to	45	4	1.2 10 1.3	0	
14	tö	16	45	TO	52	19	1.3 70 1.4	23	
16	10	17	5,2	ŤŇ	śŚ	13	1.4 10 1.5	1	
17	iñ	20	55	TO	45	42	1.5 TO 1.6	29	
20	to	22	65	to	72	29	1.6 10 1.7	9	
22	tñ	24	72	10	78	10	1.7 TO 1.8	44	
24	in	26	78	Ťň	85		1.8 TO 1.9	2	
26	τõ	28	85	TO	<b>9</b> 1	16	1.9 10 2.0	16	
28	10	30	91	to	98	;	2.0 10 2.4	47	
30	10	32	9A	Ťn.	104	9	2.4 10 2.6	6	
32	in	19	104	TO .	127	11	2.6 10 2.8	3	
39	tň	45	127	TO	147		2.8 10 3.0	Š	
45	tň	55	107	10	180	Å	1010 1.5	ź	
55	TO.	71	180	to	272	R	3 5 10 4.0		
74	10	100	222	10	236	0		,	
1	10	100	£ 3 6		260	*		Š	


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### NEVN

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	87	AREA	Threshold = Mean + 1.50 d		
8.0 TU 10.0 TU 15.0 TU 25.0 TU 25.0 TU 30.0 TU 35.0 TU	BY 10.0 15.0 20.0 25.0 30.0 35.0 40.0	AREA FREQUENCY 66 50 44 25 13 13 13 3	Threshold = Mean + 1.50 σ Wavelength = 4.5 - 5.5 μm Mean = 283.12 Kelvin σ = 1.50 Kelvin		
40.0 TO 45.0 TO 50.0 TO 75.0 TO 100.0 TO 150.0 TO 200.0 TO 250.0 TO 300.0 TO 400.0 TO UVER	45.0 50.0 100.0 200.0 250.0 300.0 400.0 500.0 500.0	5 8 17 11 18 7 8 1 2 5 22			

TOTAL NUMBER OF ELLIPTICAL AREAS = 318

539 FEATURES WITH AREAS LESS THAN 8.00 SQ, METERS WERE ALSO RECOGNIZED

BY PERIMÉTER					BY SHAPE		
METER	8	FEET		FREQUENCY	SHAPE FACTUR	FREQUENCY	
0 TU	7	0 T ()	22	0	0.0 TU 1.0	0	
7 10	10	22 TO	32	0	1.0 TO 1.1	0	
10 TO	12	32 10	39	Ŭ	1.1 TO 1.2	7	
12 10	14	39 TO	45	3	1.2 10 1.3	3	
14 TO	16	45 TO	52	28	1.3 TO 1.4	32	
16 10	17	52 TO	55	19	1.4 TO 1.5	4	
17 10	20	55 TO	65	46	1.5 10 1.6	55	
20 TU	22	65 TO	72	21	1.6 TG 1.7	8	
01 55	24	77 10	78	12	1.7 TU 1.8	40	
24 10	26	78 TO	85	- 3	1.8 TU 1.9	12	
26 10	28	85 TO	91	22	1.9 TU 2.0	21	
28 10	30	91 TO	98	11	2.0 TO 2.4	64	
30 10	32	48 TO	104	9	2.4 10 2.6	10	
32 10	39	104 TO	127	24	2.6 TU 2.8	6	
39 TO	45	127 10	147	13	2.8 10 3.0	4	
45 TO	55	147 TO	180	13	3.0 10 3.5	19	
55 70	71	180 TO	212	21	3.5 TO 4.0	9	
71 10	100	212 10	128	19	4.0 10 4.5	9	
OVER	100	OVER	328	54	OVER 4.5	15	

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Area: NEVN (Wavelength =  $4.5 - 5.5 \mu m$ ) Temperature Threshold = Mean +  $1.80 \sigma$ Mean = 283.12 Kelvin Std. Dev. =  $\sigma$  = 1.50 Kelvin EQUIVALENT ELLIPTICAL AREAS FOR NELLIS MOUNTAINS

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#### NEVN

### DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

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	8Y	AREA	Threshold = Mean + 1.00 o
SQUARE METE	RS .	FREQUENCY	Wavelength = $9.0 - 11.4 \ \mu m$
8.0 TO 10.0 TO 15.0 TO 20.0 TO 20.0 TO 30.0 TO 30.0 TO 35.0 TO 40.0 TO 45.0 TO 50.0 TO 50.0 TO 150.0 TO 200.0 TO 250.0 TO 300.0 TO	10.0     15.0     20.0     25.0     30.0     35.0     40.0     .50.0     75.0     100.0     150.0     200.0     300.0     400.0     500.0	63 41 49 23 7 11 1 1 21 11 11 11 11 11 6 2	Mean = 285.37 kelvin σ = 2.23 Kelvin

TOTAL NUMBER OF ELLIPTICAL AREAS = 284

349 FEATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

		BY PEFIM	ETER	BY SHAPE		
MET	ERS	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 1	07	0 TO	22	0	0.0 10 1.0	1
7 1	0 10	07 SS	32	0	1.0 10	
10 T	0 12	32 TO	39	Ó	1.1 10 1.2	11
12 T	0 14	39 10	45	Ś	1.2 10 1 3	5 L 1
14 T	0 16	45 10	52	36		"~
16 T	0 17	52 T()	55	21	1 // 70 5 6	*/
17 <b>T</b>	0 20	55 TO	65	ĨĠ		0 # (
20 T	0 25	65 TO	72	20		54
1 22	0 24	72 10	78	17		14
24 T	0 26	78 TO	A5	Å		20
26 T	() 28	85 TO	Q I	16		12
28 T	0 30	91 10	9B	10	1,9 10 2.0	23
30 1	0 32	98 10	104	10	2.0 10 2.4	23
32 T	0 19	100 10	10-	67 A (	2.4 10 2.6	4
39 T	0 45	127 10	16.	16	8,5 UT 6,5	8
45 T	ល់ ៩៩	167 10	147	10	2.6 TO 3.0	6
56 7	0 71	147 10	160	15	3.0 10 3.5	7
71 1		100 10	232	14	3,5 TO 4.0	7
		232 10	378	15	4.0 TO 4.5	6
UVE	K 100	OVER	328	39	OVER 4,5	8



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DISTRI				
DISTRU		NEVN		
	BUTION OF ELL	IPTICAL AR	EAS GREATER THAN THRESHOLD	
	AV AD	•	Thurshold - Moon ( 2.50 .	
SQUARE METE	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		Inreshold = Mean + 2.50  d	·
		T NEGOLING T	Mean = $285 37$ Kelvin	
8,0 TO 10,0 TO	10.0	73	$\sigma = 2.23$ Kelvin	
15.0 TO	20.0	2		···
25.0 10	30,0	0		
35.0 TO	35.0 40.0	0		
40,0 TU	45.0 50.0	3		
50.0 TO 75.0 TO	75,0 100,0	2		
100.0 TO 150.0 TO	159.0	2 0		
200,0 TO	250.0	3		
300.0 TO	400.0	S		
40910 10 • OVER	500.0 500.0	0 1		
TOTAL NUMBER OF E	LIPTICAL AREAS -	32		
38 FEATURES	WITH AREAS LES	35 THAN 8.00	D SQ. METERS WERE ALSO RECUGNIZE	0
	BY PERIMETER		HY SHAPE	
METERS	FEET	FREQUEN	CY SHAPE FACTUR FREQU	JENCY
	A + ·· ·	0	0.0 10 1.0	0
0 TO 7 7 TO 10	25 07 e 26 07 55	0	1.0 7() 1.1	0
0 T0 7 7 T0 10 10 T0 12 12 T0 14	9 TO 22 22 TO 32 32 TO 39 39 TO 45	0	1.0 70 1.1 1.1 TU 1.2 1.2 TU 1.3	0 1 0
0 TO 7 7 TO 10 10 TO 12 12 TO 14 14 70 16 16 TO 17	9 TO 22 22 OT 9 22 TO 32 32 TO 39 39 TO 45 45 TO 52 50 TO 52	0 0 4	1.0 T() 1.1 1.1 T() 1.2 1.2 T() 1.3 1.3 T() 1.4 1.4 T() 4 E	0 1 0 3 0
0 T0 7 7 T0 10 10 T0 12 12 T0 14 14 T0 16 16 T0 17 17 T0 20	9 TO 22 22 TO 32 32 TO 39 39 TO 45 45 TO 52 52 TO 55 55 TO 65	0 0 4 4	1.0 T() 1.1 1.1 T() 1.2 1.2 T() 1.3 1.3 T() 1.4 1.4 T() 1.5 1.5 T() 1.6	0 1 0 3 0 7
0       10       07       7         01       01       7       12         10       10       12       12         12       10       14       14         14       07       16       16         16       10       17       17         17       07       02       02         22       07       02       22	9     10     22       22     10     32       32     10     39       39     10     45       45     10     52       55     10     65       65     10     72       72     10     76	0 0 4 4 0 2 2	1.0 T() 1.1 1.1 T() 1.2 1.2 T() 1.3 1.3 T() 1.4 1.4 T() 1.5 1.5 T() 1.6 1.6 T() 1.7 1.7 T() 1.6	0 1 0 3 0 7 2
0 T0 7 7 0T 0 10 T0 12 12 10 14 14 0 16 14 0 16 14 0 16 16 T0 17 17 17 20 20 T0 22 22 T0 24 24 T0 26 26 T0 26	9       10       22         22       10       32         32       10       45         45       10       52         52       10       55         55       10       65         72       10       72         72       10       85         78       10       85         85       10       91	0 0 4 4 0 2 2 0 0	1.0 T() 1.1 1.1 T() 1.2 1.2 T() 1.3 1.3 T() 1.4 1.4 T() 1.5 1.5 T() 1.6 1.6 T() 1.7 1.7 T() 1.6 1.8 T() 1.9 1.9 T() 2.0	0 1 0 3 0 7 2 1 1 2
0       T0       7       10       10         10       10       12       12       12       12       12       12       12       12       12       14       14       14       16       16       16       16       16       16       16       16       17       17       17       17       17       17       17       17       17       17       17       17       20       20       20       20       20       20       20       20       20       20       20       20       20       20       20       20       10       26       26       10       26       26       10       26	9       TO       22         22       TO       32         32       TO       39         39       TO       45         45       TO       52         52       TO       65         55       TO       65         72       TO       76         78       TO       85         95       TO       91         91       TO       98         92       TO       104	0 0 4 4 0 2 2 0 0 1 1	1.0 T() 1.1 1.1 T() 1.2 1.7 T() 1.3 1.7 T() 1.3 1.3 T() 1.4 1.4 T() 1.5 1.5 T() 1.6 1.6 T() 1.7 1.7 T() 1.6 1.8 T() 1.9 1.9 T() 2.0 2.0 T() 2.4 2.4 T() 2.6	0 1 0 3 0 7 2 1 1 1 2 4 4
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	9     10     22       22     10     32       32     10     32       39     10     45       45     10     52       52     10     55       55     10     65       72     10     76       72     10     76       78     10     85       95     10     91       91     10     98       92     10     104       104     10     127       104     10     147	0 0 4 4 0 2 2 0 0 1 1 1	1.0 TO 1.1 1.1 TU 1.2 1.2 TU 1.3 1.3 TO 1.4 1.4 TU 1.5 1.5 TO 1.4 1.6 TO 1.7 1.7 TU 1.6 1.8 TO 1.9 1.9 TO 2.0 2.0 TO 2.4 2.6 TO 2.8 2.6 TO 2.8	0 1 0 3 0 7 2 1 1 2 4 4 4 4
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	9 TO 22 22 TO 32 32 TO 32 32 TO 39 39 TO 45 45 TO 55 55 TO 65 65 TO 72 72 TO 76 78 TO 85 65 TO 91 91 TO 98 98 TO 104 104 TO 127 127 TO 140 180 TO 312	0 0 4 4 0 2 0 0 1 1 1 5	1.0 T() 1.1 1.1 T() 1.2 1.7 T() 1.3 1.7 T() 1.3 1.3 T() 1.4 1.4 T() 1.5 1.5 T() 1.6 1.6 T() 1.7 1.7 T() 1.6 1.8 T() 1.9 1.9 T() 2.0 2.0 T() 2.0 2.4 T() 2.6 2.6 T() 2.6 2.6 T() 3.5 3.5 T() 4.0	0 1 0 3 0 7 2 1 1 2 4 4 4 4 4 1 2 3

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### NVH1 (Desert) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

BY AREA Threshold = Mean + 2.00  $\sigma$ Wavelength =  $3.0 - 4.2 \mu m$ SQUARE METERS FREQUENCY Mean = 307.45 Kelvin 8.0 10 10.0 176  $\sigma = 2.77$  Kelvin 10.0 10 15.0 88 15.0 TO 20.05 84 20.0 10 31 25.0 25.0 10 30.0 18 30,0 10 10 35.0 TO 10 40.0 40.0 TO Ŷ 45.0 45.0 TO 5 50.0 50.0 10 75.0 14 75.0 TU 100.0 6 100.0 10 150.0 6 ž 150.0 10 200.0 200.0 TO 250,0 Ô 250.0 10 300.0 0 300.0 10 400.0 0 400.0 TU 500.0 ٥ OVER 500.0 n (Note: Noise spikes removed from TOTAL NUMBER OF ELLIPTICAL AREAS preceding picture.) 459

1770 FEATURES WITH AREAS LESS THAN 8.00 SR. METERS WERE ALSO RECOGNIZED

BY PERIMETER

BY SHAPE

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METERS		FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 TO	7	0 TO	22	1	0.0 TU 1.0	1	
7 10	10	22 10	32	õ	1.0 TO 1.1	Ō	
10 10	12	32 10	39	Ó	1.1 10 1.2	76	
12 10	14	39 TC	45	68	1.2 10 1.3	58	
14 TO	16	45 TO	52	98	1.3 10 1.4	97	
16 10	17	52 TO	55	16	1.4 10 1.5	19	
17 10	20	55 TO	65	91	1.5 10 1.6	58	
20 10	22	65 TÚ	72	12	1.6 10 1.7	22	
22 10	24	72 10	78	11	1.7 10 1.8	33	
24 10	26	78 TO	85	25	1 A T() 1-9	55	
26 10	28	45 10	01	13	1 9 70 2 0	22	
28 10	10		08	16		10	
20 10	30		40	14		12	
10 10	32	90 II) Iol TO	104	24		32	
36 10	37	104 10	12/	21	2.6 10 2.8	0	
34 10	45	127 10	147	13	2.4 10 3.0	1	
45 TU	55	147 10	180	15	3.0 10 3.5	5	
55 TU	71	180 TO	232	14	3.5 TU 4.0	1	
71 10	100	535 TO	326	11	4.0 TO 4.5	1	
UVER	100	0VE+	328	6	OVER 4.5	0	



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# NVH1 (Desert) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

BY AREA			Y AREA	ε∧ Threshold ≈ Mean + 2.50 σ					
	SQUARE	METEI	28	FR	EQUENCY	Wavel	ength = 3.0 ~	4.2 µm	
	•					Mean	= 307.45 Kelv	in	
	8.0	то	10.0		46		_		
	10.0	ta l	15.0		25	σ = 2	.77 Kelvin		
	15.0	to	20.0		16	-			
	20.0	tñ	25.0		10				
	25.0	TU	30.0	-	2				
	30.0	TO	35.0		2				
	35.0	TO	40.0		ō				
	40.0	TO	45.0		1				
	45.0	10	50.0		i				
	50.0	TO	75.0		1				
	75.0	to	190.0		ō				
	100.0	το	150.0		n				
	150.0	Ta	0.005		Ó				
	200.0	10	250.0		0				
	250.0	ĩo	300.0		ò				
	300.0	TO	400.0		Ó				
	400.0	10	500.0		0				
	nv	ER	500.0		0	(Note:	Noise spikes	removed	from
<b>T</b> 01	AL NUMBE	R OF EL	LIPTICAL A	REAS =	104		preceding pi	cture.)	

