ACQUISITION AND PROCESSING PROGRAM OF ERTS DATA IN SOUTH FLORIDA

E. T. Wimberly
A. L. Higer
E. H. Cordes
A. E. Coker
U.S. Geological Survey
Miami, Florida 33130

April 1973

Type II Progress Report for Period 1 October 1972 - 1 April 1973

Prepared for:

Goddard Space Flight Center
Greenbelt, Maryland 20771

Publication authorized by the Director, U.S. Geological Survey

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle	5. Report Date
Acquisition and processing program of ERTS data in south Florida (SR 272)	April 1973
	6. Performing Organization Code
7. Author(s) E. T. Wimberly, A. L. Higer (IN 414), E. H. Cordes, A. E. Coker	8. Performing Organization Report No.
9. Performing Organization Name and Address	10. Work Unit No.
U.S. Geological Survey Miami, Florida 33130	11. Contract or Grant No. S-70243-AG
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	Type II - Progress Rept. 1 Oct. 72 - 1 Apr. 73
Arthur W. Fihelly Goddard Space Flight Center Greenbelt, Maryland 20771	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Interfacing is underway to add other input parameters to the thirteen DCP's now transmitting by the NASA communication line to the Miami office of the U.S. Geological Survey. A data memory system will also enhance the data frequency of the present DCP by providing storage for later transmission. From water levels and cumulative rainfall supplied from the DCS, a simplified water budget was devised for a water management area in South Florida. Hydrologic models are also being planned for other areas. The U.S. Air Force's DAPP (Data Acquisition and Processing Program) system is being used to supplement ERTS imagery. The satellites on the DAPP system have six-hour frequencies over Florida and are useful for interpolation where ERTS imagery has been sparse.

17. Key Words Suggested by Author	18. Distribution Statement
Data memory system, Water management areas, Precipitation, Evapotranspiration Imagery Temperature	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Not applicable	21 p.	

Figure 2A. Technical Report Standard Title Page. This page provides the data elements required by DoD Form DD-1473, HEW Form OE-6000 (ERIC), and similar forms.

INT: 2090-72

ERTS Type II Progress Report
(for period of October 1, 1972 thru April 1, 1973)

By

E. T. Wimberly, A. L. Higer, E. H. Cordes, and A. E. Coker

a. Title: Acquisition and Processing Program of ERTS Data in South Florida

ERTS-1 Proposal MMC 272

b. GSFC ID No. of P.I.: I 414

c. A data memory system is being developed at the Mississippi Test Facility to interface directly with the DCP. This equipment and modifications will enhance the data frequency of the present DCP by providing addressable storage registers to hold the sensor values for transmission at a later time. In operation the DCP will sequentially address the memory registers for stored data rather than use the data generated at the input terminals. The regular functions of the sensor inputs (analog, serial digital and parallel digital) will remain unchanged; only the internal data train will be interrupted prior to encoding and transmission.

Some progress has been made to input wind-speed and direction parameters as time and quadrature averages for use in water budget studies.

d. Fifteen DCP's were allotted to the Miami office of the U. S. Geological Survey. At the present thirteen DCP's are in operation (two transmitters were found to have faulty programming boards). The deployed DCP's are distributed over the water management areas shown in figure 1. They have been found to be especially useful in the remote areas of the Everglades water basin. Figure 2 shows the data collection network in the water management areas and a typical DCP. The platforms presently monitor changes in the level of the free water surface and cumulative rainfall, both on an hourly frequency. Interfacing is underway to add other input parameters such as wind speed and direction with quadrant and time averaging. Other parameters such as water conductance and solar radiation are also being considered for interfacing during the next reporting period (April - May). Figure 2 does not show a station operating in the Big Cypress Area and another at the Miami office of the U. S. Geological Survey. But, all thirteen operating stations are shown in figure 3 and are listed in table 1 for reference.

