EXECUTIVE SUMMARY

The essential messages

- Earth observations from space (EOS) are the single most important and richest source of environmental information for Australia. They enable a wide range of essential services to be given to the community, with multi-billion dollar annual benefits to the nation as a whole.
- Australia's needs for EOS data are increasing rapidly. Extensive EOS information is essential for addressing urgent national challenges in climate change, water, natural disaster mitigation, transport, energy, agriculture, forestry, ecosystems, coasts, oceans and national security.
- The satellite-provider nations have many new missions planned for the next 10 to 15 years, providing powerful new EOS capabilities for addressing Australia's needs. We have, however, become fully dependent on foreign-owned satellites and we can no longer significantly influence their capabilities in support of our unique requirements. Time is running out for our historical free-rider status on the international EOS system.
- Australia must immediately embark on a national strategy to secure long-term access to the international EOS system and to better focus its capabilities on Australian-specific needs for EOS information. We must also greatly strengthen our national EOS operational, data acquisition, data processing, research, education and industry infrastructure to take full and timely advantage of existing EOS satellites and the many new opportunities that will become available over the next decade.
- The opportunity costs of living with the national EOS status quo are mounting rapidly. The strategy set down in this plan will ensure that Australia realises the additional multi-billion dollar economic, social and environmental benefits that are potentially available from full participation in the global EOS enterprise, and which are likely to be widespread across the Australian community.

1. Introduction

Everyone needs Earth observations. Accurate and reliable information on the state of the atmosphere, oceans, coasts, rivers, soil, crops, forests, ecosystems, natural resources, ice, snow and built infrastructure, and their change over time, is directly or indirectly necessary for all functions of government, all economic sectors and almost all day-to-day activities of society.

EOS provide an essential means for meeting this need and a primary rationale for the world's trillion dollar annual investment in space science and technology. They promise to transform Australia's capacity to address such critical national challenges as climate change, water availability, natural disaster mitigation, safe and secure transport, energy and resources security, agriculture forestry and ecosystems, coasts and oceans, and national security.

Australia is already a major user and beneficiary of EOS. Our large land area, low population, long coastline, vast Exclusive Economic Zone and extreme vulnerability to a wide range of natural hazards have made it essential that we take the maximum possible advantage of the unique capabilities of EOS. We have long experience and invaluable pockets of expertise in the use of EOS for natural disaster mitigation, weather forecasting and warning, navigation, mapping and mineral exploration, natural resource management, ocean and coastal monitoring, and for many other public and private purposes.

Australia is, however, fully dependent for these purposes on EOS satellites that are funded and operated by other countries. The vast majority of EOS satellite missions are provided and maintained by foreign governments (and consortia of governments) for their national purposes and as a global public good in support of disaster reduction, public safety, economic development, environmental stewardship and general community wellbeing around the world. While a number of Australian Earth observation agencies have historically contributed in complementary ways to the total Earth observation system, Australia is, and is widely seen to be, a free-rider on the international system of cooperation to which several developing countries are now contributing much more strongly than we are.

Australia's dependence on EOS is growing rapidly. The new generation of global satellite missions progressively coming into operation is strongly directed at the comprehensive measurement from space of the essential climate variables required to support the work of the Intergovernmental Panel on Climate Change (IPCC) and the UN Framework Convention on Climate Change (UNFCCC). We will be reliant on information from these missions to meet Australia's monitoring and reporting obligations under the UNFCCC framework, as well as for addressing our own array of national problems concerning the impacts of climate change.

The recent Commonwealth government establishment of an Australian Space Science Program opens up welcome opportunities for Australia to benefit from the empowering capabilities of the new EOS technologies, but our time is almost up as a free-rider on the EOS programs of the satellite-provider nations. These nations have made it clear that they expect Australia, as a major developed country, to contribute to the internationally coordinated EOS system. We cannot expect to be able to continue to rely on the generosity and goodwill of other countries. We will soon have to make clear our long-term willingness to contribute much more strongly in complementary ways to the total global Earth observation system and begin planning to join other satellite-operating countries as a provider of satellites for our own purposes and as a meaningful Australian contribution to the globally coordinated Earth observation systems.

