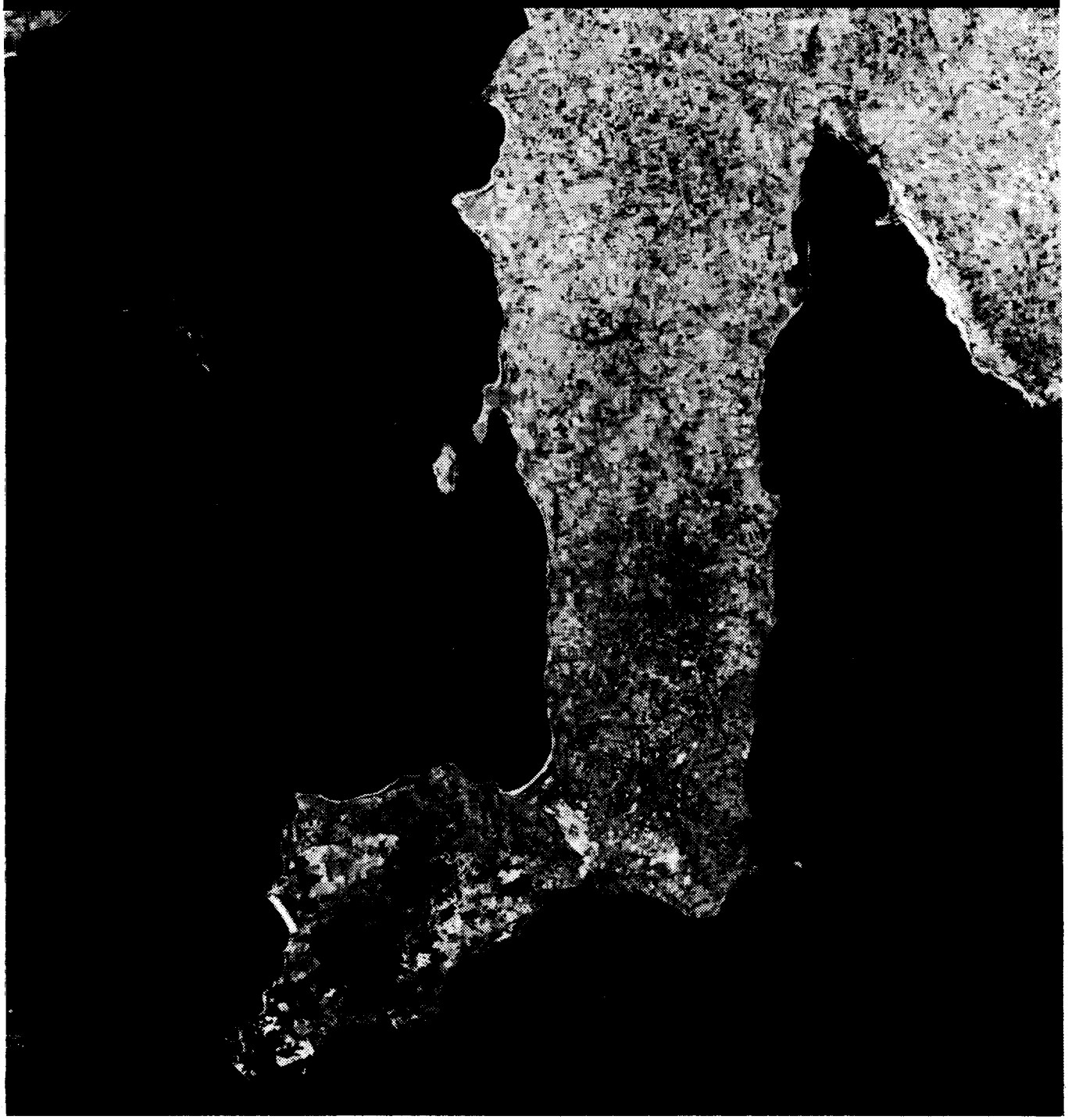
NEWSLETTER

FOR THE REMOTE SENSING INDUSTRY



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FRONT COVER STORY

No, it's not Italy!

After a successful launch from the Vandenberg Air Force Base in California on 1 March 1984, the approximately 1950kg LANDSAT-D prime spacecraft was put through orbit-adjust manouvres before reaching its 705km near-polar orbit. Since then, NASA engineers have checked out all computer, communications, telemetry and other spacecraft systems before declaring it operationally 'green' and handing it over to NOAA on 6 April 1984.

The front cover shows the first of many LANDSAT-5 MSS images acquired and processed by ALS; it was ordered by our digital engineer Mr Robert Denize, for evaluation and testing of LANDSAT-5 data — it is the Yorke Peninsula near Adelaide, on path 98, row 84 of the Worldwide Reference System (WRS) on 11 April 1984.

After thorough testing of the data and spacecraft specific modifications to our computer software we were able to start cataloguing LANDSAT-5 data at the start of cycle 3 on 9 April 1984.

We continued to support both spacecrafts until the end of LANDSAT-4 catalogue cycle 42 on 2 May 1984. As the two satellites are 8 days (half cycle) apart, we are fortunate to have 8 day coverage of most of Australia for the period 9 April to 2 May.

ALS now supports the spacecraft designated as prime spacecraft, LANDSAT-5.

The Multi Spectral Scanner (MSS) data quality is high and all instruments perform to specification. Only one minor hitch occured on 29 March, when after progressive failure in the coil of one of the two thruster valves some fuses were blown in the valve driver of the Rocket Engine Module-D Thruster. The result is the loss of the thruster and a consequent loss of redundancy. Other Stations report that the Thematic Mapper (TM) too is performing nominally; it currently provides up to 100 US scenes and 225 international scenes per day to a maximum of 52 scenes per orbit.

The Tracking and Data Relay Satellite System (TDRSS) is functioning well, but is currently not available on a routine basis as acquisitions must be manually edited into the Schedule with a limit of two LANDSA-5 scenes per day.

Naturally this does not apply to data from the Pacific region until after the TDRS-B launch which is scheduled for February 1985. The launch will be with a newly designed USAF/Boeing initial upper stage (IUS) from the Space Shuttle, following the first test of the IUS on mission 51-C scheduled for launch on 9 December, 1984 (AW&ST 24/9).

John Bruyn (User Services)

We have not moved

However, the local authorities have revised the street addresses of all the blocks in Oatley Court and we have been given a new number. Our address now is:

Australian Landsat Station
22-36 Oatley Court
BELCONNEN ACT 2616
OR
PO Box 28
BELCONNEN ACT 2616

Our telephone (PABX) numbers are (062) 51-5411 or 52-4411.

Dear Reader

Have you ever read an article or paper in which acronyms were used repeatedly while you forgot or never knew the meaning of it? Well, many of use have.

In the remote sensing industry a large range of acronyms are used. To save you the frustration that many of us have felt in the past, we have borrowed Dr John Richard's (University of NSW — Centre for Remote Sensing) list of acronyms and abreviations, and expanded it somewhat.

We hope that you will find it useful!

If you do have any queries or you find that some of your pet RS — acronyms are missing, we would love to hear from you.

