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Member Report by CSIRO on behalf of Australia

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1 Introduction

The year 2000, in addition to being the year that Sydney was the [Olympic City](#), has been a very active and productive year for Australia in developing its Space Industry activities, in international collaboration in Earth Observation, as well as in Space Science and Space Policy. The following Plenary Report lists some of the highlights.

2 CEOS, Working Groups & IGOS

Dr Graham Harris, Chief of CSIRO Land & Water continues as the CEOS Plenary delegate for Australia and Dr David Jupp, Head of COSSA, the Contact. Australian scientists continue to play an active role in the Working Groups with Dr Ian Barton being the primary interface with WGCV and Mike Clarke with WGISS. CSIRO has hosted both IOCCG and WGISS meetings in the last year as reported below. Active participation in subgroups by a number of scientists has been fully supported by CSIRO and their reports can be found at <http://www.eoc.csiro.au> in the "Reports" area of "Travel & Reports".

CSIRO and Curtin University have been very supportive of the new Ad Hoc Working Group in Education and are keen to see it develop even further in the future. CSIRO is also a host to the CEOS developed CILS, IDN and the JRC World Wide Fire Web that is an associated GOFc activity.

CSIRO hosted the tenth CEOS WGISS meeting at CSIRO headquarters in Canberra 10 – 12 May 2000. On the 8th and 9th May there was a supporting workshop that focussed on regional and global activities in Spatial Data Infrastructure (SDI) programs and their relationship to CEOS and earth observation data activities. Reports for the preliminary workshop can be found on the COSSA Web site under "CEOS" (<http://www.eoc.csiro.au/ceos/wgiss-10/>).

There is considerable involvement by Australian scientists from many agencies in existing and proposed IGOS proposals through the Partners and other forums (such as IOCCG). The efforts by CEOS to define the satellite remote sensing needs for these activities is regarded as very important by Australian groups. The Ocean Theme has had significant Australian input through their work in GODAE and directly into the current planning process. In addition, there is continuing active participation in the Upper Air Project, Ocean Biology and GOFc. Australia was also represented at the initial meeting of the WGCV Sub-group on Land Product Validation, and continues to be actively represented on both WGCV and WGISS.

A series of meetings are being held in Perth during November that are aimed at developing scientific and observational programs for the Indian Ocean. One of these meetings, called SOCIO (Sustained Observations for Climate in the Indian Ocean), is closely aligned with the objectives of the GODAE program. SOCIO will investigate and report on studies and observations required for the Indian Ocean over the next decade. Australian scientists are also involved in the GODAE globally blended SST project and will attend the inaugural meeting in Italy during early November.

3 Flight and Ground Segment Activities

3.1 ARIES

CSIRO remains lead agency in the ARIES project (a plan to build and launch a dedicated commercially-operated hyperspectral satellite system for resource and environmental applications worldwide). The focus of the business is intended to be on value-added information products for commercial and government uses and is reflected in the name of the recently established operating company "ARIES Information Services Pty Ltd". During 2000 CSIRO has been engaged in updating the project's detailed commercial feasibility, market projections, applications development and negotiating with several Governments, Government Agencies and commercial partners regarding support and future information needs". Significant and diverse applications development for this project, and other spaceborne hyperspectral missions, (eg. Hyperion and CHRIS/PROBA) are being supported through COSSA/EOC and CSIRO Divisional Hyperspectral programs involving over 25 scientists (http://www.eoc.csiro.au/hswwww/EOC_data.htm).

3.2 Fedsat (November 2001)

<http://www.crcss.csiro.au/>

The Australian research microsatellite Fedsat, is on-track for launch on NASDA's H-IIA Rocket with ADEOS-II and the Japanese microsatellites WEOS and Microlabsat. The launch is currently scheduled for November 2001, from Tanegashima Space Center. FedSat is to carry a GPS payload supplied by NASA under a collaborative MOU signed in July this year: this navigation payload will be used to profile the Earth's upper atmosphere as well as for precise orbit determination. The mission will also carry a fluxgate magnetometer; a high-performance computing experiment; a Ka and UHF communication payload, and a public interest payload containing messages from the public, in commemoration of the Australian Centenary of Federation. The UHF component of the communication payload will be used to relay *in situ* environmental data from remote locations. In July 2000 the platform contractor Space Innovations Limited ceased trading. Platform assembly will now be finalised in Australia over the next few months, after completion of solar panels and other components in England with the assistance of the Rutherford Appleton Laboratory and Surrey Space Technology Limited. The communications payload is near completion in Australia and the other payloads will be delivered and integrated to the platform in the first half of 2001. Fedsat is a project of the Cooperative Research Centre for Satellite Systems (CRCSS) and will be controlled from facilities located at the University of South Australia (a member of the CRCSS) in Adelaide.