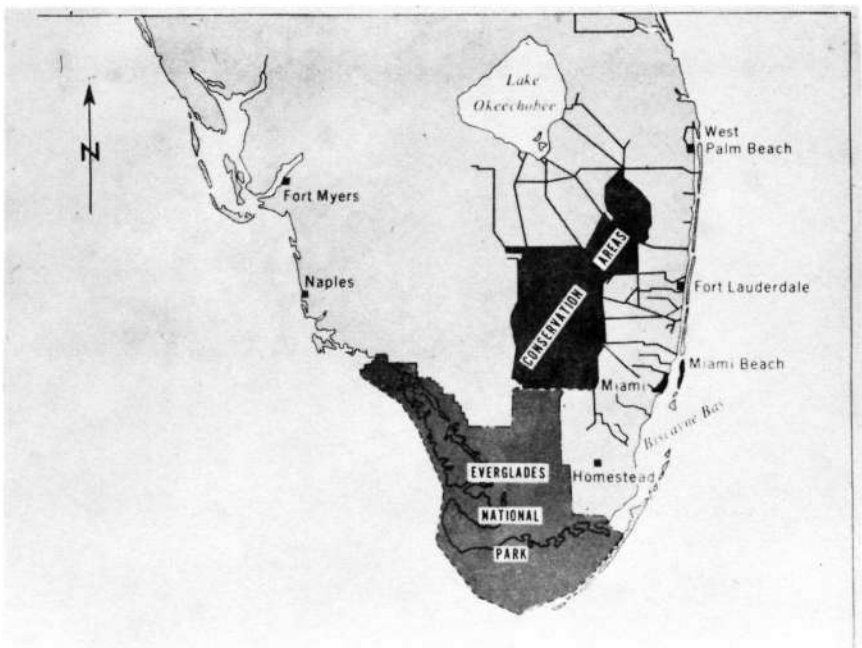
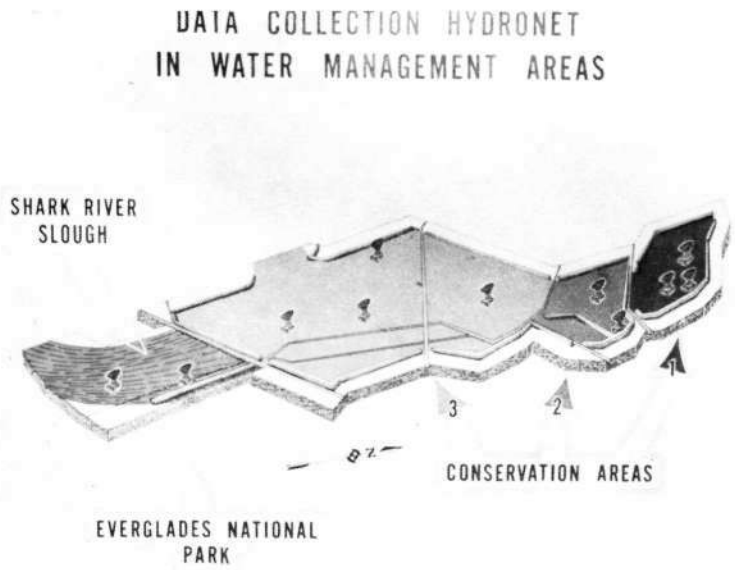


Figure 1.-- Map of south Florida outlining water management areas.



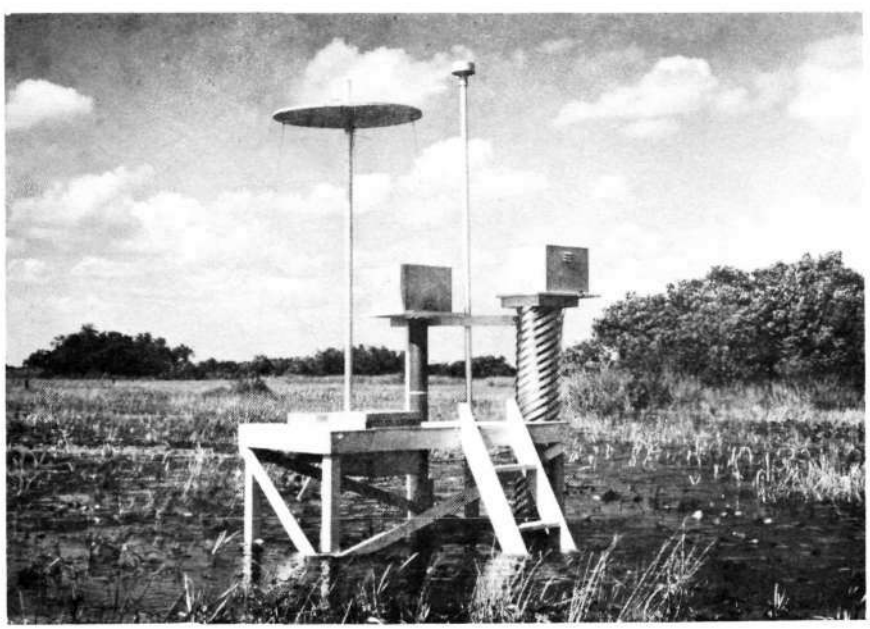


Figure 2.-- Data collection hydronet in water management areas and a typical Data Collection Platform (DCP).