This report is designed to help Australia begin its urgently needed transformation to an active participant in the global EOS enterprise and to being a much more effective user of EOS information for our own unique national purposes. It briefly reviews Australia's current EOS activities and future national needs, and sets out the essential elements of a national EOS strategy and implementation schedule that will set Australia on a sound course for provision and application of EOS data in support of national needs and priorities over the next decade and beyond.

2. Current activities

EOS data are already the single most important and richest source of environmental information for Australia. They cover the huge gaps in surface-based and airborne remote sensing systems, and provide the comprehensive information needed for environmental stewardship over the Australian continent, its surrounding oceans, and Antarctica. Satellite instruments can capture multispectral images with a spatial resolution of less than 50 metres over this entire area and can measure detailed properties of the atmosphere, land and oceans at one to six hourly intervals, with a spatial resolution of 1 to 50 kilometres. This coverage, density and volume of information cannot be matched by any other observational system.

Many major EOS-related activities throughout Australia now rely critically on the long-term continuity of consistent and accurate information derived from satellite missions operated by the USA, the European Union, Japan, China and Canada. We are also involved with these nations, and others such as India, Indonesia, Russia and South Korea, under our International Science Linkages Program and various bilateral programs for cooperation in science and technology.

Australia is a member of the intergovernmental Group on Earth Observations (GEO), which consists of 79 UN member states, the European Commission, and 56 participating organisations. GEO is implementing a 10-year plan to put in place a Global Earth Observation System of Systems (GEOSS), which is emerging as the overarching global framework for cooperation and coordination in the implementation of Earth observing systems for nine major societal benefit areas. The space-based components of GEOSS embrace the known plans of international satellite missions to the year 2025.

Australia's current international engagement in EOS activities occurs primarily through inter-agency and project-specific links to the national space agencies of other countries, and through GEO and its major component coordinating mechanisms such as the Committee on Earth Observation Satellites (CEOS) and the Coordination Group for Meteorological Satellites (CGMS). Our international engagement is, however, hampered by the fact that we have no clear national focus for EOS activities, no EOS strategic plan and no identified funding source for support of Australian participation in international EOS programs.

Within Australia, there is some current activity in most aspects of EOS except for the provision and operation of spacecraft but, overall, the level of activity is well below capacity and it falls far short of meeting present national needs. There is a large diversity in the use of EOS throughout Australia and, in order to get a full picture, it will be necessary to conduct a more detailed audit of the true national capacity, costs and effectiveness to perform EOS-related services.

There is no doubt, however, that EOS are playing a major role in helping Commonwealth, state and local government agencies to discharge a wide range of responsibilities in such areas as land, coast, ecosystem, agriculture and fisheries management, environmental protection, and provision of emergency services for fires, floods, earthquakes, tsunamis and cyclones. EOS are helping

Commonwealth agencies discharge their specific responsibilities in national security, border protection, weather forecasting, natural disaster mitigation, national mapping, transport, forestry, agriculture, water resources, the Murray-Darling Basin, the national environment, and climate change mitigation.

The major areas of scientific expertise in EOS in Australia are in the development and application of atmospheric, oceanographic, hydrological, cryospheric, ecological, geological, geophysical and geodetic sciences. EOS applications are currently being used to varying degrees for many purposes in Australian society but, in all cases, the utilisation is below potential capacity and falls well short of meeting identified needs. It has been shown that EOS data input essentially doubles the useful range of weather forecasting for Australia but, at present, we are not able to make full use of more than a small part of the data available from foreign satellites.

Australia has, however, established world leadership in the use of EOS for carbon accounting. Other important EOS applications include national security, border protection, natural disaster mitigation, water resources management, agriculture, fisheries and forestry management, geophysical and resources mapping, geodesy, mineral and petroleum exploration, solar and wind energy development, transportation and tourism, Antarctic research, many aspects of the monitoring of Australia's climate, ecosystems, and the marine environment.

