Contributions to the global earth observation system of systems by China

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Abstract: In the context of contemporary improved international cooperation in earth observation, this paper assesses the potential contributions from China to the Global Earth Observation System of Systems (GEOSS). Based on an analysis of existing barriers to Chinese contributions to GEOSS, this paper makes recommendations for the development of international cooperation in earth observation area by China leading to the mutual benefits for China and the international community through Chinese involvement in GEOSS.

Key words: earth observation, international cooperation, GEOSS

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1 INTRODUCTION

The 21st century poses many challenges for human beings in sustainably exploring and utilizing resources. With increasing globalization, many common environmental problems relating to sustainable development are attracting increasing attention throughout the world. Consequently there is a need for increasing awareness and improved understanding of the earth system within which humans exist. Strengthening of international cooperation in the earth observation field is essential for meeting these needs.

The World Summit on Sustainable Development held in Johannesburg in 2002 emphasized the need for improved coordinated observations of the earth. In response to, the first ministerial summit on earth observation was held on July 31, 2003 in the capital of U.S., Washington DC, where 33 countries, the European Union and 21 senior officials of international organizations involved in earth observation attended the meeting. After two year of efforts, the 10-year implementation plan of the Global Earth Observation System of Systems (GEOSS) was approved at the 3rd Earth Observation Mministerial Ssummit Meeting on February 17, 2005 in Brussels (GEOSS, 2005). The Summit decided formally to set up an inter-governmental organization called the Group for Earth Observation (GEO) responsible for the coordination and implementation of the Global Earth Observation System of Systems (GEOSS) which is now supported by over 70 countries, the European Union and more than 60 international organizations.

GEO recognized that comprehensive sustained observation and understanding of the earth system would help improve and expand the global capacity to achieve sustainable development and identified nine socio-economic benefit areas (SBA). These were:

- reducing the loss of life and property brought by natural or man-made disasters;
- understanding the environmental factors affecting human health and safety;
- improving energy management;
- understanding, assessment, prediction, mitigation and adaptation to climate change and its variability;
- further understanding the water cycle, by improving the water resource management level;
- improving the quality of weather information and weather forecasting;
- strengthening the management and protection of terrestrial, coastal and marine ecosystems;
- promoting the development of sustainable agriculture,
- combating desertification;
- Understanding, monitoring and protection of biological diversity.

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It is obvious that the goals of GEOSS can not be realized by any individual country. They need contributions from all over the world, especially from those countries which have advanced space technologies. China, as a country with decades of efforts and achievements in space technology and its applications, will become more and more important to GEOSS.

2 POTENTIAL CONTRIBUTIONS FROM CHINA TO GEOSS

The Group on Earth Observations (GEO) is an intergovernmental organization with a voluntary partnership of nowadays 80 governments, the European Commission and 60 intergovernmental, international, and regional organizations. Its aim is to build a Global Earth Observation System of Systems, or GEOSS. To achieve that, the importance of data sharing has been emphasized in each EO Summit meeting from the very beginning in 2003, and GEOSS Data Sharing Principles has been approved at the Third EO Summit in Brussels. China, as an initiative country of GEO with its unique characteristics, is playing an important role in GEO and GEOSS. As the largest country in Asia with huge population, China is significant in global environmental protection and climate change due to its unique geographical characteristic including location of sitting in the East Asia Monsoon Belt that experiences the largest variation of earth environment, the highest mountain of Himalaya and the 9.6 million square kilometers acreage of whole country. Consequently, the Chinese Satellites and the data resources recorded from in situ, aircraft and satellite networks are essential to GEO and GEOSS for global environment monitoring.

2.1 Comprehensive series of EO satellites

China is developing its own comprehensive remote sensing system by developing Earth Observation (EO) satellites, data receiving and processing systems and application systems. At present China has both sun-synchronous and polar-orbiting satellites: it has already established a fully operational meteorological satellite service system. The goal for China is to establish operational satellite application systems in multiple areas to support its sustainable economic and social development. In the future, the system will be extended to include operational earth resource satellites, marine satellites, environmental and disaster monitoring satellites, as contributions to realizing its goal of a comprehensive earth observing system.

2.1.1 Meteorological satellites

Chinese Meteorological satellites are named as the FY series, with the number followed indicating the different types of Satellites. FY followed by even numbers indicate geostationary meteorological satellites like FY-2 and FY-4 series; whereas FY followed by odd numbers are polar-orbiting meteorological satellites, such as FY-1 and FY-3 series (Zhang, 2007).

