Data Retransmission Via Satellites

ERTS I

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Final Report

On December 16, 1971, the National Aeronautical and Space Administration (NASA) announced the acceptance of a proposal submitted by the Canada Centre for Inland Waters (CCIW) for participation in the ERTS I DCP experiment.

The purpose of this investigation was to acquire technical capabilities in the data retransmission field, and to assess scientific data received over this telemetry link.

GENERAL

A Data Collection Platform (DCP) was purchased from General Electric and supplied early in their first production run.

During the summer of 1972 a buoy was fitted out at CCIW (Fig. 1 & 2) with the ERTS DCP, antenna and sufficient battery supplies for three months unattended service. The sensors used were Rosemount platinum resistance thermometers, conditioned with Rosemount type 440L2 resistance bridge amplifiers, for both air and water temperatures. A type 15-7012 Hydro-dynamics sensor was installed to measure humidity. The air temperature and humidity sensors were mounted, in a suitable housing, on the antenna mast about 3 meters above the water line. The water temperature sensor was mounted on the buoy hull, 0.3 meters below

the average water line.

The DCP interface was so connected that Channels 1, 2 and 3 were paralleled for air temperature, Channels 4, 5 and 6 were paralleled for water temperature, relative humidity was connected to Channel 7 and the battery voltage was sampled on Channel 8. This method of connecting the sensors checked the sampling difference (if any) between channels (A to D convertors) the multiplexer and the encoder.

FIELD OPERATIONS

In order to obtain frequent monitoring data, the buoy was anchored near meteorological buoy #4 (near the Niagara River Bar), of the network for the International Field Year for the Great Lakes (IFYGL), where a micro-meteorological program was being conducted. Both on-site monitoring and data from buoy #4 was used to assess the ERTS DCP data. The ERTS buoy remained in position from 31 July to 11 December. With the exception of a 3-week period in October (when the buoy was damaged by a passing ship and had to be returned to CCIW for repairs) the ERTS DCP functioned without any problems.

During the winter the DCP continued to operate from CCIW.

In March of 1973 the DCP developed a fault and was sent to Wallops Island repair depot for servicing. Several faults were found (and rectified) on the programmer board.

During the summer of 1973 the DCP was installed on a tower, in the Great Lakes, to provide water quality data (Fig. 3 & 4). The sensors used for this installation consisted of"

1. a KIPP solarimeter
2. a HYDRO-PRODUCTS Irradiance Meter Model 420

3. a CCIW Three-Channel Color Index Meter.

The KIPP solarimeter was interfaced with a digital integrator which occupied Channels 1 and 2. The rest of the sensors were conditioned for analog inputs. (Channels 7 and 8 were not used during this data collection period). Several on site monitoring tests were again carried to check the data. During a storm of the weekend of October 27 the tower was damaged and the DCP was lost and could not be located (may it RIP, buried no doubt in several feet of sand).

Data Link

The data transmitted by the DCP was received by two ground stations. The majority of transmissions were relayed through the NASA Goddard Space Flight Centre (GSFC) ground station, with some duplicate transmissions being relayed through Goldstone (California). There were occasional transmissions received by Goldstone which were not received by GSFC. This means that the data link was completed, by these two ground stations, while the satellite covered some six thousand miles (east to west) in four successive orbits. The reception probability was stated as 95% for one transmission every twelve hours, for this random access method. To date the transmissions received average eight every twelve hours for the buoy system (1972 field installation) and about half that number for the tower system (1973 installation).

The initial arrangement for Canadian users to receive their data was from GSFC, through the Canadian Embassy (Washington) by mail to Ottawa at the Canada Centre for Remote Sensing (CCRS), and then by mail to the users. However, initially, a two month delay was experienced in receiving data and arrangements were then made for a direct dispatch from

the Embassy to CCIW with a delay of about one week.

During the month of December (1972) a teletype line was established between GSFC and CCRS. The data is received at CCRS with about a three-hour delay. The data, at CCRS, is entered on two computer files and can be obtained through a computer telephone terminal or telex terminal. This reduced the delay to the users to about twenty-four hours.

Data Assessment

During the period August to December, 1972, and the field season of 1973, all transmissions were coded to the highest quality (code 7). Only one transmission was queried (1972) as to data accuracy. The Operational Control Centre at GSFC checked out this transmission and discovered it was due to noise on the teletype line between Goldstone and Washington. The check sum which is now included in all DCP messages verifies any errors received over the link.

When comparing the ERT-1 DCP data for 1972 with that of IFYGL station #4 and on site monitoring, the average accuracy was in the order of 0.5%; each gauged channel agreed within ± one LSB. (See Table #1).

