ACRES

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RADARSAT Downlink Agreement Signed

THE AUSLIG, ACRES AND RSI CONTINGENT WITH RADARSAT SUB-DISTRIBUTORS, AGRECON AND GEOIMAGE, AT THE SIGNING CEREMONY. STANDING, LEFT TO RIGHT: PAUL TRESIZE, BRIAN BUTTON, JIM MOLLISON, SHAWN BURNS, IAN SHEPHERD, PETER HOLLAND, ROBERT TACK, MADELEINE CLARK, DAVID HISDAL, BOB WALKER. SITTING: JOHN LEE, JOHN PAYNE, TODD PEARSON, DANIEL JAKSA. INSET: AUSLIG GENERAL MANAGER, PETER HOLLAND (LEFT), AND RADARSAT INTERNATIONAL PRESIDENT, ROBERT E TACK, SHAKE ON THE RADARSAT DOWNLINK AGREEMENT.

A Network Station License Agreement between RADARSAT International and the Commonwealth, represented by AUSLIG, was signed by the President of RSI, Robert E Tack, and AUSLIG General Manager, Peter Holland on 24 November 1997. This agreement allows ACRES to directly downlink the Synthetic Aperture Radar data from the RADARSAT satellite and to produce products from this data. Data reception will be conducted at ACRES Data Acquisition Facility in Alice Springs.

This agreement brings to Australia a wide range of new remote sensing products using SAR technology. Radar images can be used in a broad range of applications including mineral/petroleum exploration and geological mapping, DEM generation, agriculture and land use monitoring, coastal and ocean applications such as ship detection and oil spill monitoring, watershed modelling, flood mapping and topographic mapping.

There is a wide range of RADARSAT image products available. Image size varies from 50 x 50 km with the Fine Beam Mode to 500 x 500 km for the ScanSAR Wide Mode. Resolutions vary from 10 to 100 metres depending on the Beam Mode selected.

ACRES will be tested for RSI's Blue Ribbon Certification in March 1998. This certification process requires ACRES to produce RADARSAT products that meet the stringent quality specification directed by RSI. It is also expected that ACRES will be applying for part certification within the Bronze, Silver and Gold Certificates at the same time.

To provide maximum assistance to our customers in placing requests for scene searches and the ordering of RADARSAT data products, ACRES has appointed the following organisations as sub-distributors.

- AGRECON Pty Ltd
- Environmental Research and Information Consortium (ERIC)
- GEOIMAGE Pty Ltd, Brisbane QLD, Darwin NT, Perth WA
- Geo Mapping Technologies Pty Ltd
- Landcare Research, New Zealand
- Remote Sensing Services, Department of Land Administration, WA

For more information on RADARSAT products, please contact these sub-distributors (see the back cover for contact details), or refer to the ACRES web pages on http://www.auslig.gov.au.

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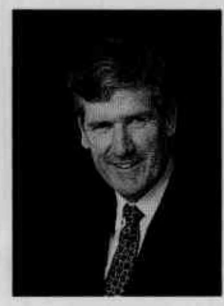


You will read elsewhere in this publication about the many new products and services which we have introduced since the last edition of *ACRES Update*. These include the release of an upgrade to our digital catalogue, and the availability of digital products on CD-R.

Many other projects are in various stages of development, with some to be released in 1998. A major project to upgrade our ground station at Alice Springs is well underway, which will provide even faster access to information on new acquisitions. Local reception and processing of RADARSAT data will be available mid-year, which will provide a faster delivery of all RADARSAT products to users. A new processor is planned to replace the ageing VAX system which we have nurtured since 1988. This will certainly provide a shorter turnaround time of all customers' orders. As well as the direct reception of RADARSAT data, new SPOT and Landsat satellites are both scheduled for launch, and ACRES will be incorporating data from these satellites into its product range. A new acquisition planning/satellite-scheduling tool will be introduced to provide improved efficiency. We look forward to announcing the completion of these projects in due course.

ACRES continues as a consortium partner in the ARIES project, ARIES being the Australian Resource Information and Environment Satellite. The feasibility study for the satellite was successfully completed during 1997, and the business structure is now being settled, before the development of the project begins in 1998. It is proposed that ACRES will have a key responsibility for the development of the ground segment of the project.

Due to changes in federal administrative arrangements during 1997, ACRES and AUSLIG are now part of the Department of Industry, Science and Tourism. In mid-1998, ACRES will be moving to the building now occupied by AUSLIG, about 100m from ACRES current location.

