China: Earth Observation system in the coming 5-10 years

SHAO liqin, NRSCC
Ministry of Science and Technology
Space segment
• Satellite system

Meteorological Satellite

Orbit FY-1 - A, B, C, D
Geo-stationery FY-2 - A, B, C, D, E
FY-3A
FY-4
<table>
<thead>
<tr>
<th>Domain</th>
<th>Basic parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Atmosphere and Cloud</strong></td>
<td>Atmosphere: Wind Vector, Precipitation Estimate, Precipitation index, Outgoing Long-wave Radiation at TOA, Upper-level Troposphere Relative Humidity, Atmospheric Temperature Profile, Humidity Profile, Water Vapor Content, Total Precipitable Water, Tropical Cyclone Watch, Fog Detection, Flux at TOA</td>
</tr>
<tr>
<td></td>
<td>Atmosphere Component: Total Ozone, Ozone Profile, Aerosol</td>
</tr>
<tr>
<td></td>
<td>Cloud: Cloud Optical Thickness, Cloud Phase, Cloud Type, Cloud Cover (Total Amount, High Cloud Amount), Cloud Top Height</td>
</tr>
<tr>
<td><strong>Ocean</strong></td>
<td>Sea surface: Sea Surface Temperature, Sea-Ice cover, Ocean Color/Chlorophyll, phytoplankton, Sea Surface Wind Speed, Marine Disaster (Red tide, Sea Water Pollution, Hutai break out)</td>
</tr>
<tr>
<td><strong>Terrain</strong></td>
<td>Land surface: Land Surface Temperature, Surface Soil Moisture, Snow cover, Snow depth, Vegetation Index, Fraction of Photosynthesis Active Radiation (FPAR), Leaf Area Index (LAI), Surface Albedo, Earth Radiation Budget, (Included Solar Radiation), Land Cover Type, Net Primary Product, Flooding Index</td>
</tr>
<tr>
<td></td>
<td>Disaster: Typhoon, Rainstorm, Fire Detection, Dust Devil, Snow Disaster, Flood, Drought</td>
</tr>
</tbody>
</table>
FY-2 resolution optical 1.25km IR5km
FY-3
Global
All whether condition
Multi-spectrum
• Marine Satellite HY-1A
• ( HY-1B、HY-1C、HY-1D、HY-1E )
• ( HY-2A、HY-2B、HY-2C )
• ( HY-3A、HY-3B )
我国第一颗海洋卫星——海洋一号HY-1 OCEAN
2002年5月15日
HY-1B/C ocean color
HY-2 ocean dynamic environment
• Environment satellite:
  • First stage (HJ-1) A, B, C, 2 optical 30m/720km and 1 SAR 20m/100km
    128 channels 100m/50km, 5nm
  • Second stage: 8 satellites
    4 optical
    4 SAR
• Resource Satellite

• CBERS - 1, CBERS - 2,

• CBERS - 3, CBERS - 4
CBERS-02B

A 19.5m GSD MSI with a swath of 113km

A 2.36m GSD PAN with a swath of 27km
CBERS1--03/04星
10m/120km
5m/60km
CBERS - 3, high resolution surveying 2-5-10m
• Small satellites:
  • Beijing-1
  • Shijian-4, -5, -6 ;
  • Qinghua
  • Tansuo-1
  • Chuangxin-1
# Beijing-1 Cameras

## Multi-spectral camera

<table>
<thead>
<tr>
<th>band (nm)</th>
<th>resolution</th>
<th>scan swath</th>
</tr>
</thead>
<tbody>
<tr>
<td>620-530</td>
<td>32m</td>
<td>600 km</td>
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<tr>
<td>630-690</td>
<td>32m</td>
<td>600 km</td>
</tr>
<tr>
<td>760-900</td>
<td>32m</td>
<td>600 km</td>
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</tbody>
</table>

## Panchromatic camera

<table>
<thead>
<tr>
<th>band (nm)</th>
<th>resolution</th>
<th>scan swath</th>
</tr>
</thead>
<tbody>
<tr>
<td>500-800</td>
<td>4m</td>
<td>24km</td>
</tr>
</tbody>
</table>
Beijing-1 image (Hefei, China, 4m + 32m)
Beijing-1 (4m) image, Airport of Teheran, Iran
Satellite Panchromatic camera 1m

Multi-spectral camera 4m 0.4-0.9μm, 20-30km
• Spacecraft

• SZ1, SZ2, SZ3, SZ4, SZ5

• SZ6, SZ7, …
我国第一艘试验飞船——神舟一号SZ-1 1999年11月20日
我国第一艘无人飞船——神舟二号SZ-2
2001年1月10日
China’s Shenzhou V manned spacecraft was launched 15 October 2003.
Navigation Satellite

Beidou

GPS

Galileo

...
BEIDOU 我国第一代卫星导航定位系统——北斗导航试验卫星 2000年10月31日
China has participated in the Galileo program.
Electron-Magnetic earth quick monitoring satellite
我国风云三号气象卫星观测格林兰冰岛冰块融化过程

Monitoring period: 7月16日– 8月 17 2008 (kiruna station)
MERSI monitoring figures for melting process of inshore ice body in Northeast of Greenland Island
Monitoring period: July 16–August 17 2008

cracking ice body
Greenland Island

Monitoring period: July 16 – August 17 2008
Greenland Island

Monitoring period: July 16 – August 17 2008
Greenland Island

Monitoring period: July 16–August 17, 2008
Greenland Island

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Monitoring period: July 16–August 17 2008
Greenland Island

Monitoring period: July 16–August 17 2008
Receiving System

Antenna
Airborne Remote Sensing System in China
Airborne Remote Sensing System

OMIS imaging Spectrometer

CCD Camera

Imaging Spectrometer

RC30 Camera
Airborne Remote Sensing System
China Integrated Earth Observation System
by following Ministries & Agencies:

Ministry of Science and Technology (MOST)
China Meteorological Administration (CMA)

Ministry of Civil Affairs (MCA) and National Committee for Disaster Mitigation (NCDM)
Ministry of Land and Resources (MLR)
Ministry of Water Resources (MWR)
Ministry of Agriculture (MOA)
Ministry of Construction (MOC)
Ministry of Environmental Protection (MOEP)
State Forestry Administration (SFA)
State Bureau of Surveying and Mapping (SBSM)
State Oceanic Administration (SOA)
State Earthquake Administration (SEA)
Chinese Academy of Sciences (CAS)
Why CIEOS?