709 FEATURES WITH AREAS LESS THAN 8.00 SG. METERS WERE ALSO RECOGNIZED

FREQUENCY

0 0

0

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14 7

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0

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BY PERIMETER FEET

0 10

τo

22 TO 32 TO

39 T.O.

45 10

52 TO 55 TO

65 10

72 10

78 TO

85 TO

91 10

98 TO

104 TD

127 10

147 TO

180 TU 232 TU

OVER

METERS

7

10

12

14

16

17

50

55

24

26

28

30

32

39

45

55 71 100

100

0 10

7 10

12 10

14 10

16 TO 17 TO

50 IU

22 10

24 TO 26 TO 28 TO 30 TO

35 10

39 TO

45 10 55 TO

71 TO

OVER

10 10

52 55

65 72

78

85

91

9Å 104

127

147

140 272 328

358

внаре	FA	CTOR	FREQUENCY
0.0	10	1.0	0
1.0	۲O	1.1	0
1.1	10	1.2	27
1.2	16	1.3	17
1.3	τO	1.4	25
1.4	τO	1.5	7
1.5	70	1.6	5
1.6	10	1.7	4
1.7	10	1.8	10
1 A	10	1.9	4
1.9	τO	2.0	2
2.0	TO	2.4	3
2.4	τü	2.6	0
2.6	τU	8.5	0
2.8	τO	3.0	0
3 0	10	3.5	0
3.5	10	4.0	0
4.0	10	4.5	0
ា	VER	4,5	0

BY SHAPE



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# NVH1 (Desert)

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

			BY	AREA	Threshold = Mean + 1.50 $\sigma$		
	SQUARE	METERS		FREQUENCY	Wavelength = $4.5 - 5.5 \mu m$		
	8.0 10,0 15.0 20.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0 150.0 200.0 250.0 300.0 400.0 250.0 0 250.0 30.0 0 0 0 0 0 0 0 0 0 0 0 0 0	TO       TO <th><math display="block"> \begin{array}{c} 10,0\\ 15,0\\ 20,0\\ 35,0\\ 35,0\\ 40,0\\ 45,0\\ 50,0\\ 75,0\\ 100,0\\ 250,0\\ 250,0\\ 250,0\\ 250,0\\ 300,0\\ 400,0\\ 50,</math></th> <th>155 119 146 61 28 30 10 19 15 35 19 21 4 1 6 0 30</th> <th>Mean = 295.02 Kelvin σ = 0.87 Kelvin</th>	$ \begin{array}{c} 10,0\\ 15,0\\ 20,0\\ 35,0\\ 35,0\\ 40,0\\ 45,0\\ 50,0\\ 75,0\\ 100,0\\ 250,0\\ 250,0\\ 250,0\\ 250,0\\ 300,0\\ 400,0\\ 50,$	155 119 146 61 28 30 10 19 15 35 19 21 4 1 6 0 30	Mean = 295.02 Kelvin σ = 0.87 Kelvin		
	U 1	L I 1					

्रकोर्ग्या के मिलती, हे कि से स्टार्ग्य के नहरते हिल्लीहे त्रिकाइट्रीक्ष की सिंह को कि के क्लिकिक के किसी स्टल्

TOTAL NUMBER OF ELLIPTICAL AREAS = 672

500.0

1102 FEATURES WITH AREAS LESS THAN 8,00 SO, METERS WERE ALSO RECUGNIZED

BY PERIMETER BY SHAPE RETARS FEET FREQUENCY SHAPE FACTOR FREQUENCY 0 TO 22 32 7 0 TO 0.0 10 1.0 0 1 7 10 10 22 TO ۵ 1.0 10 1,1 0 10 TO 12 TO 32 TO 39 TO 12 1.1 39 0 TO 1,2 24 14 45 8 TO 1.3 9 14 10 45 TO 52 TU 52 55 65 16 1,3 TO 1.4 89 107 16 TO 17 TO 17 20 22 24 26 28 30 43 1.4 TO 1.5 21 55 TO 110 1.5 10 1.6 121 20 10 65 TO 72 10 1.7 48 1,6 72 TO 76 TU 78 85 22 10 38 TO 1.8 78 1.7 24 TO 25 TO 28 TO 30 TO 14 TO 1.9 1.8 18 85 TO 91 417 1.9 TO 2.0 46 26 39 91 TO 98 2,0 10 2,4 155 32 98 TO 104 2,4 TO 2.6 2,6 TO 2.8 25 32 TO 39 TO 39 S0 104 TO 18 157 45 TO 3.0 TO 3.5 127 TO 147 26 2.8 45 TO 55 147 TO 180 36 3,0 24 55 TO 71 TO 71 100 TO 535 28 3,5 10 4.0 7 33 37 100 232 TO 378 4,0 10 4,5 9 OVER 100 OVER 328 OVER 4.5 3



Std. Dev. =  $\sigma$  = 0.87 Kelvin EQUIVALENT ELLIPTICAL AREAS FOR NELLIS DESERT

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## NVH1 (Desert) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

• .	87	AREA	Threshold = Mean + 2.00 $\sigma$
SQUARE METE	ER S	FREQUENCY	Wavelength = 4 5 - 5.5 µm
8.0 TO 10.0 TO 15.0 TO 20.0 TO 25.0 TO 30.0 TO 30.0 TO 40.0 TO 40.0 TO 40.0 TO 50.0 TO 100.0 TO 150.0 TO 250.0 TO	10.0 15.0 25.0 30.0 35.0 40.0 50.0 75.0 100.0 150.0 200	17 7 2 3 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Mean = 295.02 Kelvin σ = 0.87 Kelvin

TOTAL NUMBER OF ELLIPTICAL AREAS = 30

164 FEATURES WITH AREAS LESS THAN 8,00 SO, METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPE		
METER	9	PEET		FREQUENCY	SHAPE FACTU	REQUENCY	
0 10	7	0 TO	22	0	0.0 TO 1.0	0	
7 10	10	55 IO	32	0	1.0 TU 1.1	Ó	
10 10	12	32 10	39	é	1.1.10.1.2	x	
12 TO	14	39 TO	45	2	1 2 10 1.3	ĩ	
14 TO	16	45 TO	52	10	1 3 10 1 4	12	
16 TO	17	52 TO	55	. 4	4 4 10 1 5	1-	
17 10	20	55 TO	65	 A			
20 10	22	65 10	72	1		•	
22 10	24	72 10	78	1		1	
24 10	26	78 10	10	0	1.7 10 1.6	2	
26 10	20	70 II) 65 10	0.1	1	1.8 10 1.9	Ŭ	
24 10	20	07 10	41	1	1,9 10 2,0	2	
20 10	50	41 10	98	1	2,0 TU 2,4	1	
50 TO	52	98 T()	104	1	2.4 TO 2.6	0	
35 10	39	104 T()	127	1	5.6 10 5.8	0	
39 TO	45	127 10	147	0	2.8 TD 3.0	0	
45 TN	55	147 10	180	Ó	3.0 TO 5.5	õ	
55 T()	71	180 TO	232	Ō	3.5 10 4.0	õ	
71 10	100	232 10	328	0		ů,	
UVER	100	OVER	328	õ	OVER 4.5	ŏ	

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# NVHl (Desert)

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	<b>B</b> Y	AREA	Threshold = Mean + 2.00 σ
SQUARE METE	Rð	FREQUENCY	Wavelength = 9.0 - 11.4 µm
8.0 10	10,0	100	Mean = 298.72 kelvin
10.0 TO 25.0 TO 20.0 TO	15,0 20,0 25,0	02 76 36	
25.0 TO 30.0 TO	30.0	12 17	· .
40.0 TU 45.0 TU	45.0 50.0	4 1	
≥0.0 TO 75.0 TO 100.0 TO	75.0 100.0 150.0	9 2 1	
150.0 TU 200.0 TU	200.0	3	
300.0 TU 400.0 TU	400.0 500.0	0	
OVER	500.0	1	

TOTAL NUMBER OF ELLIPTICAL AREAS = 353

860 FEATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

BY PERIMETER					BY SHAPE		
METERS		FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 T 0	7	0 TO	22	0	0.0 10 1.0	2	
7 10	10	22 TO	32	2	1.0 10 1.1	0	
10 70	12	32 10	19	ō	1.1 10 1.2	9	
12 10	14	39 10	45	ĩ	1.2 10 1.3	6	
14 10	16	23. 10	62	69	1.3 10 1.4	74	
16 10	17	52 10	55	31	1.0 10 1.5	6	
17 70		65 10	15	75	15101.6	70	
20 70	55	55 10	72	* C. 5 D		4.2	
20 10	20	05 10	12	20		10	
<b>55 1</b> 0	24	72 TU	78	21	1.7 10 1.8	00	
24 TO	56	78 TU	85	5	1.8 TO 1.9	15	
26 TO	28	85 TO	91	24	1.9 TO 2.0	24	
28 TO	30	91 TO	98	18	2.0 10 2.4	43	
30 10	32	98 10	104	14	2.4 10 2.6	10	
32 10	19	104 10	127	31	2.6 10 2.8	6	
10 10	45	127 70	147		2 8 10 3.0	ī	
27 10	66		147				
45 10	22	147 10	180	4	3.0 10 3.5	2	
55 TO	71	180 TO	232	9	5.7 10 4.0	2	
71 TO	100	232 10	328	4	4,0 TO 4,5	1	
OVER	100	OVER	328	6	AVER 4,5	1	



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Area: NVH1 (Wavelength =  $9.0 - 11.4 \mu m$ ) Temperature Threshold = Mean +  $2.50 \sigma$ Mean = 298.72 Kelvin Std. Dev. =  $\sigma$  = 1.21 Kelvin EQUIVALENT ELLIPTICAL AREAS FOR NELLIS DESERT

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## NVH1 (Desert)

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

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	6 Y	AREA	Threshold = Mean + 2.50 $\sigma$
SQUARE ME	FRS	FREQUENCY	Wavelength = $9.0 - 11.4 \mu m$
8.0 T0 10.0 T0 15.0 T0 20.0 T0 25.0 T0 35.0 T0 45.0 T0 45.0 T0 45.0 T0 50.0 T0 150.0 T0 150.0 T0 250.0 T	$   \begin{array}{c}     10.0 \\     15.0 \\     20.0 \\     30.0 \\     35.0 \\     40.0 \\     45.0 \\     75.0 \\     100.0 \\     150.0 \\     200.0 \\     200.0 \\     300.0 \\     400.0 \\     400.0 \\     500.0 \\      500.0 \\     500.0 \\     500.0 \\    $	5 1 2 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0	Mean = 298.72 Kelvin σ = 1.21 Kelvin
UNER	500.0	0	

TOTAL NUMBER OF ELLIPTICAL AREAS = 10

105 FEATURES WITH AFEAS LESS THAN 8,00 SQ, METERS WERE ALSO RECUGNIZED

BY PERIMETER					BY SHAPE		
METER	8	FEET		FREQUENCY	SHAPE FACTUR	FREQUENCY	
0 10	7	0 10	55	0	0.0 TO 1.0	0	
7 10	10	55 TO	32	0	1.0 TU 1.1	0	
10 TO	12	35 10	39	0	1.1 TO 1.2	0	
15 10	14	59 T()	45	0	1.2 10 1.3	0	
14 10	16	45 TO	52	3	1.3 10 1.4	Ś	
16 10	17	52 tu	55	2	1.4 TO 1.5	ī	
17 10	20	55 TN	65	2	1.5 10 1.6	ż	
20 10	25	65 TU	72	0	1.6 TO 1.7	õ	
01 55	24	72 10	78	2	1.7 10 1.8	Ó	
24 TO	26	7A TO	A 5	ō	1.8 10 1.9	õ	
56 TO	28	85 10	91	Ō	1.9 TU 2.0	ò	
28 10	30	91 T.)	98	ō	2.0 TU 2.4	Ň	
30 10	32	96 10	104	Ó	2.4 10 2.6		
32 10	39	104 10	127	ō	2.6 10 2.8	ő	
39 10	45	127 10	147	Q	2.8 70 5.0	Ň	
45 10	55	147 10	180	1	3.0 10 3.5	ŏ	
55 TO	71	180 TO	232	ō	3.5 10 4.0	ő	
71 10	100	232 10	328	ō		V 0	
OVER	100	OVER	328	ō	OVER 4.5	0 0	

L530 P123 1750 ft P523P

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Area: NVH1 (Wavelength = 3.0 - 4.2 μm) Temperature Threshold = Mean + 2.00 σ Mean = 312.90 Kelvin Std. Dev. = σ = 3.52 Kelvin EQUIVALENT ELLIPTICAL AREAS FOR NELLIS DESERT - DRY LAKE

# NVH1 (Dry Lake) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		HY AREA		Threshold = Mean + 2.00 o		
SQUARE	HETERS		FREQUENCY	Wavelength = $3.0 - 4.2 \mu m$		
				Mean = 312.90 Kelvin		
8.0	10	10.0	15			
10.0	To	15.0	3	o = 3.52 Kelvin		
15.0	T()	20.0	7			
20.0	10	25.0	4			
25.0	то	30.0	- 1			
30.0	TO	35.0	i			
45.0	10	40.0	Ō			
40.0	<b>T</b> O	45.0	1			
45.0	T()	50.0	0			
50.0	TO	75.0	1			
75.0	10	100.0	1			
109.0	T()	150.0	1			
150.0	10 .	200.0	0			
200.0	το .	250.0	0			
250.0	TO	300.0	Ó			
300.0	Tù	400.0	Û			
400.0	<b>T</b> O -	500.0	e			
0V	FH 1	500.0	7			

TOTAL NUMBER OF ELLIPTICAL AREAS - 42

215 FEATURES WITH AREAS LESS THAN 8,00 SQ, METERS WERE ALSO RECOGNIZED

BY PERIMETER

#### BY SHAPE

METERS		FEFT		FREQUENCY	SHAPE FACTUR	FREQUENCY
0 10	7	0 Tu	52	0	0.0 10 1.0	0
7 10	10	111 55	32	0	1.0 TO 1.1	0
10 TO	12	37 10	39	Ō	1.1 10 1.2	4
12 10	14	39 TO	45	4	1.2 10 1.3	3
14 10	16	45 10	52	9	1.3 10 1.4	Ā
16 TU	17	52 10	55	· 1	1.4 10 1.5	3
17 10	20	55 10	65	7	1.5 10 1.6	ι, Γ
20 10	22	65 70	72	ŝ	1.6 10 1.7	ź
22 10	24	72 10	78	j	1.7 10 1.8	7
24 10	56	78 YU	85	Ō	1.8 10 1.9	1
26 TO	28	85 10	91	ū	1.9 TU 2.0	ò
28 10	50	41 11	98	2	2.0 10 2.4	4
30 10	32	98 TH	104	ž	2.4 10 2.6	
32 10	39	104 10	127	ī	2.6 10 2.6	0
39 10	45	127 10	147	ő	2 8 10 3.0	0
65 10	55	147 TO	180	ï	<b>X 0 TO 3.5</b>	1
55 10	71	180 TU	232	Ô	3 5 10 4.0	;
71 10	100	232 10	328	ĭ	4 0 10 4.5	
LIVEN	100	OVER	328	4	OVER 4.5	Š

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# NVH1 (Dry Lake) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

Threshold = Mean +  $3.00 \sigma$ BY AREA FREQUENCY Wavelength =  $3.0 - 4.2 \ \mu m$ SQUARE METERS Mean = 312.90 Kelvin 8.0 10 10.0 16  $\sigma$  = 3.52 Kelvin 10.0 TO 15.0 11 15.0 TO 20.0 5 20.0 10 25.0 1 25.0 10 ٥ 30.0 35.0 30.0 TO Û 35.0 111 40.0 1 40.0 TU 45.0 1 45.0 TO 50.0 0 3 50.0 TO 75.0 5.0 TH 100.0 ۱ 100.0 TU 0 150.0 150 A TU 200.0 200.0 10 Ő 250,0 250.0 10 300.0 0 300,0 TO 400,0 ٥ 400.0 TO OVER 500.0 0 500.0 0 TOTAL NUMBER OF ELLIPTICAL AREAS -39

103 FEATURES WITH ARFAS LESS THAN 8.00 SQ. METERS HERE ALSO RECOGNIZED

BY PERIMETER

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HY SHAPE

METER	\$	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
<b>0 1</b> 0	7	0 T()	22	C	0.0 TO 1.0	0
7 10	10	22 10	32	Ô	1.0 TO 1.1	0
10 10	12	32 10	39	0	1.1 TO 1.2	3
12 TO	14	39 10	45	2	1.2 10 1.3	0
14 10	16	45 T()	52	7	1.3 10 1.4	6
16 10	17	52 10	55	• 2	1.4 TO 1.5	0
17 10	20	55 10	65	7	1.5 10 1.6	e
20 TO	22	65 TO	72	10	1.6 TU 1.7	1
22 10	24	72 10	78	1	1.7 70 1.8	6
24 10	26	78 11)	85	0	1.8 TO 1.9	0
26 10	2.8	85 TI)	91	1	1.9 10 2.0	2
28 10	30	91 TO	98	1	2.0 TO 2.4	4
30 10	32	98 T()	104	Ó	2.4 10 2.6	5
32 10	39	104 TH	127	2	3.5 UT 6.5	1
39 10	45	127 10	147	0	2 B TU 5.0	1
45 10	55	147 10	180	1	3.0 TU 3.5	Ō
55 10	71	180 70	232	3	3.5 10 4.0	Ċ
71 10	100	232 TO	328	2	4.0 10 4.5	0
OVER	100	<b>EVER</b>	328	Ō	OVER 4.5	0