3.3 AATSR (on ENVISAT with DETR, UK)

The ATSR series of satellite instruments has been an important component of the European Space Agency's earth observation platforms ERS-1, ERS-2 and ENVISAT. The instruments have been specifically designed to measure sea surface temperature from space with an unprecedented accuracy of near 0.25K. The first two instruments have been launched and have provided data continuously (except for 7 months in 1996) since August 1991.

Australia has been a major participant in the ATSR programs both in the science/applications and in the hardware development and construction. For AATSR - the third instrument due to fly on ENVISAT in 2001 - Australia has contributed to 30% of the cost of the instrument. In detail the Australian hardware contributions include the following:

- For ATSR Australia contributed to the construction of the Digital Electronics Unit and the design of the signal channels. For ATSR-2 the contribution included construction and testing of the Focal Plane Assembly and supply of the Electronic Ground Support Equipment.

- For AATSR, Australia's 30% contribution included construction and testing of the Focal Plane Assembly, construction of the Instrument Electronics Unit, the Pre-Amplifiers, and the fore-optics, and supply of the Electronic Ground Support Equipment.

Australia continues to be actively involved in all aspects of the ATSR program including geophysical data validation and the development of scientific and industrial applications of the data products.

The CSIRO has been involved with the ATSR program since its conception in 1980. CSIRO supplies support to the continuing program through membership of the ATSR Core Group, the AATSR Program Steering Panel, the AATSR Science Advisory Group, and the ATSR Science Team / User Group.

3.4 X-Band Network (SPOT, Landsat 7, RADARSAT, ERS, TERRA, etc)

<http://www.auslig.gov.au/>

<http://www.rss.dola.wa.gov.au>

<http://www.terss.org.au/>

Australia has a well established, high quality X-Band network with two fully operational and automated stations at Hobart (TERSS) and Alice Springs (run by ACRES). Landsat 7, Spot 1,2&4, ERS-2, RADARSAT-1 and other data are routinely collected and browse images made available on the web within a few hours of an overpass.

There are moves to expand this network through a second dish at Alice Springs and the development of a lower bit-rate reception facility in Perth, Western Australia. Reception in the north of Australia is being actively considered. Australian X-Band sites are routinely acquiring Direct Broadcast MODIS data from the TERRA satellite. A range of further missions are being considered for the coming year, including the US EO-1 mission. In addition to this activity, there are a growing number of organisations utilising the Australian landmass for satellite tracking and relay. There is every reason to expect these activities to grow further in the future.

3.5 NOAA Stations

<http://www.bom.gov.au/>

Australia has a wide network of NOAA stations. The Bureau of Meteorology stations are highly standardised in hardware and software. Data are routinely used for many operational purposes from weather reporting to crop forecasting. Australia's National Land & Water Resources Audit (<http://www.nlwra.gov.au/>) has made extensive use of such continental scale data. Standardised and widely available CSIRO software tools collectively called "[CAPS](http://www.dar.csiro.au/rs/avhrr_processing_software.htm)" (http://www.dar.csiro.au/rs/avhrr_processing_software.htm) are being established to ensure that consistent and standard application products can flow from all HRPT sites. The Bureau of Meteorology also routinely collects and uses GMS data, China's Fengyun 1&2, Meteosat, GOES and ERS data in addition to NOAA data for integration with its weather and climate services. The Bureau of Meteorology is active in GCOS and TRMM. NOAA data are routinely used by a large number of Commonwealth and State environmental agencies.