John Bruyn (User Services)

A	Angstrom (10^{-10}m)
AARS	Asian Association on Remote Sensing
ACS	Attitude Control System
ACT	Australian Capital Territory
AESIS	Australian Earth Sciences Information System
AFB	Air Force Base (USA)
AgRISTARS	Agriculture and Resources Inventory Surveys through Aerospace Remote Sensing (USA)
ALCORSS	Australian Liaison Committee on Remote Sensing by Satelite
ALS	Australian Landsat Station
AMG	Australian Map Grid
AMF	Australian Mineral Foundation
AO	Announcement of Opportunity
APRSS	Australian Photogrammetric and Remote Sensing Society
APS	(former APRSS) Australian Photogrammetry Society
AS	Academia Sinica (China)
ASP	American Society of Photogrammetry
ASTEC	Australian Science and Technology Council
AVHRR	Advance Very High Resolution Radiometry (NOAA)
AW&ST	Aviation Week and Space Technology (weekly by McGraw-Hill)
BGR	Blue, Green, Red — Order in which bands are assigned to a colour in image processing
BMOE	Brouwer Mean Orbital Elements
bps	bits per second
BPS	Bulk Processing System (ALS)
B&W	Black and white
CAS	Chinese Academy of Sciences
CCD	Charge Coupled Device
CCIR	International Radio Consultative Committee (ITU)
CCITT	International Telegraph and Telephone Consultative Committee (ITU)
CCRS	Canada Centre of Remote Sensing
CCT	Computer-compatible Tape
CIR	Colour Infrared
CNES	Centre National d'Etudes Spatiales (France)
CNIE	Commision Nacional de Investagaciones Espaciais (Argentina)
CNR	National Research Council (Italy)
COSPAR	Committee on Space Research
CPU	Central Processing Unit (Computer)
CRT	Cathode Ray Tube
CSC	Computer Sciences Corporation (USA)
CSIR	Council for Scientific and Industrial Research (S.Africa)
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
CUCRS	Commonwealth Users Committee on Remote Sensing
CZCS	Coastal Zone Colour Scanner (NOAA)
DAF	Data Acquisition Facility (ALS — Alice Springs)
dB	Decibel
DEMUX	Demultiplexer
Domsat	Domestic Communications Satellite
DPF	Data Processing Facility (ALS — Canberra)
DRE	Department of Resources & Energy (Australia)
D/SBD	Defence Space Business Daily (USA)
DSIR	Department of Scientific & Industrial Research (New Zealand)
DST	Department of Science & Technology (Australia)
EBR	Electron Beam Recorder
ECI	Earth Centre Inertial
EDC	Eros Data Centre (USA)
EM	Electro-magnetic
EMR	Electro-magnetic Radiation
EOC	Earth Observation Centre (Japan)
EOSAT	Earth Observing Satellite Co. (RCA Astro Electronics Div. and Hughes Aircraft Co.)
ERIM	Environmental Research Institute of Michigan (USA)
ERS	Earth Resources Satellite (Japan)
ERTS	Earth Resources Technology Satellite (first in the LANDSAT series of Satellites and was renamed just before LANDSAT-2 was launched)
ESA	European Space Agency
ESRO	European Space Research Organisation
EVA	Extra Vehicular Activity (Manned space flights)
FOV	Field of View
GARP	Global Atmospheric Research Program
GCP	Ground Control Point
GE	General Electric Co. (USA)
GEMS	Global Environment Monitoring System
GHz	Giga Hertz (10^9 cycles per second)
GOES	Geostationary Operational Environmental Satellite
GMS	Geostationary Meteorological Satellite
GMT	Greenwich Mean Time
GPS	Global Postioning System
GSFC	Goddard Space Flight Center (USA)
GSTDN	Ground Space flight Tracking and Data Network
HCMM	Heat Capacity Mapper Mission
HDDT	High Density Digital Tape
HDTR	High Density Tape Recorder
HRV	High Resolution Visible (SPOT)
ICE	International Cometary Explorer
IEEE	Institute of Electrical and Electronics Engineers
IFOV	Instantaneous Field of View
I^2S	International Imaging Systems (USA)
INPE	Instituto de Pesquisas Espaciais (Brazil)
INTA	Instituto Nacional de Technica Aeroespacial (Spain)
IPF	Image Processing Facility (GSFC)
IR	Infrared
ISPRS	International Society for Photogrammetry & Remote Sensing
ISRO	Indian Space Research Organisation
ITU	International Telecommunications Union
IUS	Inertial Upper Stage (Space Shuttle Launch of Satellites)
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Centre (USA)
Kbps	Kilo bits per second (10^3 cycles per second)
KSC	Kennedy Space Centre (USA)
LACIE	Large Area Crop Inventory Experiment
LAGEOS	Laser Geodynamic Satellite
LARS	Laboratory for Applications of Remote Sensing
LAPAN	Indonesian National Institute of Aeronautics and Space
LBR	Laser Beam Recorder
LGSOWG	Landsat Ground Station Operations Working Group
LS	Landsat
LTWG	Landsat Technical Working Group
Mbps	Mega bits per second (10^6)
MDA	MacDonald-Dettweiler and Associates Ltd (Canada)
METSAT	Meteorological Satellite
MHz	Mega Hertz(10^6 cycles per second)
MOMS	Modular Optoelectronic Multispectral Scanner System
MOS	Marine Observation Satellite
MOSAICS	Multi Observational Satellite Image Correction System (CCRS)
MOU	Memorandum of Understanding
MSFC	Marshall Space Flight Centre (USA)
MSS	Multi Spectral Scanner
MTF	Modular Transfer Function
MUX	Multiplexer
NASA	National Aeronautics and Space Administration (USA)
NASDA	National Space Development Agency (Japan)
NATMAP	Division of National Mapping (DRE-Australia)
NEp	Noise Equivalence Reflectance
NESDIS	National Environmental Satellite, Data, and Information Service (NOAA, USA)
NETD	Noise Equivalence Temperature Difference
NIR	Near Infra-Red
NITR	National Institute for Telecommunications Research (S-Africa)
nm	Nanometer (10^{-9}m) used for wavelengths smaller than visible light (also known as millimicron)
NOAA	National Oceanic and Atmospheric Administration
NRCT	National Research Council of Thailand
NRSA	National Remote Sensing Agency (India)
NSCA	National Safety Council of Australia
NSTL	National Space Technology Laboratories (USA)
NT	Northern Territory (Australia)
OBC	On board computer
OCC	Operations Control Centre
OSTA	Office of Space and Terrestrial Applications (USA)
OTV	Orbital Transfer Vehicle
PAM	Payload assist module
PDU	Power Distribution Unit
Pixel	Picture Element
POF	Product Order Form (ALS)
PPS	Precission Processing System
PST	Pacific Standard Time
QLP	Quick Look Print
RBV	Return Beam Vidicon
RFP	Request for Proposal
RESTEC	Remote Sensing Technology Centre (Japan)
RMS (rms)	Root Mean Square
RS	Remote Sensing
RSAA	Remote Sensing Association of Australia
RSC	Remote Sensing Committee
RTPB	Real Time Play Back
SAA	Space Association of Australia
SAM	Stratospheric Aerosol Measurement
SAR	Synthetic Aperture Radar
SARSAT	Search and Rescue Satellite Aided Tracking
SEP	Societe Europeenne de Propulsion (France)
SEL	Space Environment Laboratory (NOAA)
SESC	Space Environment Services Centre (NOAA)
SFC	Space Flight Centre
SG	Surveyor General
SIR	Shuttle Imaging Radar
SLAR	Side Looking Airborne Radar
SMA	Scan Mirror Assembly
S/N (SNR)	Signal to Noise Ratio
SOM	Space Oblique Mercator (map projection)
SPAS	Shuttle Pallet Satellite System
SPARRSO	Space Research and Remote Sensing Organisation (Bangladesh)
SPB	Space Projects Branch (DST)
SPOT	Systeme Probatoire d'Observation de la Terre (France)
SRS	Statistical Reporting Service
SRSC	Satellite Remote Sensing Centre (S-Africa)
SSC	Swedish Space Corporation
STI	Space Tracking Industry
STS	Space Transportation System (Shuttle)
TDRS(S)	Tracking and Data Relay Satellite (System)
TIR	Thermal Infra-Red
TM	Thematic Mapper
um(μm)	Micrometer (10^{-6}m, used in wavelengths of visible light and IR)
UOSAT	University of Surrey Satellite (UK)
USDA	US Department of Agriculture
USDC	US Department of Commerce
USDI	US Department of the Interior
USGS	US Geological Survey
UTC	Universal Time (Coordinated)
UTM	Universal Transverse Mercator (map projection)
VICAR	Video Image communication and Retrieval
VLBI	Very Long Baseling Interferometry
WRS	World-wide Reference System