Following the FY-1 series (launched on Sep 7, 1988), satellites in the FY-3 series are the second generation (launched on May 27, 2008) of Chinese polar orbiting meteorological satellites (Zhang, 2007). FY-3A and B will carry 9 payloads to provide global, all-weather, multi-spectral images and sounding capabilities to provide quantitative observations and services. The FY-3 series will be advanced meteorological satellites with a spatial resolution of up to 250m. The World Meteorology Organization (WMO) has agreed to accept the series as part of the WMO operational meteorological satellite constellation for 2005—2020.

The FY-4 series will be the second generation of Chinese geostationary meteorological satellites after the FY-2 series which is planned to be launched after 2010 (Zhang, 2005). It will make use of 3-axial stabilized satellite platform to increase its capability for more frequent observations of selected areas; it will also have more imaging scanner channels, an infrared vertical atmospheric sounder and a lightening imager.

2.1.2 Marine satellites

Marine satellites named the HY series followed by different numbers have different functions such as sensing ocean quality, ocean dynamics and the ocean environment.

HY-1 series satellites including HY-1A and HY-1B launched in May, 2002 and April, 2007 respectively are used to detect chlorophyll concentration, suspended sediment concentration, and dissolved organic matter, pollutants, as well as sea surface temperature with the visible and infrared sensor (Pan, 2004). The satellite series plays an important role in developing and utilizing the marine bio-resources, detecting the ocean pollution, investigating and developing coastal resources and studying global environmental changes.

The objective of the HY-2 series of satellites with microwave sensors is to monitor ocean dynamics including global ocean wind field and to provide operational oceanic forecasts, global ocean topographic data, sea level and gravity field monitoring. It includes an altimeter dual-frequency in Ku and C-bands, a scatterometer and a microwave imager. Applications include disaster reduction, sea surface weather, sea ice monitoring and forecasting ENSO events. HY-2 satellites are expected to be launched every 3 to 4 years starting from 2009 to 2020.

One mission of the HY-3 series is to observe and monitor the marine environment. Synthetic aperture radars will provide imagery with a resolution of as fine as 1m and for a 20—40km swath, data with 5m resolution for a 60—80km swath and ScanSAR data at 10m resolution for a 120—150km swath (Jiang, 2008). The satellites will provide high resolution data of ocean targets, waves, oil spills, winds, currents, and coastal zone resources. The data can be applied in several areas including national security, marine environmental protection, monitoring of marine pollution, coastal zones survey and development and management of marine resources.

2.1.3 Earth resources satellites

China is developing its second generation of earth resource satellite in cooperation with Brazil. The first two satellites under the Chinese Brazilian Earth Resources Satellite (CBERS) series were launched in 2003 and 2007. Based on CBERS-1 and CBERS-2, the subsequent CBERS-3 and CBERS-4 satellites will be improved by adding a multi-spectral (10—20m) CCD camera with a 5m panchromatic band; the swath width will be 120km and 60km respectively; there will also be an Infrared Multi-Spectral Scanner (IRMSS) and Wide Field Imaging (866km Swath width) payloads. The next generation of Chinese earth resource satellite will also include synthetic aperture radar.

2.1.4 Small satellites

China launched Shijian-5 in 1999, which is based on a multi-purpose, 3-axial stabilized small satellite platform developed by China. Based on the platform, China is launching a small satellite constellation for environment and disaster monitoring known as the HJ series of satellites (sometimes also called environment and disaster monitoring satellites). The HJ series consists of four optical satellites and four SAR satellites; the orbit of the constellation is sun synchronous, with a revisit time of 96 hours with one satellite or 48 hours with two satellites. The payloads of the satellites include a CCD camera, infrared camera, hyper-spectral camera and S-band SAR (Wang *et al*., 2005). The optical sensors have a 650km swath with a 10:45AM sun-synchronous orbit. Since the four satellites have a 90° phase distributed in the same orbit plane. The SAR Satellites have 500km swath 6:00AM and 4:00pm sun synchronous orbits, with the resolution and frequency respectively as 30 m MS (0.43—0.52 μm, 0.52—0.60 μm, 0.63—0.69 μm, 0.76—0.90 μm), Swath: 360 km×2; 100 m 128 Bands (0.45—0.95 μm), 50 km; 150 m IR (0.75—1.10 μm, 1.55—1.75 μm, 3.50—3.990 μm), 300 m IR (10.5—12.5), Swath: 720 km; SAR: S band, 20 m (four looks), 100 km swath (Xue *et al*., 2008).