The data that duplicated by NASA and Goldstone were identical. This means that the ground control stations process the data in an identical manner.

The data received during 1973 was also checked by on site monitoring and showed the expected agreement. (See Table #1).

CONCLUSIONS

The random access method used with the ERTS-1 DCP's has proven to be very reliable, and exceeds (as far as CCIW is concerned) the published specifications.

The DCP however does not meet all the requirements for scientific data measurements. More transmissions or more data is required from some sensors. This requirement is being overcome, to some extent, by other agencies by the addition of an add-on memory and/or using electronic integrators.

The ground communications has not always proven adequate, especially if a relay point is introduced into the system. It may take several days to discover any problems with a DCP. I recommend that the principal investigator should be informed directly by the ground control station when a DCP fails to transmit in any twelve-hour period.

TABLE #1

TYPICAL DATA

	Water Temp. ^{o}C	Air Temp. ^{o}C	R.H. %
	Year 1972		
	Month of August		
ERTS Buoy	22.2	14.7	69
#4 IFYGL Buoy	22.8	15.1	72
Monitored at ERTS Buoy at Approx. 1400 Z	22.5	14.9	71
	Month of September		
ERTS Buoy	20.7	19.8	72
#4 IFYGL Buoy	21.2	20.1	79
Monitored	21.0	20.0	76
	Month of October		
ERTS Buoy	12.9	13.3	80
#4 IFYGL Buoy	12.6	13.8	83
Monitored	12.7	13.1	79
	Month of November		
ERTS Buoy	6.47	5.49	87
#4 IFYGL Buoy	6.8	5.6	91
Monitored	6.7	5.6	90

Year 1973

Months of September and October

	Irradiance %	Solar LYS/Day
ERTS Tower	1.0	440
Shore Station	-	400
Monitored	0.8	-