In February, Paul Trezise will be returning as Manager of ACRES, and I will be moving to the Information Access Program at AUSLIG. In this new role, I look forward to maintaining some contact with all users of ACRES products.

Ian Shepherd

Geocentric Datum of Australia — GDA94

Laurie Oliver

Australia is moving from the Australian Geodectic Datum of 1966 (AGD66) to a new geodetic datum, the Geocentric Datum of Australia 1994 (GDA94), for its mapping and other spatial data information products (see http://www.anzlic.org.au/icsm/icsm-main.htm). As a result, coordinates of points in Australia will change by about 200 metres in a north-easterly direction. The actual size and orientation of the change will vary from area to area. ACRES has adapted its production system to accommodate this new datum.

GDA94 is based on a global coordinate system closely aligned to the World Geodetic System 1984 (WGS84), the datum used in the Global Positioning System (GPS). GDA94 is based on the International Terrestrial Reference Frame (ITRF). This was chosen in favour of WGS84 because it is a more recently defined system. The US Department of Defence developed WGS84 over fifteen years ago. This decision was confirmed in early 1994, when WGS84 was modified to align it more closely with the ITRF. GDA94 and WGS84 are compatible at better than a metre.

Up till now ACRES map-oriented products (levels 8,9 &10) have been produced in a UTM projection based on the Australian Geodetic Datum of 1966 (AGD66) so that the raster of the image product is aligned with the Australian Map Grid (AMG) for the relevant zone.

We have set up parameters in our production system to define GDA94 and WGS84 datums **so that customers may NOW order products on these datums** too. The products will still be in a UTM projection, so products on GDA94 datum will be on MGA94 (Map Grid of Australia 1994) and products on WGS84 will be on UTM_GS84.

For the time being AGD66/AMG will be the **default** option for map-oriented products but you may order GDA94/MGA94 or WGS84/UTM products by requesting this in the comments section of the ACRES order form. This notice applies only to Landsat and SPOT products at this time.

Further information on these geodetic datums and some Microsoft Excel spread sheets for conversion calculations are a available from the AUSLIG WWW site at http://www.auslig.gov.au, click on Geodesy. See also the brochure inserted in this edition of *ACRES Update*.

ACRES Distributor Meeting

Jim Mollison

ACRES held it's annual distributor meeting from 24-26 November 1997. The meeting provided a forum for the exchange of information and ideas relating to the remote sensing market and ACRES products, services and strategic directions. ACRES received very useful feedback during a new session involving reports from each distributor.

The annual distributor awards were once again presented for distributors achieving excellence in sales performance. For 1996–97 the recipients were:

Gold award: GEOIMAGE

Silver award: Remote Sensing Services, DOLA (WA)

Bronze award: Department of Natural Resources (QLD)

There was also a new award for the distributor with the highest percentage growth in sales for ACRES data. This award went to GeoMapping Technologies (QLD).

ACRES and our distributors were fortunate in having several representatives from other data suppliers, to make presentations regarding recent developments with their respective satellite systems. In attendance were Ted Stapinski from ARIES, John Douglas from Earthwatch and Mark Judd from Geomatic Technologies/Space Imaging EOSAT. Several representatives from RADARSAT International were also present to provide applications training to RADARSAT Distributors.

The distributor dinner proved to be an enjoyable occasion and included the official signing of the RADARSAT down link agreement by AUSLIG and RADARSAT International (see separate article).

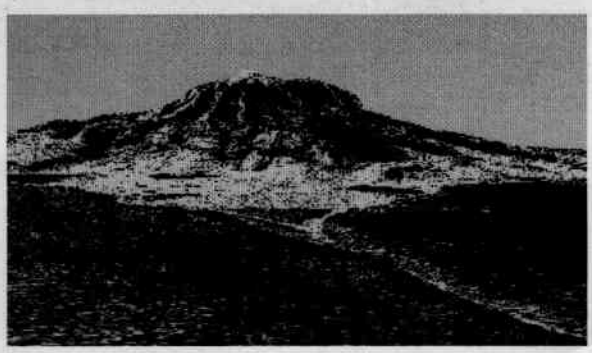
ABOVE: AUSLIG GENERAL MANAGER, PETER HOLLAND, PRESENTS THE WINNER OF THE INNAUGURAL 'HIGHEST GROWTH IN SALES AWARD' TO ADRYA KOVARCH OF GEO MAPPING TECHNOLOGIES.