Privatisation — Commercialisation

Following the success of earlier Landsat satellites and the recognition that the information acquired this way would benefit both the public and private sector, it was concluded in the late 1970's that the system could be financed and managed on commercial terms, albeit with heavy reliance on 'value-added' products.

Following the transfer from R&D status of the Landsat program under NASA to an operational status under NOAA, the Reagan Administration decided to limit the funding of the program to operational cost and processing of Multi Spectral Scanner (MSS) data, while maintaining funds to launch LANDSAT-5 and the Thematic Mapper (TM) data processing system.

A large US firm made a bid for both the land and weather satallite systems and proposed that the government would enter into a long term agreement to purchase the data. While government officials concluded that this would not significantly reduce cost and lead to 'privatisation' rather than 'commercialisation', the firm's proposal focussed government and public attention on the issue.

Following the Reagan Administration's proposal in March 1983 to sell the satellites, the Commerce Department issued draft Requests for Proposal (RFP) to industry, that allowed them to bid on any combination of land and satellite systems.

That same October however, following criticism from several sources, the US Senate adopted an amendment to the $US 10.5 billion State, Commerce and Justice Departments spending bill, that forbade the Commerce Department to spend any more public money on the sale of the weather satellites.

This still left the over $US 1 billion Landsat system (nett expenditure around $US 20 million pa); the assests include the Landsat 4 and 5 spacecraft, their command and control capabilities and the MSS and TM processing facilities.

On 3 January 1984, the Commerce Department released new RFP's for the sale of LANDSAT only.

After an extension on the deadline by the Commerce Department to 19 March 1984 there were seven bidders. One of these, Geospectra Corp, was disqualified for lack of financial strength, but was reported to be involved in forming a partnership with 10 mining and petroleum companies to design, launch and operate a geological remote sensing satellite called Geostar (AW&ST 25/6). Eastman Kodak, leading a team including TRW, Fairchild and the Environmental Research Institute of Ann Arbor (Michigan), found the conditions and terms set by the Commerce Department unacceptable.

In its 24 July letter to the department, Kodak ruled out participation as long as the condition of a $250 million ceiling on government investment and contractor matching of that amount or more, remained in force (AW&ST 6/8).

EOSAT, an expressly formed joint venture for the LANDSAT initiative by the RCA — Astro Electronics Division and the Hughes Aircraft Co., planned to proceed under the $250 million ceiling. EOSAT would take over the LANDSAT 4/5 operation immediately on a cost reimbursement basis and build and launch LANDSAT 6 and 7 in 1988 and 1991 respectively, to maintain data continuity.

Malcom Baldridge, Secretary of the Department of Commerce announced last September that EOSAT would be the designated commercial operator of LANDSAT 5 (AW&ST 23/9). Its proposal called for a twelve year program to operate the existing LANDSAT-5 facilities at NASA and to build and launch four more satellites. Landsat-6 would carry a Thematic Mapper similar to that of LANDSAT-5 but it would be fitted with the improved Emulator Multi Spectral Scanner (EMSS), with four spectral bands at 60m resolution. In the proposal, it was further planned that LANDSAT-7 and subsequent spacecraft would be fitted with 10/20 metre resolution multispectral linear array sensors (D/SBD 9/7/84).

John Bruyn (User Services)

NASA Plans Landsat — 4 Orbital Repair

Mission could involve space shuttle in tanker role; repair or retrieval would first use maneuvering unit in polar orbit

Washington — The National Aeronautics and Space Adminstration's Landsat Program Office has asked space shuttle managers to plan for an April, 1986, repair or retrieval of the cripple $60-million General Electric Landsat 4 Earth resources spacecraft.

The mission could result in the first demonstration of space shuttle tanker capabilities and manned maneuvering unit operations in polar orbit.

The flight would be a follow-on to the Solar Maximum satellite repair earlier this year and the successful rescue of the Indonesian Palapa satellite during Space Shuttle Mission 51-A, last November. Both are part of a growing move to exploit the shuttle's satellite repair capabilities (AW&ST Apr. 2, p. 18).

The landsat repair/retrieval mission would involve an astronaut in the Martin Marietta manned maneuvering unit docking with the Landsat 4 spacecraft at 285-naut-mi. altitute in polar orbit, following launch of the orbiter Discovery from Vandenberg AFB, Calif.

Selection of the repair option would provide a demonstration of space shuttle tanker capabilities. Following Landsat's repair, Discovery would refuel the satellite so that it could propel itself back to a 380-naut-mi. operational orbit.

If only the retrieval is planned, the same manned maneuvering unit pickup would be flown, but Landsat 4 would be returned to Earth for ground refurbishment instead of being repaired in space.

NASA managers said the successful Solar Max repair provides an important boost to the even more difficult Landsat repair plan.

Second Polar Flight

The Landsat 4 retrieval/repair mission is scheduled as the second shuttle polar orbit flight to be launched from Vandenberg AFB. Depending upon Vandenberg launch site readiness, however, the mission could be the first U.S. manned flight launched into polar orbit, shuttle officials said.

The first Vandenberg mission is scheduled for October, 1985, based on launch site readiness, although questions remain on whether NASA or the U.S. Air Force has a requirement for a polar orbit payload for launch at that time. There is increasing doubt about whether there will be a Vandenberg — launched shuttle mission in October, 1985,

Landsat 4 has lost 50% of its solar array electrical power and is likely to lose more. Its thematic mapper direct ground link has failed, as has its prime command and data-handling computer (AW&ST Aug. 1, 1983, p. 12).

The spacecraft's condition over the next several months will be an important factor in determining whether the satellite is to be repaired in orbit or retreived for repair on Earth.

Retrieval Logistics

Landsat 4 is in a 380-naut-mi-high circular polar orbit, too high for space shuttle retrieval. A further loss of electrical power in that high orbit could leave Landsat 4 stranded with no chance of shuttle retrieval.

To protect against this, the Goddard Space Flight Center has loaded its ground computers with special software so that within 2 hr. of an additional failure, Goddard could command Landsat 4 to maneuver 100 mi. lower to an altitute where a loss of satellite control would not preclude the shuttle retrieval and repair.