Australia's research capabilities in EOS are of high quality and well respected internationally. However, they are mostly small, fragmented and the product of opportunistic involvement of Australian scientists in satellite data studies and as principal investigators in foreign satellite missions, as leaders of local calibration/validation projects and the like. They include both research into fundamental scientific problems (such as climate change and sea-level rise) and a wide range of research groups committed to developing the potential of new EOS missions and instruments for practical application in the Australian context.

There are major weaknesses in national planning, coordination and resourcing arrangements, in data archival and access, and in education, training and capacity-building activities. These weaknesses are limiting Australia's opportunities to fully exploit the potential utility of space-based observations. University groups, Cooperative Research Centres (CRCs) and some government agencies contribute to EOS education, training, capacity building and staff development, but Australia has no coordinated national approach to building and maintaining its pool of EOS expertise. Our national EOS arrangements reflect the historical response of individual agencies and university research groups to needs and opportunities as they emerged at the time, with only very limited overall national planning and coordination. This is also reflected in the current status of EOS satellite downlink ground stations.

Major ground stations for EOS data reception have been designed and are operated primarily to serve the separate purposes of the Bureau of Meteorology (for national weather, climate, water and related services), Geoscience Australia (for national mapping, navigation and other geophysical purposes), the specific and extensive EOS data needs of Western Australia (through the Perth-based WASTAC consortium), and the needs for research and applications over the Southern Ocean and Antarctica (through the Hobart-based TERSS consortium). CSIRO is involved in the two consortia and in data access aspects for all these networks. An Australian company has exclusive reception and distribution rights to the commercial SPOT constellation of satellites and has established a Geospatial Acquisition Centre in Adelaide.

The Australian Earth observation industry comprises about 100 small and medium enterprises engaged in basic data acquisition and sales and the provision of specialised consultative services, mainly with respect to EOS high-resolution spatial information products. The major clients are Commonwealth government organisations (particularly the Department of Defence), state, territory and local government users, and the mining and resources sector. Only in two known instances are locally built and operated imaging technologies used in the procurement of these services.

3. Future needs and opportunities

The global community is addressing future needs for Earth observations via an integrated, coordinated and consultative approach which aims to transfer the global benefits of observational science and technology to the community. Australia needs to align itself with this global approach that has been adopted by almost all other major developed countries. In the first instance, this requires the establishment of a national coordinating mechanism for the strategic planning of EOS activities.

Accurate and timely scientific observations form the basis of almost all scientific research, as well as the development of new systems and services to improve the prosperity and operation of our society. To use EOS to address our critical national challenges, we need to ensure that:

- Australia has continuing access to a timely and consistent stream of EOS data that are calibrated for Australian conditions and that EOS mission-to-mission transition is managed so that there is no disruption to the continuity of national and state-based programs and data sets which are critically dependent on EOS information; and
- Australia's capacity to transform EOS data to essential information is developed from the current relatively few key areas in natural resource management to a broad range of applications.

To meet these requirements, we need to develop a coordinated approach to prepare national and state infrastructure for imminent major changes in the operation of the global EOS system, and to strengthen the links, communications and support between state and Commonwealth EOS-based programs, as well as the activities of universities, CRCs and industry. We must strategically assess the optimal design and maintenance of our national data reception, our computing and communications infrastructure, and our data archive and access systems, in the light of major changes that will be introduced in the next 5 years in the global space-based data collection and distribution system.

Australia is developing Earth system modelling and spatial data analysis capabilities that are essential to assimilate the next generation of EOS data and convert them into products and services, but we are not well prepared to access and assimilate the flood of complex new data streams that will soon become available to improve the capabilities of these models. A greatly strengthened and more focused research effort is needed to develop the EOS applications required to address major national challenges. This must include both user-driven research in the key applications sectors and provider-driven research into the application of new EOS data to Australia's national needs. The first essential step is to develop a national EOS priority-setting mechanism that includes the scientific and applications communities.