CLOCKWISE FROM ABOVE: GEOIMAGE IS PRESENTED WITH ITS 5TH GOLD AWARD FOR EXCELLENCE IN ACRES DATA SALES PERFORMANCE. THE AWARD IS ACCEPTED BY GEOIMAGE'S MANAGING DIRECTOR, BOB WALKER; KEN DAWBIN OF REMOTE SENSING SERVICES, DOLA, WA, IS PRESENTED WITH THE SILVER AWARD; JO PLUNKETT ACCEPTS THE BRONZE AWARD FOR THE QUEENSLAND DEPARTMENT OF NATURAL RESOURCES.

BELOW: THE ACRES DISTRIBUTORS' MEETING DINNER PROVIDED A WONDERFUL OPPORTUNITY TO SPREAD CHRISTMAS CHEER. FROM LEFT: BRIAN TUNSTALL (ERIC), DAVID HART (DEHAA), BOB JONES (ACRES), GARY TAUNTON (LIC), ADRYA KOVARCH (GEO MAPPING TECHNOLOGIES) AND TED TYNE (ENCOM).

Heard Island — Australia's Highest Mountain.

Laurie Oliver



This perspective view of Heard Island from the South-East was created using two different applications of RADARSAT imagery. Firstly, two RADARSAT scenes acquired at different viewing angles were used, along with ground control information, to derive a DEM of the island. Next, the DEM was used to orthocorrect one of these scenes and to create a precision geocoded ortho-rectified radar image that was then 'draped' over the DEM to create the perspective view.

Estimating Cotton Yields, Generating Yield Maps and Precision Farming Using Satellite Imagery

Brian Button, AGRECON

The Australian cotton industry produces more than 2 million bales of cotton annually, of which 93% is exported, making Australia the 4th largest contributor to world cotton trade. 80% of cotton grown in Australia is irrigated, with yields typically around 7.5 bales/ha (227 kg) compared to dryland cotton yields of around 3 bales/ha. Large differences in yield per hectare and total production are due to climatically induced differences (drought: 1.1 million bales in 1985 and 1.5 million bales in 1995, non-drought: 2.2 million bales in 1992, 2.5 million bales from 378,000 hectares by 1300 growers forecast for 1997) in available water supplies.

Timely and accurate cotton yield forecasts at the farm and industry level are essential for crop management, forward planning and marketing. Current methods of pre-pick yield estimation involve teams of agronomists sampling rows of cotton within fields to generate fruit counts per metre which are converted to yield estimates in bales per hectare. This is time-consuming, expensive, and not necessarily accurate, as the sample is generally too small to be representative of the whole field. A better method would be one that assessed entire fields on an industry wide basis, in a non-destructive manner, quickly and cost-effectively.

Satellite imagery provides a cost-effective method of assessing the spectral characteristics of entire fields quickly and easily. The spectral response of a canopy of cotton plants is a good indicator of leaf area, total biomass and vigour, which ultimately determines yield potential.

These principles underlie the development of a model to predict cotton yield from the spectral response of cotton crop canopies. This model, by the Canberra based firm of Agricultural Reconnaissance Technologies Pty Ltd (trading as AGRECON), represents the culmination of more than five years of research work.

To be commercially viable the model was designed so that accurate yield estimates could be generated quickly, at strategic times during the growing cycle, for any part or grouping of individual fields, enterprises or regions. The model also needed to be robust to accommodate varietal differences, planting and watering schedules, seasonal and regional differences in climatic conditions and soil types along with other parameters likely to affect spectral response.

Of even greater potential benefit than yield estimates is the development of a technique, applying the appropriate yield estimation algorithm to every pixel, to generate accurate pre-harvest yield maps for individual fields and farms with high metric integrity. In addition to highlighting yield variability and associated agronomic conditions, this promises to bring precision farming to the cotton industry in a very simple and economic way, without the expense and technicalities of machine based yield monitors.

To develop the model, US based Landsat Thematic Mapper satellite imagery was acquired in digital format three times each season - at the end of December, end of January and end of February - over nine growing seasons (1987–8 to 1995–6). Computer based processing and analysis was undertaken for a selection of fields totalling 68,000 ha for which actual yields were known.

After initial image pre-processing, spectral statistics for each field were extracted and analysed statistically to identify the best combination of input data for the model. It quickly became apparent that imagery from different dates within each season as well as drought and non-drought conditions contained marked differences in cotton canopy spectral response. Accordingly, different forms of the same model were developed to maximise the accuracy of yield estimates at different times during the season and under different conditions.