The four optical satellites and 4 SAR satellites will be launched from 2008—2010. The first three satellites consist of two optical satellites and a SAR satellite, called the “2+1” Project. The first two satellites were launched in September 2008 and a further optical satellite was expected to be launched in 2009.

2.2 Ground segment: EO data acquisition and processing

As the demand for remote sensing applications has increased, systematic data acquisition has become essential to maintain reliable information services. China first established its own satellite ground receiving and processing systems in the 1980s for foreign satellites. There are now corresponding institutes for each of the different classes of satellites under different government departments. Their main mission is to receive, process, archive and distribute the data from various remote-sensing satellites, and also to carry out scientific research to improve data reception, processing archiving and distribution. China’s operational remote sensing satellite data service network consists of the China Remote Sensing Satellite Ground Station (China RSGS), the China Center for Resource Satellite Data and Applications (CRESDA), the National Satellite Meteorological Center (NSMC) and the National Satellite Ocean Application Service (NSOAS). Each of them belongs to a different governmental department. China developed its own meteorological satellite receiving stations in Beijing, Guangzhou and Urumchi for both polar orbiting and geostationary meteorological satellites. The marine satellite ground application system has stations in Beijing and Sanya. It is also notable that several MODIS ground-receiving stations were also built at many academic and education institutions in China especially in Beijing.

The Chinese Academy of Sciences, established the China Remote-Sensing Satellite Ground Station (RSGS) as a subordinate department in 1986. The China RSGS receives and processes satellite remote-sensing data covering all the area of China. There are about a million scenes of multi-spectral satellite data and 50,000 scenes of microwave remote-sensing data in its archive. The China RSGS has the capability to receive and process data from several satellites including Landsat, SPOT、RADARSAT-1, ERS-1/2, ENVISAT, CBERS and etc. Users served by this station include governmental ministries, regional governments and individuals from both China and overseas.

The China Center for Resources Satellite Data and Applications (CRESDA) was established in October 1991. Its responsibilities include operational management and data distribution associated system technology, data pre-processing, application and research, with CBERS and Environment Satellites, also named as HJ satellites. CRESDA also work on the construction of application demonstration and analysis model covering related fields as agriculture, forestry, water conservancy, land use, a quick response system for disasters in agriculture, forestry, and with flood, and drought effects. It has their own data collection, evaluation, processing, calibration/validation, distribution systems.

The National Satellite Meteorological Center (NSMC) was founded in 1971. It is a scientific research and operational facility of the China Meteorological Administration. With their own 3 ground receiving stations, NSMC is able to receive and process meteorological satellite data from both Chinese and foreign satellites for weather forecasting and natural disaster monitoring. The NSMC also carries out theoretical and experimental research on radiation transmission in the atmosphere, development of algorithms applied to meteorological satellite data as well as the application of meteorological satellite data.

The National Satellite Ocean Application Service (NSOAS), established in 2000, is a subordinate institute of the State Oceanic Administration of the Ministry of Land and Resources of China. NSOAS’s ground-receiving stations in Beijing and Sanya, are responsible for the remote sensing data from HY-1, HY-2 and HY-3 including the collection, processing, analysis, archiving and distribution focusing on monitoring of the oceanic environmental, oceanic dynamics and environmental resources.

In October 2002, the first remote sensing radiation calibration site of China was set up in Gansu Province. Through cooperation with the White Sands Test Facility of USA and the Toulouse calibration site of France, establishing this facility was an important milestone for China in calibration and validation of satellite remote sensing, which is critical for supporting quantitative analysis and applications.

3 BARRIES AND SOLUTIONS IN DEVELOPING A NATIONAL INTEGRATED EARTH OBSERVATION SYSTEM

China is devoting considerable resources in developing earth observing systems nowadays. There are however significant challenges including the development of long term climate quality data sets and the difficulties in moving from research to operational systems hindering the development of an integrated Chinese Earth Observation System.