NOAA was forced to launch the Landsat 5/D-prime spacecraft Mar. 1 to back up the failing Landsat 4.

Landsat 4 was launched July 16, 1982, and was to have functioned for at least three years. Its problems reduced utilization of the spacecraft, however, after only one year of operation.

Under the repair option, the primary Landsat 4 task would involve the replacement of the spacecraft's failing 19.6-ft-long solar arry with a new array. Landsat 4 then would be refueled.

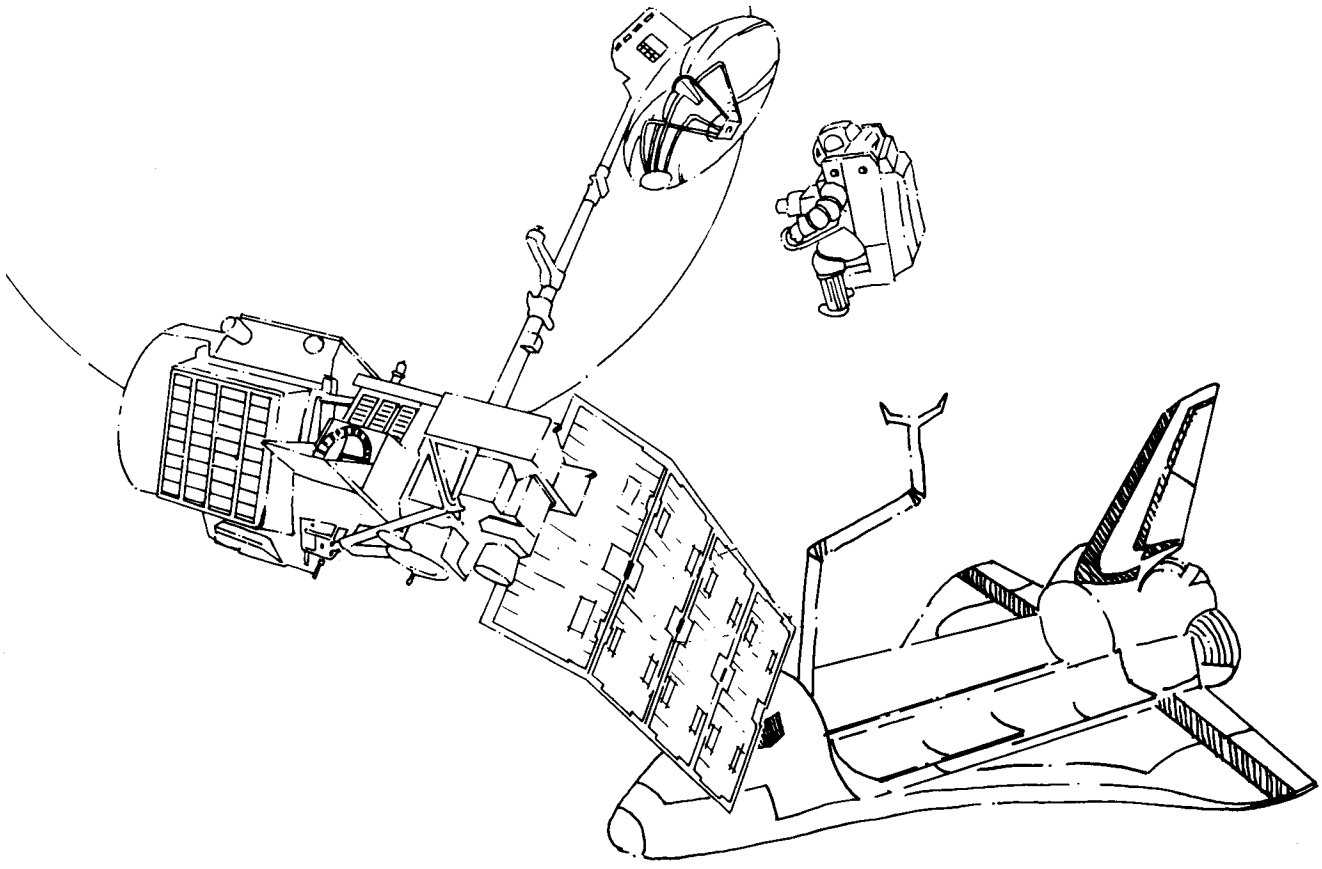
The mission plan for either the repair or just retreival would first involve the use of the Landsat hydrazine system to lower the satellite to about a 285-naut-mi. orbit where the spacecraft can be reached by the space shuttle.

Whether this altitude reduction will be done as part of a comfortably space routine or as an emergency maneuver will depend on the satellite's condition, especially any further solar array degradation.

It is desirable to keep Landsat 4 at its operational altitude for as long as possible because it is providing NOAA some thematic mapper and multispectral scanner data through the TRW/Spacecom tracking and data relay satellite, although only on a limited basis.

About 180 lb. of the spacecraft's hydrazine load would be burned to achieve the altitude reduction, according to Frank Cepollina, manager for Goddard Space Flight Center's satellite servicing project.

Once Landsat achieves the lower altitude, Discovery would be launched from Vandenberg on a direct orbit



Artist impression of astronaut aiding in recovering the ailing Landsat-4 spacecraft.

insertion trajectory to achieve a rendezvous with Landsat 4.

With Discovery flying 200 ft. away from Landsat, an astronaut in a manned maneuvering unit would be deployed to dock with Landsat 4 to insure spacecraft stabilization for the shuttle retrieval phase of the mission.

Payload Bay

The orbiter would maneuver close to Landsat 4, attach the arm to the spacecraft and place the satellite in the aft payload bay while maneuvering unit crewman undocked and parked the Martin Marietta unit back in the forward bay.

Landsat 4 is a stable spacecraft and would not necessarily require use of the manned maneuvering unit as part of the operation. However, use of the maneuvering unit in the plan is expected because it provides an extra element of control over the retrieval operation.

In addition, depending on the Landsat's future condition, the spacecraft may need to be placed in a slow spin-stablized mode if additional solar panel degradation causes a loss of three-axis control. A slow spin-stablization motion would need to be stopped before shuttle pickup, and the maneuvering unit provides a means to do that.

Under the repair option, the maneuvering unit crewman and teammate in the bay would use the Grumman work platform on the end of the shuttle arm to detach the failed solar array and attach a new panel to the spacecraft.

Other repairs requiring penetration of the side of the vehicle or removal of modular multimission spacecraft boxes also could be undertaken.

Refueling of the spacecraft would be a critical operation in the repair option.

The Landsat 4 thematic mapper and the multispectral scanner imaging systems need to operate at about the 380-naut-mi. altitude, and the spacecraft would have to propel itself from the shuttle retrieval altitude back to the operational altitude. To do this its hydrazine tank would have to be refilled by the orbiter crew. Landsat 4 was designed to be retrieved in space and returned to Earth for refurbishment. It was not, however, designed for in-orbit refueling.

The crew on the April, 1986, mission would have to penetrate hydrazine fuel receptacles designed only for groundbased servicing of the vehicle.

Astronaut Army Lt. Col. Robert L. Stewart demonstrated this could be done safely in a Landsat hydrazine tool and hardware extravehicular activity test on shuttle Mission 10.