In conjunction with the strengthening national EOS research effort, there is a need to make a major investment in EOS training and capacity building in the mission agencies, the university sector and the applications communities. There is a concurrent need to build the capacity of industry and

the EOS commercial sector to help support and further exploit emerging opportunities associated with an expected transformation of Australia's role and national policies for the use of space-based technologies.

Australia's new National Framework for Climate Change Science identifies key areas where science must deliver information to inform important decisions for the nation. Much of the required environmental information can only be provided by the space-based observations that will come from the new generation of global EOS missions. Australia must rapidly embrace the opportunity to exploit these new data to the fullest.

The world is entering another period of major change in the science, technology and mode of use of EOS data. Australia has a great opportunity to expand its current access to and use of EOS information in the period 2010–25. The plans and status of all global EOS missions for 2010–25 are already catalogued. The GEOSS 10-Year Implementation Plan provides a broadly-based international framework for integration of space-based and surface-based Earth observation activities.

Opportunities are emerging for Australia to enter into new partnerships to make better use of Earth observations from space, which give reason for industry and commerce to be more optimistic about satisfying some of their future needs. The Department of Defence has already taken such an initiative and Australian society may be able to achieve further benefits from this through future synergies between the civil and defence EOS programs.

Other partnership opportunities are emerging for cooperation in both public good and commercial satellite missions. These range from involvement in missions using constellations of micro-satellites to missions in which Australia might modestly share some of the costs, or provide one or more of the satellite sensors. Argentina, Indonesia, Mexico, Nigeria, South Africa, Thailand and Venezuela have recently announced plans to establish EOS missions. Most of these programs are modest and involve cooperative ventures with other nations.

4. Strategy for the next decade and beyond

The working group proposes a strategy for meeting Australia's future EOS needs based on the following goal, strategic objectives and strategic initiatives:

Strategic goal:

To maximise Australia's social, economic and environmental benefits from the acquisition and application of EOS.

Strategic objectives:

To use the critical value adding input of EOS:

- to monitor, understand and predict climate change and variability, to assess the impacts of climate change, and to develop strategies to mitigate and adapt to climate change on national, regional and global scales;
- to monitor, understand and predict the water balance across Australian catchments in order to optimise the management of water;
- to monitor natural disasters and to develop strategies to manage and mitigate the impacts of natural disasters in the Australian region;
- to monitor and predict weather and other environmental factors in order to ensure the safety and security of Australian transport and navigation systems on land, sea and in the air;

- to assess sites for renewable energy sources and to predict weather and climate conditions relevant to overall load management and to expected energy demand in Australia;
- to monitor, manage and plan agriculture, forestry and natural ecosystems in Australia;
- to monitor, manage and predict the environment of the coasts and oceans around Australia; and,
- to monitor Australian borders and to assure national security.

Strategic initiatives:

- develop and implement a new overarching national EOS policy framework;
- develop a mechanism to assess and review national EOS priorities;
- develop a national approach to optimising Australia's EOS infrastructure;
- establish a critical mass of strategic EOS research and education capability;
- enhance EOS industry capability to support an increased Australian global role in EOS;
- safeguard essential EOS use of the radio spectrum; and
- establish international partnerships in EOS provision.

In the short to medium term, the proposed strategy involves the consolidation and strengthening of our established EOS capacities and the gradual building of our competence and credentials for playing a much larger role than we have in the past in the collaborative global arrangements. By 2025, we should become an established provider, as well as a user, of EOS capabilities in ways which enable us to better serve our national needs while also benefiting to the full from becoming part of the coordinated global system for meeting the EOS needs of all countries.

The key enabling strategic initiative is the development and implementation of a new overarching EOS policy framework. Policy development should build on recent initiatives to establish the Australian Space Science Program and to invest heavily in space-based technology for strategic defence purposes. The overarching policy framework should define:

- national policies for Australia's strategic engagement with the international community;
- national policies for the acquisition and use of EOS to support the national challenges;
- the role of science, technology, innovation and industry in addressing these challenges;
- national contributions to global EOS activities, including our contribution to GEOSS;
- guidelines for managing Commonwealth-state interests in EOS exploitation; and
- synergies for defence and civil use of EOS information.