3.6 SeaWiFS reception

<http://www.marine.csiro.au/>

<http://www.aims.gov.au/>

Australia has three fully operational SeaWiFS sites collecting data covering much of the coastal and ocean areas adjacent to Australia. The sites are at Perth, Townsville & Hobart. The latter two sites have a NASA real-time license that allows the data to be used in real-time fisheries research programs. Australian scientists are involved in international efforts to

maximise the value of these data in coastal waters as well as for fisheries management, climate studies and resource applications.

3.7 Archiving, Warehousing & Data Nodes

<http://www.auslig.gov.au/>

<http://www.cmis.csiro.au/eogeo/>

Earth Observation data are collected, archived and made accessible through many different paths and varieties of networks. Moves to standardise and increase access include international cooperation such as involvement with the CEOS WGISS, CILS, IMS, INFEO and IDN as well as national activities related to spatial data in general. Australia has an Australian Spatial Data Infrastructure (ASDI) (<http://www.auslig.gov.au/asdi/index.htm>) initiative which provides a pathway for well-established earth observation data to integrate with spatial information.

The Australian Spatial Data Directory (ASDD) provides search access to a range of earth observation and spatial data across federal and state jurisdictions. Activities funded at federal and state level are supporting development of access to data and services in distributed environments. There is active participation in international standards bodies through working with groups such as Australian web Mapping Consortium, Open GIS Corporation and CEOS WGISS. This is providing a primary base for developing better access to spatial information, including earth observation data, access to the data and web based e-commerce. The fundamental links between EO data and the spatial information industry were explored at the WGISS workshop accompanying the CEOS WGISS meeting in Canberra in May, 2000 (<http://www.eoc.csiro.au/ceos/wgiss-10/>).

Australia is a contributor to other developing global data collection and analysis products such as the World Fire Web (WFW) (<http://www.gvm.sai.jrc.it/fire/>). CSIRO EOC in Canberra, in addition to being a node for the WFW is a collaborator in the USGS Global 1 km Data Project (<http://edcwww.cr.usgs.gov/landdaac/1KM/1kmhomepage.html>), collecting NOAA data from up to seven stations for archiving and stitching into a regional base data set. CSIRO has also agreed with UNEP to host a NODE of GEOSS (derived from CILS), thereby supporting an operational node of a WGISS-developed data system. Preparations to operate an IDN node in support of the MD8 rollout program are also well advanced.

3.8 Collaboration in International Space Missions and Mission Cal/Val

Australian scientists continue to participate in the science, applications and development programs of a number of space agencies through successful responses to announcements of opportunity and direct collaboration through joint research programs. These activities include participation in NASA, ESA and NASDA science and instrument teams to which Australia brings a valuable Southern Hemisphere perspective.

In particular, Australian scientists are involved as Principal Investigators in missions including EO-1 Hyperion, MODIS, ASTER, AATSR, GLI, SRTM and MERIS. Proposals to participate in NEMO have also been developed. These have involved significant contributions and international agreements. Australia has an extensive range of land and ocean sites where continuous data collections are being developed for Cal/Val and applications studies. The base Cal/Val sites have in many cases been utilised and communicated through CEOS WGCV activities. Cal/Val sites are maintained over both land and water surfaces and continue to enhance data quality for infrared, visible and microwave sensors. In Bass Strait, just north of Tasmania, CSIRO operates one of the few high quality altimeter validation sites in the Southern Hemisphere. This site has been a valuable cog in the precision measurements obtained through the Topex/Poseidon program.

CSIRO has a special program of involvement in the NASA EO-1 mission where the Hyperion Hyperspectral sensor will provide the first civilian hyperspectral data from a space platform.

A range of sites are being used under an umbrella PI structure organised by COSSA. More information can be found under Hyperspectral on the COSSA/EOC web pages (<http://www.eoc.csiro.au/>).

ACRES and CSIRO are also developing proposals for a NASDA/ALOS international data node with associated science plan and regional distribution.

4 Cooperative Research Centre for Satellite Systems

<http://www.crcss.csiro.au/>

The Centre was established in 1998 and aims to deliver sustainable advantage for Australian industries, universities and government agencies involved in services based on applications of small satellites. It comprises six universities, two government agencies and four private companies, and it conducts research, education and training: over fifty PhD and Master students are currently enrolled. The Centre is carrying out the *FedSat* mission, Australia's first scientific satellite in over thirty years.