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NVH1 (Dry Lake) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		BY AREA	Threshold - Mean + 1.00 σ	
SQUARE N	ETERS	FREQUENCY	Wavelength = $4.5 - 5.5 \mu m$	
			Mean ≈ 290.16 Kelvin	n an
8.0 TU	10.0	40		
10.0 10	15,0	19	$\sigma = 0.91$ Kelvin	
15.0 TO	20.0	31	•	
20.0 TU	25.0	10		
25,0 TO	30.0	. 1		
30.0 то	35,0	7		
35.0 10	46.0	1		
40.0 TO	45.0	3		
45.0 10	50.0	6		
50.0 TO	75.0	7		
75.0 TU	100.0	. 2		
100.0 TO	150.0	3		
150.0 TO	200.0	1		
01 0.00S	250.0	3		
250.0 10	300.0	1		
300,0 TO	. 400.0	\$		
400.0 T()	500.0	1		
<b>DAEN</b>	500.0	3		
TOTAL NUMBER OF	F ELLIPTICAL	AREAS = 141		
519 FEATUR	ES WITH ARE	AS LESS THAN 8.	NO SO. METERS WERE ALSO RECOGNIZE	Ð

SHAPE

BY PERIMETER

METERS								
		FFET			FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 10	7	0	TO	22	S	0.0 70 1.0	4	
7 10	10	22	TO	32	1	1.0 TÜ 1.1	0	
10 10	12	32	ŤΩ	39	Ō	1.1 10 1.2	7	
15 TU	14	39	TO	45	6	1.2 10 1.3	, ,	
14 TI)	16	45	<b>T</b> ()	52	19	1.3 10 1.4	18	
16 10	17	52	<b>T</b> O -	55	2	1.4 TO 1.5		
17 10	20	55	τn	65	18	1.5 10 1.6	13	
20 <b>T</b> D	22	65	τ0	72	16	1.6 10 1.7	5	
55 IÙ	24	72	TU	78	6	1.7 10 1.8	11	
24 TO	50	78	TO	85	4	1.8 TO 1.9	ĩ	
26 10	<b>2</b> 8	85	10	91	6	1.9 10 2.0		
0T 85	30	91	TO	98	6	2.0 TU 2.4	20	
3) 10	32	98	<b>T</b> ()	104	3	2.4 10 2.6		
32 10	39	104	10	127	10	2.6 10 2.8	1	
39 10	45	127	10	147	0	2.8 10 3.0	ц Ц	
45 T.)	55	147	TO	180	Q	3.0 10 3.5	10	
55 TO	71	180	10	212	9	3 5 70 4 0	10	
71 10	100	232	TO	328	7	4.0 10 4.5	ĩ	
OVER	100	. nv	FR	328	17		Å	



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## NVH1 (Dry Lake) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

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al La Sola

	87	AREA	Threshold = Mean + $3.00 \sigma$
SUUARE N	ETERS	FREQUENCY	Wavelength = $4.5 - 5.5 \mu m$
			Mean = 290.16 Kelvin
8.0 TC	10.0	0	
10.0 70	15.0	2	σ = 0.91 Kelvin
15.0 TC	0.05	2	
50.0 IC	25.0	0	
25.0 TC	30.0	0	
30.0 TE	) 35.0	1	
35.0 Tü	) 40.0	0	
40.0 TC	) 45.0	0	
45.0 TC	50.0	0	
50.0 10	) 75.0	2	
75.0 TL	100.0	0	
100.0 TU	150.0	. 1	
150.0 TO	0.005	0	
200.0 TC	250.0	2	
250.0 TC	) 300,0	0	
300.0 TC	) 400.0	0	
400.0 TC	500.0	1	
OV£∺	500.0	3	
AL NUMBER O	OF ELLIPTICAL ARI	EAS = 14	

TOTAL NUMBER OF ELLIPTICAL AREAS -

7 FEATURES WITH AREAS LESS THAN 8,00 SR. METERS WERE ALSO RECOGNIZED

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SHAPE FACTOR

0.0 TO :.0

1,0 TU 1,1

1.1 10 1.2

1,2 10 1.3

1.3 TU 1.4 1.4 TU 1.5

1.6 10 1.7

1.9 10 2.0

3.0 10 3.5

3,5 TO 4,0 4,0 TO 4,5

OVER 4.5

10 1.6

TO 1.8

TO 2.4

TO 2.6 TO 2.8 TO 3.0

1,4

1.5

1.7

1 A

5.0

2.4

5.8

HETERS FEET FREQUENCY 0 TO 7 0 TU 55 7 TO 10 TO 10 55 IU 32 12 32 TD 39 45 52 12 10 14 39 10 16 17 14 10 45 10 16 10 57 τu 55 17 10 20 55 TO 65 72 22 24 26 50 10 65 TO 22 10 78 75 10 24 10 78 10 85 56 10 28 85 10 91 01 85 30 91 TU 98 30 TO 32 TO 32 39 98 TO 104 104 TO 127 39 10 45 127 10 147

147 10

160 TO

232 10

OVER

180

232

328

328

See. 14

45 TO 55 TO

71 10

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OVER

55 71

100

100

BY PERIMETER

L 530 L 440 L 350

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Area: NVH1 (Wavelength =  $9.0 - 11.4 \mu m$ ) Temperature Threshold = Mean +  $1.00 \sigma$ Mean = 201.94 Kelvin Std. Dev. =  $\sigma$  = 1.57 Kelvin EQUIVALENT ELLIPTICAL AREAS FOR NELLIS DESERT - DRY LAKE

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### NVH1 (Dry Lake) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

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जन्मकर्णन् ति जिसिमित कि जिसिम्बर्ग कर सबस्त कर ने प्रायन्त्र क्योंक अधिविधि कि कि मिसि के विकास के व्यक्ति कि

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	8	( AREA	Threshold = Mean + $1.00 \sigma$
SQUARE METER	8	FREQUENCY	Wavelength = $9.0 - 11.4 \mu m$
8.0 TO 10.0 TO 15.0 TO 20.0 TO 25.0 TO 30.0 TO 35.0 TO 46.0 TO 45.0 TO 50.0 TO 150.0 TO 150.0 TO 200.0 TO 300.0 TO 300.0 TO	$     \begin{array}{r}       10.0 \\       15.0 \\       20.0 \\       35.0 \\       40.0 \\       45.0 \\       50.0 \\       75.0 \\       100.0 \\       150.0 \\       200.0 \\       300.0 \\       400.0 \\       500.0 \\       300.0 \\       400.0 \\       500.0 \\       300.0 \\       400.0 \\       500.0 \\       300.0 \\       400.0 \\       500.0 \\       300.0 \\       400.0 \\       500.0 \\       300.0 \\       500.0 \\       300.0 \\       500.0 \\       300.0 \\       500.0 \\       300.0 \\       500.0 \\       300.0 \\       500.0 \\       300.0 \\       500.0 \\       300.0 \\       500.0 \\       300.0 \\       500.0 \\       300.0 \\       500.0 \\       300.0 \\       500.0 \\       300.0 \\       300.0 \\       300.0 \\       500.0 \\       300.0 \\       500.0 \\       300.0 \\       500.0 \\       300.0 \\       500.0 \\       300.0 \\       500.0 \\       300.0 \\       500.0 \\       300.0 \\       500.0 \\       300.0 \\       500.0 \\       300.0 \\       500.0 $	20 16 6 3 0 1 2 1 3 4 2 1 1 2 1 1 2	Mean = 29ī.94 Kelvin σ = 1.57 Kelvin
OVER	500.0	7	

TOTAL NUMBER OF ELLIPTICAL AREAS - 72

133 FEATURES WITH AREAS LESS THAN 8,00 SQ, METERS WERE ALSO RECOGNIZED

BY PERIMETER						BY SHAPE		
ME	TER	5	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 1	TO	7	0 TO	22	0	0.0 TO 1.0	2	
7 1	ro	10	0T SS	32	0	1.0 TU 1.1	1	
10 1	סז	12	32 TU	39	0	1.1 10 1.2	10	
15 1	10	14	39 10	45	7	1.2 10 1.3		
14 1	10	16	45 TD	52	15	1.3 10 1.4	11	
16 1	10	17	52 10	55	ĩ	1.4 TO 1.5		
17 1	0	20	55 TO	65	1 Î	1.5 TB 1.6	7	
50 1	10	2.5	65 10	77	4	1.6 10 1.7		
55 1	10	24	72 10	78	2	1 7 10 1 8	с С	
24 1	10	56	78 TO	85	ű		2	
26 1	0	28	85 TO	91	7	10 10 144	v F	
28 1	0	30	91 TO	0.A	4		2	
30 1	10	32	98 10	104	0	2.0 10 2.4	7	
32 1	in	10	100 10	104	<sup>2</sup>	2,4 10 2,6	1	
19 1	tn	45	107 10	401	ć	2.6 10 2.8	1	
15 1	rn -	сс сс	121 10	147	Ů.	2.8 TO 3.9	1	
55 1	10	77	147 10	180	4	3.0 TU 3.5	3	
71 1	10	100	100 10	252	3	3,5 TU 4,0	1	
11 0		100	235 10	328	1	4.0 10 4.5	Ó	
UVE	L.Η	100	DVER	328	14	OVER 4.5	5	



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# NVH1 (Dry Lake) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		BY ARFA	Threshold = Mean + 1.50 $\sigma$
SQUARE	METERS	FREQUENCY	Wavelength = 9.0 - 11.4 µm
3.01 10.01 15.01 25.01 30.01 35.01 40.01 45.01 50.01 50.01 150.01 250.0	10.0 $10.0$ $10.0$ $10.25.0$ $10.25.0$ $10.25.0$ $10.35.0$ $10.35.0$ $10.35.0$ $10.35.0$ $10.35.0$ $10.35.0$ $10.35.0$ $10.50.0$ $10.75.0$ $10.250.0$ $10.250.0$ $10.250.0$ $10.250.0$ $10.250.0$ $10.250.0$ $10.250.0$ $10.500.0$ $10.500.0$	3 0 1 0 0 0 1 3 0 0 0 1 1 1 1	Mean = 291.94 Kelvin α = 1.57 Kelvin
1141	CH 900.0	د	

TOTAL NUMBER OF ELLIPTICAL AREAS = 11

6 FEATURES WITH AREAS LESS THAN 8.00 SQ. METERS WERE ALSO RECOGNIZED

#### BY SHAPE

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BY PERIMETER					BY SHAPE	
METER	s	FEET		FREQUENCY	SHAPE FACTUR	FREQUENCY
0 10	7	0 10	22	1	0.0 TU 1.0	4
7 10	10	22 10	32	2	1.0 TU 1.1	0
10 10	12	32 10	39	0	1.1 TO 1.2	1
12 10	14	39 10	45	υ	1.2 TO 1.3	0
14 10	16	45 10	52	0	1.3 TO 1.4	0
16 TO	17	52 10	55	1	1.4 TO 1.5	1
17 10	2.0	55 TO	65	0	1.5 TU 1.6	Û
20 TO	22	65 TU	72	0	1.6 TU 1.7	1
72 10	24	72 10	78	0	1.7 10 1.8	0
24 70	56	78 TO	85	0	1.8 TU 1.9	· 0
26 TO	28	85 T()	91	1	1.9 TU 2.0	0
28 10	30	91 10	98	o	2.0 10 2.4	2
30 10	32	98 10	104	à	2.4 TU 2.6	0
32 10	39	104 10	127	Ö	2.6 TU 2.0	Ó
39 10	45	127 10	147	o	2 A TO 3.0	1
45 TO	55	147 10	180	0	3.0 TU 3.5	0
55 10	71	180 10	232	1	3.5 TU 4.0	0
71 10	100	232 10	328	ó	4.0 TU 4.5	0
OVER	100	0150	7 5 8	e l	OVER 4 5	•

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#### NELLIS AFB, NEVADA

#### Power Spectra

Spectral Bands: 2.0 - 2.6 μm 3.0 - 4.2 μm 3.5 - 3.9 μm 4.5 - 5.5 μm 9.0 - 11.4 μm

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ومارجهن وأفقال أشفعك فالبرا ووارده ومرازع وماطعها والمتحاط التألية المرجو وجازما والمرتجا والمرجع ورادكم وكالمت



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### PISCAH CRATER Data

Wavelength Bands:

8.0-10.9 µm, 9.4-12.1 µm, 11.3-13.5 µm

IFOV: 3.5 mrad (11.3-13.5); 21x28 mrad<sup>2</sup> (8.0-10.9, 9.4-12.1)

Altitude: 1000 ft

Depression Angle: 90°

<u>Time</u>: 0830 hrs

Flight Direction: South-Southeast

Ground Speed: v200 ft-sec<sup>-1</sup>

Area Covered (Approx.): 6950 ft long x 820 ft wide

<u>Meteorology</u>: Visibility 50 mi; clear and bright, dry; cloud cover 10%

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**VERIM** 

PISGAH CRATER, CALIFORNIA

\*Histograms

Spectral Bands: 8.0 - 10.9 μm 9.4 - 12.1 μm 11.3 - 13.5 μm

\* Circles define a Gaussian curve with the same mean and standard deviation as the actual histogram. An "S" on some curves indicates saturation. Because of limits on gain settings some values may exist beyond the digital limits of 0 and 255, the digital dynamic range of the data processing.







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# PISCAH CRATER, CALIFORNIA

Means and Standard Deviations for Spectral Bands

Spectral Bands:	Channel 1:	8.0 - 10.9 μm (°K)
	Channel 2:	9.4 - 12.1 μm (°K)
	Channel 4:	11.3 - 13.5 µm (^K)

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### PISGAH CRATER

Number of Subregions = 1 Pixel Subarea Divisions at: 1 328 Line Subarea Divisions at: 1 1988 Line Increment Used = 1 Pixel Increment Used = 1 Channels: 1(8.0 - 10.9 µm) 2(9.4 - 12.1 µm) 4(1+.3 - 13.5 µm)

Channels	l	2	4
Mean	2,8859E+02	2.8841E+02	2.8951 <b>E+</b> 02
St. Dev.	2,3106E+00	2.3612E+00	2.8894E+00
Total Points	460743	460743	6500 <b>7</b> 6

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### PISGAH CRATER

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	84 .	REA	Threshold = Mean + 2.22 $\sigma$
SQUARE MET	ERS	FREQUENCY	Wavelength = 11.3 ~ 13.5 $\mu m$
SQUARE MET 3.0 TO 5.0 TO 10.0 TO 20.0 TO 20.0 TO 20.0 TO 35.0 TO 40.0 TO 40.0 TO 45.0 TO 50.0 TO 50.0 TO 150.0 TO 200.0 TO	ERS 5.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0 150.0 250.0	FREQUENCY 101 52 22 2 7 1 1 1 3 2 1 1 2 0 0 0	Wavelength = 11.3 ~ 13.5 μm Mean = 289.51 Kelvin σ = 2.89 Kelvin
300.0 TO 400.0 TO	400.0 500.0	0	
OVER	500.0	0	

TOTAL NUMBER OF ELLIPTICAL AREAS \* 197

576 FEATURES WITH AREAS LESS THAN 3,00 SQ. METERS WERE ALSO RECOGNIZED

BY SHAPE

FREQUENCY

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METER	8	FEET		FREQUENCY	SHAPE FACTU
0 T U	7	0 TU	55	0	0.0 T() 1.0
7 TA	10	27 TU	32	46	1.0 10 1.1
10 10	12	32 TO	3	41	1.1 TO 1.2
12 10	14	39 TU	45	36	1.7 10 1.3
14 10	16	45 TI)	52	21	1.3 TO 1.4
16 10	17	52 TO	55	ō	1.4 10 1.5
17 10	20	55 TI)	65	10	1.5 TO 1.6
20 10	5.5	65 YU	72	3	1.6 TO 1.7
01 55	24	72 10	78	6	1.7 TO 1.8
24 TO	26	78 TO	35	4	1.8 TU 1.9
20 TU	28	85 TU	91	2	1.9 11 2.0
28 10	30	91 TO	98	4	2.0 TU 2.4
30 10	32	9Å T()	104	n	2,4 70 2.6
32 10	39	104 TO	127	10	8.5 07 6.5
39 10	45	127 10	147	3	2.8 TO 3.0
45 10	55	147 TO	180	3	3.0 10 3.5
55 10	71	180 TO	232	<u> </u>	3,5 11 4.0
71 10	100	232 TO	328	2	4.0 10 4.5
UVER	100	OVER	328	ž	OVER 4,5

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# **PISGAH CRATER** DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