3.1 Barriers

3.1.1 Lack of coordination between remote sensing systems

Although considerable progress is being made in remote sensing applications especially for earth observation related to global change in China, there are still some prominent problems including lack of a comprehensive data sharing systems, insufficient data calibration and validation (cal/val) capabilities, inadequate acquisition strategies and insufficient higher order products. The calibration and validation, measurement traceability and data formats are not completely in compliance with international standards. So far, there is no mechanism to integrate data resources from different departments, and there is also no portal which providing integrated access to these multiple data resources either for users in China or overseas.

There are 15 governmental departments involved in Earth Observation systems in China. They all have their own independent remote sensing systems with different priorities. Their satellite systems and their corresponding ground segments operate under their own governmental administrations independently; some of them such as CRESDA operate under multiple agencies. This administrative complexity in turn has led to complex sets of arrangements with regard to data access, delivery and policy.

Since there are several different agencies which have developed their own individual observation and data delivery systems, this has resulted in unnecessary duplication in some areas. The fact that each agency only works to meet its own requirements, the absence of a national data policy has resulted in certain limitation of data sharing. The Chinese government is aware of this problem, and proposes to resolve it in the future in accord with the National Plan, named as China Integrated Earth Observation System, which is a ten-year plan (MOST *et al*., 2007).

3.1.2 Lack of state level EO coordination mechanism

China has developed national level agencies to manage satellite programs such as the National Remote-Sensing Center, the National Satellite Meteorology Center, the China Resources Satellite Application Center, the National Satellite Oceanic Application Center and the China Remote-Sensing Satellite Ground Station. There are also several satellite remote-sensing institutions in state departments, which play important roles for national land resources survey, ecological conservation and restoration, and environmental protection, as well as in major state projects, such as the National High-tech R&D Program, namely the National 863 Program. However none of these can have the capability to integrate these existing national systems and programs, because they belong to different ministerial governmental departments, to some extent, though the state council has introduced limited coordination of some important cross-ministry programs like forester monitoring project collaborated between State Forester Administration and Environment State Bureau, but comprehensive exchange and communication mechanisms, at a national level are required to integrate and oversee the multiple Chinese programs. With a multiplicity of ministries and other government bodies responsible for observations; the lack of government-wide policies, standards and protocols for earth observations inevitably seriously undermines the development of a Chinese national spatial data infrastructure.

Data sharing has always been the leading issue among all the controversial issues, an overall strategy for data sharing and to decide what to archive is necessary and under strong needs, also even if data sharing is agreed to in principle, an agreement on standards is crucial as well. This should be a kind of systematic engineering for improving the earth observation in China. So an overall strategy plan is necessary, and besides that the detail implantation plan including data sharing policy and agreement between users is also very crucial for carrying out the earth observation efficiently.

3.1.3 Lack of implementation plan

China has developed a comprehensive integrated earth observation strategy called the "China Integrated Earth Observation System (Ten -Year Plan)" (MOST, CMA, 2007), This System includes twelve operational observing systems and seven inter-agency integrated earth observing systems:

Chinese operational observing systems

(1) Comprehensive Disaster Observing System,
(2) Integrated Agricultural Observing System,
(3) Integrated Hydrological Monitoring System,
(4) Integrated Land Observing System,
(5) Integrated Observing System for City/Township & Landscapes,
(6) Integrated Meteorological Monitoring System,
(7) Seismological and Geophysical Monitoring Systems,
(8) Integrated Environment Monitoring System,
(9) Integrated Forest & Ecological Monitoring System,
(10) Basic Ocean Monitoring System,
(11) Integrated Surveying and Mapping Information Platform,

(12) Scientific Research-oriented Monitoring System.

Chinese inter-agency integrated earth observing systems

(1) China Climate Observing System
(2) China Atmospheric Chemistry Observing System
(3) China Water Cycle Observing System
(4) China Carbon Cycle Observing System
(5) China Ecological Observing System
(6) China Oceanographic Observing System
(7) China Meridian Space Environmental Observing System

Some of these earth observation systems are well developed such as the Meteorological Monitoring System, but others are still in their early stages; some networks are run by research bodies, which pose problems in terms of long term implementation. Also the multiplicity of ministries and government bodies for earth observation will place a heavy burden on coordination and administration if integrated implementation is to be achieved.

Although China has formulated this Earth Observation Ten-year Plan, much of it is conceptual and lacks a clear implementation plan, to specify the concrete actions needed both to develop the individual components and to integrate them.