Comparison with actual yields achieved revealed that satellite based yield estimates generated were most accurate where imagery was acquired at or near the end of January.

To evaluate the accuracy of the model, cloud free early February 1997 Landsat imagery was used to generate yield estimates for 237 fields on 15 separate holdings comprising a total of 24,904 hectares, producing more than 188,500 bales or 7.66

bales/hectare (3.10 bales/acre) representing more than 6% of Australia's 1996–7 cotton crop.

A comparison of satellite and ground based agronomic yield estimates with post cotton farm yield results found that the satellite based model was significantly more accurate than conventional ground based agronomic techniques, especially at the farm and field level, but took only a fraction of the time to generate.

Satellite estimates for a further 25,000 hectares of 1996–7 cotton crops were compared with post gin yields for individual fields on 25 other well distributed holdings to evaluate accuracy of yield estimates across a wide variety of soil and growing conditions in different valleys. Similar levels of accuracy were achieved.

On a regional or composite basis, satellite based estimates were less than 1% below actual yields. At the farm level more than 55% were within 5% of actual yields and more than 84% were within 10% of actuals. At the field level, around half of all fields estimated were within 5% of actual yields and three quarters were within 10%. In absolute terms, satellite yield estimates for one quarter of all fields were within 0.25 bales/ha (0.1 bales/acre) of actual yields. Almost half were within 0.5 bales/ha (0.2 bales/acre). More than 70% were within 0.75 bales/ha (0.3 bales/acre), 85% were within 1.0 bale/ha (0.4 bales/acre) while error rates of more than 1.5 bales/ha (0.6 bales/acre) were exceeded for only 6% of all fields assessed.

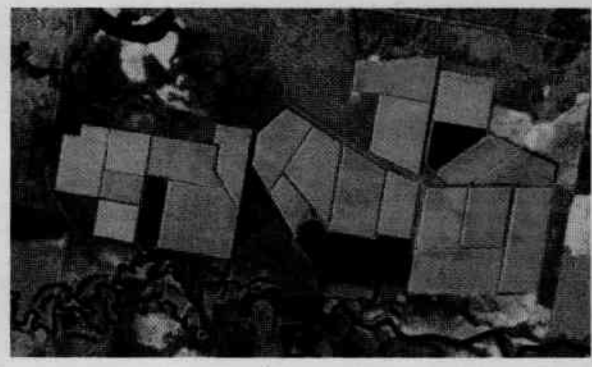
Analyses of the 6% of fields exhibiting the greatest difference between actual and estimated yields from satellite based models showed that the fields in question were generally small in size (between 10 and 75 hectares). Overestimates were typically being associated with low yielding varieties on newly irrigated country while underestimates were typically associated with high yielding varieties on established and well managed irrigation country.

Although the accuracy of satellite based estimates exceeded everyone's expectations, the model will become even more robust by incorporating paired satellite spectral response and yield data back into the model on an ongoing basis and adding further refinements.

The accuracy and timeliness of satellite based yield estimates and yield maps offer strong commercial advantages to individual farmers, bankers, processors, government commodity analysts and to the Australian cotton industry as a whole.

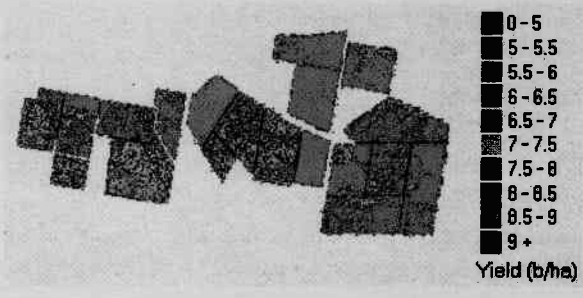
SATELLITE BASED YIELD ESTIMATES

- Are more accurate, timely, reliable and cost effective at the field, holding, enterprise, district, region, catchment and industry level being based on the entire field rather than statistically questionable samples of ground based agronomic boll counts and plant observations.
- Enable the extent and magnitude of hail and other forms of crop damage to be readily assessed.
- Provide increased certainty in managing unsold crop.
- An objective tool for early preparation and tabling of banking submissions.
- Complement yield maps for timely forward planning and scheduling of picking this year's crop and decision making for the following year.