The advances in science and technology have greatly enhanced human capability in understanding the nature, in utilizing natural resources and in creating happy life for the people. The high & new technologies developed for the Earth observations and obtained data have a special irreplaceable role in promoting sustainable economic and social development in all countries.
China is entering the stage for building a moderately prosperous society in an all-round manner, and for accelerating the process of social modernization. The Chinese Government has requested “We must always put people first. Serving the people wholeheartedly and to apply the Scientific Outlook on Development, to pursue a comprehensive, well-coordinated and sustainable socio-economic development”, which emphasizes the harmonization between man and nature. To meet these objectives, it is necessary to enhance observations in atmosphere, hydrosphere, soil and ecological environment.
As one of the members of GEO, China’s representative serves as one of 4 Co-chairs of GEO. The establishment of China’s integrated Earth observing system not only meets the demands in China, but it will also make its due contribution to the Global Earth Observation System of Systems (GEOSS)…
Concepts:

In the framework of China’s Integrated Earth Observation System (CIEOS), all existing individual Earth observation systems established at the national, local and sector levels will be integrated into one system, in order to make composite observations on land, in air, ocean and space under all weather conditions at the required time in a unified manner.
Principles:

1) To satisfy the major national needs, and give to all sectors at central, provincial levels playing important role;
2) To identify observation parameters & standards, to coordinate overall observing station layouts, and to make full use of all observing systems;
3) To integrate all observing system platforms and stations, including physical integration of all observing systems at the same platforms, functional integration of the observing systems in the key zones, integrated system operating, unified observational methodologies and standards, in order to meet the precision specifications required for applications, to ensure continuity and consistency of all observations, and eventually to create a unified & standardized operational network system through integration of all existing observing systems.
4) To set up an effective mechanism for data assurance & quality control, data evaluation & feedback, to strengthen data management & access, to enhance services & product development, especially those products oriented to decision making processes.
5) To strengthen collaboration in building capacities of all domestic observing systems, and, with a global vision, to carry out extensive international cooperation.
Development Objectives

CIEOS observations will be integrated at all levels, to reduce duplications, to optimize overall system structure, and to create an advanced integrated system covering air, land, ocean and space. The high quality and sustainable Earth observational data and information service will be provided to governments, sectors, local and users for application to agriculture, food security, land & resource security, ecological security, disaster prevention & mitigation, urban development & township management, basic surveying & mapping, major construction projects and spot area monitoring, etc. CIEOS will push, steer and promote technological development of all relevant agencies and system capacity building, and it will enhance a coordinated sustainable economic & social development.
Overall Layout

It is proposed to strengthen existing 12 operational observing systems operated by individual agencies, and to implement integrated 7 inter-agency observation programmes, on the current basis. It is also proposed to set up some regional Earth Observation Centers, to enhance observations in key regions and major areas, to shape an optimized basic CIEOS network for acquiring accurate, sustainable, reliable, standard observations & primary products, to achieve standardized massive data storage, security management, high-performance processing, and to support data exchange, dissemination, access, sharing & services, including product development and the basic service required by governments, scientists and general public.
Fig. 1: An Overall Structure of CIEOS
Available Observing Systems

- Comprehensive Information on Disaster & Obs. System
- Integrated Agricultural Observing System
- Integrated Hydrological Monitoring System
- Integrated Land & Resources Observing System
- Integrated City/Town/Landscape Observing System
- Integrated Meteorological Monitoring System
- Seismological & Geophysical Monitoring System
- Integrated Environment Protection Monitoring System
- Integrated Forest & Ecological Monitoring System
- Integrated Oceanographic Monitoring System
- Integrated Surveying & Mapping Information Platform
- Scientific Research-oriented Monitoring System

Fig. 2 The available observing systems operated by agencies.
Comprehensive Information on Disasters & Observing System (operated by NCDR/MCA)

Objectives
To conduct comprehensive disaster monitoring and assessments, including disaster monitoring, risk assessments, forecasts & early warnings, emergency disaster assessment, loss in economic terms, disaster relief & rehabilitation assessment, etc.; Operations cover villages, towns, counties (cities) and at the national level and they provide an important supportive role to decision-making in response to natural disasters, and in taking emergent disaster assessment & relief actions. The major disasters include drought, flood, typhoon, landslide, mud/rock flow, earthquake, snow hazard, fires, sand/dust storm, sleet and floating ice humps, etc. The monitoring & assessments include disaster-pregnant environment, relevant parameters and thresholds of disaster carriers and disastrous events concerned.
Disaster monitoring system
1) Direct disaster reporting network: 150,000 reporters (incl. rural areas);
2) Natural Disaster relief plan (DRP) network: 2688 stations, including:
   (1) At provincial: 31 stations;
   (2) At city/prefecture level: 310 stations (333 cities & prefectures in all);
   (3) At county level: 2347 stations (2861 counties in total)
3) Satellite monitoring and forecasting system for environment and disaster
   (1) Small satellite constellation (first stage: 2 optical satellites, second stage: 4 optical satellites, 4 SAR satellites)
   (2) Operate and management system
   (3) National Disaster Mitigation-oriented Application System
Integrated Agricultural Observing System
(operated by MOA)

Objectives
To monitor acreage, growth, yield, variety and quality of summer, autumn and winter crops nationwide; to monitor soil moisture, drought, flood, insects/pests and other agricultural disasters; to issue forecasts & early warning on food security; to conduct surveys on crop growing area, land use change, farmland conditions; to monitor grassland productivity, grass yield, grassland degradation, grass-livestock balance; to conduct survey on agricultural sources of pollution; and to make surveys on disasters in fishery & aquatic production.