Overall, satellite remote-sensing has become an increasingly important component of the Chinese Earth Observation System. The phenomena and scales where satellite remote-sensing is used have been constantly expanded. A large number of key application technologies in many areas, such as disaster monitoring, agriculture monitoring and forester monitoring, have been developed. Infrastructure facilities including ground systems and aero & space systems have been strengthened and completed. The research and technological activities are very active, and transferred into operational capabilities of the application system. A national satellite remote-sensing application system including the commonly standards and protocols has to be taken into shape as soon as possible to meet the growing increase demanding.

3.1.4 Shortage of global vision in EO international cooperation

Even though China has made a remarkable progress in many aspects of EO area, but to some extent, China is still in the shortage of global vision in EO international cooperation activities. These embodiments can be found prominently in following three aspects:

(1) Not active in international organizations

China, as one of Co-Chair Country of GEO, lacks of a comprehensive and systematic implementation plan of participation in the EO related international organizations. Therefore there are not many Chinese staffs and experts in the international organizations supported by Chinese government who can play the influential and sustainable role in those international programs and activities. Even among the GEOSS 9 themes including Disasters, Health, Energy, Climate, Water, Weather, Ecosystems, Agriculture and Biodiversity, there is no one theme of which China takes the leadership. There are about more than 200s of international organizations including inter-governmental and non-governmental organizations in the world related to EO areas, but the amount of international organizations which Chinese has been involved in are very limited. So far there are less than 40s EO related international organizations in which Chinese has been involved.

(2) Not active in international programs

Although China participated in many international activities such as, conferences, symposiums, workshops and other professional activities, and has been involved in some science and technology programs and projects, but these participations are all very general rather than deeply involved in terms of being involved into whole procedure of preparation stage and operation stage such as designing, developing plan, and running of implementation. And there is no leading role taken by Chinese in any projects among CEOS, IGOS-P and GEO programs. Table 1 shows the example of Chinese involvement in IGOS-P themes, as you can see there is no one theme led by China, and even there is no one theme in which Chinese has been involved.

(3) No special regulations to guarantee the human resources and funds

Although China has participated in EO international activities for 20 years, but so far there is no special regulation on EO international cooperation. And there is lack of special mechanism to guarantee the human resources and funds for participation of EO international cooperation. Although China Meteorology Administration (CMA) is representing China as the Co-Chair of GEO, but CMA is not in the position to make domestic regulation

Table 1 IGOS-P Themes leadership and involvement (Li, 2007)

Themes	Leading organizations	Cooperators	Main organizations	Observations
Ocean	IOC/UNESCO And CEOS/NASA	IOC, WMO, others	NASA, CNES, others	GOOS
Carbon cycle	IGBP	GTOS, GOOS	NASA, others	GTOS, GOOS, GAW, others TBD
Water cycle	CRPW and CEOS/NASDA	CEOS, others	NASDA, ESA	TBD
Disaster	UNESCO, CEOS/ESA	Others	ESA	GARS Proposed
Atmospheric chemistry	WMO	CEOS	ESA, NASA, others	GAW, TBD
Coastal area (coral reef)	CEOS/NOAA UNEP (Coral)	IGBP, UNEP	NASA, NOAA, others (NOAA, others)	GOOS, GTOS

TBD: To be decided

for participation of EO international cooperation. In this situation, the accumulation of resource is becoming difficult without stable human resource and funds to support these international activities. Representatives of China vary from time to time depending on their own interests or their organization's interest. Sometimes it becomes experts' individual activities without any financial support from government. So it is obviously that participation of EO international cooperation is difficult to become a stable and sustainable activity if the national regulation regarding to the international involvement of EO activities could not be formulated and put forward into service. Consequently China will be difficult to play really contribution role to GEO.

3.2 Recommended solutions

The GEOSS plan provides useful guidance for the development of more effective Chinese Earth Observing Systems. It emphasizes the need for earth observation to be directed towards benefiting specific societal benefit areas. To achieve this will require a coordinated international effort based on comprehensive data sharing. GEOSS also emphasizes the need to use remote sensing observations for multiple purposes, to develop end to end information systems, to facilitate data access and to establish comprehensive data policies with the agreement of GEOSS Data Sharing Principles of being full and open exchange of data, metadata, and products shared within GEOSS, All shared data, metadata, and products will be made available with minimum time delay and at minimum cost; and All shared data, metadata, and products being free of charge or no more than cost of reproduction will be encouraged for research and education (GEOSS, 2009).