Astronaut Kathyrn D. Sullivan demonstrated the technique further using actual hydrazine fuel during an extravehicular activity on shuttle mission 41-G last October.

Hydrazine Burnoff

Because the polar orbit crew would be penetrating a potentially hazardous hydrazine system, the plan is to burn off about 140 lb. of hydrazine that would be left in the spacecraft after its altitude descent maneuver.

Just how and when this should be done is being assesed because use of hydrazine could be a factor both in controlling spacecraft attitude and in maintaining proper spacecraft thermal condition.

The hydrazine is on board primarily for large orbital adjustment maneuvers, while attitude control is handled by momentum wheels.

Landsat's imaging systems have to be maintained at a proper temperature. If solar arry power fails further it may be necessary to shut down the momentum wheel attitude control to allow remaining electrical power to flow to instrument heaters, forcing the hydrazine system into attitude control.

NASA is assessing engineering questions involving the role of the hydrazine system to determine how best to operate the satellite from a retrieval safety and instrument survival standpoint. it also is assessing hydrazine system implications for returning the satellite to Earth if that option is pursued.

Retrieval Altitude

NASA also is examining the implications of whether or not a repair and refueling would allow enough fuel to remain on Landsat 4 to return again to a shuttle retrieval altitude if that were to become necessary.

The solar panels' electrical power problems have occurred because of the potting material used with the wiring in the arrays. The potting material has had the effect of breaking wires leading from the panel to the spacecraft during the course of day/night thermal cycles on the satellite.

There are four segments in the panel. The power from only two of those segments is reaching the spacecraft, limiting satellite operations. Analysis shows it is likely that a third panel will eventually have the same problem, leaving only 25% power — a situation that could result in a loss of spacecraft control.

Goddard controllers are prepared to lower the Landsat's altitude immediately if the third panel shows signs of imminent failure.

General Electric Landsat managers said the company provided hardware specifications to Hughes for the wiring system but did not provide adequate thermal cycle data. The General Electric specifications and lack of thermal data are to blame in the loss of Landsat 4 power, the company's Landsat managers said (AW&ST Aug. 1. 1984, p. 13)/

Ground controllers at Goddard have maintained the Landsat 4 panel at an angle to the Sun that minimizes heating to reduce the severity of the thermal cycles, a change that also further limited spacecraft power.

Acknowledgement

The Australian Landsat Station gratefully acknowledges the author of most of this article, Mr Craig Covault, and the publishers of Aviation Week & Space Technology (April 9, 1984), McGraw Hill.

Delta Launch Ends An Era

When Delta 174/Landsat 5 was launched from Space Launch Complex 2 West at Vandenberg Air Force Base on March 1, it marked the end of two closely related eras. The prime payload aboard was Landsat 5, the latest spacecraft in that revolutionary earth resources observation series.

For Kennedy Space Center's Expendable Launch Directorate, the launch of Delta 174 was the final pearl in an 18-year, 39-mission string of successes from the west coast site. The mission also marked the 40th straight success for the workhorse Delta.

An hour after its 9.59 a.m. PST liftoff, with the Delta second stage passing to the west of the island of Madagascar, a 13-second reignition of that stage circularized the polar orbit at an altitude of 440 miles. Minutes later, the two-ton Landsat spacecraft was separated, followed by the 133-pound UOSAT-B, a 'hitchhiker' payload. UOSAT-B is an amateur radio and scientific research satellite designed and built by Britain's University of Surrey.

Delta launches from NASA facilities near Purisma Point on Vandenberg began with the Delta 41 ESSA-3 weather satellite mission in October 1966. They have continued at the rate of one or two each year since that time.

'We obviously hate to see launch activites at that pad end,' commented Charles D. Gay, expendable vehicles director 'It's been a highly successful and rewarding program conducted by a highly motivated team — and we're pleased that our last shot from SLC-2W was a success.

We've conducted six Delta launches from Vandenberg in the past three years using the KSC team rotated out here on temporary duty. Now we plan to finish the Delta program at KSC with the same degree of succcess and professional pride as we saw with the Delta program on the west coast.'

NASA's Delta program currently has five remaining missions set, three in 1984, and the final two in the summer of 1986.

NASA ACTIVITIES

Landsat 5 Orbit Drift

Towards the end of ALS catalogue cycle 9 on 30 July 1984, Landsat 5 exceeded the 10 km limit of the Worldwide Reference System (WRS) in a westerly direction.

Predictions of the drift were made earlier by NOAA, based on a solar flux average. It is expected that at current solar flux levels the spacecraft would have continued to drift westward if no orbit adjustment was made. By 23 August 1984 the satellite had reached 22km west of WRS before thrusters were fired to steer the spacecraft slowly back onto WRS. (See Fig 2.) A

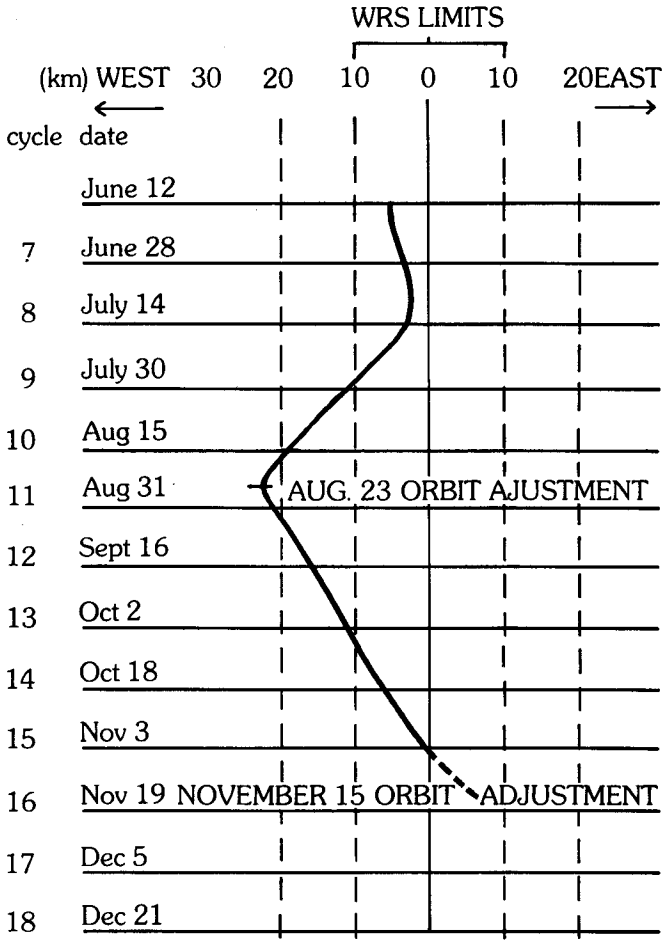


Fig. 2 **Landsat 5 Distance from WRS**

John Bruyn (User Services)

procedure to perform retrograde orbit adjustments to prevent Landsat 5 from drifting outside the 10km limit is under review.

This is the first time a Landsat satellite was allowed to drift outside WRS before adjustment was made. Particularly the extent of the drift is most unusual — as yet, NOAA has not given an explanation as to why they allowed the satellite to drift this far. Speculation that the backup-thruster malfunction may be the reason has not yet been confirmed.