Monitoring system has 58 stations, including:
1) Soil Ecological Conditions Monitoring Network: 15 stations;
2) Regional Ecological Monitoring Network: 18 stations;
3) Agricultural Biological Resources Monitoring Network: 15 stations;
4) Fishery Resource Environment Monitoring Network: 7 stations;
5) Harmful Biologics Control & Monitoring Network: 3 stations.
Integrated Hydrological Monitoring System (by MWR)

Objectives

To monitor main rivers in China,

**Hydrological monitoring** including: run-off, underground water, precipitation, evaporation, sediment, watercourse, artificial river peak, etc;

**Water quality monitoring** including water temperature, pH value, turbidity, COD, BOD etc

**Soil erosion monitoring** (main erosion modulus);

**Hydrological infrastructure distribution**, construction, operation monitoring;

**Disaster monitoring** including flooding, drought, landslide, ice run.

Note: ground water (mostly based on confined water data from MLR)
Monitoring system includes:

1) Hydrological Observation System

(1) Hydrological Observation Network: 4448 stations
(2) Water Level Observation Network: 1523 stations
(3) Rainfall Observation Network: 22742 stations
(4) Evaporation Observation Network: 1797 stations
(5) Ground Water Monitoring Network: 17155 stations
(6) Water Quality Monitoring Network: 8016 stations
(7) Hydrological Experimental Station Network: 71 stations

2) Water and soil conservation monitoring system

National water and soil conservation monitoring system composes 4 class distributions.
First class is the water and soil conservation monitoring center of MWR.
Second class is the water and soil conservation monitoring center for 7 river basins (Yangtze river, Yellow river, Haihe river, Huaihe river, Pearl river, Song-Liao river, and Taihu lake).
Third class is the water and soil conservation monitoring stations of provincial level.
Fourth class is the water and soil conservation monitoring sub-stations according to the real situation.
Integrated Land Observing System (operated by MLR, including SBLR & CGS)

Objectives
To conduct nationwide basic geological survey (1:250,000), with a priority being given to geological & mineral resource surveys on the major mineral belts (1:50,000); to make the second round national land survey (1:10,000 to 1:100,000); to dynamically monitor urban land uses by remote sensing (1:10,000 to 1:2000); with a priority being given to the surveys on mineral belts; to dynamically monitor the mineral resource exploration mines; to make surveys on regional land subsidence; to survey on geological disasters (1:100,000), focusing on the surveys on the geological environment, etc.
Monitoring system: 21,639 stations, including:

1) Geological Disaster Monitoring Network:
   217 stations at prefecture/city level
2) Ground Water Monitoring Network:
   1,422 stations (at national level)
   20,000 stations (at provincial level)
3) Dynamic monitoring of land use By remote sensing:
   86 major cities
4) Dynamic monitoring of mineral resource exploration
   mines: 86 major cities
5) Geological & ecological environment monitoring: Tibet/Qinghai
   Bohai Sea rim
   Southwest Karst region
Integrated Observing Systems in Cities/townships & Landscapes (operated by MOC)

Objectives

To conduct remote sensing (RS)-based monitoring for national major scenic-spot planning; to implement 86 major city planning-oriented monitoring projects endorsed by the State Council; to monitor urban girded management information; to monitor nationwide green cities; digital photography-based large scale urban topographic mapping & data monitoring; to implement digitalization demonstration projects of major national scenic areas; RS-based monitoring for urban system planning of metropolitans/key regions/cities/towns; RS-based monitoring for urban land use & building demolition planning; RS-based monitoring of historical cities; RS-based monitoring of nationwide major towns; RS-based monitoring of urban land use & development.
Monitoring system: 1101 stations, including:

(1) Urban Planning-oriented Monitoring & Observing Network: 86 stations for overall urban planning examined by the State Council;

(2) Scenic Spots Monitoring Network: 187 stations;

(3) Historical City Monitoring Network: 108 stations;

(4) Garden City Vegetation Monitoring Network: over 100 stations;

(5) Urban Planning-oriented Observing Network: over 20 stations;

(6) Other stations: approximately 600 stations.
Integrated Meteorological Monitoring System (operated by CMA)

Objectives

To monitor the occurrence, development & damages of severe meteorological disasters, and to provide timely & accurate forecasts, predictions & services for their prevention & mitigation. To set up a ground-based, airborne & space-based integrated observing system, in which the ground component covers surface meteorological information, climate observations, ground-based remote sensing, ground-based mobile observations, atmospheric boundary layer sounding, atmospheric composition (including sand/dust storm) observation, acid rain observation, mid- & high-level atmospheric observing systems; space-based observations include observations from aircraft, balloon, rockets; air-borne observations incorporate high- & low-orbit satellites & aircrafts. To achieve modernization of meteorological operations, to construct a climate observation system targeted to atmosphere, hydrosphere, biosphere, cryo-sphere and land process, as an important component of the Earth Observation System.
CMA’s Integrated Surface Meteorological Observing System

(1) Reference climate station network: 143 stations
(2) Basic meteorological station network: 530 stations
(3) Ordinary meteorological station network: 1736 stations
(4) Atmospheric radiation station network: 98 stations
(5) Acid rain station network: 294 stations
(6) Atmospheric composition (incl. sand/dust storm) monitoring station network: 45 stations
(7) Soil moisture station network: 433 stations
(8) Agricultural meteo-station network: 624 stations
(9) Atmospheric background station network: 7 stations
(10) Lightning detection/positioning network: 101 stations
(11) Doppler weather radar station network: 101 stations
(12) Upper air observation station network: 120 stations
(13) ground-based space observing station network: 30 stations

(incl. those under construction)
China’s climate observing system is considered as an important part of the meteorological observing system restructuring, and the basic concepts & major outcomes of the “China’s Climate Observing System Implementation Plan” have been incorporated.

It focuses on development of the integrated multi-sphere (atmosphere, hydrosphere, biosphere, cryo-sphere and land process) observations in 16 key climate zones, and it sets the targets for construction of the national climate observatories. According to ground-based, air-borne, space-based, integrated approach and the principles for creating multi-purpose & multi-function stations, the optimal unified & integrated designs have been conducted for the overall observation layout, observational elements, operational observation procedures, etc., and pilot plan has been implemented at some selected national observatories.
2) China’s meteorological satellite system includes the following components:
(1) Polar-orbiting meteorological satellite series: The first generation of polar orbiting meteorological satellite FY-1 series, four satellites have been launched and used in Chinese meteorological service. The second generation of polar-orbiting meteorological satellite FY-3 series, the first satellite FY-3A has been launched successfully. It is in orbit testing now.
(2) Geo-stationary meteorological satellite series: The first generation of Geo-stationary meteorological satellite FY-2 series, four satellites have been launched and used in weather forecast service. The second generation of Geo-stationary meteorological satellite FY-4 series, they are at the definition and pre-configuration stage now.
(3) National ground system, including 4 domestic ground stations in Beijing, Guangzhou, Wulumuqi, Jiamus and one rented station overseas, national operating & data processing and archiving centre (National Satellite Meteorological Centre). The ground system has ability for data receiving, processing, applying, archiving, distributing and sharing from both Polar-orbiting and Geo-stationary meteorological satellites that are operating in China and overseas. It has great capability to produce products and character parameters of Atmospheric, Land and Sea Surface automatically.
An integrated airborne, space- and ground-based seismological & geophysical observation system will be established, incorporating the multi-technique surface observation network (i.e. earthquake, deformation, geo-electricity, geomagnetic, and subsurface geo-fluid measurements), the Earth observation technologies including thermal infrared, InSAR, satellite-based geo-magnetic & geo-gravity measurements, in order to achieve a comprehensive real-time (or near real-time) & large-scale Earth observations from air, space and land on earthquakes, volcano activities, deformation of active faults, geothermal status, geomagnetism, and other geophysical fields on a continual basis. This system will be used for earthquake predictions, warnings, basic research on earthquake mitigation measures, Earth science studies, national major construction projects, international diplomacy and national defense, and it will provide S&T data for achieving public safety against earthquakes in China.
Observation systems:

1) An Integrated Surface Earthquake Observation System
   (1) Surface Observation Network:
   Surface Earthquake Observation Network: over 1000 stations
   Earth Crust Deformation Observation Network: over 310 stations
   Geo-electricity Observation Network: over 120 stations
   Geo-magnetism Observation Network: 100 stations
   Geo-fluid Observation Network: over 290 stations
   (2) GPS Observation Network: over 2300 stations

2) An Integrated Airborne and Space-based Observation System
   (1) Satellite Observation System: It makes full use of the available satellite
       resources for developing satellite techniques on earthquake & geomagnetic
       observations, for making comprehensive earthquake observations via
       infrared, InSAR, geomagnetic, geo-gravity measurements, and for virtually
       creating a 3-D earthquake observation system, which provides a wider range
       of information on earthquake precursors and is capable to make dynamic 3-D
       monitoring on multiple geophysical fields;
   (2) Airborne Observations: the aircraft geomagnetic & interference radar
       remote sensing system will be developed, as an effective supplementary
       means to the integrated earthquake observation system covering land, air &
       space; it is tasked with inter-comparisons of various observations on a
       irregular basis, so as to improve capabilities in making high resolution &
       quick observations in emergency cases.
Integrated Environment Monitoring System (operated by SEPA)

Objectives

To construct a ground application system of the environmental satellites, to develop distributive environmental space data service platforms, to establish environmental remote sensing system that functions on a reliable and operational basis, so as to form an integrated national & environmental quality monitoring system based on environmental satellites and ground environment monitoring systems. To monitor environmental air qualities, including SO2, NOX, TSP, PM10, CO, VOCS and other pollutants; to make remote sensing-based monitoring on greenhouse gases (CO2, CH4, O3, etc.) and long-range transport of pollutants. To monitor water quality of major rivers, lakes, reservoirs, off-shore regions, estuaries and other water bodies, including CHL, BOD, COD, TOD, CDOM, SS, TP, TN, number of Coliforms and thermal pollutants, etc.; to make comprehensive monitoring & assessments on nationwide and regional ecological environments, national natural reserves, key ecological protection areas, ecologically sensitive areas, massive projects/regional development zones, ecological engineering zones on a regular basis. To monitor solid wastes, mainly the soil pollution as result of waste water irrigation in the “vegetable basket project” zones, spatial distribution and impacts of solid pollutants. To conduct emergency monitoring on major environmental pollution accidents, including algal blooms, red tide, oil slick, chemical leaks, explosions, biomass burning, etc. To monitor sources of pollution, including sources of hazardous industrial pollutant/waste water discharges along rivers, more than 6,000 key pollutant sources nationwide under surveillance, sources of waste gasses from coal/charcoal, metallurgical, oil-refinery and construction material industries, etc.
Monitoring system: 2,389 stations in total.

1) Surface Environmental Monitoring Stations: over 2,000 stations
   (1) Air Quality Monitoring Network
       Urban Air Quality Monitoring Network: 340 stations;
       Rural Air Quality Monitoring Network: 30 stations;
       East Asian Acid Deposition Monitoring Network: 9 wet deposition (acid rain) measurement sites; 4 dry deposition monitoring sites; 4 inland water body monitoring sites;
       Sand/dust Storm Monitoring Network: 80 stations

   (2) Water Environmental Quality Monitoring Network:
       Surface Water Monitoring Network:
           593 river cross-section monitoring stations;
           152 lake/reservoir monitoring sites, all covering 745 cross-sections;
       Off-shore Sea Water Quality Monitoring Network: 299 stations
       Shallow Ground Water Quality Monitoring Network: 125 cities, of which 75 make deep ground water quality measurements.
(3) Acoustic Environment Monitoring Network:
Regional Environmental Noise Monitoring Network: 378 cities
Road Transport Noise Monitoring Network: 398 cities
(4) Ecological Monitoring Network 12 stations

2) Environmental satellite-based Integrated Monitoring System
An environmental satellite is planned to launch in early 2008, the payload instruments include optical, hyper-spectral and radar sounders, which will facilitate quick, real-time and dynamic monitoring of large-scale ecological & environmental qualities and changes, and tracking the occurrence & development of some emergency environmental pollution events by environmental protection agencies, so as to provide technical support for information access in environment management. Currently, China is planning to set up a SEPA Environmental Satellite Application Centre. This centre, when established, will achieve comprehensive processing and integration of environmental satellite data, surface environment monitoring data and other relevant data, through its data processing/analysis system, database system and operational environment monitoring system, etc., so as to improve the operational capabilities in comprehensively monitoring air quality, water quality, regional ecological environment and emergency environmental accidents, etc.
Integrated Forest & Ecological Monitoring System
(operated by SFA)
Objectives
To monitor forest resources, including natural forests & ecological forests; to monitor forest meteorological conditions & forest-related parameters; to monitor desertification, wetland resources, wild life; to monitor forest fires, diseases & pests, and to monitor ecological engineering projects & forest ecological environment, etc.