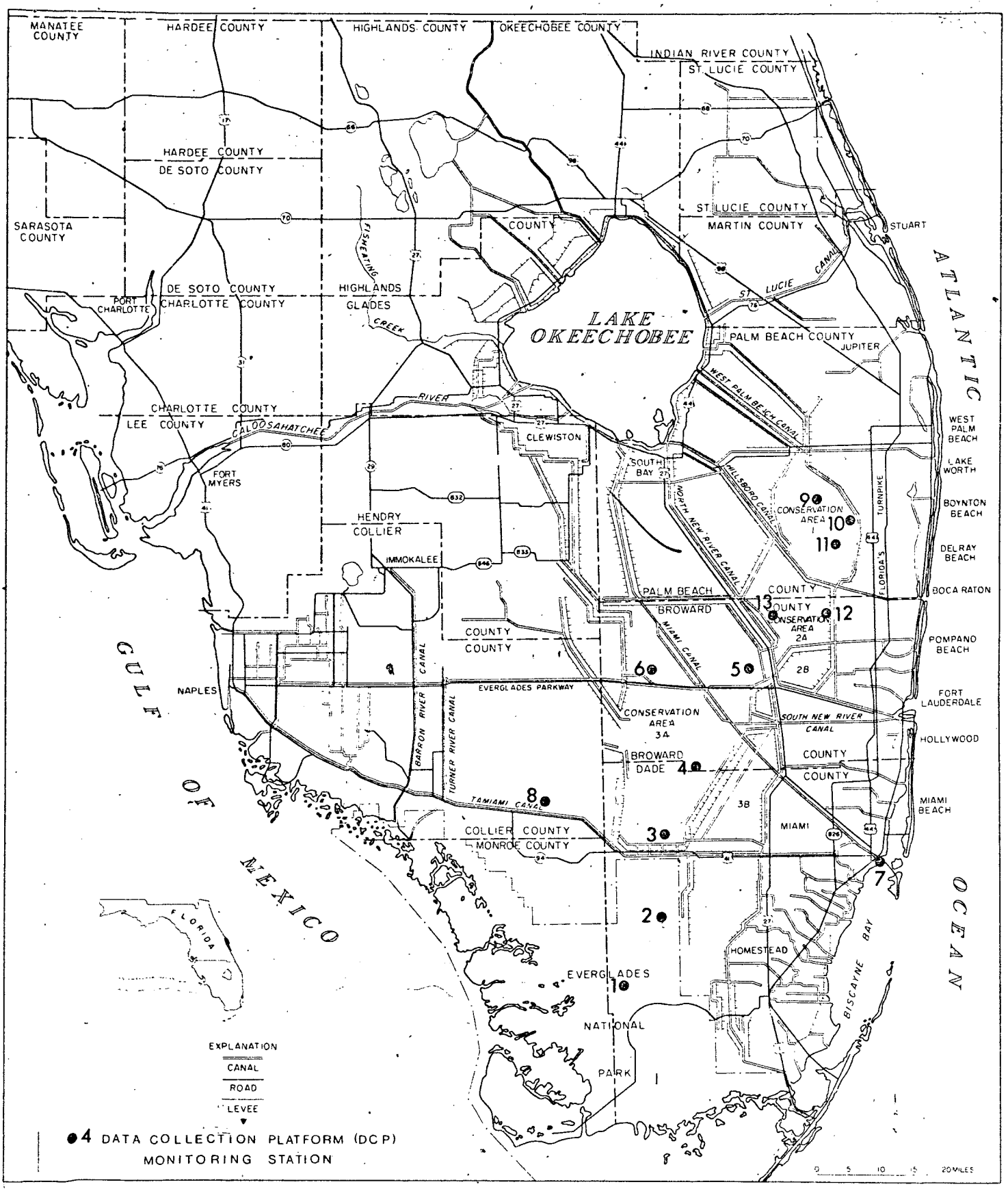


FIGURE 3 – LOCATION MAP OF THE PRESENT DATA COLLECTION PLATFORM NETWORK

Table 1.--Locations of operating data collection stations (April 1973).

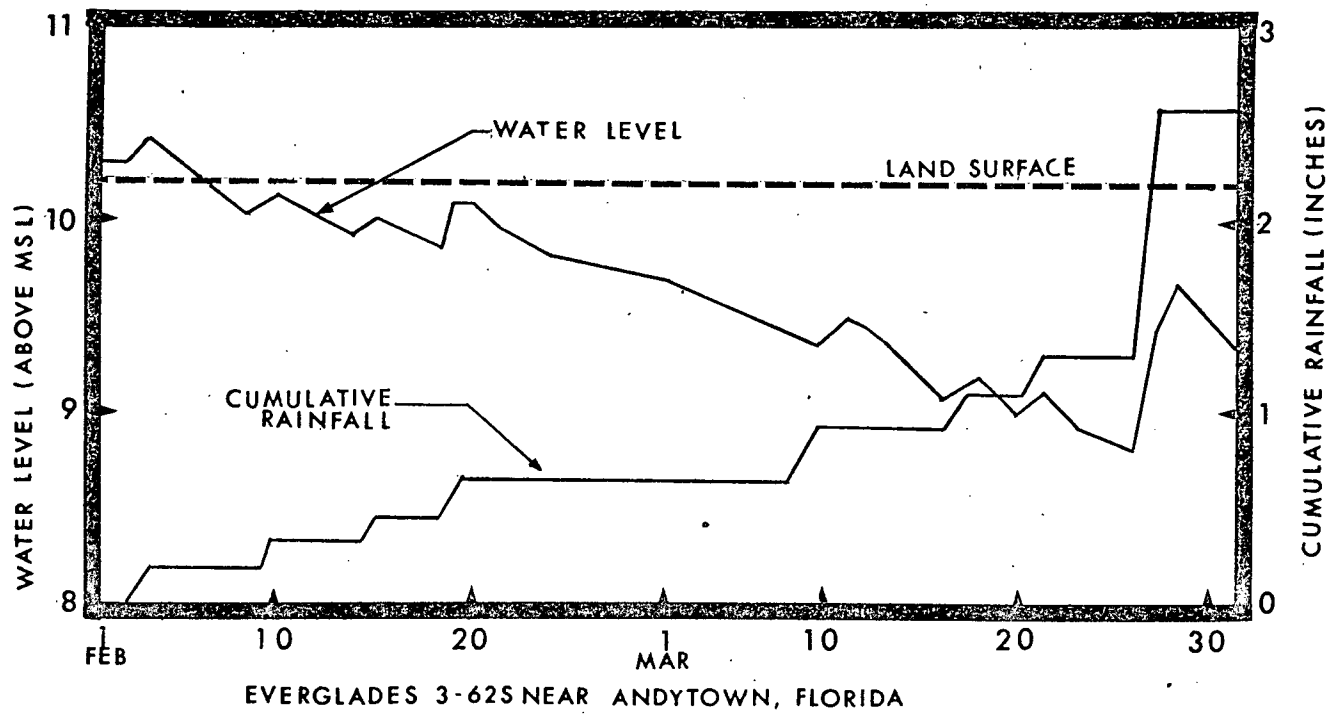
MAP NO.	STATION NAME	PLATFORM I.D.	LATITUDE	LONGITUDE
1.	Everglades P-14S nr. Homestead	6256	25°32'12"N	080°47'06"W
2.	Everglades P-5S nr. Homestead	6121	25°38'54"N	080°41'18"W
3.	Everglades 3-65S nr Miami	6321	25°48'55"N	080°43'18"W
4.	Everglades 3-64S nr. Miami	6070	25°58'24"N	080°40'18"W
5.	Everglades 3-63S nr. Andytown	6236	26°11'18"N	080°32'09"W
6.	Everglades 3-62S nr. Andytown	6033	26°10'57"N	080°44'13"W
7.	901 S. Miami Ave. at Miami	6252	25°45'53"N	080°11'36"W
8.	Tamiami Canal at bridge 105 nr. Monroe	6250	25°51'05"N	080°58'50"W
9.	Everglades 1-141S nr. Loxahatchee	6313	26°31'10"N	080°19'40"W
10.	Everglades 1-128S nr. Boynton Beach	6363	26°30'00"N	080°13'15"W
11.	Everglades 1-142S nr. Delray Beach	6362	26°26'55"N	080°17'10"W
12.	Everglades 1-112S nr. Margate	6214	26°17'01"N	080°17'54"W
*13.	Everglades 1-111S nr. Andytown	6055	26°16'50"N	080°25'10"W