Figure 2 shows that following the 23 August orbit correction, the spacecraft began drifting eastward at an almost linear rate of 4.25km per cycle. By the start of cycle 15 however, the eastward drift had increased to around 7.5km per cycle. Drifting at this rate would again take the spacecraft outside the 10km WRS limit, but this time in the opposite direction. To prevent this from happening, an orbit adjust was made on 15 November 1984 towards the end of catalogue cycle 16.

It is hoped that following this last orbit adjustment, Landsat 5 will maintain a more steady WRS path. ALS will continue to monitor the spacecraft's movements and keep you up to date in the colour micro-image catalogue newsletter.

ALS News

Image quality reduction for path 089 on 27 April 1984

Landsat 5 scenes of path 089 on 27 April 1984 have their data catalogue quality flag reduced form 7777 to 4444 for each of the four MSS bands.

The cause of this reduction in quality is a discontinuity of about one pixel on line to line registration between pairs of lines. The problem occurs about once every swath and is probably due to spacecraft perturbations caused by a bad ephemeris load (orbit parameters transmitted to the spacecraft) to Landsat 5.

Landsat 5 was entered into a safe hold condition at the end of path 89 to correct for the bad load, and subsequent passes have not shown a repeat of the problem.

Robert Denise (ALS, Digital Engineer)

$100,000 for TM-SPOT upgrade study

An allocation of $100,000 was made in the 1984/85 Federal Budget for the Australian Landsat Station (ALS) upgrade preliminaries.

The upgrade is to enable ALS to receive and process image data from the Landsat Thematic Mapper (TM) at 30 metres resolution and the French SPOT satellite with stereo capability on 20 and 10 metre resolution.

Current rough estimates are that such an upgrade would cost in the vicinity of $13.2 million over three years and includes:

a. An upgrade of the Data Acquisition Facility (DAF) at Alice Springs to receive image data from TM and SPOT on X-Band, at a rate of up to 120 mega bits per second and store this at high density on a suitable rapid access medium.
b. An upgrade of the Data Processing Facility (DPF) in Canberra, which involes the acquisition of new computer hardware and software to cope with the aroud 230 million pixel values of a TM scene, and new film writing and processing equipment to cope with the less than 10um image pixels and the expected increase in demand.

In otherwords, at both facilities, the ALS needs to be able to handle much greater volumes of data at much higher rates.

The supply of $100,000 allows a team of ALS specialists to complete most of the necessary preliminary action to let an upgrade contract; the work is expected to be completed during the current financial year.

A further approach by members of the Australian Remote Sensing Industry will be made to the Government early in 1985, seeking an estimated 13.2 million over three years. Once these funds have been allocated, upgrade contracts can be negotiated.

John Bruyn (ALS, User Services)

Natmap News

Natmap digital elevation data programs

Digital contours

Availability of full-cover digital contours is linked to two events: completion of the NTMS 1:100 000 and 1:250 000 scale compilation programs, and acquisition of a scan digitizing system.

Current estimates are for the 1:100 000 scale compilation program (20 metre contours) to be completed by 1986, and the 1:250 000 scale program (50 metre contours) during 1987. Acquisition of a scan digitizing system is currently under consideration, and subject to the necessary approvals the scanner would be purchased during 1985/86.

However, some digitizing of contours has already commenced as part of the on-going Natmap and Royal Australian Survey map compilation programs. Currently, digital contouring has commenced or has been completed in some 15% of 1:100 000 scale map areas, although this percentage may be expected to rapidly rise after acquisition of a scanner.

Digital elevation models (DEM)

A three-level Natmap DEM program is proposed:

Level One (1:1 million scale)

The level one DEM (DEM 1-is to be produced from irregularly distributed spot heights and the digitized coastline. The computed DEM 1 elevations will be on a latitude-longitude grid with a spacing of 0.01 degree (approximately 1 Km).

Level Two (1:250 000 scale)

The level two DEM (DEM 2) is to be produced primarily from scan digitized 50 metre contours, and will also provide national coverage, at an anticipated latitude-longitude grid spacing of 10 seconds (approx 300 metres).

Level Three (1:100 000 and larger scales)

Level three DEMs are to be produced on a project basis to satisfy other-agency and Natmap requirements for more accurate models. Data sources will include 20 and 10 metre digitized contours, photogrammetric spot heights, streams and other topographic data. With 1:100 000 scale data (20m contours), an appropriate grid spacing would be 100 meter AMG eastings and northings, while individual elevations would have an accuracy of approximately 10 metres.

DEM Production program

Development work for DEM 1 has now commenced, with the objective of completing national coverage during 1985. Production of DEM 2 is linked to acquisition of a scan digitizer, while the capacity to produce DEM 3 models is dependant on software development.

The Natmap contact officer for the DEM 1 project is Mr Andrew Clarke (062) 525991.

Andrew Clarke (Natmap)

Australian News

Australian monitor Rabaoul volcanoes

A team from the National Safety Council of Australia (Victorian Division) earlier this year returned from a successful mission to Rabaul in Papua New Guinea. They assisted the staff of the government's Vulcanological Observatory and the Natural Disasters Organisation in their efforts to gain a better understanding of the imminent volcanic eruption.

Rabaoul is located at the junction of two major continental plates on the so called 'Ring of Fire' which circles the Pacific Ocean. It has a deep, enclosed harbour, which itself is the partly drowned caldera of earlier volcanic eruptions. The last major eruption in 1937 caused 500 deaths and much destruction. A new mountain was then formed from the sea in just three days — and appropriately named Vulcan.

Geologists at the Rabaul Vulcanological Observatory know that another eruption is inevitible and is likely to occur within the next few months.

Tension in the earth's crust, and in the lives of otherwise friendly people of Rabaul, is building daily. The most recent crisis involved 1800 earth tremors on a single day — Easter Sunday. The staff of the Observatory are monitoring the activity of the mass of magma under them by measuring seismic responses, ground deformation and the temperature of the land and sea.

The Papua New Guinea government requested the assistance of the NSCA to determine the extent and temperature of thermal sources across the whole caldera, about 10km across. The team from Morwell responded quickly with their aircraft equipped with a thermal infrared scanner. Previously, this has been used mainly for bushfire detection and mapping during our critical summer months, to assist the Country Fire Authority and the Forests Commission Victoria.

Thermal mapping of volcanoes is an ideal application for the sophisticated equipment, and conforms to NSCA's concern for public safety. The image produced by the instrument in the aircraft is a calibrated temperature response of the active craters and nearby thermal springs.

The team of four spent a week in Rabaul, and conducted missions over the volcanoes on most days. A field check of ground temperature involved a climb by one of the members, Markus Walther, into an active crater.

Vulcanologists at the Observatory were thankful for the support provided and enthusiastic about the value of the survey showing the extent of thermal areas and providing an accurate baseline for the anticipated changes.

Graeme Lacy (NSCA)

Space Races to Tasmania

For four hours next April, Tasmania will be the location for a major international scientific experiment. NASA's Space Shuttle Columbia will push through the Earth's ionosphere, and the hole it leaves will be the focus of scientists from around the world. The Tasmanian experiment will be run by Professor Graeme Ellis, former professor of physics at the University of Tasmania.

Professor Ellis says, study of the hole will provide information which could plan the maps future astronauts will use to travel the universe. He will use a telescope to be built near Hobart to monitor radio waves that penetrate the hole. He said the experiment was likely to benefit Man's understanding of plasma physics, which is behind the burning of hydrogen at high temperature to produce electricity.

