Building up an Earth Observing System for Digital Earth

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ABSTRACT Digital Earth is an important field of information technology and a research frontier of geosciences in the 21th century. Earth observation is a core within the content of Digital Earth. This paper presents an issue on building up a national earth observing system from three-folds: information acquisition, processing and application; proposes the development of several first priority techniques; and points out the importance of international collaboration.
KEY WORDS Earth observing system, Digital earth, First priority techniques, International collaboration

1. The Role and Development of Earth Observa-tion Technology

Within the scope of science and technology, only earth observation technology from the space can provide a global, repeat and continuous data coverage for the earth surface. These data are used to understand the earth system (Asrar and Dozier, 1994). The earth is a comprehensive system involving all fields related to every discipline about geosciences. The earth observing technology from the space and complex computer simulation works are playing an irreplaceable role in the study of the earth system, and are key techniques in building up the digital earth (Guo, 1999).

Over the past 30 years, earth observation technology has achieved a considerable progress. Since 1960s' a number of airborne earth observing systems have been developed, followed by the successful launch of meteorological satellite, Landsat, Seasat, space shuttle, etc. At present, a series of satellite-borne earth observation programs are implementing. The sensors on board are operated at visible, infrared and microwave bands. Many breakthroughs on the techniques for processing the earth observing data have been achieved, including the timing process of aboard data, the process of voluminous hyperspectral data, and the process of imaging radar data (Guo, 1998). Satellite earth observation, particularly in recent years, has been undergone rapid development. Several civilian and commercial satellites were developed and are in operation. The visible remote sensing sensor's resolution has increased from 30 m to 6 m, such as Landsat, SPOT, ADEOS and IRS-1 C. Some commercial satellites with resolution of 1 m and 3 m have been launched one after another. Small satellites with weight of 100 to 500 kg have been risen abruptly. There will be more civilian and commercial small satellites for earth observation being used in Brazil, Israel, Italy, South Korea, Thailand and USA. The launch of Seastar makes it possible to get commercialized color images of the ocean. In microwave remote sensing, the launch of Radarsat satellite has brought along a large international collaborative program ending in 2007. The implement of USA's EOS program will bring the earth observation to an unprecedented era of development.

The development of hardware system for spaceborne earth observation has much higher requirements for data processing, analysis and compressing techniques. As a result, some software and hardware have been developed, such as Graphic User Interface (GUIS), data processing software, geographic information system, image compression and storage toolkit, image browser etc; and computer hardware is updating from time to time.

2. Building up National Earth Observing System

2.1. Development of National Earth Observing System

After more than 20 years development, significant achievements have been made in China for the earth observation. China has launched returnable remote sensing satellites and polar orbiting meteorological satellites, built up remote sensing satellite ground receiving station, developed multiple remote sensing sensors, and formed an airborne remote sensing system. Data processing techniques have been developed, and remote sensing applications in multiple layers and multiple fields have been undertaken. A noticeable benefit has been gained from the above activities. The development of earth observation program in China is oriented towards new goals (Guo, 1998).

There are still many shortcomings of earth observation in China. On the technology aspect, there is a lack of a stable and long duration data acquisition means in spaceborne and airborne earth observing systems, and also there is a lack of our own copyright software for processing remote sensing data. On the planning aspect, a mid-term

and long-term earth observation program at national level is still not appeared.

The problems facing to China in relation with population, resources, environment and sustainable development have raised much higher demands to the earth observation. Having undergone the development since 1970s', remote sensing in China has accumulated plentiful experiments in science and technology. Now, the time for developing China's national earth observing system is becoming mature.

2.2. Constructing National Earth Observing System

2.2.1. Contents of National Earth Observing System Framework

National earth observing system should be composed of three parts: information acquisition, information processing and information application.

Information acquisition: We should develop resources satellite, oceanography satellite, meteorological satellite for detecting land, ocean and meteorology, also develop radar satellite, hyperspectral satellite, and small satellite for specific uses. It is needed to improve the capabilities of receiving the advanced earth observing satellite data of the world. We are developing an airborne earth observation system, constituting of optical remote sensing sensors with high spectral and high spatial resolution as well as imaging radar. We also need to develop ground-based information acquisition and measurement techniques and system, such as some devices carried by vehicles. Therefore, a three level (ground-airborne-spaceborne) earth observing system could be established.