*Changed platform I.D. number as noted in section h of this report.

e. The water levels and cumulative rainfall for the telemetry stations in Conservation Area 3A are plotted in figures 4 and 5. The land surface elevation shown is from U. S. Corps of Engineers, Jacksonville, Florida. The data from these stations can be used in many ways as shown in figure 6. In this figure rainfall, inflows, outflows and storage in Conservation Area 3A are shown for the months of February and March.

Conservation Area 3A was subdivided into Thiessen* polygons. Each polygon is a sub-basin catchment monitored by a DCP station in the respective polygon. The recorded rainfall at each station is applied uniformly over the area of the polygon. The volume of rainfall or the flux into the conservation area is then calculated from the sub-basin totals as shown in figure 6. In February the distribution of rainfall in Conservation Area 3A ranged from 0.68 inches in polygon 2 to 1.56 inches in polygon 4. In March the highest rainfall, 3.88 inches, occurred in polygon 3 with a low of 1.81 inches in polygon 4. The inflows and outflows for Conservation Area 3A are both measured or estimated with assistance from both the Central and Southern Florida Flood Control District and the U. S. Corps of Engineers.

*A. H. Thiessen, "Precipitation Averages for Large Areas", Monthly Weather Rev., July 1971, p. 1082.



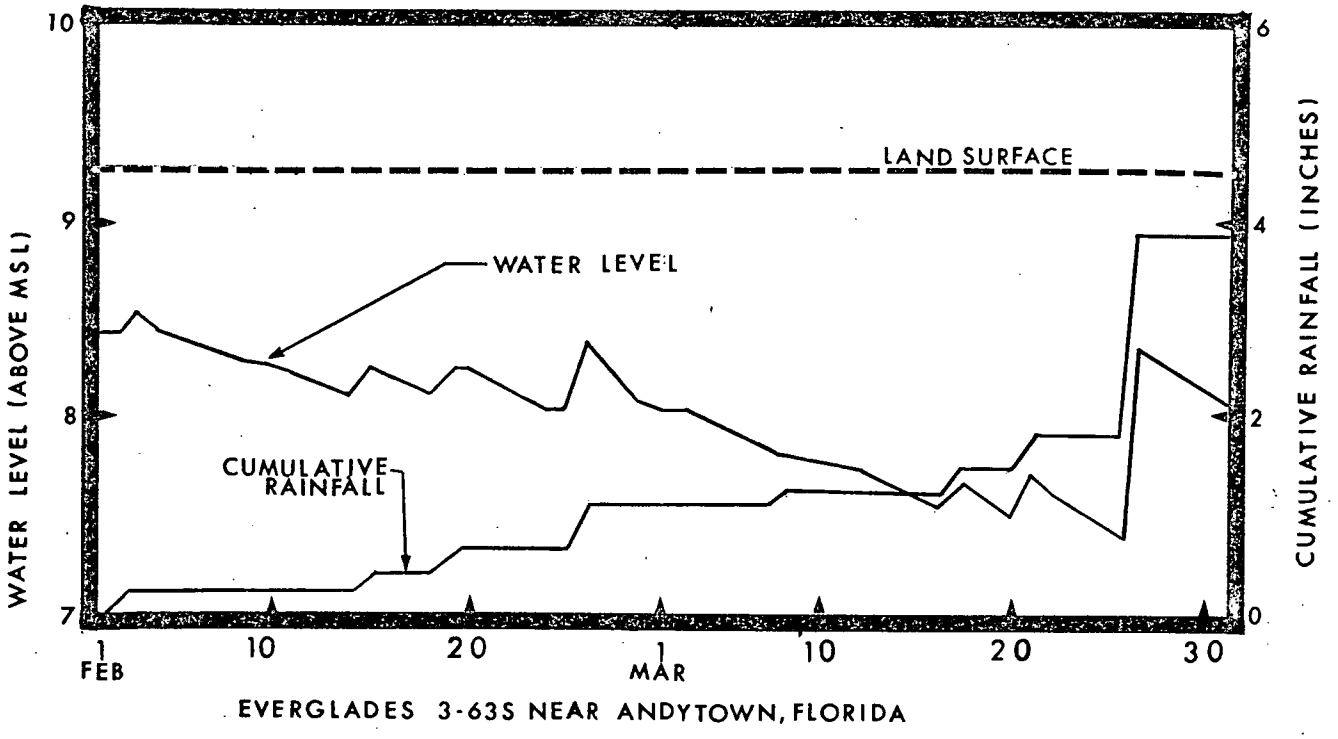
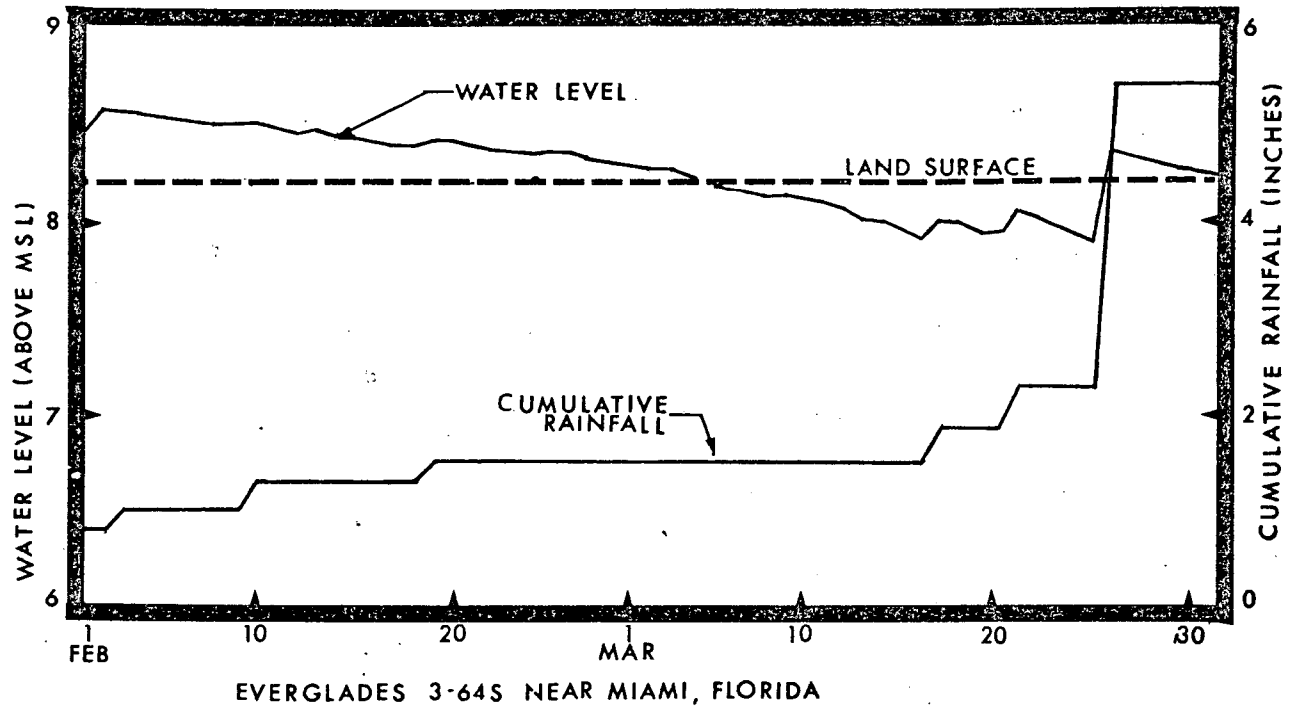