Threshold = Mean + 2.75  $\sigma$ SQUARE METERS FREQUENCY Wavelength =  $11.3 - 13.5 \, \mu m$ 3.0 10 Mean = 289.51 Kelvin 5.0 ĉó 5.0 10 10.0 17 10.0 10 15.0  $\sigma$  = 2.89 Kelvin З 15.0 10 2 10.05 20.0 TU 25.0 C 25.0 TU 30.0 0 30.0 TU 0 35.0 35.0 10 40.0 1 40.0 10 45.0 0 45.0 TO 50.0 0 50.0 TQ 0 75.0 75,0 TU 0 100.0 100.0 TO 150.0 0 150.0 TU 200.0 0 200.0 10 250.0 0 250.0 10 300.0 Ô 300.0 10 400.0 ٥ 400.0 TO 500.0 0 OVER 0 500.0

49 TOTAL NUMBER OF ELLIPTICAL AREAS =

OVER

170 FEATURES WITH AREAS LESS THAN 3.00 SR. METERS WERE ALSO RECOGNIZED

BY PERIMETER BY SHAPE METERS FREQUENCY SHAPE FACTOR FREQUENCY FFET 0 10 7 0 T() 0.0 TU 1.0 22 0 0 7 10 22 TO 32 TO 10 32 13 1.0 10 1.1 Ô 10 10 12 39 11 1.1 10 1.2 0 1.2 TO 1.3 12 10 39 TO 14 45 7 3 1.3 10 1.4 14 10 45 TO 52 16 3 13 16 10 52 TO 17 35 ۵ 1.4 10 1.5 3 55 TO 5 1-7 10 20 ა5 10 1.5 TU 1.6 11 0S 22 65 TC 72 0 1.6 10 1.7 а 1.7 10 1.8 01 55 24 72 70 78 3 1 1.8 10 1.9 24 10 26 78 TO 85 1 Ь 1.9 10 2.0 59 10 28 85 TO 91 Û 3 28 10 30 91 10 98 2.0 10 2.4 5 0 30 10 9 R TO 104 2.4 10 2.6 32 0 1 2.6 10 2.8 39 104 10 2 32 10 127 0 2.A TO 3.0 39 TO 45 147 127 10 0 1 45 10 55 147 Th 180 0 3.0 10 3.5 0 55 10 71 180 Th 232 3.5 11 4.0 0 1 4.0 10 4.5 OVER 4.5 100 232 10 71 10 328 0 0 100 OVER

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PISGAH CRATER, CALIFORNIA

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Power Spectra

Spectral Band: 11.3 - 13.5 µm









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#### HUME1 Data

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Wavelength Bands: 2.0-2.6 µm, 2.0-4.2 µm, 4.5-5.5 µm, 9.0-11.4 µm 1FOV: 2.5 mrad Depression Angle: Altitude: 1750 ft Time: 1215 hrs Flight Direction: West Ground Speed:  $202 \text{ ft-sec}^{-1}$ Area Covered (Approx.): Total) 6350 ft long x 2800 ft wide

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#### HUME2 Data

Wavelength Bands: 2.0-2.6 µm, 3.0-4.2 µm, 4.5-5.5 µm, 9.0-11.4 µm IFOV: 2.5 mrad 35° Depression Angle: Altitude: 1000 ft Flight Direction: West Time: 1420 hrs Ground Speed: 202 ft-sec<sup>-1</sup>

Area Covered (Approx.): Glints) 1000 ft long x 900 ft wide (sun glint on water)

Meteorology (HUME1 and HUME2): Visibility > 15 mi; slight haze; high scattered clouds; water calm, slight rolling waves.

3.10-2












\*(Note: Line range of scene analyzed was 101-1550; not completely shown here.)

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3.10-8



### PORT HUENEME, CALIFORNIA

Histograms\*

Spectral Bands:	2.6 - 2.6 µm
	3.0 - 4.2 µm
	4.5 - 5.5 µm
	9.0 - 11.4 µm

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<sup>8</sup>Circles define a Gaussian curve with the same mean and standard deviation as the actual histogram. An "S" on some curves indicates saturation. Because of limits on gain settings some values may exist beyond the digital limits of 0 and 255, the digital dynamic range of the data processing.















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#### PORT HUENEME, CALIFORNIA

Means and Standard Deviations for Spectral Bands Correlations Between Spectral Bands\*

Spectral Bands: Channel 6:

2.0 - 2.6  $\mu m (\mu W - cm^{-2} - sr^{-1} - \mu m^{-1})$ Channel 10: 3.0 - 4.2 µm (°K) Channel 11: 4.5 - 5.5 µm (°K) Channel 12: 9.0 - 11.4 µm (°K)

<sup>\*</sup> Because of the relatively small temperature changes in the scenery, there is a nearly linear relationship between the temperature and radiance statistics for the thermal channels. It is pertinent, therefore, to compute correlations between radiance and temperature channels.

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#### HUME1

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#### TOTAL SCENE

Number of Subregions = 1 Pixel Subarea Divisions at: 10 636 Line Subarea Divisions at: 101 1550 Line Increment Used = 1 Pixel Increment Used = 1 Correlation Channels: 6 (2.0 - 2.6 µm) 11 (4.5 - 5.5 µm) 12 (9.0 - 11.4 µm)

6	11	12
1.000		
0.791	1.000	
0.767	0.921	1.000
	6 1.000 0.791 0.767	6 11 1.000 0.791 1.000 0.767 0.921

Channels	6	11	12
Mean	7.8128E+01	2.9454E+02	3.0054E+02
St. Dev.	5.0523E+01	4.7889E+00	7.9584E+00
Total Pts.	907700.	907700.	907700.

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# HUME2 GLINTS

Number of Subregions =	1		
Pixel Subarea Divisions	at at	: 301	500
Line Subarea Divisions	at:	1351	1550
Live Increment Used = 1	L		
Pixel Increment Used =	1		
Correlation Channels:	6 10	(2.0 - (3.0 -	2.6 µm) 4.2 µm)
	11	(4.5 -	5.5 µm)
	12	(9.0 -	11.4 µm)

Correlation	6	10	11	12
6	1.000			
10	0.846	1.000		
11	0.892	0.683	1.000	
12	-0.094	-0.113	0.049	1.000

Cuannels	. 6	10	11	12
Maan	1.5025E+02	3,1405E+02	2.9083E+02	2.8846E+02
St Dev.	1.1205E+02	1.3863E+01	2.7197E+00	6.4991E-01
Total Pts.	39800.	39800.	39800	3980

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PORT HUENEME, CALIFORNIA

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Ellipse Statistics

Spectral Bands: 2.0 - 2.6 µm 3.0 - 4.2 µm 4.5 - 5.5 µm 9.0 - 11.4 µm

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ERIM HUME1 DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD BY AREA Threshold = Mean + 1.50  $\sigma$ SQUARE METERS FREQUENCY Wavelength =  $2.0 - 2.6 \mu m$ Mean = 78.15  $\mu$ W-cm<sup>-2</sup>-sr<sup>-1</sup>- $\mu$ m<sup>-1</sup> 8.0 10 10.0 42  $\sigma = 50.52 \,\mu W - cm^{-2} - sr^{-1} - \mu m^{-1}$ 10.0 TU 15.0 78 15.0 10 20.0 44 25.0 20.0 10 23 25.0 TU 30.0 16 30.0 10 35.0 20 - A Balante 35.0 10 40,0 14 40.0 TU 45.0 11 45.0 10 50.0 11 50.0 10 75.0 22 75.0 10 100.0 16 100,0 10 150.0 16 150.0 TO 200.0 6 200.0 10 250.0 A 300.0 250.0 TO 2 300.0 10 400.0 5 400.0 TO 500.0 3 OVER 500.0 18 Ę, TOTAL NUMBER OF ELLIPTICAL AREAS -355 854 FEATURES WITH AREAS LESS THAN 8.00 SQ, HETERS WERE ALSO RECUGNIZED BY PERIMETER BY SHAPE METERS FREQUENCY FEET SHAPE FACTUR FREQUENCY 0 TO 22 32 39 7 0 TO 0.0 TU 1.0 0 ٥ 7 10 10 22 TO 0 1.0 10 1.1 0 10 10 32 10 12 0 1.1 TO 1.2 6 12 TO 14 TO 14 39 10 45 1,2 10 1,3 15 17 52 55 16 45 TO 0 1.3 TU 1.4 26 16 10 17 52 10 27 1.4 10 1.5 55

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17 10

55 10

28 10

30 10

32 10

39 10

45 TO

55 10

71 10

OVER

20 10

24 10

56 10 20

22

24

26

28

30

32

39

45

55

71

100

100

55 TO

72 10

91 10

104 TO

151 10

147 TO

180 TO

232 10

OVER

10 78

65 10

85 10

98 10 65

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1.5 10 1.6

1.6 TO 1.7

1.8 10 1.9

2.0 TO 2.4

2.4 10 2.6

2,6 10 2,8

2.8 11 3.0

3,0 10 3,5

3.5 10 4.0

4.0 TO 4.1

INVER 4.5

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TO 1.8

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Area: HUM] (Wavelength = 2.0  $\cdot$  2.6 µm) Radiance Threshold = Mean + 2.0  $\sigma$ Mean = 78.13 µW-cm<sup>-2</sup>-sr<sup>-1</sup>-µm<sup>-1</sup> Std. Dev. =  $\sigma$  = 50.52 µW-cm<sup>-2</sup>-sr<sup>-1</sup>-µm<sup>-1</sup> EQUIVALENT ELLIPTICAL AREAS

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### HUME1

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	BY AREA	Threshold = Mean + 2.0 $\sigma$
8.0 TU 10. 10.0 TU 15. 15.0 TU 20. 20.0 TU 25. 25.0 TU 30. 30.0 TU 35.	BY AREA FREQUENCY 14 21 21 11 21 21 21 21 21 21 21 21 21 21	Threshold = Mean + 2.0 $\sigma$ Wavelength = 2.0 - 2.6 $\mu$ m Mean = 78.13 $\mu$ W-cm <sup>-2</sup> -sr <sup>-1</sup> - $\mu$ m <sup>-1</sup> $\sigma$ = 50.52 $\mu$ W-cm <sup>-2</sup> -sr <sup>-1</sup> - $\mu$ m <sup>-1</sup>
40,0   T()   45     45,0   T()   50     50,0   T()   75     75,0   T()   100     100,0   T()   150     150,0   T()   200     200,0   T()   250     250,0   T()   300     300,6   T()   400     400,0   T()   500	5   3   3   3   3   1   2   2   2   2   2   2   2   2   2   2   2   2   2	
UVER 500.	<i>,</i> 5	

TOTAL NUMBER OF ELLIPTICAL AREAS = 114

358 FEATURES WITH AREAS LESS THAN 8,00 SQ. METERS WERE ALSO RECOGNIZED

BY PERIMETER

BY SHAPE

PETER	\$	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 TU	7	0 T.O	22	0	0.0 10 1.0	0
7 YO	10	22 TO	32	0	1.0 TO 1.1	0
10 TO	12	32 TO	39	0	1.1 10 1.2	0
12 10	14	39 10	45	2	1.2 10 1.3	3
14 TG	16	45 T()	52	0	1.3 TO 1.4	Н
16 TO	17	52 10	55	9	1.4 70 1.5	7
17 10	20	55 TO	65	12	1.5 TO 1.6	18
20 10	55	65 TO	72	15	1.6 10 1.7	15
61 SS	24	72 TI)	78	0	1.7 TO 1.8	13
24 TO	26	78 TO	85	8	1.8 TO 1.9	9
26 TO	28	85 TO	91	4	1.9 10 2.0	5
26 10	30	91 TO	98	6	2.0 10 2.4	23
30 10	35	98 TU	104	0	2.4 10 2.6	-ż
32 10	39	104 TO	127	17	2.6 10 2.8	5
39 10	45	127 TU	147	8	2.8 10 3.0	2
45 TO	55	147 10	190	10	3.0 19 3.5	3
55 10	71	180 TO	232	3	3.5 TU 4.0	ő
71 10	100	232 10	328	7	4.9 10 4.5	õ
OVER	100	OVER	328	13	OVER 4.5	1

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Area: HUM1 (Wavelength =  $4.5 - 5.5 \mu$ m) Temperature Threshold = Mean + 2.00  $\sigma$ Mean = 294.54 Kelvin Std. Dev. =  $\sigma$  = 4.79 Kelvin EQUIVALENT ELLIPTICAL AREAS

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## HUME1

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	ъv	AREA	Threshold = Mean + 2.00 $\sigma$
SQUARE METER	\$	FREQUENCY	Wavelength = $4.5 - 5.5 \mu m$
800ARE METER 8.0 TU 10.0 TU 15.0 TU 20.0 TU 25.0 TU 30.0 TO 35.0 TU 40.0 TU 45.0 TU 50.0 TU 75.0 TU	S 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 75.0 100.0	FREQUENCY 21 35 19 11 8 6 6 6 6 3 8 3 3	Wavelength = 4.5 - 5.5 μm Mean = 294.54 Kelvin σ = 4.79 Kelvin
100,0 TU 150,0 TU 200,0 TU 250,0 TO 300,0 TU 400,0 TU UVER	150.0 200.0 250.0 300.0 400.0 500.0 500.0	7 6 1 2 1 2 4	

TOTAL NUMBER OF ELLIPTICAL AREAS = 149

241 FEATURES WITH AREAS LESS THAN 8,00 SQ. METERS WERE ALSO RECOGNIZED

	BY PERIMETER		BY SHAPE			
METEN	9	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 10	7	0 T()	25	0	0.0 10 1.0	0
7 10	10	55 TU	32	0	1.0 TO 1.1	0
10 TO	12	32 10	39	0	1.1 10 1.2	3
12 10	14	39 10	45	10	1.2 01.3	10
14 TO	16	45 TO	52	0	1.3 TO 1.4	16
16 TD	17	52 10	55	17	1.4 10 1.5	12
17 10	20	55 TO	65	20	1.5 10 1.6	21
01 05	22	65 TO	72	13	1.6 10 1.7	16
22 TO	24	72 10	78	0	1.7 10 1.8	12
24 TO	26	78 TO	AS	10	1.8 10 1.9	11
26 TU	28	85 TO	91	9	1.9 10 2.0	7
28 TO	30	91 TO	98	9	2.0 TU 2.4	19
30 10	32	98 10	104	0	2.4 10 2.5	6
32 TO	39	104 TO	127	12	2.6 10 2.8	4
39 TO	45	127 10	147	6	2.8 10 3.0	3
45 TO	55	147 TO	180	10	3.0 10 3.5	6
55 10	71	180 TO	232	- 9	3.5 10 4.0	3
71 TO	100	232 10	328	7	4.0 TH 4.5	ō
OVER	100	OVER	328	17	OVER 4.5	õ

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Area: HUM1 (Wavelength =  $4.5 - 5.5 \mu$ m) Temperature Threshold = Mean +  $3.00 \sigma$ Mean = 294.54 Kelvin Std. Dev. =  $\sigma = 4./9$  Kelvin EQUIVALENT ELLIPTICAL AREAS

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## HUMEJ

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

		BY AREA	Threshold = Mean + $3.00 \sigma$
SQUARE	HETERS	FREQUENCY	<b>Wavelength = 4.5 - 5.5</b> μm
8.0     10.0     15.0     20.0     25.0     30.0     40.0     50.0     75.0     100.0     20.0     30.0     30.0     30.0     30.0     300.0	10.0     10.0       TU     15.0       TU     20.0       TU     20.0       TU     20.0       TU     25.0       TU     35.0       TU     35.0       TU     40.0       TU     40.0       TU     40.0       TU     40.0       TU     100.0       TU     100.0       TU     100.0       TU     250.0       TU     250.0       TU     300.0       TU     400.0	3 4 2 1 0 4 0 0 0 2 0 0 0 0 0 0 0 0	Mean = 294.54 Kelvin σ = 4.79 Kelvin
400.0 ° OVI	TU 500.0 ER 500.0	0 N	

TOTAL NUMBER OF ELLIPTICAL AREAS = 17

24 FEATURES WITH AREAS LESS THAN 8,00 SG. METERS WERE ALSO RECOGNIZED

BY PERIMETER

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METER	9	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 TU	7	0 10	22	0	0.0 TC 1.0	0
7 to	10	22 TU	32	0	1.0 TU 1.1	0
10 TU	12	32 TO	39	0	1.1 TO 1.2	0
01 21	14	39 TO	45	1	1.2 10 1.3	1
14 10	16	45 TO	52	õ	1.3 TO 1.4	Ō
16 10	17	52 Ti)	55	0	1.4 10 1.5	1
17 to	20	55 TO	45	3	1.5 TO 1.6	1
20 TO	22	65 TO	72	1	1.6 10 1.7	5
01 52	24	72 TU	78	ō	1.7 70 1.8	3
24 TO	26	78 TO	85	2	1.8 10 1.9	0
26 TC	28	85 TQ	91	1	1.9 10 2.0	4
11 8S	30	91 TO	98	2	2.0 10 2.4	3
30 TU	32	98 T()	104	0	5.4 TU 2.6	2
32 TU	39	104 T()	127	3	2.6 11 2.8	Ú
39 TI)	45	127 10	147	0	2.8 10 3.0	0
45 10	55	147 10	180	3	3.0 10 3.5	0
55 10	71	180 TO	535	Ō	3.5 10 4.0	0
<b>/1 T</b> O	100	535 TO	328	0	4.0 TO 4.5	0
OVER	100	OVER	358	1	OVER 4.5	0