5 Space Industry Activity

Australia has a well developed industry in space-related engineering. There is also a lot of recent activity in Australia, and involving Australian groups, in satellite launch for a range of purposes but some of which will lead to earth observations.

5.1 ASRI

<http://www.asri.org.au/>

ASRI (the Australian Space Research Institute) are carrying out and promoting a range of very small to medium sized launch vehicle and payload tests aimed at education and research. These include involvement with:

AUSROC (Australian Rocket series, based largely on student project activity) (<http://www.asri.org.au/>);

JAESAT (Joint Australian Engineered Satellite) is being developed at Queensland University of Technology (QUT). QUT is a member of the CRCSS (<http://jaesat.asri.org.au/>);

ALUMINATE (Australian Lunar-Mars Investigation And Technical Evaluation) is a feasibility study being conducted at the University of Queensland under ASRI auspices (<http://aluminate.asri.org.au/>).

HYSHOT is being developed by University of Queensland and international partners for proposed launch late in 2000 (<http://www.mech.uq.edu.au/hyper/>);

BLUESat is a UNSW student microsatellite project, which has been operated and managed by students since 1997/1998 (<http://www.bluesat.unsw.edu.au/>).

5.2 Launch Sites & Launch Activities

There is also a range of planned Launch sites and launch activities in Australia being investigated and under active development. Groups include:

5.2.1 Kistler Aerospace Corporation (Woomera, South Australia)

Kistler is a US company, which proposes to develop and operate a launch facility at Woomera, South Australia. Kistler set up its first Australian company Kistler Woomera Pty Ltd in mid-1997. The second company, Spaceport Woomera Pty Ltd, followed it in 1998. These companies will manage the Australian operation.

Estimated investment in construction is AUD\$400 million. A further AUD\$1 billion will be invested in the development of the vehicle, known as the K-1. The K-1 is being designed as the world's first fully reusable commercial space vehicle targeting the global commercial low Earth orbit telecommunications satellite launch market.

Kistler has advised that construction of the spaceport is likely to commence in 2001. Test launches are likely to commence twelve months after the commencement of construction. The company expects to undertake approximately 25 launches per annum, once fully operational.

5.2.2 Asia Pacific Space Centre (Christmas Island, Indian Ocean)

APSC is an Australian company founded in 1997 to establish a satellite launch facility on Christmas Island in the Indian Ocean. The company is based in Sydney, with offices in Christmas Island, San Diego and Singapore.

APSC intends to use Russian rockets as its primary launch vehicle. The launch vehicle will consist of three stages and will target geostationary orbit. Construction is expected to commence early in 2001 and Russian and Australian engineers are now meeting monthly to finalise the design and to plan the construction works. Up to twelve launches per annum are planned commencing in 2001-2002.

APSC has recently purchased the casino on Christmas to provide accommodation for international visitors and technical experts. Total investment capital is approximately A\$550 million and approximately 400 full-time jobs will be generated.

5.2.3 United Launch Systems International (Hummock Hill Island, Queensland)

ULSI, an Australian company with international shareholding, was founded in 1997 to develop a space launch complex at Hummock Hill Island, sixty kilometres south of Gladstone in Queensland. The complex will include a launch facility, space and technology park and residential and leisure facilities. The project is estimated to have an investment value of AUD\$570 million and to provide up to 1050 full time jobs over three years. Construction is expected to commence in 2001. Test launches are anticipated to take place in 2003/04, with commercial operations commencing in 2004/05.

ULSI intends to use the new Unity launch vehicle, which is being designed and developed by a consortium of Russian companies. The vehicle will be customised for the low earth orbit satellite market and can be adapted to suit the constellation requirements of satellite owners. Unity belongs to the family of liquid oxygen and kerosene fuelled launch vehicles and uses existing proven Russian technology.

5.2.4 Spacelift Australia (START Launchers from Woomera for LEO launches)

Spacelift Australia is an Australian company formed in July 1999 to establish a mobile satellite launch facility at Woomera, South Australia. It intends to use Russian START rockets, which are a converted version of the PC -12M (SS 25) ballistic missile.