FIGURE 4 — HYDROGRAPHS OF EVERGLADES STATIONS 3-62S / 3-63S



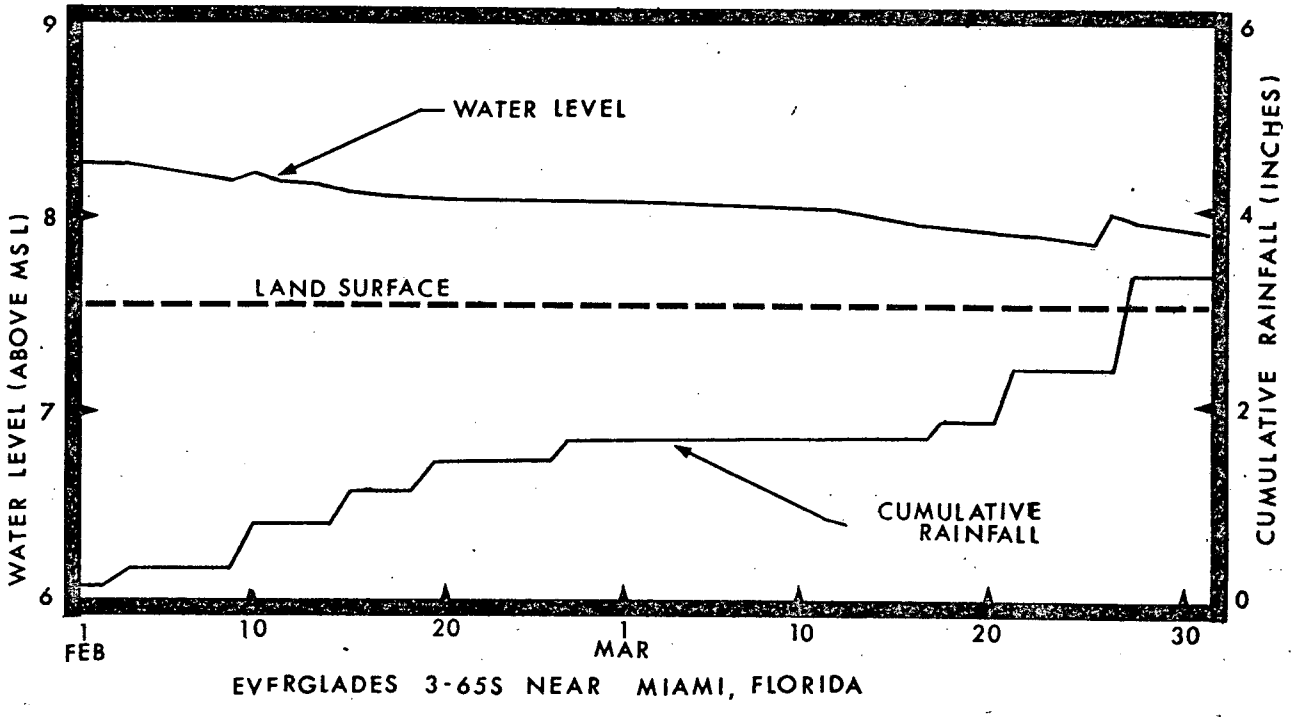


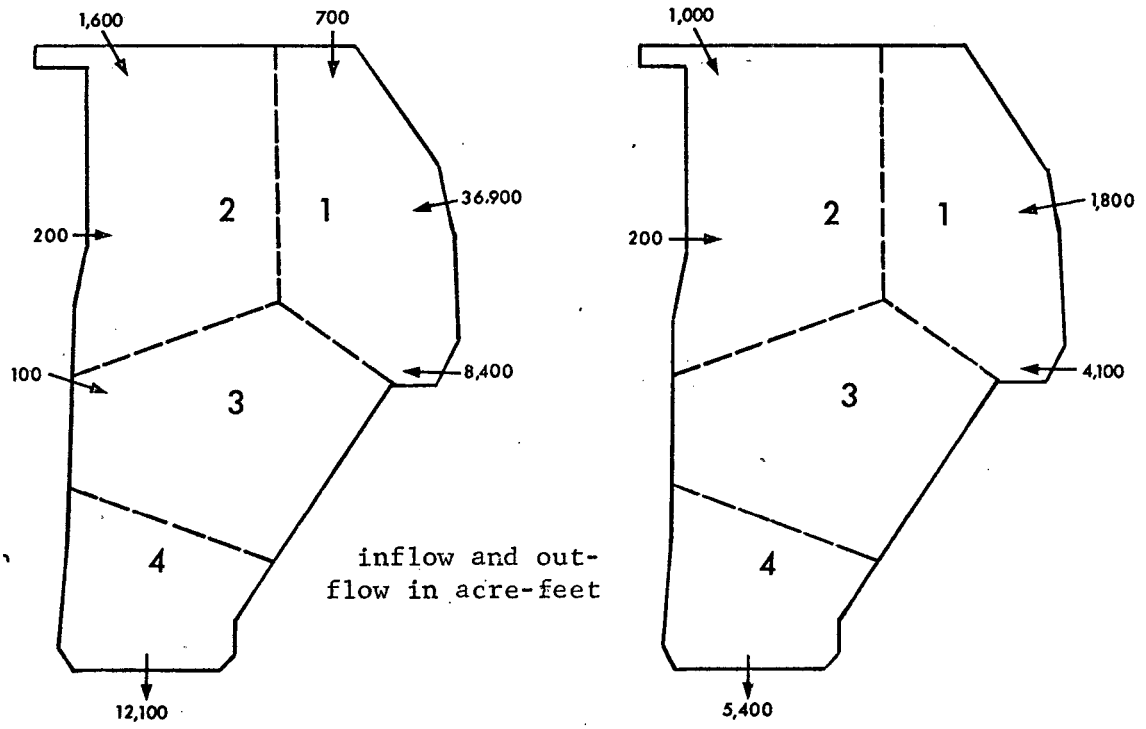
FIGURE 5 – HYDROGRAPHS OF EVERGLADES STATIONS 3-64S / 3-65S

FEBRUARY

Area	Rainfall (acre-feet)
polygon 1	11,500
2	9,200
3	16,400
4	9,100
Total	46,200

MARCH

Area	Rainfall (acre-feet)
polygon 1	30,200
2	26,100
3	46,000
4	10,500
Total	112,800



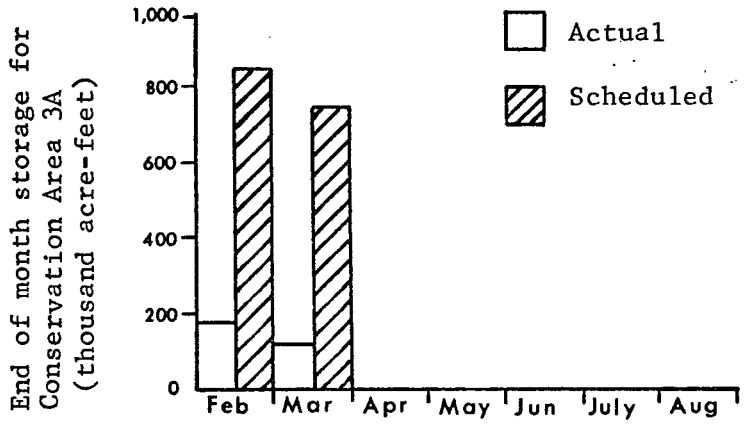


Figure 6.-- Rainfall, storage, inflow and outflow for Conservation Area 3A in February and March 1973.