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Area: HUM1 (Wavelength =  $9.0 - 11.4 \mu m$ ) Temperature Threshold = Mean +  $2.00 \sigma$ Mean = 300.54 Kelvin Std. Dev. =  $\sigma$  = 7.96 Kelvin EQUIVALENT ELLIPTICAL AREAS

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## HUME1 **UISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD**

	BY AREA	Threshold = Mean + 2.00 $\sigma$
SQUARE HETERS	FREQUENCY	Wavelength = $9.0 - 11.4 \ \mu m$
6.0 TU     10.0       10.0 TU     15.0       15.0 TU     20.0       20.0 TU     25.0       25.0 TU     30.0       35.0 TU     40.0       40.0 TO     45.0       55.0 TU     50.0       45.0 TU     50.0       50.0 TU     75.0       100.0 TU     150.0       150.0 TU     250.0       20.0 TU     250.0	FREQUENCY 26 47 25 18 7 14 7 3 14 2 7 7 7 1 3	Wavelength = 9.0 - 11.4 μm Mean = 300.54 Kelvin σ = 7.96 Kelvin
100.0 TO 400.0 400.0 TO 500.0 EVER 500.0	2 2 5	

TOTAL NUMBER OF ELLIPTICAL AREAS = 197

387 FEATURES WITH AREAS LESS THAN 8,00 SQ. METERS WERE ALSO RECOGNIZED

BY SHAPE

BY PERIMETER

M	ETER	S	FEET		FREQUENCY	SHAPE FACTUR	FREQUENCY
Q	ĊŢ	7	0 10	22	0	0.0 T() 1.0	0
7	TO	10	07 55	32	0	1.0 TU 1.1	0
10	TO	12	32 TO	39	0	1.1 TO 1.2	1
51	10	14	39 10	45	7	1.2 TO 1.3	8
14	10	16	45 TI)	52	0	1.3 TU 1.4	23
16	10	17	52 10	55	26	1.4 TO 1.5	9
17	TO	20	55 TU	65	15	1.5 TO 1.6	34
20	10	22	65 TO	72	÷4	1 6 10 1 7	10
22	ŢŪ	24	72 10	78	0	1.7 10 1.8	23
24	10	26	78 TU	85	18	1.8 70 1.9	10
56	10	85	85 TO	91	6	1.9 TU 2.0	ب
28	TO	30	91 T()	98	11	2.0 10 2.4	31
30	10	32	98 TO	104	0	2.4 10 2.6	5
32	10	39	104 TO	127	26	2.6 10 2.8	7
39	10	45	127 10	147	7	2.8 10 3.0	2
45	10	55	147 10	180	14	.0 10 3 5	12
55	10	7:	180 TO	232	8	3 5 10 4.0	3
71	10	100	232 10	328	9	4.0 10 4.5	4
0	VER	100	OVER	328	24	DVER 4.5	0

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			HUME	CAR ADRATED THAN THOSE		
	DISTRIBU	IION OF E	LLIPTICAL AR	EAS GREATER THAN THRES	HOLU	
		£Υ	ARFA	Threshold - Mean + 3	<u>00</u> σ	
	SQUARE METER	5	FREAUENCY	Wavelength = $9.0 - 11$	.4 um	
				Mean = 300.54 Kelvin	• • •	
t.	8.0 TU 10.0 TU	10.0	1 2	$\sigma = 7.96$ Kelvin		
	15.0 TO 20.0 TU	20.0 25.0	2		e do forde a valora.	
	25.0 TO 30.0 TO	30.0 35.0	0 1			
	35.0 TO 40.0 TO	40.0 45.0	1 1			
	45.0 TO 50.0 TO	50.0 75.0	1			
	75.0 TO 100.0 TU	100.0 150.0	0 0			
	150.0 TO 200.0 TO	200.0 250.0	0 1			
	250.0 TO 300.0 TO	300.0 400.0	0 0			
	409.0 TU UVER	500.0 500.0	() ()			
<b>N</b> . /	TOTAL NUMBER OF ELL	IPTICAL ARE	\S = 11			
	22 FEATURES W	ITH AREAS	LESS THAN 8.00	) SR, METERS WERE ALSO RE	CUGNIZED	
	в	Y PERIMETE	R	HY SF	APF	
	METERS	FEET	FREQUENC	Y SHAPE FACTOR	FREQUENCY	
	0 TO 7 7 TO 10	010 0752	0 32 0	0.0 TO 1.0 1.0 TO 1.1	0	
	10 T() 12 12 T() 14	32 TO 39 TO	<b>3</b> 9 0 45 0		ບ ບ	
	14 TO 16 16 TO 17	45 TO 52 TO	52 0 55 0	1,3 T() 1,4 1,4 T() 1 S	0 2	
	17 TO 20 20 OT 71	55 TO 65 TO	65 1 72 3	1.5 T() 1.6 1.5 T() 1.7	0	
	22 OT 24 24 OT 45	72 TO 78 TO	78 Ó	1,0 10 1,7 1,7 TU 1,8	0	
	26 TO 28 28 TO 30	85 T() 91 T()	91 0 98 1		د 0 د	
	30 TO 32 32 TO 39	98 TO 1	04 0 27 0	2,4 TU 2,6	0	
	39 TO 45 1 45 TO 55	127 TO 1	47 2	2,8 T() 3,0	1	
	55 TU 71 1	10 10 1 180 Tr) 2	32 U 38 D	3,0 T( 5,5 3,5 T() 4,0	2 0	
	UVER 100	OVER 3	28 <u>1</u>	4.0 TH 4.5 OV[R 4.5	U D	

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HUME2 DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	В	Y ARFA	Threshold = Mean + 2.00 $\sigma$
SQUARE MET	ERS	FREQUENCY	Wavelength = $2.0 - 2.6 \mu m$
			Mean = $150.25 \mu\text{W} - \text{cm}^{-2} - \text{sr}^{-1} - \mu\text{m}^{-1}$
8.0 TO	10.0	14	-2 1 1
10.0 70	15.0	10	$\sigma = 112.05 \text{ W-cm}^2 - \text{sr}^2 - \text{um}^2$
15.0 TO	20.0	ŝ	
20.0 10	25 0		
25.0 TO	30 0	1	
30 0 TO	36 0	1	
35.6 10	<u> </u>	<b>د</b>	
	40.0		
49.0 10	43.0	1	
47.0 10	50.0	0	
50.0 10	75.0	0	
75.0 TO	100.0	3	
100.0 10	150.0	õ	
150.0 10	200.0	Ő	
200.0 10	256.0	ň	
250.0 TU	300.0	ő	
300.0 TO	400 0	0	
400-0 T()	500.0	0	
CIVEN	500.0		
UTCK	100 ° 0	1	

TOTAL NUMBER OF ELLIPTICAL AREAS = 40

36 FEATURES WITH AREAS LERS THAN 8,00 SO, METERS WERE ALSO RECOGNIZED

AY PERIMETER				BY SHAPE		
METE	RS	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 TU	7	10 TO	22	0	0.0 70 1.0	0
7 Y D	10	22 TO	32	0	1.0 70 1.1	õ
10 TO	12	32 10	39	0	1.1 TO 1.2	7
15 10	14	39 TO	45	4	1.2 10 1.3	0
14 10	16	45 10	. 52	11	7 3 10 1.4	15
16 TO	17	52 10	55		1 1 10 15	5
17 10	20	55 10	65	8	1.5 10 1.6	L. 21
20 10	52	65 TO	72	ž		~
22 10	24	72 10	78	5		6
24 10	26	78 10	85	1		2
26 10	28	45 10	01	1		1
28 10	30	01 10	04	N 0	1,9 10 2.0	2
10 10	10	08 70	90	Ū,	2. 10 2.4	3
77 70	20	40 10	104	Ų	5.4 10 5.6	0
36 10	54	104 10	127	2	5.6 10 5.8	0
39 10	45	127 10	147	2	2.8 TU 3.0	0
45 10	55	147 TU	180	0	3.0 TO 3.5	D
55 10	71	180 TO	535	2	3.5 10 4.0	Ð
71 10	100	232 TO	328	1	4.0 TU 4.5	ŏ
OVER	100	OVER	328	1	OVER 4 5	ĭ

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# HUME2 (Water Glints)

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	BY AREA	Threshold = Mean + 3.00 $\sigma$
8.0 TO   10.0     10.0 TO   15.0     15.0 TO   20.0     20.0 TO   25.0     25.0 TO   30.0     30.0 TO   35.0     35.0 TO   40.0     45.0 TO   50.0	BY AREA FREQUENCY 4 8 5 0 1 1 3 0	Threshold = Mean + 3.00 $\sigma$ Wavelength = 2.0 - 2.6 $\mu$ m Mean = 150.25 $\mu$ W-cm <sup>-2</sup> -sr <sup>-1</sup> - $\mu$ m <sup>-1</sup> $\sigma$ = 112.05 $\mu$ W-cm <sup>-2</sup> -sr <sup>-1</sup> - $\mu$ m <sup>-1</sup>
50.0 10 75.0 75.0 TU 100.0 100.0 TO 150.0	1 1 0	
150.0 T() 200.0 200.0 T() 250.0 250.0 T() 300.0 300.0 T() 400.0	1 0 0 0	
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA	0 1	

TOTAL NUMBER OF ELLIPTICAL AREAS - 32

51 FEATURES WITH AREAS LESS THAN 8.00 SQ. METERS WEPE ALSO REGUGNIZED

BY PERIMETER					BY SHAPE		
METER	9	FEET		FREQUENCY	SHAPE FACTOR	FREQUENCY	
0 T(I	7	0 TU	52	0	0.0 10 1.0	٥	
7 10	10	25 TO	32	0	1.0 10 1 1	ů 6	
10 TO	51	32 TO	39	Ó	1 1 10 1 2	, ,	
12 10	14	39 TU	45	2	1 2 70 1 1	4	
14 TO	16	45 TO	52	-		4	
16 10	17	52 10	65	ŏ		4	
17 10	20	55 10		÷		ć,	
20 10	22	A5 TO	27		1.3 10 1.0	4	
22 10	24	12 10	76	1	1,6 10 1,7	4	
24 10	26	76 10	76	3	1.7 10 1.8	1	
26 10	24		<b>N</b> 3	2	1.8 10 1.9	5	
34 10	10	85 10	91	4	1.9 10 2.0	1	
	30	91 TQ	9.8	5	2,0 TU 2,4	D	
50 10	52	98 10	164	1	2.4 10 2.6	0	
52 10	39	104 T/J	157	0	2.6 10 2.8	0	
39 tri	45	127 TO	147	1	2.8 10 3.0	Ň	
45 70	55	147 10	180	2	3.0 TO 3.5	0	
55 10	71	180 TO	232	ō	3.5 t() 4 0	Ň	
71 10	100	23 ° TO	328	ĩ	40104.0	0	
OVER	100	OVER	328	i		1	

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Area: HUM2 (Wavelength = 3.0 - 4.2 μm) Temperaturo Threshold = Mean + 2.00 σ Mean = 314.05 Kelvin Std. Dev. = σ = 18.86 Kelvin EQUIVALENT ELLIPTICAL AREAS - WATER GLINTS

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## HUME2 (Water Glints) DISTRIBUTION OF 'ELLIPTICAL AREAS GREATER THAN THRESHOLD

	BY ARFA	Threshold = Mean + 2.00 $\sigma$
SQUARE METERS	FREQUENCY	Wavelength = 3.0 - 4.2 µm
8.0 10 10 0	20	Mean = 314.05 Kelvin
10.0 TO 15.0	5	σ = 18.86 Kelvin
15.0 TO 20.0	9	
20.010 25.0	5	
30.0 T() 35.0	3	
35.0 10 40.0	1	
40.0 TO 45.0	1	
50.0 TU 75.0	ż	
75.0 TU 100.0	1	
150.0 TO 200.0	U 0	
200.0 TU 250.0	0	
250.0 T() 300.0	0	
400.0 10 500.0	0	
DVER 500.0	1	

TOTAL NUMBER OF ELLIPTICAL AREAS = 52

72 FEATURES WITH AREAS LESS THAN 8,00 SR. METERS WERE ALSO RECUGNIZED

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BY PERIMETER

METERS FEET FREQUENCY 0 10 0 TO 7 55 7 10 32 10 55 10 10 10 12 32 TO 45 52 15 10 14 39 10 14 10 45 TO 16 16 10 17 52 ាត 55 65 72 17 10 20 55 10 20 10 22 65 10 0T 55 24 72 10 7 A 24 10 26 7 R τu 65 10 28 85 10 91 01 85 30 91 T() 98 30 10 98 TO 32 104

104 10

127 10

147 10

190 TO

232 10

OVER

127

147

180

232

328

328

1.0 TU 1.1 1.1 TU 1.2 1,2 10 1,3 1.3 10 1.4 1,4 TU 1,5 1,5 TU 1,6 1,6 10 1,7 TO 1.8 .7 1.8 10 1.9 1.9 10 2.0 0 TU 2.4 2.4 10 2.6 2.6 10 2.8 2,8 10 3,0 3.0 10 3.5 3,5 10 4,0 4.0 TU 4.5 OVER 4.5

SHAPE FACTOR

0.0 TU 1.0

BY SHAPE

FREQUENCY

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# HUME2 (Water Glints) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	BY	AREA	Threshold = Mean + 3.00 $\sigma$
SQUARE METI	ERS	FREQUENCY	Wavelength = $3.0 - 4.2 \ \mu m$
8.0 TO 10.0 TO 15.0 TO 25.0 TO 25.0 TO 35.0 TO 35.0 TO 40.0 TO 55.0 TO 40.0 TO 55.0 TO 150.0 TO 150.0 TO 200.0 TO 200.0 TO 200.0 TO 200.0 TO 200.0 TO 200.0 TO 200.0 TO	10.0 15.0 20.0 35.0 35.0 40.0 45.0 50.0 75.0 100.0 150.0 200.0 300.0 300.0 500.0 500.0	5 5 8 2 1 0 0 1 0 4 3 0 0 0 1 1 1 0 3	Mean = 314.05 Kelvin σ = 18.86 Kelvin

TOTAL NUMBER OF ELLIPTICAL AREAS = 34

31 FEATURES WITH AREAS LESS THAN 8,00 SG, METERS WERE ALSO RECOGNIZED

BY PERIMETER

#### BY SHAPE

HETERS F		FEET	FEET FREQUEN		Y SHAPE FACTOR	
0 TO	7	0 TO	22	0	0.0 10 1.0	0
7 TO	10	<b>55</b> .0	32	Ó	1.0 70 1.1	ŏ
10 10	12	32 (0)	39	ò	1.1 10 1.2	6
12 10	14	39 TO	45	3	1.2 10 1.3	ž
14 TO	16	45 10	. 52	6	1.3 TO 1.4	ŭ
16 10	17	52 TO	55	ō	1.4 10 1.5	ō
17 10	20	55 70	65	<u>s</u> .	1.5 10 1.6	ž
01 05	22	65 TO	72	Ō	1.6 10 1.7	2
SS 10	24	72 TO	78	õ	1.7 TO 1.8	1
24 10	26	78 10	65	2	1.8 T() 1.9	;
0T 85	85	85 TU	91	ō	1.9 10 2.0	1
01 85	30	91 TO	98	2	2.0 10 2.4	i
30 10	32	98 TO	104	1	2.4 10 2.6	í
35 10	39	104 TO	127	i	2.6 10 2.8	5
39 10	45	127 10	147	i	2.8 10 3.0	0
45 10	55	147 10	180	2	3.0 10 3.5	ž
\$5 TO	71	180 10	232	1	3.5 10 4.0	
71 10	100	232 10	328	Š	4 C TU 4.5	i
OVER	100	DVER	328	ŝ	OVER 4.5	i


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## HUME2 (Water Glints) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