The START launch vehicle, produced by the Moscow Institute of Thermal Technology (MITI), is based on a unique technology. Its major distinction from other launch vehicles is mobility, which allows it to be easily transported by air to almost anywhere on the globe, including Australia. Other reported advantages of the rocket include its simplicity in use and relative safety. Spacelift has entered into an exclusive agreement for the supply of START rockets.

Estimated investment in the project is A\$66 million and 170 people are expected to be employed on a full-time basis. The company has been granted Major Project Facilitation status by the Commonwealth Government.

5.2.5 The Falcon Project

The Falcon Project is a British venture that incorporates solid propellant rocket technology from the United States of America and is targeting the micro-satellite launch market. The Project is considering conducting commercial launch operations from Woomera in South Australia.

The first phase consists of a series of sub-orbital test launches proposed for the end of 2000. Two, or possibly three, sub-orbital test launches are proposed. These are intended to achieve altitudes of 45 miles (72km), 225 miles (360km) and 450 miles (720km). Orbital test launches are planned for late 2001.

Extra information about Asia Pacific Space Centre can be found at

<http://www.iocomm.com.au/apsc/index.htm>

Extra information on United Launch Systems International can be found at

<http://www.uls.com.au/>

Extra information about Spacelift Australia can be found at <http://www.spacelift.com.au>.

5.3 Space Activities Act

<http://www.isr.gov.au/>

The Australian Government's Australian Space Activities Act, 1998 has been operating over the past year. The Act provides a framework for the operation of commercial space activities in Australia and their licensing. Its provisions include detailed procedures for granting Space Licenses and Launch Permits. Licensing applies to Australian launch activities both in Australia and overseas and is overseen by the Space Licensing and Safety Office (SLASO).

The Space Activities Act requires a Space Licence to operate a particular launch vehicle from a particular launch facility in Australia. In addition, each launch must be authorised by a Launch Permit. The licensing system set out in the Act will be staged to minimise, and where possible, prevent duplication of effort and reduce turnaround time for launch operations approvals. At the same time, the process is designed to protect public health and safety, property, and national security and foreign policy interests. In particular, the Act sets out the powers and functions of a Launch Safety Officer, who would be required for each launch facility, and identifies requirements for recovery operations and accident investigation. Importantly, the Act is designed to operate in tandem with other relevant Commonwealth legislation, such as that dealing with the protection of the environment.

The other purpose of the Act is to ensure the observance by Australia of its commitments under the UN space treaties, in particular, under the Convention on International Liability for Damage Caused by Space Objects. Accordingly, the Act places liability for damage resultant from space activities on companies procuring or undertaking a launch by requiring them to hold the appropriate insurance. This includes the third party insurance requirements and limits that will apply based on an estimate of maximum probable loss arising from any launch failure. The Act also requires that Australians procuring a launch of a space object from overseas obtain an Overseas Launch Certificate. This will enable the Government to manage the financial and foreign policy risks that may arise from such launches. Also consistent with Australia's international responsibilities, the Act provides for the establishment of a Register of Australian space objects.

Regulations are currently being prepared which will provide further details about the licensing regime and application process. These are being developed in two tranches - dealing with safety and non-safety aspects of space activities - with the non-safety regulations expected to be tabled in Parliament in the last quarter of this year, and the safety regulations early next year.

5.4 International

5.4.1 NASA

An Agreement between the Government of Australia and the Government of the United States of America concerning Space Vehicle Tracking and Communication Facilities has been in place since 29 May 1980.

Australia has recently negotiated Amendments to the Agreement on Space Vehicle Tracking and Communication Facilities with the United States of America (US), which will continue the operational arrangements for the National Aeronautics and Space Administration (NASA) facilities located in Australia. The Canberra Deep Space Communication Complex, managed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and located at Tidbinbilla in the Australian Capital Territory, is one of three facilities around the world that comprise the NASA Deep Space Network. NASA also maintains a Tracking and Data Relay Satellite Ranging System Facility at Alice Springs, Northern Territory.

5.4.2 IGA WITH RUSSIA

The draft *Agreement Between the Government of the Russian Federation and the Government of Australia on Cooperation in the Field of the Exploration and Use of Outer Space for Peaceful Purposes* was initialled by the Department of Industry, Science and Resources and the Russian Aviation and Space Agency on 16 December 1999 in Canberra and is expected to be signed in December 2000.