SATELLITE BASED YIELD MAPS

- Can be generated using a 12-year database of historic imagery.
- Facilitate precision farming through site specific management 2 to 3 years ahead of machinery based harvest monitoring methods.
- Provide information regarding within-field variability up to 2 months prior to picking, or 12 months before planting by using historic imagery.
- Incur no increase in management burden or capital outlay while potential benefits of site specific management are being assessed.
- Do not need contractors or owners to install yield monitors, GPS and computer hardware and software.
- Not affected by signal failure from external reference stations and resultant gaps in yield maps.
- No different to purchasing other crop inputs.



A commercial satellite based yield estimation and yield mapping service is being conducted in conjunction with the 1997–8 cotton crop, with IAMA acting as sole distributor to rural landholders. Yield estimates and yield maps are being marketed under the Far Sight range of products. Yield maps and boundaries of green cotton within individual fields are available as coloured prints in A4 format as well as a range of digital file formats to ensure compatibility with precision farming software such as Rockwell's Vision system. Similar information in aggregated form is being made available to processors, insurance and other industry participants.

Intellectual property rights over the model remain with AGRECON which will generate all yield estimates and yield maps. Administration and industry liaison with IAMA and non-landholders is being conducted through Precision Ag Services Pty Ltd, a new service company co-located with AGRECON.

AGRECON is also collaborating with IAMA with the objective of developing satellite based crop monitoring and pre-harvest yield estimation tools for other major crops including winter cereals, oilseeds, rice and sugar.

For more information please contact Associate Professor Brian Button (see the back cover for contact details).

SPOT Variable Window — Increase in Maximum Size

Jim Mollison

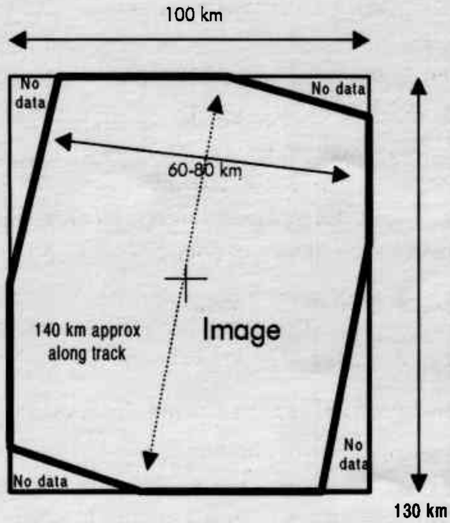
All ACRES products that are map-oriented (aligned to the AMG) can also be termed variable window products. These products give customers greater flexibility in choosing the amount of imagery included in a product. The customer selects a rectangular window by specifying the latitude and longitude of its centre and the extent, in kilometres, East–West and North–South. A particular path and date of imagery is also nominated by the customer, and all imagery from that path (image swath) falling inside the specified window is extracted to form the product.

The ACRES processing system necessarily contains limitations with regard to the maximum sized variable window that can be specified. For SPOT data, these limitations have recently been increased in two ways:

- The maximum area that can be specified has been increased from 10,000 sq km to 13,000 sq km
- The maximum North-South dimension is now 130 km

Please note that despite the increase in window size our processing system still has an along-track limit of 140 km for SPOT data, and any pixels in the product extending beyond this limit will be blank. The accompanying diagram shows this effect in the NE and SW corners of the product. The amount of these blank pixels will depend on the N-S dimension of your variable window, the latitude of acquisition and the viewing angle of the satellite. Of course if 10,000 sq km still satisfies your needs, this area can continue to be ordered to avoid the larger data volume associated with the new 13,000 sq km limitation. Your distributor or ACRES can provide further details and explanations.

Despite this increase in maximum window area available, the price of the maximum sized SPOT variable window has remained unchanged, allowing greater value and flexibility for ACRES customers.



NB: EXACT SHAPE OF IMAGE AREA DEPENDS ON SWATH WIDTH AND ANGLE OF SWATH FROM NORTH

A Product for New Users - Customised Sample Product

Jim Mollison

In March 1997, ACRES introduced the new Customised Sample Product to aid in market development of Landsat and SPOT satellite imagery. This product is aimed at expanding the awareness and distribution of satellite data in Australia. The product consists of a subsidised digital data set, covering a small area as defined by the customer. It is a special offer, available only until 31 March 1998, and sold primarily through distributors.

Customers may order up to 625 sq km (eg 25km x 25km) for Landsat, or up to 225sq km (eg 15km x 15km) for SPOT over any area they desire. This allows new users to try satellite imagery over their own area of interest at a more affordable price compared to standard products. There is a limit to the number of Customised Sample Products available per client.