Monitoring system:
1) Including a Forest Inventory/Monitoring System;
2) Land Desertification Monitoring System;
3) Forest Fire Monitoring System;
4) Four Nationwide Forest Monitoring Systems, including the Wetland Monitoring System
5) A Terrestrial Ecological System Field Observation & Research Centre;
6) A Observation/Research Network: Chinese Forest Ecosystem Research Network (CFERN), Chinese Desertification Ecosystem Research Network (CDERN) and Chinese Wetland Ecosystem Research Network (CWERN);
7) Ecosystem Observation Network: 42 stations
Basic Ocean Monitoring System operated by SOA

Objectives
To make oceanic monitoring and to issue oceanographic forecasts, including sea surface temperature, salinity, sea waves, oceanic topography, sea surface wind fields, sea surface air pressure, sea ice, ocean characteristic imagery, chlorophyll, suspending sediments, etc.; to monitor disastrous oceanic events for mitigation, including ocean storms, high waves, tsunami, sea ice, Red tide, etc.; to monitor ocean pollution, such as sea surface oil slicks, major ocean pollutants, thermal circulating water, organic pollutants, nutritious salts & heavy metal components, etc.; to explore & develop ocean resources (e.g. sea aquatic production, oil & natural gas exploitation); to maintain national oceanic rights & interests, to monitor the enforcement of marine laws & regulations; to conduct research on interactions between oceans and global change. To establish an airborne, space-based, ship-based and subsurface ocean monitoring system, so as to an integrated oceanic monitoring system, covering atmosphere, land and ocean, as an important component of the Earth observation system in China.
Monitoring system has 120 oceanic stations

1) Basic Oceanic Monitoring Network affiliated to the State Oceanic Administration (SOA) has 1 national centre (National Marine Environmental Monitoring Centre), 3 regional oceanic centres (Yellow Sea, East China Sea & South China Sea), 11 central oceanic observation centres and 45 oceanic stations.

2) Basic Coastal Oceanic Monitoring Network: 11 provincial oceanic centres & about 50 local oceanic observation stations (at prefecture or city levels).
Integrated Surveying and Mapping Information Platform (operated by SBSM)

Objectives
A unified new-generation high-precision dynamic surveying & mapping system will be set up, covering both land and sea across the nation; to accomplish aerial photography of over 6,000,000 km², aimed at achieving necessary coverage by satellite remote sensing with different resolutions; the basic geographical information coverage will exceed 95% of the territorial land in 1:50,000, with an annual updating rate targeted to 20%; the basic geographical information will achieve a necessary coverage in 1:10,000, with an annual updating rate targeted to 20%; the basic geographical information in 1:2,000 or even higher resolution will virtually cover all cities & towns above counties with an annual updating rate targeted to 30%. A digital geographical framework will be essentially created for producing a range of useful public products, the network service of basic surveying & mapping products will be materialized to basically meet the demands in economic & social developments.

Monitoring system:
Continuous GPS reference station network: around 600 stations;
Unified full land/sea coverage and high-precision National Geodetic Control Station Network: about 5,000 controlled observation points.
Scientific Research-oriented Monitoring System (operated by CAS)

Objectives
To create an integrated ecological observing system covering farmlands, forests, grassland, wetlands, deserts, lakes and oceans in order to continue playing the demonstrative role of China’s ecological system research within the framework of the International Long Term Ecological Research (ILTER) Network as well as in the Global Terrestrial Network-Ecology (GTN-E) under the Global Terrestrial Observing System (GTOS) programme.

Observing system (120 observation stations)
Chinese Ecological Research Network (CERN): 39 observation stations;
Special Environment & Disaster Monitoring Network: 11 stations (covering glaciers, cryo-sphere, land slide (mud & rock flow), thunder & lightning, hail storm, remote sensing, desert, ecological & remote sensing experiments, etc.), observation stations at Arctic & Antarctic and 1 generic research center.
CAS Sun-Earth Space Environment Observation & Research Network: 9 integrated observation stations (covering geomagnetic, mid & upper atmosphere, ionosphere, cosmic rays, space weather, etc.) and a station-chain data data centre.
Ground-based Integrated East Hemisphere Space Environment Monitoring & Meridian Research Network: Under the current Meridian Project, on the basis of the 15 stations which will be built (led by CAS and involved by the SEA, Ministry of Information Industry, Ministry of Education, CMA, SOA, etc.), additional 30 stations will set up, with observations covering mid & upper atmosphere, ionosphere, geomagnetic, interplanetary scintillation, solar wind high-intensity plasma, full Solar magnetic fields, etc.

Off-shore Oceanic Observation & Research Network: 1 oceanic observation platform or a buoy will be set up at around the Yellow Sea cold mass, Yangtze River Estuary, Yongxing Island of the Xisha Islands, Yongshu Reef of the Nansha Islands respectively, so that an integrated observation network will be created combining with the existing CERN bay-ecological environment monitoring stations (i.e. located at Jiaozhou Bay, Daya Bay and Sanya Bay), and 3 oceanic research vessels (*Science-1, Science-3 and Experiment-3*), covering high-resolution, multi-element, real-time off-shore ecological & environmental system observations.

Regional Atmospheric Background Observation Network: It is composed of 4 CERN stations and 1 astronomical station, which are field stations located in Northeast, North, South, Southwest, Northwest China respectively. The current observations include the concentration of major greenhouse gases against atmospheric backgrounds, network dry & wet depositions monitoring.
Fig. 3 China’s integrated earth observation systems
## Climate parameters to be observed

<table>
<thead>
<tr>
<th>Domain</th>
<th>Basic climate parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Atmosphere</strong></td>
<td>Earth surface: temperature, rainfall, air pressure, surface radiation budget, wind speed and direction, vapor, upper-level atmosphere: Earth radiation budget (including solar radiation), upper-level atmospheric temperature (including MSU), vapor, wind speed and wind direction, vapor, cloud characteristics</td>
</tr>
<tr>
<td></td>
<td>Atmospheric components: carbon dioxide, methane, ozone, other long-life greenhouse gases*, and aerosol characteristics</td>
</tr>
<tr>
<td><strong>Ocean</strong></td>
<td>Sea surface: SST, sea surface salinity, sea-level height, sea status, sea ice, ocean currents, sea color, etc.</td>
</tr>
<tr>
<td></td>
<td>Under sea surface: temperature, salinity, nutrient salt, carbon, tracer, and phytoplankton</td>
</tr>
<tr>
<td><strong>Terrain</strong></td>
<td>River flow, under ground water, water level of lake, snow cover, ice cover and glacier, permafrost, albedo, terrestrial cover, FAPAR, LAI, biomass</td>
</tr>
</tbody>
</table>