The Agreement concludes two years of negotiations on a bilateral framework aimed primarily at facilitating the transfer of Russian technology to Australia, including launch vehicles to be used in commercial space launches from Australia.

5.4.3 UNCOPOUS

The Australian Government considers that an effective regime of international space law is a pre-requisite for the exploration and peaceful uses of outer space, and given this, is undertaking an active role in the work of the United Nations Committee on Peaceful Uses of Outer Space (UNCOPUOS), and in particular, the legal sub-committee.

Australia is one of only a handful of countries to be a signatory to all five treaties relating to space activities, and is concerned that some elements of the five international space treaties to which it is a signatory must be updated to more accurately reflect the growing commercialisation and internationalisation of space activities.

We have therefore recently been active in seeking a review of these treaties. Our thrust has been to ensure an effective international framework that embodies universally accepted principles for the exploration and peaceful uses of space. This framework should be relevant to contemporary realities in space activities, as well as future technological developments, and should ensure that all nations can compete on an equal basis. The Government's aim is to ensure that Australian industry is not unfairly disadvantaged vis-à-vis countries that are not signatories to existing treaties.

6 Other Activities

6.1 Hyperspectral Scanning

<http://www.intspec.com/>

Australian industry has produced an advanced hyperspectral instrument called HYMAP that is being used for resource mapping and also calibration and validation of a wide range of Southern Hemisphere sites for planned satellite missions. Hyperspectral research in Australia

has benefited significantly from this development through the growing volume of high quality data.

There has been extensive coverage by Hymap in missions over a wide range of geographic and applications sites in Australia in the past year as a prelude to the development of the Australian ARIES activities and in preparation for the extensive Calibration and validation activities planned in support of the Hyperion sensor on EO-1 (see http://www.eoc.csiro.au/hswwww/EOC_data.htm).

6.2 The AirSAR Mission

<http://airsar.jpl.nasa.gov/>

NASA and Australia collaborated in a major airborne scientific mission using the JPL AirSAR instrument and the MASTER scanner to map landforms and vegetation in large areas of Australia and other Pacific Rim countries in September/October 2000. The mission acquired data over eighteen countries in the region, and is a multi-parameter radar and multi-spectral science and technology demonstrator for each of the key scientific research areas of: forestry and vegetation, agriculture, coastal analysis, geology and tectonic processes, interferometry, disaster management, and urban and regional development. It provides an opportunity for investigators with diverse backgrounds to collect, analyse and apply state-of-the-art data for earth science studies in preparation for datasets likely to become available in the near future from satellite and commercial airborne systems. Called the "PACRIM 2000" mission, it used NASA's DC-8 airborne research laboratory, flying at altitudes of up to 8000 metres, to chart and assess previously unknown information about the countries visited.

7 Australian Earth Observation in the future

<http://www.cossa.csiro.au/>

In the future, the operating environment anticipated in Australia will have:

- greater commercial involvement and activity;
- a base of mature science to underpin the market;
- a developed base of standards;
- an applications focus.

The integration of satellite based remote sensing data into the main-stream of Spatial Information is well under way and its future standards and commercial industry operations will often be as an aspect of the Spatial Information Industry. The moves in this area have been discussed previously.

Research and Development occurs through Government, industry and at Universities. To give some examples of current activities, in CSIRO, some highlights areas in research and development of space based science and earth observation being pursued in the current Triennium are:

- Real time information from space and airborne platforms (including Direct Broadcast, telemetry and onboard processing) for applications;
- Exploring the benefits of advanced sensor technology (including designed hyperspectral sensors and Lidar) for improving earth observation products;
- Building a mature industry and market for earth observation products;
- Maturing the science base for the markets (including the development of standards);
- Meeting Australia's international regional information obligations (including carbon accounting).

However, the activity in Australia is much wider than CSIRO and Australian scientists, government and industry are active in promoting this future and see the important international activities of CEOS, its working groups and the IGOS development as a key to achieving it. For example, the recent Federal Government initiative of an Action Agenda for the Australian Spatial Information Industry, addressing market and business impediments and the competitiveness of the industry, will further develop the increasing exploitation of EO data.

8 Acknowledgements

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Australian Delegate
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