5. Implementation of the strategy

The established Commonwealth, state and academic institutions currently involved in various aspects of EOS data utilisation, research and management are major strengths for Australia. Within the limits of available resources, these institutions prioritise their use of EOS to help deliver their various mission outputs. Major weaknesses lie in EOS-specific arrangements for national coordination and national strategic planning, and the lack of a clearly recognised national focus for dealing with EOS matters internationally.

The working group supports the approach recommended by the November 2008 Senate Economics Committee report of a gradual change in institutional arrangements commensurate

with those needed to accompany the evolution of Australia's proposed national and international roles. Three specific institutional initiatives are proposed in support of the implementation of the strategy:

- Establishment of a broadly-based EOS advisory council to guide the integrated strategic development of the application of EOS in Australia and to advise the Commonwealth government on strategic needs. Its first tasks should be to establish an ongoing national EOS priority-setting mechanism, including the full involvement of EOS provider institutions, the learned academies and the broader user community, and to assess priorities for the uptake of opportunities for Australian partnerships in international EOS missions and for enhanced global and regional cooperation.
- Establishment of a small national EOS office to support the EOS advisory council, to enhance the national EOS profile within Australia's new Space Science Program, and to drive and coordinate the implementation of the proposed strategy. It would be logical to establish this office as a component of the new Space Policy Unit in the Department of Innovation, Industry, Science and Research (DIISR).
- Reaffirmation and strengthening of the main Commonwealth EOS mission agencies in their role as essential elements of the core national infrastructure for EOS data acquisition, processing, applications and research.

6. Recommendations

The working group offers nine recommendations for implementation of the proposed strategy, as follows:

1 **National EOS policy.** Australian government policy on space science and industry development should include an explicit national policy on EOS, based on strengthening, broadening and coordinating existing EOS activities and a strategic commitment to full Australian participation in the international EOS system by 2025.

2 **EOS priority setting.** A high level, cross-portfolio EOS advisory council should be established with the active involvement of the national EOS provider agencies, the learned academies and the EOS user community to advise on national priorities for EOS operations, research, education and applications across all sectors and all levels of government.

3 **National EOS infrastructure.** The main operational EOS agencies and ground station consortia should jointly establish a coordinated approach to strengthening and optimising the national investment in the EOS data acquisition, processing, archival, distribution and applications infrastructure that will be needed to handle the massive increase in EOS availability and user needs over the next decade.

4 **EOS research and education.** A national plan and funding framework should be developed to establish and maintain a critical mass of strategic research and education expertise in Australian universities to underpin the operational EOS systems, services and applications in industry and government agencies.

5 **EOS industry capability.** In order to support a strengthened Australian role in the global Earth observation satellite community, the Space Science and Innovation Project Grants scheme should be enhanced within the framework of the national EOS policy to promote local industry capabilities in EOS systems development and applications.

6 **Radio spectrum for EOS.** Given the enormous social, economic and environmental benefits to Australia from the use of EOS data, those parts of the radio spectrum that are uniquely required for satellite remote sensing of atmospheric and Earth characteristics should be permanently protected from interference, in the public interest. Means should also be found for meeting the costs of commercial sharing of those parts of the radio spectrum that are used for public-good transmission of EOS data from satellites.

7 **International engagement in EOS.** Australia should strengthen its role and influence in international EOS through development of bilateral and multilateral (including regional) partnerships in EOS provision, greater involvement in the Committee on Earth Observation Satellites (CEOS), and enhanced contribution to the implementation of the Global Earth Observation System of Systems (GEOSS).

8 **EOS national office.** An EOS national office should be established as part of the Australian Space Science Program, to support the EOS advisory council, to maintain links with the operational EOS agencies, and to serve as the national focal point for Australian EOS activities.

9 **EOS mission agencies.** The EOS operational and research mandates of the Bureau of Meteorology, Geoscience Australia and CSIRO should be reaffirmed and strengthened, and they should collaborate with the Department of Defence, other Commonwealth and state EOS agencies and universities in the progressive development of a more integrated national EOS service and research framework for Australia.