* Including $\text{N}_2\text{O}$, CFCs, HCFCs, HFCs, SF6 and PFCs
Distribution of China’s climate observing system
# Contents of atmospheric chemistry observation

<table>
<thead>
<tr>
<th>Items</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerosols</td>
<td>Quality, concentration, (distribution of particles, including PM10, PM2.5, PM1), absorption, scattering, visibility, optical depth, vertical profiles, and chemical composition.</td>
</tr>
<tr>
<td>Greenhouse gases</td>
<td>Greenhouse gases in carbon cycle, halogenated greenhouse gases, CO₂ (online), CH₄ (online), CO (online), N₂O (online), SF₆(online), halogenated greenhouse gases (online)</td>
</tr>
<tr>
<td>Reactive gases</td>
<td>SO₂, NO/NO₂/NOₓ, CO, NH₃, Noy, and VOCs</td>
</tr>
<tr>
<td>Precipitation chemistry</td>
<td>Rainfall sampling, pH, conductivity, K⁺, Na⁺, Ca⁺, Ca²⁺, Mg²⁺, NH₄, SO₄⁻², NO₃⁻¹, Cl⁻¹, F⁻¹</td>
</tr>
<tr>
<td>Ozone</td>
<td>Ground ozone, ozone total and vertical profile of ozone</td>
</tr>
<tr>
<td>UV</td>
<td>UV, VU-B</td>
</tr>
</tbody>
</table>
## Basic Contents of Water Cycle Observation system

<table>
<thead>
<tr>
<th>Observational methods</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ground Hydrological observation</strong></td>
<td>Water resources: flow, precipitation, evaporation, water temperature, surface soil moisture, soil moisture in seepage area, groundwater storage, groundwater depth, groundwater level, groundwater temperature and potential, lake and river water level, reservoir water level, flow of in and out reservoir, water storages, bank temperature, area and depth of snow cover, snow water equivalent, density and depth of floating ice, ice dam height and width, ice dam upstream water level and potential, temperature of frozen ground drill hole, frozen ground type, glacier area and length, glacier spread direction, glaciers type, moraine type, ice caps and ice field area; Water quality: water temperature, dissolved oxygen, turbidity, pH value, and conductance; Mud and sand: sand content in single samples, suspended load sediment silt discharge, and sand grain analysis</td>
</tr>
<tr>
<td><strong>Environmental isotope observation</strong></td>
<td>δ²H、δ¹⁸O</td>
</tr>
<tr>
<td><strong>Ground weather observation</strong></td>
<td>Surface air temperature (SAT), surface humidity, air temperature and humidity, precipitation, sunshine hours, Global Solar Radiation, wind speed and direction, downward/upward short-wave radiation, downward/upward long-wave radiation, surface evaporation, vegetation evapotranspiration, sensible heat flux, latent heat flux, and soil heat flux.</td>
</tr>
<tr>
<td><strong>Aircraft and satellite based observation</strong></td>
<td>Visible remote sensing retrieval parameters: surface albedo, vegetation index, leaf area index, land use/cover type; Infrared remote sensing retrieval parameters: surface air temperature (SAT), surface heat flux, and surface emissivity. Microwave retrieval parameters: soil moisture, and precipitation, terrain, roughness, vegetation structure parameter; Integrative retrieval parameters: surface evaporation and vegetation evapotranspiration, sensible heat flux, latent heat flux, soil heat flux, crop water scarcity index, soil water use efficiency</td>
</tr>
</tbody>
</table>
### Basic observing contents of the carbon cycle observing system

<table>
<thead>
<tr>
<th>Observing targets</th>
<th>Observing items</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carbon storage of vegetation</strong></td>
<td></td>
</tr>
<tr>
<td>Farmland</td>
<td>Type of farmland; variety of main crops; leaf area index, aboveground biomass, underground biomass, productivity, amount of litter fall, etc.</td>
</tr>
<tr>
<td>Forest vegetation</td>
<td>Type of forest; composition of stand species, average age of stand; leaf area index, diameter, height, volume; Biomass and productivity, amount of litter fall, volume of dead trees.</td>
</tr>
<tr>
<td>Grassland</td>
<td>Type of grassland; dominant species, leaf area index; aboveground biomass, ground biomass, productivity, amount of litter fall.</td>
</tr>
<tr>
<td>Wetland</td>
<td>Type of wetland; type of dominant plants, leaf area index, surface biomass, ground biomass, productivity, amount of litter fall, etc.</td>
</tr>
<tr>
<td>Soil carbon storage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Soil type, color, mechanical composition of soil, organic matter content, soil depth, volumetric weight, soil moisture, soil nitrogen content, soil dissolved organic carbon, soil dissolved inorganic carbon</td>
</tr>
<tr>
<td>Marine carbon storage</td>
<td>Plankton biomass, water quality, nutrient salt, seawater temperature, seawater salinity, ocean color, transparency, CO₂ partial pressure</td>
</tr>
<tr>
<td>Atmospheric carbon storage</td>
<td>Concentrations of carbon dioxide, methane, black carbon, wind speed, temperature, humidity, precipitation, evaporation, global solar radiation, direct radiation, scattered radiation, photosynthetically active radiation, net radiation</td>
</tr>
<tr>
<td>Meteorological factors</td>
<td>Wind speed, temperature, humidity, precipitation, evaporation, global solar radiation, direct radiation, scattered radiation, photosynthetically active radiation, net radiation</td>
</tr>
<tr>
<td>Carbon exchange between ecosystem &amp; atmosphere</td>
<td>Flux of water, and carbon soil respiration, plant respiration, surface sensible heat flux, latent heat flux,</td>
</tr>
<tr>
<td>Remote sensing monitoring</td>
<td>Land use/land cover, vegetation NDVI, LAI, heat radiation, biological and chemical composition of vegetation, physical and chemical characteristics of soil, carbon monitoring of volcano, forest and grassland.</td>
</tr>
<tr>
<td>Carbon storage and flux of human society</td>
<td>Land-use types, biomass, productivity, carbon metabolism of human activity, carbon consumption of industry, agriculture and daily life</td>
</tr>
</tbody>
</table>
## Basic observing content of ecological observing system