	6	Y AREA	Threshold = Mean + 2.50 $\sigma$
SQUARE M	ETERS	FREQUENCY	Wavelength ≈ 4.5 - 5.5 µm
<b>5</b> • 10		_	Mean = 290.83 Kelvin
	10.0	5	
10.0 10	15.0	1	σ = 2.72 Kelvin
15.0 10	50*0	3	
20.0 TU	25.0	5	
25.0 TU	30.0	. 10	
30.0 TO	35.0	1	
35.0 TU	40.0	i	
40.0 TH	45.0	, N	
45.0 TU	50.0	ň	
50.0 TU	75.0		
75.0 TU	100.0	1	
100.0 10	150.0	<b>.</b>	
150.0 10	200.0	, , , , , , , , , , , , , , , , , , ,	
200.0 10	251.0	ň	
250.0 TU	301.0	0	
300.0 th	400 0		
400.0 TO	500.0		
11/FD		1	
UVLA	200*0	ح	

TOTAL NUMBER OF ELLIPTICAL AREAS = 16

15 FEATURES WITH AREAS LESS THAN B.00 SQ. METERS WERE ALSO RECOGNIZED

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		BY PERIME	TER		BY SH	APE.
METER	5	FEFT		FREQUENCY	SHAPE FACTOR	FREQUENCY
0 10	7	0 T.O	55	0	6.º TU 1.0	Û
7 TU	10	22 TO	32	0	1.0 10 1.1	υ
10 10	12	32 TO	39	0	1.1 TO 1.2	v
12 TO	14	39 TO	45	0	1.2 10 1.3	1
14 10	1.5	45 T(i	52	0	1.3 10 1.4	ī
16 TD	17	52 10	55	0	1.4 TO 1.5	1
17 TO	20	55 TO	65	4	1.5 10 1.6	5
20 10	55	65 TG	72	2	1.6 (0.1.7	G
01 55	24	72 10	78	ō	1 7 10 1 8	ő
24 10	2.6	78 TO	85	õ	1 8 10 1.9	ů L
26 10	58	85 TO	91	1		0
28 10	30	91 10	98	1	201024	0
30 10	32	48 TO	104	1		ĭ
32 10	39	104 TO	127	1	26 10 24	4
39 10	45	127 10	147			с. С
45 10	55	147 10	180	2		ں د
55 TÚ	71	180 10	212	0	15 TH 4 0	د ۵
71 TD	100	212 10	128	ĩ		0
OVER	100	OVER	328	3	QVER 4.5	0

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1,8 10 1.9

1.9 10 2.0

2.0 10 2.4

2.4 10 2.6

2.6 10 2.8

2,8 TU 3,0 3.0 10 3.5

3.5 TU 4.0

4.0 10 4.5

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30 10

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71 10

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78 TO

85 10

91 Tu

98 TU

104 10

127 10

147 10

180 TO

232 TO

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# HUME2 (Water Glints) DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

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BY SHAPE

FREQUENCY

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SHAPE FACTOR

0.0 10 1.0

1.0 10 1.1

1,1 10 1.2

1.2 TO 1.3 1.3 TO 1.4

1.4 TU 1.5

1,5 10 1.6

1.6 TU 1.7

1.7 TO 1.8

1.8 10 1.9

1.9 10 2.0

2.0 10 2.4

2.4 10 2.6

2.6 TH 2.8

2,8 10 3.0

3,0 TU 3.5

3,5 10 4.0

4.0 10 4.5

OVER 4.5

	ВY	AKEA	Threshold = Mean + 1.00
SQUARE MET	E.RS	FREQUENCY	Wavelength = 9.0 - 11.4
			Mean ≈ 288 46 Kelvin
6.0 TJ	10.0	39	
10.0 10	15.0	28	$\sigma = 0.65$ Kelvin
15.0 TU	20.0	20	0 0100 10011111
20.0 TU	25.0	9	
25.0 10	30.0	5	· · ·
30.0 T()	35.0	4	· -
35.0 TU	40.0	0	
40.0 TU	45.0	3	
45.0 10	50.0	1	
50.0 TO	75.0	3	
75,0 Tu	100.0	0	
100.0 TU	150.0	0	
150.0 TO	200.0	2	
200.0 10	230.0	1	
250 <b>.</b> 0 TU	300.0	1	
300.0 10	400.0	1	
400.0 10	500.0	1	
OVER	500.0	5	
TOTAL NUMBER OF	FILIPTICAL ARE	AS = 120	
	Deers with Aut		

410 FEATURES WITH AREAS LESS THAN B.00 SQ. METERS WERE ALSO RECUGNIZED

BY PERIMETER

. <b>r</b>	C 7	յո	C. I	E. M	

метен	5	FE	T	FREQUENCY	
0 10	7	0 11	, 22	0	
7 10	10	22 1	52	0	
0 10	12	32 1	j 3,9	0	
01 51	14	39 TI	) 45	6	
L4 TO	16	45 TI	u 52	25	
6 10	17	52 1	. 55	5	
7 10	20	55 T	1 65	31	
01.0	22	65 TI	57 (	10	
101 5	24	72 1	רי 76	1	
24 10	56	78 T	า 85	7	
26 10	58	85 TI	1) 9]	5	
20 10	30	S1 T	1 98	4	
10 <b>1</b> 0	32	98 TI	104	0	
52 10	59	104 T	n 127	8	
59 TO	45	127 1	1 147	4	
15 10	55	147 10	1 <b>1</b> 90	3	
5 TU	71	180 T	232 0	4	
11 10	100	232 TI	0 328	Ż	
UVER	100	OVE	8 32B	h	

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HUME2 (Water Glints)

DISTRIBUTION OF ELLIPTICAL AREAS GREATER THAN THRESHOLD

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			θ¥	AWEA	Threshold = Mean + 2.00 $\sigma$
SQUARE	METERS			FREQUENCY	Waveler: th = $9.0 - 11.4 \mu m$
					Mean = 288.46 Kelvin
5.0	TO	10.0		0	
100	TO TO	15.0		0	$\sigma = 0.65$ Kelvin
15 6	To	24.0		0	
20.0	Tu	25.0		0	
26.0	10	30 0		Ó	
21.0	10	30.0 36.ú		0	
30.0	70	JJ.0		Ó	
22.0	* U	40.0		õ	
40.0	10	45.9		0	
45.0	τu	50.0		U	
50.0	T )	75,0		0	
75.0	10	100.0		0	
100.0	10	150.0		0	
150.0	าน	200.0		ú	
200.0	to	250.0		0	
255.0	10	30.5.0		0	
4 1 0 0	10	400 à		n	
1010 0 1010 0	T.	550.0		0	
400.00	117	600 0		1	
. U	Y C R	200.0		1	

TOTAL NUMBER OF ELLIPTICAL AREAS =

1 FEATURES WITH AREAS LESS THAN 8.00 SO. METERS WERE ALSO RECOGNIZED

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BY SHAPE

		BY PERIME	TER		BY SH	A P F
METERS		FELT		FREQUENCY	SHAPE FACTOR	FREWUENCY
0.10	7	0 70	22	0	0.0 70 1.0	U
	10	52 TO	12	ú	1.0 TU 1.1	e
10 10	10	27 1.	14	0	1.1 10 1.2	0
10 10	16		1.5	0 0	1.2 10 1.3	ý
12 10	14	54 10		ů.	1.5 TO 1.4	0
14 10	16	45 10	74	0	1.4 10 1.5	U
16 10	17	57 10	ר ני	0	1 5 711 1.5	0
17 TO	2.0	55 TG	65	U	1 4 7 1 1 7	0
20 10	25	65 T.C	72	U	1 0 00 1 1 /	0
22 10	24	77 10	78	G	$1 \cdot 7 \cdot 10 \cdot 1 \cdot 0$	0
24 10	26	78 TU	5	0		0
26 10	28	85 10	91	0	1.9 10 2.0	•,
28 T()	30	91 TO	28	0	2,0 10 2,4	*
30 10	12	98 Tu	104	U	2.4 10 2.6	4)
חז בו	10	104 10	127	Ú	2.0 10 2.8	C
		127 10	1 0 7	0	2.8 14 3.0	9
39 10	4.) 	107 10	180	0	3.0 TU 3.5	U
45 10	22	47 10	24.2	0	5.5 70 4.0	v
55 TU	/1	180 10	6 16	0	0 0 4 5	U.
71 10 1	00	232 10	520	0		J
OVER 1	0.0	OVER	378	1		-

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**<u>ERIM</u>** 

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Power Spectra

Spectral Bands: 2.0 - 2.6 μm 3.0 - 4.2 μm 4.5 - 5.5 μm 9.0 - 11.4 μm

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### APPENDIX A THE MULTISPECTRAL SCANNER\*

Two multispectral scanner systems have been in use at ERIM since 1968. The M-7 scanner was used at the time the Flint, Baltimore, and Mill Creek data were generated while its predecessor the M-5 scanner was used in gathering the Pisgah Crater, Black Hills, and Mono Lake data. All data subsequent to these were collected with the M-7. The two scalners are similar so that only the M-7 is discussed in detail.

The M-7 scanner, covering a wavelength range from 0.33 to 14.0 micrometers, can operate in up to 19 different bands of the ultraviolet, visible, and infrared regions. Of these bands, 12 can be selected for tape recording at any one time. As many as five separate radiation reference sources may be recorded sequentially along with the ground video once each scan line. The total system, including boresight commeras, is usually operated in a Douglas C-47 aircraft.

The simplified diagrams of Figure A.1 illustrate a typical line scanner and its methods of airborne use. As shown in the optical schematic at the top of the figure, the scanner basically consists of an optical telescope with its narrow field of view redirected by a rotating flat mirror. This mirror causes the system to scan in a plane perpendicular to the longitudinal axis of the aircraft. A radiation detector in the focal plane of the telescope converts the focused beam of radiation to an electrical signal. The optical system's field of view (ground resolution element) first scans laterally across the aircraft ground track through an opening in the bottom of the aircraft. Then before making the next ground scan, it scans radiation references ricenta constituidade contraditiona danse inconstituidade da la della de la della de la constituidade

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The ERIM Airborne Multispectral Data Collection is described in the ERIM 190901-1-F report prepared by Philip G. Hasell, Jr. under Contract NAS9-9304. The multispectral scanner is described here in order to familiarize the reader with the multispectral scanner system used to collect the data.



FIGURE A.1 AIRBORNE MULTISPECTRAL SCANNER OPERATION

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(not shown) which are internal to the scanner. By the time the next scan begins, the aircraft has moved forward; thus subsequent line scans build upon one another to produce a continuous strip image of the terrain beneath the aircraft. Figure A.1 shows the scanner looking directly downward. It is positioned in some flights to obtain similar data while looking below the horizon by 35 degrees.

The multispectral scanner evolved from this single-channel scanner concept. This evolution required replacement of the single detector element with a system of beamsplitters, dispersing optics, and spectral filters. Figure A.2 shows the optical configuration of the current M-7 multispectral scanner. A key feature in this design is its flexibility for accepting different radiation reference sources and new detector assemblies. Weight and space savings were sacrificed to provide this flexibility, which allows increased opportunities for adaptation to a diverse number of data gathering modes. Such flexibility is an important attribute for a general-purpose experiment system.

The radiation intercepted by the five-inch diameter-collecting aperture is directed into the Dall-Kirkham telescope, which has a three-inch diameter secondary mirror. The incoming radiation prevented from entering the telescope by this secondary mirror is directed upward by a folding mirror to Detector Position 1. This three-inch diameter collecting aperture operates over the broad band of 0.3 to 14.0 µm. To provide thermal data at this position, a focusing lens designed for the 8.0-14.0 µm band is used in combination with a cooled HgCdTe detector. A dichroic mirror mounted chead of this lens diverts ultraviolet and visible radiation onto a photomultiplier detector which is filtered so the energy it receives for recording is restricted to a narrow preselected band.



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The radiation collected by the effective four-inch aperture of the Dall-Kirkham telescope is folded into a dichoric mirror which reflects radiation below 1.0  $\mu$ m but transmits that of longer wavelengths. The radiation thus transmitted is focused onto three separately filtered indium arsenide detector elements in Position 2 by a lens achromatized for the 1.0 to 2.6  $\mu$ m region. This dichroic and lens can be readily changed for different detector configurations.

Radiation at wavelengths shorter than 1.0 µm is focused onto the entrance slit of a prism spectrometer at Detector Position 3. The spectrometer divides and directs visible and near-infared radiation through a fiber-optic image slicer to as many as 12 photomultiplier tubes. (In the current configuration the radiation goes to nine separate photomultipliers.)

The radiation reference sources are positioned in line with the scan mirror, so that each source is "seen" and registered sequentially once each scan line. Currently, five reference sources are being used: an NBS lamp packaged to simulate a point source; one ambient and two temperature-controlled graybody thermal references that fill the collecting aperture; and a sky illumination reference consisting of an opal glass diffusing plate mounted in the top of the aircraft. Through electronic control of the lamp and graybodies and by means of attenuating optical filters for the sky illumination, the radiation from a<sup>1</sup>l but the ambient temperature reference sources is under operator control. During data collection, all internal sources are monitored and recorded manually by the operator. To assure their validity as references, these sources are calibrated periodically against external standards in the laboratory.

The complete airborne scanner system is diagrammed in Figure A.6. Terrain radiation enters the scanner at the bottom left; radiation detectors in the scanner assembly register this input along with that

A-5



of the reference sources. The electrical signals comprising detector video outputs are amplified in preamplifiers before being transmitted to the operator console where the operator monitors them and adjusts amplifier gain to the proper level for tape recording. To confirm satisfactory recording, he is also able to monitor signals reproduced from the tape record. The system linearly transforms input radiation to voltage analogs which are recorded on the magnetic tape. The scanner system can generate video signals in up to 19 different spectral bands over a wavelength range extending from 0.33 to 14.0  $\mu$ m. Any 12 of these bands may be digitally tape recorded at any one time on a 14-track tape machine; the other two tape recorder tracks are used for housekeeping purposes.

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Figures A.3 through A.5 show the actual relative spectral response of the detector/filter combinations, as measured by the supplier, that have been used in collecting the data described in this handbook.

The airborne system (Figure A.6) also includes an array of boresight cameras utilizing various film-filter combinations. These aerial cameras produce film records often useful in the subsequent analysis of the scanner data.

Electrical voltage representations of single line scans for the thermal and non-thermal wavelength bands are shown in Figure A.7. Note that although the detectors in all positions view, in sequence, each of the radiation references as well as the terrain (see "ground scan"), only the graybody references apply to every wavelength band. These graybody references (#1 and #2 and thermal ambient) serve as temperature calibration sources for the thermal detectors and also as a dark level source for the shorter-wavelength non-thermal detectors. The remaining sources (lamp and sky) serve as references for

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the non-thermal bands (as shown). For indexing purposes, synchronization references are generated by the scanner and recorded with the video signals. The marker pulse refers to the scan position relative to the internally mounted radiation references; the roll-stabilized pulse refers to ground scan nadir with aircraft roll motion removed. ť.

Table A.1 lists significant parameters of the M-7 scanner system. The scanner views the terrain during 90° of its scan, providing an external field of view (FOV)  $\pm 45°$  from nadir. A nominal 0.1°C NE $\Delta$ T and a 1% NE $\Delta\rho$  are achieved.\* The system operates at either of two constant scan speeds -- 60 or 100 scans per second. Electronic bandwidth 18 limited by digital sampling. Table A.2 identifies those detector assemblies currently in use with the system. Where there is a choice of detectors, the first-listed unit is the one commonly used.

The M-5 scanner, shown schematically in Figure A.8, is a doubleended scanner using a double "axe-blade" scanning mirror to direct radiation to the two ends. In most respects it is the same as the M-7 except that the data collected from the two ends of the scanner are 90° out of phase. Two M-5 scanners in the aircraft were used to collect data. Essentially the same detector assemblies were used with the M-5 as are used with the M-7 system. One M-5 scanner was used to collect multispectral data in the visible and near infrared. Calibration lamps were added in the scanner housing which did not restrict the field-of-view below the aircraft. Another M-5 scanner was used to collect thermal data, and "hot" and "cold" graylody thermal references were added at the scanner aperture so the thermal IR channels could be calibrated. These thermal plates extended into the field of view of the scanner below the aircraft so that the video was limited to approximately +20° from nadir.

NEAT = Noise Equivalent change in temperature. NEAp = Noise Equivalent change in reflection.