The Herald.

The University of New South Wales Centre for Remote Sensing

The Centre wishes to advise that from the 1st October, 1984, their new phone numbers will be:

Dr John A. Richards, Director	697-4964
Dr Bruche Forster, Associate Dir.	697-4183
Dr Tony Milne	697-4397
Ms Leanne Bischof (Image Analysis Laboratory)	697-4962
Mr Rosie Garth	697-4391
University Switchboard	697-2222

RSAA Sponsors APRSS

Following negotiations during 1983/1984 between the executives of the Remote Sensing Association of Australia (RSAA) and the Australian Photogrammetric and Remote Sensing Society (APRSS), the Association has now joined APRSS as a sponsoring member.

Until recently the Australian Photogrammetric Society (APS) has operated under the auspices of the Institution of Surveyors and the Australian Institute of Cartographers, with each group contributing three members to a federal executive. In 1982 APS changed its name to include the words 'Remote Sensing' in its title. This was in line with the earlier action taken by the international body, the International Society for Photogrammetry and Remote Sensing (ISPRS) of which APRSS is an affiliate member.

By becoming a sponsoring body of APRSS along with the Australian Institute of Cartographers and the Institute of Surveyors, the Remote Sensing Association of Australia retains its national identity and can still service the needs of its members who come from a broad spectrum ranging from technical specialists in computing and earth science research to executives in private companies involved in environmental consultancy work. In addition it now has official links with the international remote sensing community through ISPRS.

Tony Milne (Chairman RSAA)

International News

CANADA

Huge Increase in Canadian Space Expenditure

The Canadian Minister of Space who is responsible for Space Policy, the honourable D J Johnston announced a new Space Expenditure Plan of a huge $122.2 million or 38 per cent increase to bring the total federal government's committment to space to almost $446 million for the next two financial years.

While making the announcement, Mr Johnston pointed out that the Canadian space industry sells more than the government spends on space. The industry employs over 3,200 people and it is anticipated that over 500 jobs will be created as a result of this initiative.

The funds allocated under the new Space Plan will be used to enhance application of space technology to most Canadian needs in communications, remote sensing and space science.

New Space Plan Expenditures — 1984-85 to 1986-87

$ Million

ERS-1 phases C/D: Canadian participation in the construction and use of the European Remote Sensing satellite of the European Space Agency. The satellite will be launched in 1988. Canadian industry will provide part of the satellite radar system and the ground-base processing system. 29.7

RADARSAT phase B: engineering and economic studies for the detailed definition of a remote sensing satellite system capable of providing day or night, all weather, map-like images of the earth. The system would meet unique Canadian needs for offshore and land resource information. 21.1

Ground System: development of a ground system in Canada to receive, process, and extract information from ERS-1 and RADARSAT 21.5

Space Science: continuation of a co-operative international Space Science program. 18.9

MSAT Bridging Phase: the proposed MSAT program will provide communications services in the future to mobile users in vehicles, ships and aeroplanes. 23.9

Space Station Studies: the commissioning of a one-year study to define possible Canadian participation in the American Space Station Program. 2.4

Technology Development: expansion of the David Florida Laboratory to provide the additional satellite assembly and environmental test facilities required by the Canadian aerospace industry. ... 5.5

Other Items: projects to enhance the usefulness of remote sensing data, development of the Fluorescence Line Imager, communications satellite applications, environmental monitoring, and the space counsellor in Europe .....

REMOTE SENSING IN CANADA.

Canadian Centre for Remote Sensing Receives $10 million for upgrade

MDA (MacDonald, Dettwiler and Associates) of Canada has been awarded a $10 million, 31 month contract to develop, design, install and test the Multi Observational Satellite Image Correction System (MOSAICS) for the Canada Centre for Remote Sensing (CCRS). The MOSAICS technology will improve the accuracy of data gathered from satellite images and allows this data to be integrated with topographic maps and geographic data bases. The system is to be installed at the Prince Albert Satellite Station by June 1986.

MOSAICS will be designed to process images from the LANDSAT and SPOT series of earth resource observation satellites as well as from new generations of this type of satellites planned through to 1995.

REMOTE SENSING IN CANADA.

USA

Nasa Announcements of Opportunity

Thematic Mapper Research in the Earth Sciences

i. Description of the Opportunity

The National Aeronautics and Space Administration (NASA) announces the opportunity to conduct basic scientific studies of the Earth employing the unique observational capabilities of the Landsat Thematic Mapper (TM). The TM is an advanced remote sensing system designed to measure the intensity of Earth raditation within selected portions of the electromagnetic spectrum. The TM is able to conduct multispectral surveys of Earth radiation at a level of resolution and sensitivity that surpasses all previous sensor systems placed in Earth orbit.

Research to be initiated under the auspices of the Announcement is expected to build upon the results of earlier MSS investigations but to differ substantially in intent and scope. The purpose of this research program is to develop improved understanding of surface conditions and processes on the Earth through the analysis and interpretation of TM data. It is anticipated that proposals submitted in response to this Announcement will identify topical problems in various aspects of the Earth sciences that can be addressed in new and innovative ways through the analysis of TM imagery. Proposals are specifically sought for investigations in the fields of botany, ecology, geology, hydrology, and related Earth science disciplines.

Earlier Landsat research programs have provided considerable insight into the general types of Earth

science studies that can potentially be conducted with multispectral Earth imagery collected at synoptic scales on a repetitive, global basis. In addition, a variety of experiments have been conducted during the past eight years employing multispectral imagery acquired by airborne sensors that stimulate the general measurement capabilities of the TM. The results of earlier MSS data analysis projects and TM simulator studies are available in the open scientific and technical literature. (A bibliography of key references to relevant publications are available to prospective proposers).

The research program described in this Announcement will be initiated in 1985 and continued through 1987. Proposals may be submitted for investigations ranging from one to three years in duration. Two types of proposals will be considered: (1) those requesting NASA funds to support the analysis and interpretation of TM and (2) those that require TM data but do not require financial support by NASA. The latter type of proposal may be submitted by foreign (non-US) research institutions or by private organizations which could potentially benefit from participating in this type of data analysis activity.

A total of approximately five million dollars is available to conduct this research program. However, this Announcement does not constitute an obligation on the part of the US government to provide such funds for this purpose. It is anticipated that a total of 20-30 proposals will be approved, depending on the scope and complexity of individual investigations. The results of these investigations will subsequently be published in the open scientific literature.

Each proposal should identify a single individual who will serve as the Principal Investigator for the proposed study. The Principal Investigators of those proposals selected by NASA will be appointed to a Thematic Mapper Science Working Group (TMSWG). The TMSWG will meet periodically in whole or in part to review the results of ongoing research activities. The TMSWG will receive routine briefings on TM sensor performance, TM image quality, and the status of the TM data collection. In addition, the TMSWG will provide a forum for the discussion of data analysis techniques and approaches among investigators with diverse disciplinary backgrounds. This working group will be headed by the Landsat Project Scientist. Dr Vincent Salomonson of NASA's Goddard Space Flight Center currently serves as the Landsat Project Scientist.

It is currently anticipated that Landsat 5 will be the principal source of TM data for the scientific investigations conducted under the auspices of the Announcement of Opportunity. However, prospective investigators may include requests for previously acquired Landsat 4 TM data in their proposals.