<table>
<thead>
<tr>
<th>Observing targets</th>
<th>Items to be observed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biological factors</strong></td>
<td></td>
</tr>
<tr>
<td>Farmland</td>
<td>Type of farmland; varieties of main crops; growth period and height of crop, leaf area index and planting density; surface biomass, ground layered biomass, productivity, withered biomass, grain seeds, stem/leaf ratio, etc.; photosynthetic, physiological and ecological characteristics of crop leaves; soil respiration; flux of water, heat, carbon and nitrogen etc.</td>
</tr>
<tr>
<td>Forest vegetation</td>
<td>Type of forest; stand species composition, average age stands, phenology of dominant species; dominant tree species’ coverage, density, leaf area index, trunk diameter, tree height, accumulated biomass, tree-ring; biomass and productivity of different organs of arbor, withered biomass, amount of died trees; photosynthetic, physiological and ecological characteristics of leaves of dominant Plants; physiological and ecological characteristics; soil respiration; flux of water, heat, carbon &amp; nitrogen; wildlife species and population size etc.</td>
</tr>
<tr>
<td>Grassland</td>
<td>Type of grassland; dominant species, phenology, height, coverage, density, leaf area index; biomass and productivity of dominant stands, litter fall; photosynthetic, physiological and ecological characteristics of leaves of dominant plants; soil respiration; flux of water, heat, carbon and nitrogen; wildlife species and population size etc.</td>
</tr>
<tr>
<td>Wetland</td>
<td>Type, coverage and distribution of vegetation; species, phenology, leaf area index, coverage, density, height and biomass of dominant plants; photosynthetic, physiological and ecological characteristics of leaves of dominant plants; Soil respiration; flux of water, heat, carbon and nitrogen; wildlife species and is population size etc.</td>
</tr>
<tr>
<td><strong>Atmospheric elements</strong></td>
<td>Wind speed, wind direction, temperature, humidity, precipitation, evaporation, air pressure, total solar radiation, direct radiation, scattered radiation, photosynthetically active radiation, net radiation etc.</td>
</tr>
<tr>
<td><strong>Soil elements</strong></td>
<td>Soil type, its color, mechanical components, bulk density, specific heat, heat conductivity, hydraulic conductivity, water potential of soil, soil moisture, field capacity, soil temperature (vertical distribution), the depth of soil freezing; soil heat flux; soil pH value, cation exchange capacity, organic matter content, soil nitrogen content, active soil organic carbon, ammonium nitrogen, nitrate nitrogen, total phosphorus, effective phosphorus, sulfide, effective sulfur; soil microbial communities &amp; quantity etc.</td>
</tr>
<tr>
<td><strong>Hydrological elements</strong></td>
<td>Ground water level, accumulated water depth, surface runoff</td>
</tr>
<tr>
<td><strong>Remote sensing monitoring</strong></td>
<td>Vegetation NDVI, LAI, thermal radiation, biological and chemical composition of vegetation, physical and chemical characteristics of soil</td>
</tr>
</tbody>
</table>
### Basic observing elements of the ocean observing system

<table>
<thead>
<tr>
<th>Observing projects</th>
<th>Observing elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine physical elements</td>
<td>Sea temperature, seawater salinity, thermohaline profile, ocean current, sea level, sea ice, waves, transparency, sea surface wind field, oceanic gravity field</td>
</tr>
<tr>
<td>Air-sea elements</td>
<td>Air temperature, air pressure, humidity, wind speed, wind direction, precipitation, cloud, visibility, weather phenomena, water vapor, CO₂, aerosol</td>
</tr>
<tr>
<td>Marine ecological Elements</td>
<td>Water color, nutrient salt, plankton</td>
</tr>
<tr>
<td>Marine pollution</td>
<td>Sea water pollution, oil spills on the sea, suspended mud and sand</td>
</tr>
<tr>
<td>Marine biology</td>
<td>Nutrients, plankton biomass, fish, chlorophyl</td>
</tr>
<tr>
<td>Marine bed sediment</td>
<td>Seabed topography, landform &amp; sediments</td>
</tr>
<tr>
<td>Ocean current</td>
<td>Current velocity, current direction, surface current, deep current</td>
</tr>
<tr>
<td>Marine disaster</td>
<td>Tsunami (huge wave), storm surge (lake location, water gain, floodplain coverage), sea level height, tide flooded area, black stream, red tide</td>
</tr>
</tbody>
</table>
Overall layout of ocean observing system
### Basic observing content of the space environmental observing system

<table>
<thead>
<tr>
<th>Observing targets</th>
<th>Observing items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar surface and active regions</td>
<td>Photosphere, chromosphere, corona, coronal hole, sunspots, flares, filament, solar prominence, the magnetic field structure, radio flux, ultraviolet flux</td>
</tr>
<tr>
<td>Interplanetary and solar wind</td>
<td>Coronal mass ejection (CME), interplanetary shock and discontinuities, interplanetary magnetic field, plasma parameters (density, temperature, group velocity)</td>
</tr>
<tr>
<td>Earth's magnetosphere</td>
<td>Magnetic field of the magnetosphere, radiation belt, ring current, energetic particles, magnetospheric substorm, magnetospheric storm, aurora activities.</td>
</tr>
<tr>
<td>Ionosphere</td>
<td>Plasma density, temperature, velocity, total electron content, ionospheric scintillation, ionosphere disturbance, ionospheric storm</td>
</tr>
<tr>
<td>Middle and upper atmosphere</td>
<td>Atmospheric composition, density, temperature, wind field, electric field</td>
</tr>
<tr>
<td>Geomagnetism</td>
<td>Intensity and direction of the Earth's magnetic field, geomagnetic disturbance, geomagnetic pulsation, geomagnetic storm, cosmic ray</td>
</tr>
<tr>
<td>Space debris</td>
<td>Space junk, meteoroid</td>
</tr>
<tr>
<td>Space environment along satellite orbits</td>
<td>Energetic electron, neutron, heavy ion, plasma, atomic oxygen, spatial micro-debris, radiation dose, single event effect, surface charging, deep dielectric charging, space pollution</td>
</tr>
<tr>
<td>Space environment effects</td>
<td>Radiation dose-effect, charging effect, single event effect, pollution effect, atomic oxygen erosion, orbit decay</td>
</tr>
</tbody>
</table>
Fig. 4 A classification of primary products of the Earth observing systems.
For example Forest Data & products: forest area, forest types, forest coverage rate, forest leaf area index, forest canopy density, net forest productivity, forest reserves, forest age, dominant species, tree height, tree diameter, tree crown, the amount of forest litter, forest area affected by diseases & pests, forest area affected by fires, land surface temperature for forests, forest water table, heat scattered in the forest, undergrowth vegetation, litter layer moisture, wild animal & plant species, wild animal & plant quantity, ecological engineering and forest ecological environment monitoring, and forest litter of the year.
Major Application Areas of China’s Integrated Earth Observation System