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### TABLE A.1 M-7 SCANNER PERFORMANCE CHARACTERISTICS

12 Spectral Bands in UV, Visible and IR Regions 90° External FOV (±45° from n.dir) 2 mrad Maximum Spatial Resolution 0.1°C Nominal Thermal Resolution 1% Nominal Reflectance Resolution Five Radiation Reference Ports Five-Inch Diameter Collector Optics Scan Rate of 60 to 100 scans per second DC to 90 kHz Electronic Bandwidth Roll-Stabilized Imagery

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TABLE A.2 DETECTOR CONFIGURATIONS FOR ERIM M-5 AND M-7 SCANNER SYSTEMS

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	Ă	etyctor Pysi 40.3 m-15.0	tton 1 <sup>±</sup> 1 m)			Detector	r Positio	1 25	Detect	tor Position	3t	1
	Position 14 2.0 im-14 im)		Pos (0.3 r	stton 1 m-0.7 µ	۱۹. ۲	(1.1)	(:u, 11 .m:	.	10.	(.m. 1.1m. <del>)</del>	•	
Detector	B4nd ( 101)	IFUV (mr. d)	Detector	Band	I FOV (mrad	Detector	Bund (m.)	IFOV (mrail)	Detector	Band (im)	IFO E	- EI
HrCdTe1-3	2.0-11.8 or	3.1 · 3.1	L'''PM 1-3	<del>*~</del>	3.0 - 3.0	lnas 3-5	2.0-2.6 1.5-1.8	$2.0 \cdot 4.0$ 2.0 $\cdot 4.0$	1-6 Kd	0.83-1.15 0.72-0.94	2.5 . 2.5 .	2.5
HgCdTe 1 - 2	2.0-15.0	6.6 · 6.6					1.0-1.4 or	2.0 < 4.0		0.65-0.80 0.60-0.70	0 0 0 0	5.5
HgCdTe 2-2	or 2.0°10.9 9.4-12.1	21 · 28 21 · 21				InSb 3-6	2.0-2.6 1.0-1.4	2.0 < 4.0 2.0 < 4.0		0.55-0.64 0.52-0.59 0.49-0.55	5 0 0 0 0 0	22.5
	0 <b>Г</b>						01			0.45-0.51	i ci	10
H⊈CdTe 3-1	2.0 -9.1 8.7 10.7	20 - 20 20 - 20				InAs 3-6	2.0-2.6 1.5-1.8	2.0 < 4.0 2.0 < 4.0		0.40-0.47 or	5	2.5
	9.3-14.0 Or	20 - 20					1.0-1.4 or	2.0 4.0	P.N 12-1	0.67-0.94	N C	2 0
HgCdTe 1-5	2.0-12.0	3.3 · 3.3				H <sub>r</sub> CdTe 2-3	2.0-2.6 1.0-1.8	2.6 · 2.5 2.6 · 2.6		0.53-0.64	10120	121210
						InAs 1-2	0. 0. 0. 0. 1.0-2.6	3.3 < 3.0		0.50-0.54	1010	200
						2-1 -1 -20	0.01-0.2	0.F		0.41-0.48	N N	101
Votes:	Rancpass es	itablished by	replace, ble	dichro	it mirror.							
•	Budjuss es	ști bətsıldırlı	cxternal opt	iical fili	ter.							
	tAny tund be	twcen 0.3 .m	0.7 und 0.7 un n	nay be :	selected by	external optica	d filter.					

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the of the detectors shown may be installed in the position shown. Any 12 channels of a given configuration may be selected for FM recording on magnetic tupe.

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## APPENDIX B DATA PROCESSING AND CALIFRATION

The digital multispectral scanner data selected for terrain backgrounds statistical analysis are converted to high-density digital tapes. The general preprocessing procedure used to create calibrated data tapes is discussed in Section B.1 with a detailed discussion of the procedures used for each scene being presented in Section B.2. The corrections for overlap and unequal fields of view are described in Section B.3

#### **B.1 PREPROCESSING OF SCANNER DATA**

Each data value is recorded as an eight-bit integer ranging in value from 0 to 255. Each channel (wavelength band) is recorded on a separate tape channel and the amplifier gains adjusted so that all data values usually fall in the 0-255 range with saturation occurring occasionally. The scan lines for a single M-7 scanner channel or reflective IR M-5 scanner channel consist of 790 data points of which the first 646 are scene elements (pixels) covering the range -45° to +45° with respect to nadir while the remaining 144 points are calibration values, 24 data points for each of six calculation sources. For the thermal M-5 scanner channels, the scanner elements cover pixels 162 to 484 with pixels 1-161 and 485-646 being used for the graybody thermal sources.

Before the scanner data may be used to generate scene statistics some preprocessing is required:

- 1. The high-density digital tapes must be converted to computercompatible tapes.
- 2. Each channel must be calibrated in temperature or radiance using the calibration data at the end of each scan line.

- 3. Averaging was employed to reduce oversampling and to equalize any differences in the fields of view of the various detectors.
- 4. A set of calibrated, formatted tapes must be generated.

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The first of these processes, conversion of high-density tapes to computer-compatible tapes, is accomplished using the conversion facilities at ERIM's Earth Resources Data Center. The result of this conversion process is a low-density (800 or 1600 bpi) tape for each of the scenes desired. Using these tapes, the remainder of the preprocessing (2, 3, and 4) is performed using a computer code written for the University of Michigan's AMDAHL computer system. It is the set of calibrated tapes generated from this code that is used for all image processing.

The data values appearing on the calibrated tapes are themselves integers, ranging from 0 to 255, but these integers have been modified so that a linear relationship exists between them and the apparent scene radiance or temperature. The lata in the near-IR channels are converted to equivalent radiance in  $\mu W/cm^2 \cdot sr \cdot \mu m$ ). The equivalent radiance is the value of the spectral radiance at the center wavelength of the filter produced by a 2850 K NBS lamp source filling the sensor aperture and giving the same detector response. The data in the thermal IR channels are converted to apparent temperature in degrees The apparent temperature is the temperature of a blackbody Kelvin. filling the sensor aperture producing the same detector response. A table of apparent temperatures and their corresponding band radiances is included as Table B.1 in Section B.2. The radiance (or temperature) is recovered from the integer data values using multiplicative and additive factors recorded in the tape header record for each channel. These "mult" and "add" factors are determined from the

B-2

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calibration sources appearing at the end of each scan line assuming a linear relationship between radiance and detector output (see Section B.2). For channels calibrated in radiance, the integer values on the calibrated tape differ from those on the original computer-compatible tapes by at most a zero-level correction. For channels calibrated in temperature, however, the new integers are distinctly different from the original values since those on the calibrated tape are linear in temperature while those on the original tape are proportional to radiance.

Averaging is employed to reduce oversampling and to equalize differences in the fields of view of the various detectors. The degree of oversampling is generally largest in the along-track direction because of the constant (60/sec) scan rate. The degree of oversampling in the cross-track direction is small in almost all of the data because a 3.8 x  $10^{\circ}$ /sec sampling rate is used to produce a sample as large as 2.5 mr to correspond to the 2.5 mr cross-track field of view of most of the detectors. The technique that has been used for averaging lines to reduce oversampling, rather than dropping an appropriate number of alternate lines, was developed for two reasons: (1) to improve the signal-to-noise ratio in the resulting data, and (2) to equalize any differences in the along-track fields of view of the various detectors for calculating the spectral correlation coefficients. The same averaging technique can be used to reduce any overlap in the cross-track direction and to equalize any differences in the cross-track fields of view of the various detectors, but cross-track averaging was not found to be necessary in any of the data. Figure B.1 is a schematic representation of the procedure used (Section B.3). In this example, D is the largest along-track field of view of the channels and d the field of view

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of the channel being averaged. The averaging is done by summing the radiances of the scan line times their overlap with the desired output line and dividing by the sum of the overlap factors. If the scan lines for the largest field of view are themselves overlapped, non-overlapped fields of view are generated by taking as output lines those with fields of view D, each of which is displaced by D as in the right side of Figure B.1. Overlap factors are then determined in an identical manner between the original scan lines with field of view D and this set of non-overlapped output lines.

After calibration and field of view averaging, a new data tape is generated. To be compatible with existing data processing systems, this tape is written in ERIM-7094 format which consists of 36-bit words each of which contain four data values. The individual scan lines are written with the channels interleaved with 646 nine-bit data points per channel per scan line. The "mult" and "add" factors required for calibration of the data are written in the tape header record along with necessary format information. These tapes are then used directly as input to new or existing statistics generation programs.

#### **B.2 CALIBRATION OF SCANNER DATA**

As discussed in Section 3.1, output from the ERIM scenners is in the form of digital tapes in which the data values are represented by integers ranging in value from 0 to 255. At the end of each scan line a set of calibration sources is scanned and the integers observed for these sources are used to calibrate the data in apparent radiance or temperature. The resulting calibrated tape also represents the data as integers but these integers are adjusted so that they are linear in radiance or temperature and a set of multiplicative and additive factors are used to convert these integer values to the appropriate units.

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The calibration sources scanned once per scan line are: controllable temperature "hot" and "cold" plates; an ambient temperature plate; a visible-near-IR lamp; an ultraviolet lamp; and a sun sensor. The visiblereflective IR channels (approximately 0.4 µm to 3.0 µm) are generally calibrated in radiance using the visible-near-IR lamp as a radiance standard and the "ambient" plate as a dark level reference. If a linear relationship is assumed between radiance and detector output, the apparent radiance of the target (the radiance observed at the scanner aperture) is given by

$$L_{T}^{a} = \left(\frac{V_{T} - V_{A}}{V_{g} - V_{A}}\right) (L_{g} - L_{A}) + L_{A}$$
(B-1)

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 $V_T =$  The integer value observed for the target  $V_A =$  The integer value observed for the ambient plate  $V_g =$  The integer value observed for the lamp

 ${\rm L}_{\rm L}$  = The radiance of the lamp at the center of the bandpass of the channel to be calibrated

 $L_A$  = The ambient radiance at the center of the bandpass of the channel to be calibrated

and  $L_{\rm T}^{\bf a}$  is the apparent radiance of the target which is related to the actual target radiance  $L_{\rm T}$  as

$$L_{\rm T}^{\rm a} = L_{\rm T} \tau_{\rm p} + L_{\rm p} \tag{B-2}$$

where  $\tau_{\rm p}$  is transmission of the intervening path and  ${\rm L}_{\rm p}$  the radiance of this path.

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The lamp radiance  $L_{g}$  in Equation B-1 is obtained from a calibration of the visible-near-IR lamp using an NBS standard lamp while the ambient radiance  $L_{A}$  is taken as the radiance of the ambient temperature plate with emissivity  $\varepsilon_{A}$  given by

$$L_{A} = \epsilon_{A} L_{A}^{BB} + (1 - \epsilon_{A}) L_{A}^{BB}$$
(B-3)

where the first term is the radiance emitted from the plate and the second term the surrounding radiance reflected from this plate. Since the ambient temperature plate and its surroundings are at the same temperature, this equation simply gives  $L_A$  equal to  $L_A^{BB}$  or the radiance of a blackbody at ambient temperature.

Equation B-1 is then written in terms of a "mult" and an "add" factor as

$$L_{T}^{a} = V_{T} \cdot MULT + ADD$$
 (B-4)

where

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$$MOLT \simeq W$$

$$ADD = L_A^{BP} - WV_A$$

and

$$W = (L_{g} - L_{A}^{BB}) / (V_{g} - V_{A})$$
 (B-5)

The computer program used for calibration initially averages the integer values (bin values) of the calibration sources for all scan lines in the image and outputs a mean and a standard deviation for them. If the standard deviations are small compared to the mean values the program allows for an "average" calibration in which the mean bin values of  $V_{g}$  and  $V_{\Lambda}$  are used in Equations B-4 and B-5. In this case the integer data values on the calibrated tape are the same as those in the original

B-7

tape; only "mult" and "add" factors are evaluated by the calibration procedure. However, if the standard deviations are not small compared to the means, indicating a drift in the system, a "line-by-line" calibration is required. For this type of calibration values of  $V_g$  and  $V_A$ are taken from the calibration sources at the end of <u>each</u> scan line and these values used to determine "mult" and "add" factors from Equation B-5. These factors are then used to modify the integer data values of a given scan line so that only one "mult" and "add" factor is required for the total image. The single "mult" and "add" factors used are those determined from the mean  $V_g$ ,  $V_A$  values and the modified integer data value is taken as

$$V_{T} = \frac{V_{T} \cdot MULT + ADD - ADD}{MULT}$$
(B-6)

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where the average factors are MULT and ADD, those determined for each line are MULT and ADD, and  $V_{\rm T}^{'}$  is the modified integer data value.

The long wavelength 1R channels ( $\lambda \ge 3.0$  µm) are calibrated in temperature and require a somewhat more involved calibration procedure. Since the detector output is proportional to radiance and not temperature, the first step in the process is to relate bin value (integer data value) to radiance, as in the reflective 1R channels, using the "cold" plate as a dark level reference, the "hot" plate as a radiance standard, and the "amblent" plate to correct for ambient radiation levels. If a linear relationship is again assumed between detector output and radiance the apparent target radiance is given by an equation identical to (B-1) except that the ambient radiance ( $L_A$ ) end bin value ( $V_A$ ) are replaced by those for the "cold" plate ( $L_C$ ,  $V_C$ ) and the lamp radiance ( $L_A$ ) and bin value ( $V_q$ ) are replaced by those for the "hot" plate ( $L_H$ ,  $V_H$ ):

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$$\mathbf{L}_{\mathrm{T}}^{\mathrm{A}} = \mathbf{L}_{\mathrm{C}} + \left(\frac{\mathbf{v}_{\mathrm{T}} - \mathbf{v}_{\mathrm{C}}}{\mathbf{v}_{\mathrm{H}} - \mathbf{v}_{\mathrm{C}}}\right) (\mathbf{L}_{\mathrm{H}} - \mathbf{L}_{\mathrm{C}})$$
(B-7)

In this case however the "hot" plate radiance is given by

$$L_{H} = c_{H}L_{H}^{BB} + (1 - c_{H})L_{A}^{BB}$$
(B-8)

where  $\epsilon_{\rm H}$  is the emissivity of the "hot" plate,  $L_{\rm H}^{\rm BB}$  the radiance of a blackbody at the same temperature as the "hot" plate, and  $L_{\Lambda}^{\rm BB}$  the ambient blackbody radiance. Similarly, the "cold" plate radiance is given by

$$L_{C} = v_{C}L_{C}^{BB} + (1 - v_{C})L_{A}^{BB}$$
(B-9)

In both of these expressions the first term is the radiance emitted by the plate while the second term is the ambient radiance reflected by the plate.

Substitution of Equations B-8 and B-9 fato (B-7) and taking the plate emissivities equal gives

$$\mathbf{L}_{\mathrm{T}}^{\mathrm{A}} = \left[ \mathbf{L}_{\mathrm{C}}^{\mathrm{BB}} + (\mathbf{I} - \mathbf{r}) \mathbf{L}_{\mathrm{A}}^{\mathrm{BB}} \right] + \left( \frac{\mathbf{v}_{\mathrm{T}} - \mathbf{v}_{\mathrm{C}}}{\mathbf{v}_{\mathrm{H}} - \mathbf{v}_{\mathrm{C}}} \right) \left[ \mathbf{r} \left( \mathbf{L}_{\mathrm{H}}^{\mathrm{BB}} - \mathbf{L}_{\mathrm{C}}^{\mathrm{BB}} \right) \right]$$
(3-10)

This equation could be used for calibration but the amb<sup>+</sup>ent radiance  $L_{\Delta}^{BB}$  would have to be calculated from ambient temperature measurements. This may be avoided by again assuming linearity of the detectors and taking

$$\mathbf{L}_{A}^{BB} = \mathbf{L}_{C} + \begin{pmatrix} \mathbf{V}_{A} - \mathbf{V}_{C} \\ \mathbf{V}_{H} - \mathbf{V}_{C} \end{pmatrix} (\mathbf{L}_{H} - \mathbf{L}_{C})$$
(B-11)

as for  $L_T^A$  in Equation B-7. Substituting Equations 3-8 and B-9 into this expression it is found that many of the terms cancel and the ambient

radiance is given by

$$L_{A}^{BB} = L_{C}^{BB} + \left(\frac{V_{A} - V_{C}}{V_{H} - V_{C}}\right) \left(L_{H}^{BB} - L_{C}^{BB}\right)$$
(B-12)

where all radiances are now blackbody radiances evaluated at the plate temperatures. Making a final substitution of Equation B-12 into Equation B-10 and rearranging terms gives

$$L_{T}^{a} = L_{C}^{BB} + W \left[ (1 - \varepsilon) V_{A} - V_{C} \right] + \varepsilon W V_{T}$$
 (B-13)

where

$$W = \begin{pmatrix} L_{H}^{BB} - L_{C}^{BB} \\ \hline V_{H} - V_{C} \end{pmatrix}$$
(B-14)

Equation B-13 then relates the data bin values  $(V_T)$  to radiance and a second transformation is required to convert these values to temperature.