China can benefit from the work of GEO through a comprehensive range of assistance from developed countries, including staff training, capacity building and data sharing, to enhance the awareness and understanding of the earth system of the developing countries their societies and, thereby contribute to sustainable development. As a large rapidly developing country participation by China in GEOSS provides a very good opportunity to reduce the gaps between China and more developed countries in earth observation. Also GEOSS provides opportunities for China to contribute to global earth observations. How to effectively use the international platform GEOSS to further strengthen the impact of China in international cooperation and enhance China's international status is a question worth pondering. The GEOSS 10-year implementation plan, provides a basis for improving China's earth observation system.

3.2.1 Need for a state level EO coordination mechanism and national strategic plan

There are many benefits to be gained through the development of a more integrated approach to earth observations in China. This will only be achieved through the development of a national level policies for earth observation and the implementation and adoption of earth observations as part of a national spatial data infrastructure. This means that the national government needs to establish national policies, standards and protocols based as far as possible on those laid out in by GEO and also by international organizations. The latter will facilitate use by China of international observational assets and products. The need for this is clearly demonstrated in the increasingly prominent, occurrence of natural disasters, the shortage of water and energy resources which hinder economic development. Without an overall state policy the different observational systems under multiple authorities will almost certainly not be able to share data and information and hence benefits from the substantial Chinese investments in earth observation will never be fully realized.

The development and application of China's earth observation technology has made considerable progress, and basically has established the basic earth observation systems for the atmosphere, oceans air, and land. However no individual country any longer can provide all the earth observation needed for all applications. Hence an integrated use of observations within the framework GEOSS is essential, Moreover we believe that China should not merely be a beneficiary of such cooperation but should also with its significant remote sensing assets be a major contributor to international environmental observations. China's satellites have the capability not only to inform us of the environmental status of China but have the power to provide information about the environment throughout the earth. This will help neighboring countries and regions to benefit from Chinese expertise and ultimately assist in the sustainable development of the planet. This argues for the full use of Chinese achievements in the field of earth observation,

3.2.2 Enhance the global collaboration through promoting data sharing international wide

Nowadays, more open data policies are becoming an increasingly common idea throughout the world, to promote data sharing, many policies relating to the distribution and availability of remote sensing data have been implemented and GEO is attempting to develop these internationally.

China has and is making substantial investments in remote sensing satellites. Such satellites provide invaluable environmental information as was demonstrated in the Sichuan Earthquake. The use of such data is strongly affected by data policy especially relating to charging. For example, it was clearly demonstrated that the change of CBERS policy which made data free for Chinese users resulted in an order of magnitude increase in use. It has been clearly demonstrated that with a few exceptions (such as ultra high resolution data) that there is not a commercial market for remote sensing data. Since the satellites are funded through the government, the citizens of China have already contributed to the creation of the data resources and charging them would in effect be making them pay twice. The incremental cost of making data openly available via the internet is very small: indeed the process of charging and collecting payments are the largest component of the costs. Given that national needs by the Chinese government requires that such data are readily available on the internet, these data should be available to all. It follows that the best return on Chinese investments will be to make its remote sensing data openly available to all Chinese users at no additional cost.

Internationally there are a variety of approaches to data charging policy: some are highly restrictive involving not only charging for use but also inhibiting any subsequent data sharing as is the case for SPOT data. Japanese ASTER data has currently to be paid for but once a scene has been purchased then open sharing is allowed. The United States introduced the most open remote sensing data policy for government-acquired civilian remote sensing data: the policy for overseas use of most data is the same as that for national use. Some exceptions did exist such as data from Landsat but now all Landsat data, current and historical are available at no cost. In the first year of adoption of this policy the number of Landsat scenes distributed is expected to increase from c.20000 to c. 1 million. Brazil has also adopted a similar open policy for its CBERS data. The incremental costs of making all data available at no charge to all users is negligible once the decision is made to make data available at no charge to national users. If China adopted such an international policy then this would make a major internationally recognized contribution to GEOSS and ultimate to the sustainability of the earth; this also would greatly add to the prestige of China in terms of making data openly available for the benefit of other nations and in making the world aware of its technological progress.

Taking account of these previous considerations it is proposed therefore that the following policy be adopted for remotely sensed data from Chinese civilian satellites.