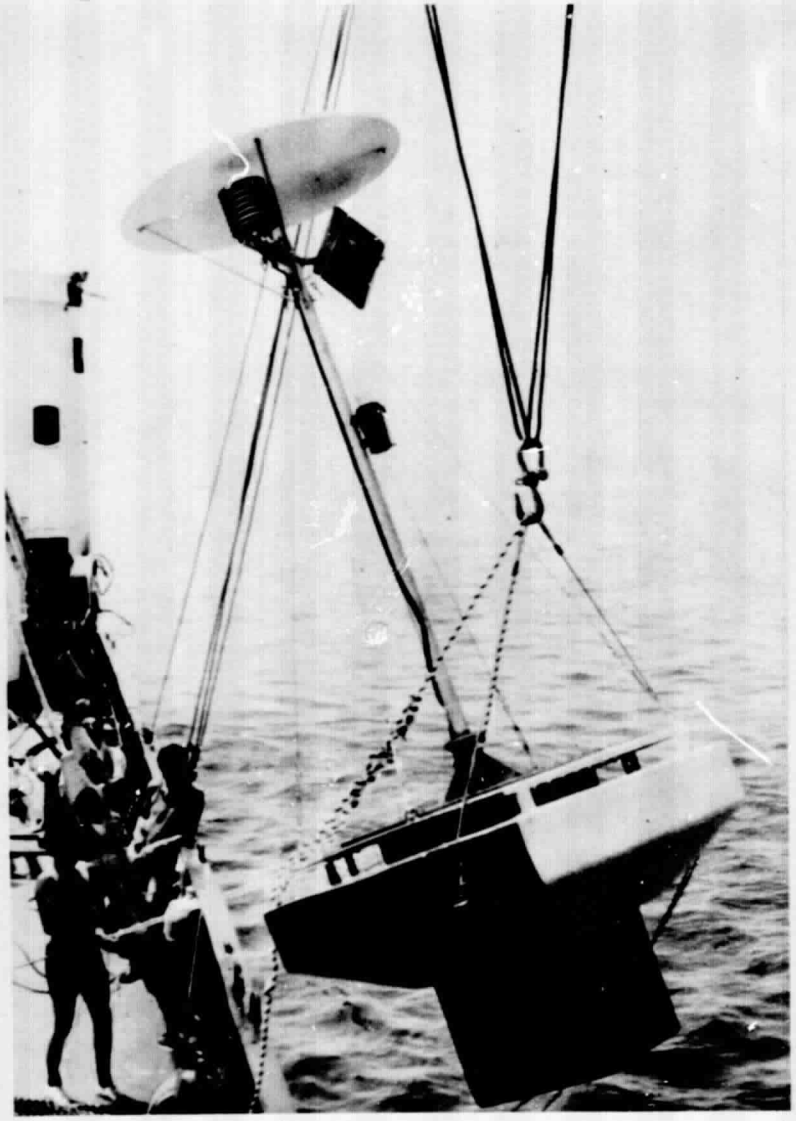

Fig. 1

ERTS BUOY
LAUNCHING

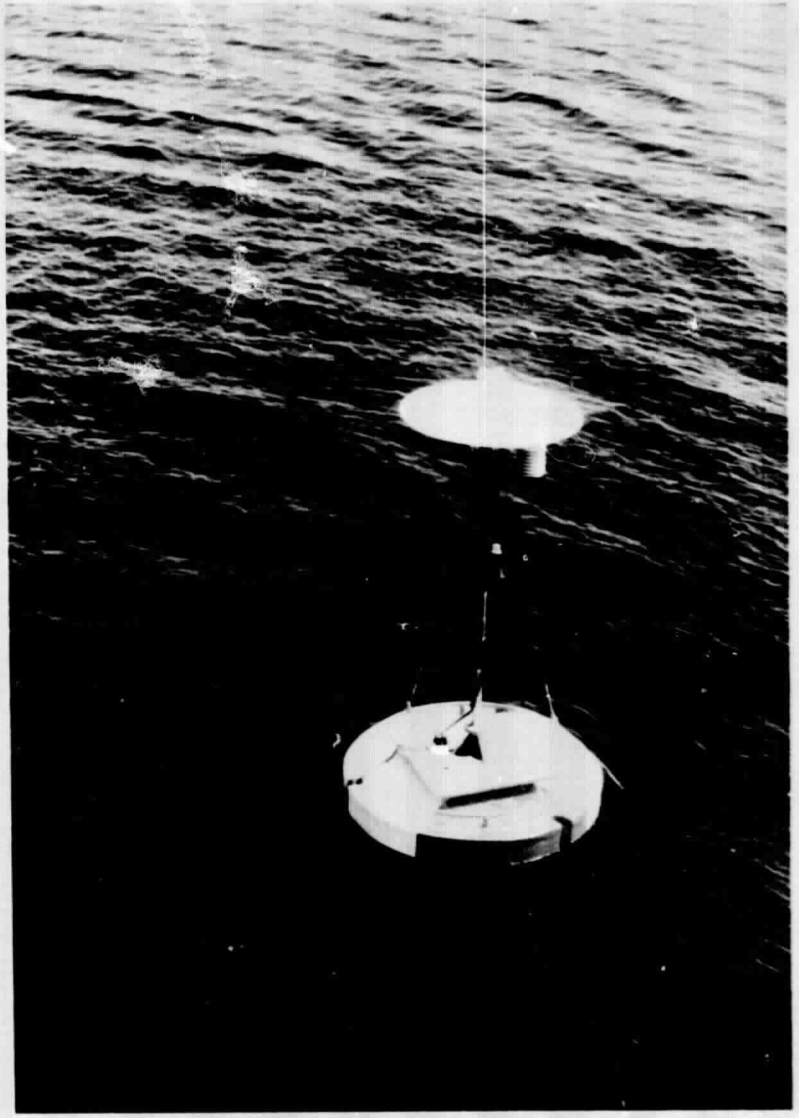

Fig. 2

ERTS BUOY