Prices for the product are:

LANDSAT TM 4 bands	$300
LANDSAT TM 7 bands	$340
SPOT XS or PAN	$340

Please contact your distributor for details.

A Short History of Landsat MSS

Mike Linney & Paul Wise

INTRODUCTION

The Multi-Spectral Scanner (MSS) technology carried on board the Landsat series of satellites, one through five, gave users of its data a regular view of the earth never available before. ACRES estimates that over the 17 years of MSS data collection, in excess of 309,000 MSS scenes have been archived with the most popular eras being that of Landsats 2 and 5.

LAUNCH DATES AND SATELLITE SERVICE

While the first Landsat satellite (then called ERTS for Earth Technology Resources Satellite) was launched in 1972, ACRES did not directly downlink data into Australia until 1979. The following table summarises the launch dates and satellite service periods for Landsat.

Landsat 1: July 1972 to January 1978 (5.5 years)

Landsat 2: January 1975 to February 1982 (7 years)

Landsat 3: March 1978 to March 1983 (5 years)

Landsat 4: July 16 1982 to July 1988 (6 years)

Landsat 5: March 1 1984 to current (13+ years)

The first MSS dataset that ACRES has in its archive is path 106, acquired 14 September 1979, from Landsat 2. This path is similar to the current Landsat 5 path 99 which covers a swath through the Gulf, down the east side of Alice Springs, over the Simpson Desert, Lake Eyre North and out over Port Lincoln. The last MSS dataset is path 108, acquired from Landsat 5, at the end of November 1997. This path covers the swath from Cape Londenderry to Esperence through the Great Sandy, Gibson and Great Victoria Desserts.

At the time of termination, Australia was the only country still receiving MSS routinely, all other groundstations having terminated MSS downlinks several years previously. This conscious effort on ACRES part to provide continued access to the MSS dataset was driven by the value it saw in having a useful long term archive for the national good.

LANDSAT 1

Landsat 1, which was launched in July 1972, was immediately used in the first phase of Resources Survey program. NASA's first manned space station Skylab and NASA aircraft were teamed up with selected Landsat passes to obtain supplementary information on the spectral signatures of ground features. This helped in the location of new energy sources and improved geological mapping techniques, and to determine which data could be most effectively and economically obtained via manned or unmanned service satellites and instrument subsystems.

Due to electrical malfunctions and power budgeting that first year, the three Return Beam Vidicon (RBV) cameras and one of the Wide Band Video tape recorders, needed for acquiring images outside of North America, were deactivated. The rest of the payload functioned normally until 29 March 1973.

The second tape recorder then malfunctioned, causing image coverage of the rest of the world outside the United States and Canada to be reduced to those countries with U.S. Tracking Stations. Australia had the tracking capabilities through the antennae set up for the early Mercury, Gemini, Apollo and Skylab manned missions and continued to supply NASA with recorded real time image data on a small scale.

ERTS-1, primarily a military satellite, was renamed to Landsat-1 (Land Satellite) and released to allow world access to its data as a Scientific and Land Management Remote Sensing tool. It went full term, providing data routinely for six years, until its instruments finally began to deteriorate the worst of which was a sensor failure in the last year of operation. Transmission was finally terminated in January 1978.

LANDSAT 2

Landsat 2 was launched in January 1975 and, since Landsat 1 had far exceeded expectations as an experimental scientific earth resources tool, potential rewards were estimated in the billions of dollars annually. This cut costs by 1/20th to industry, commerce and government, complementing the data collection from Landsat 1, and resuming world coverage through wide band video tape recording and playback. Landsat-2 performed as expected but began to suffer degradation of the solar power panel arrays after about four years in orbit placing some limitations on the amount of data available. This was followed some time later by intermittent attitude control problems, which affected both the geometry and availability of the data. Nevertheless, it continued to provide significant amounts of data as a backup satellite for Landsat 3 until it was taken out of service in July 1983 with a frozen yaw wheel.

LANDSAT 3

Landsat 3 was launched in March 1978 but after the first year of operation it developed faults in the onboard electronics system. This resulted in the intermittent loss of about 28% of data on the western side of the path. The problem, known as 'late line start', required groundstations to develop special software to recover the remainder of the data. Switching between backup systems on board the satellite gave extended periods of proper operation over the next year. However, by the beginning of 1982 the fault could not be overcome and further degradation to the MSS data stream started to become evident. First the end of line code then the beginning of line code failed. Landsat 2 was brought back into service to help support the