- Remote sensing data are recognized as an invaluable source of knowledge of the environment both for China and the World.
- The fullest possible exploitation of data from Chinese remote sensing satellites should be sought.
- Full and open sharing of the full suite of remote sensing data sets from civilian government satellites for all users is a fundamental objective.
- Data should be provided at the lowest possible cost to all users in the interest of full and open access to data. This cost should, as a first principle, be no more than the marginal cost of filling a specific user request. Where data downloads impose no measurable incremental costs then users should not be charged.
- So far as is feasible the policies for international users should be the same as for national users.

Adoption of a common policy for all Chinese government institutions would provide clarity and uniform guidance in making decisions about the distribution of Chinese government civilian remote sensing data.

3.2.3 Forming a national strategic plan of international cooperation with a global vision

Given the above concerning, to China, building up a global vision in EO international cooperation is very important for China to make the sustainable development in EO international activities. To realize these expectations, china needs to formulate a comprehensive and systematic mechanism by formulation of a national regulation in EO international cooperation area to promote the following aspects:

(1) Participate actively in international cooperation program and lead some cooperation projects

China has always been committed to promote the development of China's earth observation technology and the applications by international cooperation and has achieved great effects. However, from the current situation of China's participation in the international cooperation in the field of earth observation, we are still in the situation of the passive participation, and there are few projects led by Chinese scientists in the main international cooperation plan. Therefore, further enhance China's scientific research level of the related areas through participation, leading and the implementation of some international cooperation projects; open up cooperation channels, and deepen the cooperation content, expand the cooperation scope; form important influence in the earth observation, global change, and such large-scale international research projects. At the same time, according to China's social needs, set up some programs through the study and absorption of the successful technology and experience of international experts to enhance China's scientific research and technology level, form a group of mature research teams in the relevant fields gradually.

(2) Support Chinese scientists and professional staff to be involved into international organizations

Active participation in international cooperation plans, objectives and the discussions and the development of strategies is very important. Through the establishment of close links among the staff, organizations and countries, learn the latest academic and technical progress. Make full use of China's achievements on satellite, remote sensing, aerospace, and other aspects, and expand China's influence, and in word and deed syncretism China's earth observation field into the onrush of international cooperation in science and technology. Through successfully emceed the work of the Committee on Earth Observation of Satellite (CEOS) and the Integrated Global Observing Strategy Partnership (IGOS-P) in 2004, China further established the important international status in the field of earth observation, laying a good foundation for more China's experts and staff to step into the field of international organizations and research projects. We must firmly establish the strategic thinking "intellect resource is the first resource", and actively implement the intellect strategies, and encourage and support a passel of scientists and professional staff that have outstanding achievements, organizing ability, and the international impact to take to the world, and further improve China's international status and influence, serve for the development of the society.

4 CONCLUSIONS

Without doubt, China's involvement in GEOSS will bring it considerable benefits and China has much to contribute to GEOSS. Adopting an open international data sharing policy would make China a major internationally recognized contributor to GEOSS and ultimately to the sustainability of the earth. Also this will be greatly add to the prestige of China in terms of making data openly available and in making the world aware of its technological progress. On the other hand, GEOSS shall bring benefits to China as well once we are being involved deeply in GEO activities in terms of bringing in international level experts and technology serving for China. In this case, we should strive to open up the plat of international cooperation, aim at the forefront of international science and technology, through the support and involvement into the international science and technology cooperation projects to improve the development and integration in the field of domestic earth observation, enhance science and technology innovation capacity in China and serve the overall goal of national economy development.

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中国对全球地球观测系统的贡献

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摘 要： 进一步认识地球、关注地球发展规律, 保护人类共同家园已成为世界各国政府的共识。共同发展地球观测技术, 提高对地观测能力成为新世纪世界各国的共同要求。2003 年发起, 2005 年由欧盟组织的地球观测部长级峰会上通过了全球综合地球观测系统(Global Earth Observation System of Systems, GEOSS)十年执行计划, 构成了世界范围内地球观测领域国际科技合作的主流。中国地球观测领域呈现出快速发展的趋势, 并提出了该领域的全球性发展战略, 预示着中国将在国际地球观测领域发挥越来越重要的作用。文章介绍了中国地球观测领域发展现状和趋势, 在分析中国参与全球地球观测领域国际合作现状及目前存在问题的基础上, 提出进一步促进中国参与该领域国际合作, 为中国乃至国际社会发展做出重要贡献的建议。

关键词： 地球观测, 国际合作, 国际地球观测系统