Information Processing: The system should have the ability to rapidly process data derived from Chinese airborne and spaceborne sensors as well as from international advanced earth observing satellites. It is needed to implement an integrative processing technique for remote sensing, geographic information system and global positioning system, and to implement a full digital technique. It is necessary to set up basic facilities capable of processing voluminous data and rapidly transfer spatial information.

Information Application: Aimed at serving for sustainable development strategy, human resources and environment, the earth observing system emphasizes comprehensive applications and data sharing. We should develop its application technique and enable it to have automatic recognition and intelligent analysis capabilities. We hope that the application fields of earth observing system could be industrialized.

2.2.2. Thoughts on Ddeveloping National Earth Observing System

One of the main aims to build up the national earth observing system is to serve for "digital earth" strategy. Its goal is to produce a practical system for earth observation (Guo, 1999).

The Chinese territory is an observing target from the earth observation system. To solve the Chinese problems is a most important issue. At the same time, the system can also be served for the world. It is not practical to draw a conclusion about China without the background knowledge about the world. China should contribute to the global studies of the world with our own national observing system.

China should set up an open environment for the earth observing system and pay attention to international collaborations. There is no boundary between the countries for space earth observation. We, the Chinese scientists, should not close our door to develop the technology for the system, rather we should become one of the important members in the international earth observation programs.

3. Suggestions for Developing Several Techniques in the First Priority

3.1. Small Satellite for Earth Observation

Modern small satellite adopts brand new concepts and designing ideas as well as a great deal of high technologies. The small satellites can be used either as a supplementary or substitution to the conventional products, or to accomplish some works that conventional satellites hardly do. To acquire more economic, rapid and efficient information is a major direction for international earth observation programs. Therefore, two kinds of small satellite for earth observation are proposed to develop first.

1. Small optical satellite
   The satellite can be designed with two kinds of spatial resolution. One is with resolution of 5 to 10 m so as to meet the detailed surveying demands, and another is with resolution of 50 to 100m so as to meet the demands for rapid surveying.
2. Small radar satellite
   It is to collect data that is difficult to be acquired with optical remote sensing satellites. The first satellite could be designed with single band and single polarization. It is preferred to choose C band and HH polarization. Some key techniques should conduct preliminary research as soon as possible, for example, modular SAR system, size reducing

technique, raw data record and transmission system, and satellite platform etc.

3.2. Operational Airborne Earth Observing System

Two kinds of airborne earth observing system should be built up. No matter which system they are, strong operational capability is an important prerequisite for the system.

3.2.1. Distributive Airborne System

The system is aimed at carrying out single task. A medium or small aircraft should be used as a carrier platform. The payload should be a single sensor with highly flexible and efficient characteristics.

3.2.2.Large Airborne System

The system could be met the needs of a large scale surveying at national level. An integrated remote sensing sensor should be on board a large or medium aircraft. The system is desired to have a competitive ability with satellites on some aspects.

3.3. Data Network and Information System for National Earth Observation Program

To establish a data network and information for national earth observation program is an essential issue for Digital Earth. To compile data acquired in the past and at present is needed, including data acquired by Chinese earth observation means and those covering the Chinese territory but acquired by foreign earth observation technology. Setting up a data network for earth observation and developing an information system for earth observing data are necessary. The earth observing data should be managed as an integral part of the basic facility for China's spatial information, which helps to realize sharing information objective.

3.4 Advanced Earth Observing Sensors

To Look ahead the future development and provide more information to Digital Earth, the following sensors are suggested for the future development based on China's present status. They are a) a complex high resolution imaging spectrometer; b) high resolution interferometric imaging spectrometer; c) infrared detecting technique with hyperspectral resolution; d) random tuning CCD imaging technique; e) random polarization detecting technique; f) digital multi-spectral camera system; g) laser fluorescence /infrared scanning technique; h) laser radar technique; i) imaging SAR system with multiband and multipolarization; j) interferometric SAR system; k) polarimetric SAR system.

4.Summary

Digital Earth is a frontier field emerging from the combination of geoscience and information science, space science and other modern science and technology. The development of Digital Earth will have a tremendous influence on the human beings. The success of Digital Earth depends largely on the contribution of earth observing technology. We should do our best for building up national earth observing system, and constructing Digital Earth for the arrival of "Digital Earth" era.

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