The end of month storage values shown in figure 6 are calculated by the U. S. Corps of Engineers. Net change of storage in Conservation Area 3A resulted in losses of 40,000 acre-feet in February and 48,000 acre-feet in March. During both months the total rainfall exceeded the loss in storage.

Expansion of the data collection system to include sufficient water budget parameters to calculate daily, weekly and monthly evapotranspiration losses is now being considered. A simplified water budget equation balances the input and output against a change in storage in the conservation area as follows:

P = precipitation

Q_i = Surface flow into area

ET = Evapotranspiration

Q_o = Surface flow out of area

S_b = Subsurface seepage out of area

ΔS = Storage change, gain or loss

$$P + Q_i - ET - Q_o - S_b = \Delta S$$

A calculation of evapotranspiration of 99,600 acre-feet was made for the month of February using the above equation and the following values:

P = 46,200 acre-feet

Q_i = 47,900 acre-feet

Q_o = 12,100 acre-feet

S_b = 22,400 acre-feet (estimated)

ΔS = -40,000 acre-feet (estimated)

For the month of March a similar calculation of 143,800 acre-feet was obtained for these values:

P = 112,800 acre-feet

Q_i = 7,100 acre-feet

Q_o = 5,400 acre-feet

S_b = 18,600 acre-feet (estimated)

ΔS = -48,000 acre-feet (estimated)

A similar hydrologic model is being developed for the Shark River Slough shown in figure 7. However, at the present full parameter coverage is lacking for the completion of the model.

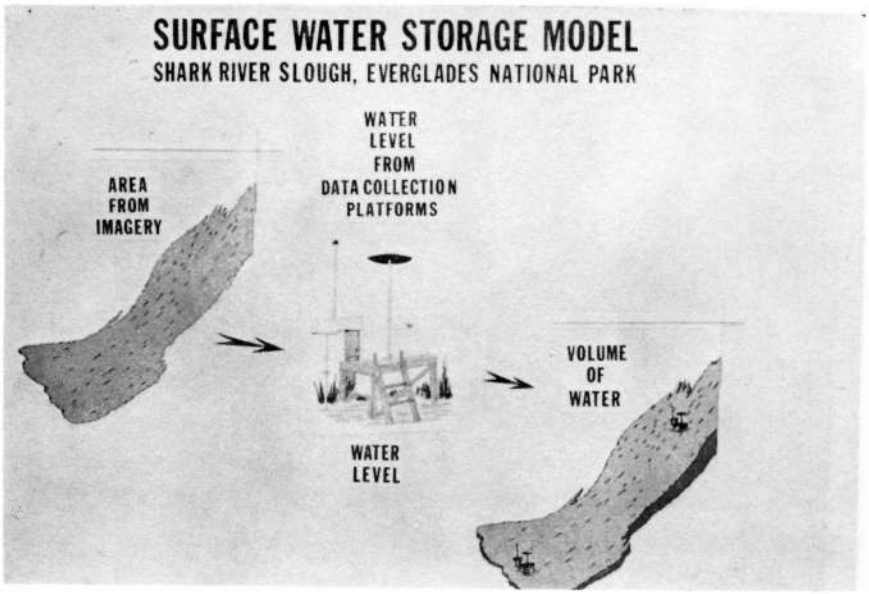


Figure 7.-- Schematic showing method of obtaining surface-water storage of the Shark River Slough by ERTS data.

Useful coverage of ERTS imagery in south Florida has been sparse largely because of the 18 day lapse in data. However, we are planning to use the Air Force DAPP (Data Acquisition and Processing Program) system to supplement ERTS imagery as shown in figures 8, 9 and 10. Table 2 gives the characteristics of the DAPP imagery. DAPP is composed of three satellites equipped with 8-channel radiometers and all weather mobile tracking and processing stations. These satellites have a six hour frequency over the Florida area. Therefore, we are able to collect and interpolate imagery between successive ERTS passes using the DAPP system.

g. Edwin H. Cordes, Research Hydrologist, has been instrumental in the following facets of the Florida data collection system:

1. Design of the data collection platforms.
2. Design of the computer program for reducing and analyzing DCS data.
3. Design of the multiplexing system.
4. Design of interfacing transducers to DCS.
5. Design of a system to interface a new timing mechanism for the DCS.

Consequently, due to his outstanding performance in this area, he has been designated by the Water Resources Division to be the coordinator of our Florida DCS program. For all requests for information concerning data acquisition and processing of DCS data please contact Mr. Cordes.

Figure 8.-- Very high resolution (1/3 nautical mile at subpoint) DAPP imagery on March 24, 1972 at approximately 7:30 AM (spectral range: 0.4 to 1.1 microns, expanded visible).

This is a fair weather day with off-shore low level wind flow over Florida and the southeast. The Grand Bahama and Andros reef area can be clearly seen. Some anamoluous grey shading east of Florida is due to the photographic processing.