AT ANCHOR

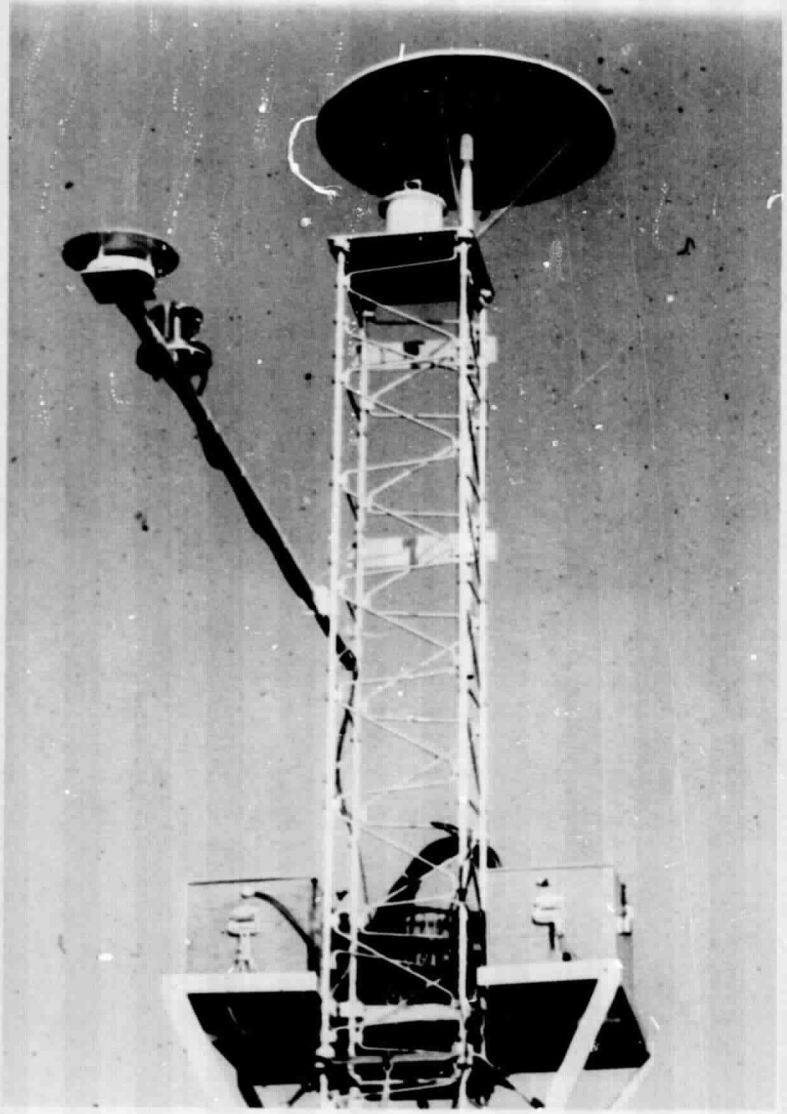

Fig. 3

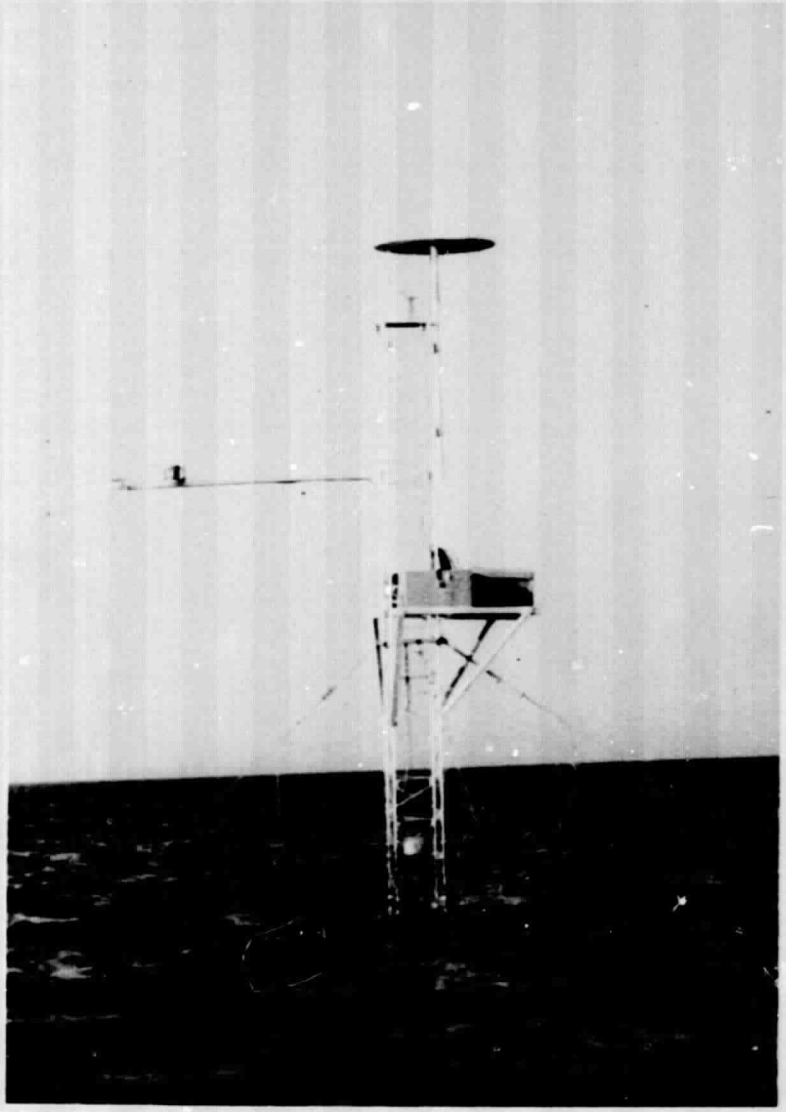

Fig. 4

ERTS TOWER INSTALLATION