The National Oceanic and Atmospheric Administration (NOAA) within the US Department of Commerce will assume responsibility for TM operations and data processing in January 1985. However, the investigators selected to participate in this research program will submit their requests for TM data acquisition and processing to NASA. These requests will be compiled and centrally co-ordinated by the Landsat Project Scientist at NASA's Goddard Space Flight Center. NASA will assume all responsibility for providing TM data to the domestic and foreign scientists selected to participate in this research program.

ii. Announcement Objectives

To be selected, proposals submitted in response to this Announcement must identify a topical problem in one or more Earth science disciplines that can be addressed in an innovative fashion employing the Landsat TM. The overall objective of this Announcement is to develop improved understanding of surface conditions and processes on the Earth through the analysis and interpretation of space acquired TM data. It is anticipated that successful proposals will address scientific objectives of the following nature:

- To develop an improved understanding of the factors influencing the growth, health, condition, and distribution of vegetation on the Earth.
- to develop an improved understanding of the processes controlling the structural and chemical evolution of the Earth's crust, and the geological history of specific crustal provinces.
- to develop an improved understanding of the Earth's water budget and and hydrologic processes that operate at local, regional and global scales.
- to develop an improved understanding of the physical and chemical interaction between different types of surficial materials such as rocks, soils, vegetation and water
- to develop an improved understanding of the interaction between the earths surface and its atmosphere over a variety of temporal and spatial scales

These objectives are presented here in a very generalized fashion. It is expected that individual proposals will identify specific topical problems that can be addressed in a meaningful fashion during a one-to three-year period of investigation.

PLEASE NOTE:

The above Announcement is only a small part of the original NASA document. For more details please write to NASA in Washington DC, 20546 and request a copy of the 'Announcement of Opportunity', A.O.NO.OSSA — 3 — 84 of 27 July 1984 'Thematic Mapper Research in the Earth Sciences'.

The Planetary Geology and Geophysics program

The Planetary Geology and Geophysics Program supports scientific investigations which contribute to understanding the geological and geophysical evolution of the planets, their satellites (including the Earth's Moon and planetary ring systems), and such smaller solar system bodies as asteroids and comets. These investigations involve several types of research efforts generation of new basic data; analysis and synthesis of existing data; or combinations of both kinds of activities. The goals of this program are to foster the gathering, synthesis, and comparative study of data that will improve the understanding of planetary geological and geophysical processes, their extent, and the results of

their interactions through time; the origin and evolution of the solar system; the nature of Earth in comparison with other planets; and the origin and distribution of life in the universe. Examples of the kinds of research supported by this program include: studies of the surfaces and interiors of planetary bodies; and the dynamical evolution of the planets, satellites, small solar system bodies, and ring systems. The program includes, without limitation, laboratory experimentation; photo-interpretation; theoretical, analytical, field and comparative studies; and cartographic compilation. Planetary cartography and geologic mapping are also supported by this program.

The Planetary Geology and Geophysics Program is an open program in which unsolicited proposals may be submitted at any time. However, it is contemplated that proposals will be reviewed by a scientific peer group on a periodic basis. Proposals received by NASA before September 1984 will be reviewed in October-November 1984, but before January 1985, will be reviewed in March 1985 by a peer panel. Thus, to receive funding starting in early FY 1985, your proposal must be received by the end of August 1984, and to receive funding starting in late FY 1985, your proposal must be received by January 1985. Selection of proposals for participation in the Planetary Geology and Geophysics Program will be made by NASA based on the reviews, program needs, and availability of funds.

If you have questions regarding data availability, proposal format, evaluation procedures, etc., you should contact Mr. Joseph M. Boyce, Discipline Scientist, Planetary Geology and Geophysics Program, Solar System Exploration division, Code EL, NASA Headquarters, Washington, DC 20546, telephone (202) 453-1597.

Exploring Jupiter's Atmosphere

The Galileo Project, America's next major unmanned planetary exploration mission continues on schedule for launch in May 1986.

The project was named in honour of the Italian astronomer who, over 350 years ago, contributed much to man's knowledge of the planet Jupiter, and follows earlier investigation by Voyagers 1 and 2 in 1979.

The Galileo spacecraft is stated to make a minimum of 11 circuits of Jupiter over 20 months and release an entry probe into the planet's turbulent atmosphere as man's first incussion into the atmosphere of an outer planet.

The spacecraft will be placed into earth orbit by the Space shuttle, after which a newly designed Centaur G' upper stage rocket will boost it towards Jupiter, some 800 million kilometers away, where it is expected to arrive 26 months later, around August 1988,

NASA ACTIVITIES

Orbital Transfer Vehicle Study

A space vehicle to move payloads from low Earth orbits to higher Earth orbits will be the subject of new study contracts awarded by NASA to both Martin Marietta Aerospace Co. and Boeing Aerospace Co.

The contracts call for parellel studies (concurrent but independent on same topic) for an Orbital Transfer Vehicle (OTV) and cost $1 million each over 15 months.

The initial concept is to transfer payloads from one orbit to another by a space or ground based upper stage rocket to be deployed by the Space Shuttle as payload or as aft cargo on the Shuttle's external tank.

The OTV could even be assembled in space and be larger than a ground base unit and carry more payload to and from its space station.

Marshall Space Flight Centre Engineers conceived as ultimate goal to develop a vehicle capable of ferrying a crew to and from geostationary orbits at around 36000km above the Earth.

NASA ACTIVITIES

Sam II Provides Environmental Information

Stratospheric Aerosol Measurement II (SAM II) is a NASA satellite instrument shich has been methodically measuring the earth's atmosphere for five years. It provides scientists with large amounts of information about the stratosphere and clearly shows the build-up of aerosols in the polar regions. Particularly the climatic effects of volcanic eruptions is manifested in the data.

Volcanic activity puts huge amounts of sulphur dioxide into the stratosphere, which opposes the 'green house effect' of carbon dioxide by reflecting some of the sun's radiation back into space.

A most surprising finding is the effect on acrylic windows on aircraft which cruise at 30 000 feet in the polar regions, where the stratosphere dips closest to the earth's surface. SAM II evidence showed that the interaction of volcanically produced sulphur dioxide and the atmosphere produces sulpuric acid which subsequently causes clouding with minute cracks called 'window crazing' on acrylic aircraft windows.

SAM II also provides scientists with data on stratospheric volcanic debris transport, velocity and dispersion as well as vortex activity in the polar regions.

The instrument further provides NASA-Langley researchers with evidence of Polar Stratospheric ice clouds (PSC's) (Dr PM Mc Cormick), which are believed to be associated with the nacreous (pearl-hued) clouds, initially thought to occur at around 70 000 feet under specific meteorological conditions. In its first two years of operation, SAM II measured more than 1 000 PSC's and since launch it has sensed, collected and dispatched to earth over 50 000 profiles on aerosol concentrations in the lower atmosphere.

The instrument is one of nine aboard the Nimbus 7 satellite which was launched on 24 October 1978.

NASA ACTIVITIES

Space Bargain

The five years old International Sun-Earth Explorer (ISEE-3) was directed on a new mission after it swooped the moon's surface at an altitude on 120km. The lunar swing-by catapulted the spacecraft towards the oncoming comet Giocobini-Zinner.