6.1 Natural Disasters & Anthropogenic Hazards
6.2 Environmental Impacts on Human Health
6.3 Energy Management
6.4 Climate change
6.5 Water Resources and Water Cycle
6.6 Meteorological and Air Quality Information, Prediction & Warning
6.7 Ecological Systems of Land, Coastal Zones & Ocean
6.8 Sustainable Agriculture and Desertification
6.9 Bio-diversity
6.10 Land Use & Land Use Change, City & Township
6.11 Exploration of oil, gas and mineral resources
6.12 Oceanic Information, Forecast & Warning
6.13 Space Environment Information, Prediction & Warning
• International cooperation
China's participation in Global Earth Observing System of Systems (GEOSS)

The Earth system is a whole. Studies and monitoring of many natural phenomena like disasters, weather, climate change, ocean and space involves global cooperation. China is a developing country, and all current earth observations made by various sectors in China are domestic observations. Since China has joined the intergovernmental Group on Earth Observations (GEO), China will strengthen its cooperation with GEOSS in the name of CIEOS. China is willing to conduct bilateral, multilateral, international and regional cooperation in the framework of GEO, and to participate actively in global earth observation activities.
For example:

International disaster monitoring and emergent environmental events monitoring
Dynamic remote sensing observations of global forest and land coverage
Remote sensing monitoring system of global agriculture
Remote sensing monitoring of global climate and environmental changes
Remote sensing monitoring of global Water System
Remote sensing monitoring of global marine environment
International Meridian Programme of space weather
Integrated remote sensing monitoring of MAIRS in Asian monsoon region
Through such cooperation with national and international organizations like CEOS, IGOS, GEO, NOAA, NASA, JAXA, CSA, DARA, CNES, ESA, EUMETSAT, UNOOSA, UNEP, FAO and WMO, China has been strengthening partnership with major space countries and with developing countries like ASEAN. China hosts actively relevant international conferences and establishes joint R&D projects, such as the Galileo Navigation Project, Dragon Project, and so on. China promotes exchange visits of experts, technical cooperation and data sharing; and keeps interest with the latest academic and technical progress. China is committing itself to integrate Chinese earth observation activities into the world's economic development, and into international cooperation in science and technology.
EO Summit I on July, 31 2003 in Washington, USA
对地观测领域第二次部长级高峰会
（日本东京，4月25日）
We emphasise that in the earth observation area, we have to strengthen global cooperation and coordination, therefore the establishment of GEO is a very important tendency,

We are also willing to support the creation of a comprehensive, coordinated, and sustained Earth observing system of systems (GEOSS).

We hope that a joint effort for GEO and the 10-year Implementation Plan will be conducted with every country and international organization.
CEOS 2004 in China

CEOS 18th Plenary together with CEOS 20 Years Anniversary in Beijing, China in Nov. 18 – 22, 2004
Galileo Cooperation with EU

- Co-operation Agreement
  EU/CN - 30th October 2003

- The National Remote Sensing Centre of China (NRSCC) became a member of the Galileo Joint Undertaking (GJU) on the 9th October 2004.

- The Chinese side committed EUR 200 million to the Galileo Programme:
  - EUR 70 million in the development phase
  - EUR 130 million for the deployment phase
Co-operation Agreement EU/CHINA
- 30th October 2003
Chiba-Europe GNSS Technology Training and Cooperation Center

19 Sep. 2003
Cooperation between China and Europe on Galileo Navigation Satellite System

The technical agreement between Galileo Joint Undertaking and National Remote Sensing Center of China was signed on Oct. 9, 2004
MOST - ESA Dragon project

1. Agricultural Monitoring in “Fujian Province” :
2. Rice Monitoring :
3. Forest Map of China :
4. Forest Fire Monitoring :
5. Techniques for Deriving Forest Information From POLInSAR Data
6. Terrain Measurement
7. Monitoring seismic activity
8. Landslide displacement monitoring
9. Flood Plain Disaster Rapid Mapping and Monitoring
10. Satellite Tools for Water Resources Assessment and Management at River Basin Scales
11. China Drought Monitoring
12. Coupling climate and ocean systems
13. Chemistry/Climate Change in the Atmosphere
14. Air Quality Monitoring and Forecasting
15. Ocean Environment, Climate
   (1)Oceanography
   (2)Ocean Color
Dragon programme 2006 symposium  Lijiang China
SINO-GERMAN COAL FIRE PROJECT
Nearly every coal field in North China, where 90% of China’s coal resources are concentrated, suffers from scattered, localized, or clustered coal fires.
Application of Satellites for monitoring and early warning of coal fires in China

Detection of unknown coal fires Analysis and monitoring
Study of geometry and dynamics
⇒ Protection of resources and the environment
2008.5.12 Wenchuan
This great earthquake reached 8.0 grade, and broke up mountain bodies and caused large-scale collapses and landslides, whilst breaking down lots of houses. The earthquake disaster is terribly serious.
International Charter

Emergency on-Call Officer (ECO)

On-Duty Operator (ODO)

Authorized User (AU)

End User (EU)

Value-Added Reseller (VAR)

Project Manager (PM)

Disaster

CSA

ESA

ERS-2 and ENVISAT

NOAA

NOAA-12, 14, 15, 16 & 17, POES and GOES

ISRO

IRS

JAXA

SAC-C

USGS

Landsat

CNSA

CBERS

DMC Constellation

DMC

International Charter
ESTABLISHMENT OF THE ASIA-PACIFIC SPACE COOPERATION ORGANIZATION (APSCO)

Officially established in December 16, 2008 in Beijing, China (2008). Chairman is Thailand
Suggestions for LCLUC/GOFC

1. to publish formal report for
global LCLUC/GOFC
some country like China LCLUC/GOFC
some river basin LCLUC/GOFC

2. mechanism and modeling
such as land-atmosphere interaction model,
to establish land change equations

3. to predict LCLUC/GOFC in some regions

4. to give some suggestions
to improve LCLUC/GOFC,
to improve environment
to harmonize human/nature, industry/agriculture
Thank you!