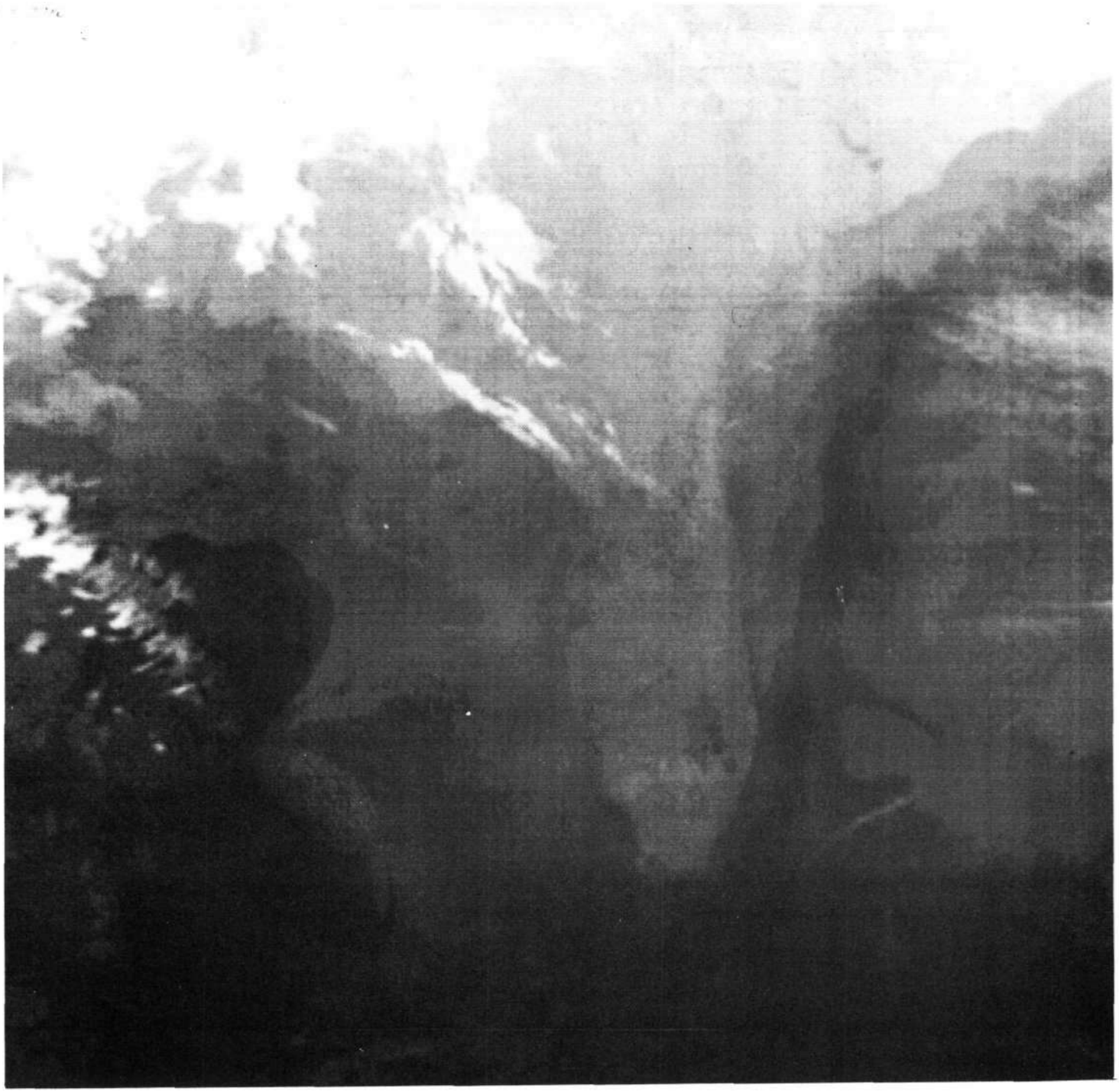


Figure 9.-- Infrared data (2 nautical miles resolution at subpoint) DAPP imagery on March 24, 1972 at approximately 7:30 AM (spectral range: 8-13 microns).

The sensed radiation is converted directly to emission temperatures for this imagery. There are 16 grey shades available in infrared data covering temperatures from 310°K to 210°K. This picture shows 16 grey shades spread over the range 300-275°K. Black is emission temperatures of 300°K or warmer; white depicts 275°K or colder.

Figure 10.-- Infrared data (2 nautical miles resolution at subpoint) DAPP imagery on March 24, 1972 at approximately 7:30 AM (spectral range: 8-13 microns).

This picture is an example of the thresholding capability in processing the temperature data. Only 4 grey shades are used: Black indicates emission temperatures of 296°K or warmer, dark grey corresponds to 295°K to 296°K, light grey is for 294°K to 295°K, and white is 294°K and colder.

Table 2.--DAPP imagery data characteristics.

	Visual		Infrared	
Resolution	2.0	0.33	2.0	0.33
Bandwidth	0.4-1.1	0.4-1.1	8.0-13.0	8.0-13.0
Sensitivity ($WCM^{-2}ST^{-1}$) (°K,EBT)	8.8(-9)-2.54(-2)	8.8(-9)-2.54(-2)	210-310	217-307
Coverage	Global	Partial	Global	Partial

Personal communication: Maj. Henry Brandli and Capt. John Oliver, Patrick Air Force Base.

h. Two of the DCP's were found inoperative. The cause of the failure is thought to be in the programming cards. The cards have been returned to Wallops Island for repair. The faulty DCP's are listed below:

DCP serial number	State	County	Town	Latitude	Longitude
*6141	Florida	Broward	Andytown	26°16'50"N	080°25'10"W
6031	Has not been placed in field				

*Replaced with 6055