The computations required to convert radiance to temperature have been minimized by noting that the radiance values are bounded; the minimum value being given by  $V_T = 0$  and the maximum by  $V_T = 255$ . Using this fact, a table of temperature versus radiance is constructed, as shown in Table B.1, by integrating the Planck function over the bandpass of the channel to be calibrated choosing a range of temperatures sufficient to cover the entire radiance range. The temperature increments in this table are taken small enough ( $vl^\circ C$ ) so that interpolation may be used to form an array of temperature versus data bin value  $T(V_T)$  for all possible bin values. It is this array which is then used to directly convert the uncalibrated data values to temperature.

Unlike the radiance data, the integer values appearing in the calibrated images for the thermal channels are never the same as those of the original image since the calibrated values are now proportional to temperature not radiance. This new set of integer data values is scaled from 0 to 255 using

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TABLE B. la	RADIANCE	FROM	3.0	_	4.2	MICRONS	ΊN	MICROWATTS	/(cm~	sr)	)

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Apparent Temperature °K Radiance 0.65034E+01 0.72623E+01 0.80966E+01 0.90126E+01 0.10017E+02 0.11116E+02 0.12318E+02 0.13629E+02 0.15060E+02 0.16617E+02 0.18310E+02 0.20150E+02 0.22145E+02 0.24307E+02 0.26647E+02 0,29176E+02 0.31908E+02 0.34854E+02 0.38028E+02 0.41445E+02 0.45119E+02 0.49065E+02 0.53300E+02 0.57840E+02 0.62703E+02 0.67906E+02 0.73469E+02 0.79410E+02 0.85751E+02 0.92512E+02 0.99715E+02 0.10738E+03 0.11554E+03 0.124212+030.13341E+03 0.14318E+03

0.15353E+03

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TABLE B.1b RADIANCE FROM 3.5 - 3.9 MICRONS IN MICPOWATTS/cm<sup>2</sup> · sr)

Radiance	Apparent Temperature °K
0.21479E+01	259
0.24074E+01	261
0.26937E+01	263
0.30089E+01	265
0.33555E+01	267
0.37360E+01	269
0.41531E+01	271
0.46096E+01	273
0.51087E+01	275
0,56534E+01	277
0.62472E+01	279
0.68935E+01	281
0.75963E+01	283
0.83594E+01	285
0.91869E+01	287
0.10083E+02	289
0.11053E+02	291
0.12101E+02	293
0.13232E+02	295
0.14452E+02	297
U.15765E+02	299
0.17178E+02	301
0.18697E+02	303
0.20327E+02	305
0.22076E+02	307
0.23950E+02	309
0.25955E+02	311
0.28100E+02	313
0.30392E+02	315
0.32838E+02	317
0.35448E+02	319
0.38228E+02	321
0.41187E+02	323
0.44336E+02	325
0.4/682E+02	327
0.51236E+02	329
0.55007E±02	331

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Jahlel R. Ballassi kespitikas

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. تم TABLE B.1c RADIANCE FROM 4.5 - 5.5 MICRONS IN MICROWATTS/(cm<sup>2</sup> · sr)

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Apparent Temperature °K Radiance 1.1129E+02 275 1.1553E+02 276 1.1989E+02 277 278 1.2439E+02 279 1.2903E+02 -280 1.338CE+02 281 1.3872E+02 1.4378E+02 282 1.4898E+02 283 284 1.5434E+02 1.5985E+02 285 1.6552E+02 286 287 1.7135E+02 1.7734E+02 288 289 1.8349E+02 1.8982E+02 290 1.9632E+02 291 292 2.0300E+02 293 2.0985E+02 2.1689E+02 294 2.2412E+02 295 296 2.3154E+02 297 2.3915E+02 298 2.4696E+02 299 2.5496E+02 300 2.6318E+02 2.7160E+02 301 302 2.8023E+02 303 2.8908E+02 304 2.9815E+02 305 3.0744E+02 306 3.1696E+02 3.2671E+U2 307 308 3.3670E+02 3.4692E+02 309 3.5739E+02 310 3.6810E+02 311 312 3.7906E+02 313 3.9028E+02

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# TABLE B.1c (Continued)

Radiance	Apparent Temperature °K
4.0175E+02	314
4.1349E+02	315
4.2549E+02	316
4.3777E+02	317
4.5032E+02	318
4.6315E+02	319
4.7626E+02	320
4-8966E+02	321
5 0335F+02	322
5 1733E+02	323
5 3162F+02	324
5 /6210202	325
J.40215T05	525

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TABLE B.1d RADIANCE FROM 8.0 - 13.5 MICRONS IN MICROWATTS/(cm<sup>2</sup> · sr)

Apparent Temperature °K Radiance 275 3.3578E+03 276 3.4194E+03 277 3.4816E+03 278 3.5445E+03 279 3.6081E+03 280 3.6725E+03 281 3.7375E+03 282 3.8033E+03 283 3.8697E+03 284 3.9369E+03 285 4.0048E+03 286 4.0734E+03 287 4.1428E+03 288 4.2128E+03 289 4.2836E+03 290 4.3551E+03 291 4.4274E+03 292 4.5003E+03 293 4.5740E+03 294 4.6484E+03 295 4.7236E+03 296 4.7995E+03 297 4.8761E+03 298 4.9534E+03 299 5.0315E+03 300 5.1103E+03 301 5.1899E+03 302 5.2702E+03 303 5.3512E+03 304 5.4330E+03 305 5.5155E+03 306 5.5987E+03 307 5.6827E+03 308 5.7675E+03 309 5.8529E+03 310 5.9391E+03 311 6.0261E+03 312 6.1138E+03 313 6,2023E+03

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# TABLE B.1d (Continued)

Radiance	Apparent Temperature K
6 2915F+03	314
6.3814E+03	315
6.4721E+03	316
6,5636E+03	317
6.6557E+03	.318
6.7487E+03	319
6.8424E+03	320
6.9368E+03	321
7.0320E+03	322
7.1279E+03	323
7,2246E+03	324
7.3220E+03	325

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TABLE B.1e RADIANCE FROM 8.0 - 14.0 MICRONS IN MICROWATTS/( $cm^2 \cdot sr$ )

Radiance Apparent Temperature °K 0.30190E+04 265 0.30773E+04 266 0.31362E+04 267 0.31959E+04 268 0.32562E+04 269 270 0.33173E+04 271 0.33792E+04 272 0.34417E+04 0.35049E+04 273 0.35689E+04 274 0.36336E+04 275 0.36990E+04 276 0.37652E+04 277278 0.38321E+04 0.38997E+04 279 0.39681E+04 280 281 0.40372E+04 282 0.41070E+04 2830.41776E+04 284 0.42490E+04 285 0.43210E+04 0.43938E+04 286 287 0.44674E+04 2880.45417E+04 289 0.46168E+04 290 0.46926E+04 0.47691E+04 291 292 0.48465E+04 293 0.49245E+04 294 0.50034E+04 0.50829E+04 295 296 0.51633E+04 297 0.52444E+04 0.53263E+04 298 299 0.54089E+04 300 0.54923E+04 0.55764E+04 301 302 0.56613E+04 0.57470E+04 303

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# TABLE B.1e (Continued)

Radiance	Apparent Temperature °K			
· · · · · · · · · · · · · · · · · · ·				
0.58334E+04	304			
0,59206E+04	305			
0.60086E+04	306			
0.60974E+04	307			
0.61869E+04	308			
0.62772E+04	309			
0.63682E+04	310			
0.64600E+04	311			
0.65526E+04	312			
0.66460E+04	313			
0.67401E+04	314			
0.68350E+04	315			
0.69306E+04	316			
0.70271E+04	317			
0.71243E+04	318			
0.72223E+04	319			
0.73210E+04	320			

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TABLE B.1f RADIANCE FROM 9.0 - 11.4 MICRONS IN MICROWATTS/(cm<sup>2</sup> . sr)

Radiance	Apparent Temperature_°K
0.14113E+64	271
0.14388E+04	272
0.14667E+04	273
0.14949E+04	274
0.15234E+04	275
0.15522E+04	276
0.15815E+04	277
0.16110E+04	278
0.16409E+04	279
0.16711E+04	280
0.17017E+04	281
0.17326E+04	282
0.17638E+04	283
C.17954E+04	284
0.18273E+04	285
0.18596E+04	286
0.18922E+04	287
0.19252E+04	288
0.19585E+04	289
0.19922E+04	290
0 20262E+04	291
0.20606E+04	292
0.20953E+04	293
0.21304E+04	294
0.21658E+04	295
0.22016E+04	296
0.22377F+04	297
0.22742E+04	298
0.23110E+04	299
0.23482E+04	300
0.23857E+04	01
0.24236E+04	302
0.24618E+04	303
0.25004E+04	304
0.25393E+64	305
0.25786E+04	306
0.26183E+04	307
0.26583E+04	308
0.26987E+04	309
0.27394E+04	310
0 2780417+04	311

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## TABLE B.1f (Continued)

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Apparent Temperature °K Radiance 312 0.28219E+04 313 0.28637E+04 **3**14 0.29058E+04 315 0.29483E+04 316 0.29912E+04 317 0.30344E+04 318 0.30779E+04 31.9 0.31219E+04 320 0.31661E+04321 0.32108E+04 0.32558E+04 322 323 0.33011E+04 324 0.33468E+04 325 0.33929E+04 326 0.34393E+04 327 0.34861E+04 0.35332E+04 328 329 0.35807E+04 330 0.36286E+04

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TABLE B.1g RADIANCE FROM 9.3 - 11.7 MICRONS IN MICROWATTS/(cm<sup>2</sup> · sr)

- <b>u</b> - Sar	Apparent Temperature °K	Radiance
· · · · · · · · · · · · · · · · · · ·	275	1.5292E+03
	276	1.5574E+03
	277	1.5859E+03
	278	1.6147E+03
	279	1.6438E+03
·····	280	1.6733E+03
	281	1.7030E+03
	282	1.7331E+O3
	283	1.7635E+03
	284	1.7942E+O3
	285	1.8253E+03
	286	1.8566E+O3
	287	1.8883E+03
	288	1.9203E+03
	289	1.9526E+03
	290	1.9853E+03
	291	2.0182E+03
	292	2.0515E+03
	293	2.0852E+03
	294	2.1191E+03
	295	2.1534E+03
	296	2.1879E+03
	297	2.2229E+03
	298	2.2581E+03
	299	2.2937E+03
	300	2.3296E+03
	301	2.3658E+03
	302	2,4023E+03
	303	2.4392E+03
	304	2.4764E+03
	305	2.5139E+03
	306	2.5517E+03
	307	2.5899E+03
	308	2.6284E+03
	309	2.6672E+03
	310	2.7064E+03
	311	2.7459E+03
	312	2.7857E+03
	313	2.8258E+03

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# TABLE B.1g (Continued)

Radiance	Apparent Temperature °K	
2 8663E+03	314	
2 9070F+03	315	
2 94825+03	316	
2 9896F+03	317	
3 0314F+03	318	
3.0734E+03	319	···· = ····
3.07546.05 3.1507+03	320	
2 1586F+03	321	
2 2017E+03	322	
2 24505403	323	
2.2430ET03	324	
3.3328E+03	325	
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B-22

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$$N = \frac{T(V_T) - T(0)}{T(255) - T(0)} 255$$
 (B-15)

where T is the temperature versus bin value array with  $T(V_T)$  equal to the temperature corresponding to bin value  $V_T$ . The "mult" and "add" factors for the thermal channels are then taken as

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$$MULT = \frac{T(255) - T(0)}{255}$$

(B-16)

### ADD = T(0)

The calibration program allows for "average" or "line-by-line" calibration of the thermal channels as it did for the reflective IR channels. Because of the amount of computation required to set up the temperature versus bin value array, only one such array is generated using the scene average values of  $V_C$ ,  $V_A$ , and  $V_H$  in Equation B-13. If an "average" calibration is used this array directly relates data bin values ( $V_T$ ) to temperature and Equation B-15 is used dir ctly. However, if a "line-by-line" calibration is required the data bin values must be modified so that B-13, using scene average values of  $V_C$ ,  $V_A$ , and  $V_H$ , gives the correct radiance. The modification of the data bin values is done in the same way as for the reflective IR channels using Equation B-6. In this case, the "mult" factors are given by eW or eW and the "add" factors by the first two terms of Equation 4-13 or

$$ADD = L_C^{BB} + W [(1 - \varepsilon) V_A - V_C]$$
$$\overline{ADD} = L_C^{BB} + \overline{W} [(1 - \varepsilon) \overline{V_A} - \overline{V_C}]$$

To avoid round-off errors the values concrimed from B-6 are not rounded to the nearest integer but taken as floating point numbers and interpolation in the  $T(V_{i_1})$  array is used to determine the temperature. This temperature is then used in place of  $T(V_{i_1})$  in Equation B-15 to evaluate the calibrated integer value.

K-23



In a typical data set both thermal and reflective IR channels are present so that both of the above procedures are used in generating a calibrated image tape.

B.3 CORRECTIONS FOR OVERLAP AND UNEQUAL FIELDS OF VIEW

Since the detectors used in the various channels (wavelength regions) vary in size and consequently in instantaneous field of view, direct comparisons of the channels is not possible unless the fields of view are normalized in some fashion. A second, although less critical, problem is that depending on the aircraft altitude, scan lines and/or pixels may be highly overlapped resulting in oversampling of the scene. Both of these problems were corrected at the time the data was calibrated by averaging the scan lines (ard/or pixels) of the smaller field-of-view channels and generating an equivalent scan line (and/or pixel) with a field of view equal to the largest field of view. This procedure must be carried out separately for scan lines and pixels within a scan line since the fields of view and the data taking rates are different in these two dimensions. In the following discussion only scan line averaging will be discussed since pixel averaging is completely analogous.

As outlined in Section B.1, the averaging procedure consists of setting up a set of contiguous output lines with a field of view equal to the largest field of view (D) and then combining the smaller fieldof-view (d) scan lines to generate equivalent lines with fields of view D. As shown in Figure B.1, the combining of scan lines is accomplished using a weighted average given by

$$J_{\mathbf{k}} = \frac{\sum_{\ell}^{\Sigma} F_{\mathbf{k},\ell} V_{\ell}}{\sum_{\ell}^{\Sigma} F_{\mathbf{k},\ell}}$$
(B-17)

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where  $V_k$  is the k<sup>th</sup> <u>cutput</u> line data value for a given pixel,  $V_l$  the  $l^{th}$  <u>input</u> line data value for the same pixel, and  $F_{k,l}$  the overlap between input line l and output line k. Since the overlap will be non-zero only for a small number of lines about the output line,  $F_{k,l}$  need only be calcula cd for a few values of l. A general expression for the

overlap is determined by considering the displacements of the scan lines from the beginning of the scene. The displacement to the bottom of input scan line & is given by

$$(l - 1) v_{a}^{\tau} + \frac{(D + d)}{2}$$
 (B-18)

where  $v_a$  is the aircraft ground velocity and  $\tau$  the scan period. The second term in this equation is included since the smaller field of view (d) is concentric with D in scan line 1 and consequently has an initial displacement (to the bottom of the scan line) given by

$$D = \frac{(D-d)}{2} = \frac{(D+d)}{2}$$
 (B-19)

As shown in Figure B.2, the overlap between input line L and output line k is then given by

$$\gamma = (\ell - 1)v_{a}\tau + \frac{(D+d)}{2} - (k-1)D$$
 (B-20)

so that the percent overlap (y/d) or overlap factor  $F_{\mathbf{k},\ell}$  is

$$F_{k,\ell} = \frac{1}{2} \left[ 1 + \frac{D}{d} \right] - \frac{1}{d} (k-1)D - (\ell-1)v_a \tau$$
 (B-21)

with the constraints

$$F_{k,\ell} \rightarrow 1 \text{ if } F_{k,\ell} \geq 1$$

$$F_{k,\ell} \rightarrow 0 \text{ if } F_{k,\ell} \leq 0$$

The absolute value appears in thi, equation to account for cases where the bottom of the input line has a greater displacement than that of the output line. It may be seen that the relationship between k and l is

$$(k-1) = \text{Integer Value of } \left[ (\ell - 1) \frac{V_{a}\tau}{D} \right]$$
 (B-22)



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> These overlap factors are then used in Equation B-17 to generate the equivalent output lines. Since in general the scan lines for the largest field-of-view channel are themselves overlapped, this procedure is used to average these lines as well so that a contiguous set of output lines is obtained in all channels. In this case, the same equations are used but d is equal to D.

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# GLOSSARY

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HUM1 or HUME1	- Overall Port Hueneme, CA Scene
HUM2 or HUME2	- Specific region of Port Hueneme, CA area exhibiting sun glint on water
IFOV - Insta	antaneous Field of View
NEVB NEVF NEVG1 or NVG1 NEVI NEVM NEVN	Mountainous Terrain Scene from Nellis AFB, NV
NEVC or NEVC1 NEVH1 or NVH1 NEVL	Desert Terrain Scene from Nellis AFB, NV

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