EO Activities in 2014
Agency Report for WGCV-38

Presented by Chuanrong Li
National Remote Sensing Center of China, Ministry of Science and Technology, P. R. China
Academy of Opto-Electronics, Chinese Academy of Sciences

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Outline

Institutional Information

Grand Events in 2014

Activities on Calibration and Validation

Future Plan
NRSCC was one of branch centers of Ministry of Science and Technology of China (MOST), and established in 1981 with its mandate in domain of RS, GIS and Navigation:

- To guide and coordinate R&D activities
- To manage China National Scientific project
- To facilitate the actions of Expert group of RS, GIS, Space explore and Navigation domain

To support the development of innovation capability and to foster the new industry

Ten official staffs at present but many secondments

The mode of “condensed kernel, wide network”
Academy of Opto-Electronics (AOE), Chinese Academy of Sciences (CAS)

- AOE was established in November 2003. Aiming at national demand and international advanced technology, AOE carries out innovation activities in optoelectronic engineering, aerospace and corresponding EO application technology, becoming a research unit with overall technique functions in the above areas.

Earth Observation Technology Application Department (ETA)

- ETA is a department of AOE in charge of R&D of EO data processing and application technology, which dedicates to provide open R&D platform for quantitative RS information technology.
- On the basis of ETA, CAS established the Key Laboratory of Quantitative Remote Sensing Information Technology in 2014, which focuses on R&D quantitative RS information quality control, information extraction and application mechanism, information service technologies.
• Relationship between NRSCC and AOE

NRSCC is running in a network support approach, the network virtually consists of 49 institutes from different department.

Chuanrong-Li, appointed by MOST as a chief scientist to lead an expert group in the domain of RS, GIS, PNS and Space exploration.
Grand Event (1) — RS strategic research

- RS strategic research plan for 13th five-year and beyond

  • Global observing

  - Atmospheric circulation
  - Water circulation
  - Electromagnetic field

  • Public service

  - High-resolution satellite imagery
  - High-definition video
  - Direct access services

- For global issues
- For public issues

- Large scale
- Long period
- Quantification

- Low-cost
- Quick response
- Intelligent
RS strategic research plan for 13th five-year and beyond

Planning will focus on the following aspects:

- Space-near space-airborne-ground integrated, visible-thermal infrared multispectral spaceborne radiation benchmark and the corresponding consistent transfer technology

- Quick observation based on micro-satellite constellation, onboard data processing and RS big data analysis technology, aiming to public services

- Advanced RS payload technology, public service oriented information processing technology and Earth science remote sensing

Evidently improve Chinese satellites calibration accuracy to ensure the consistent data quality and benefit for solving global issues.

RS information technology serves public, promoting the development of RS big data and information industry.
Proposal of spaceborne radiation benchmark system

- Achieve high-accuracy and high-stability calibration with SI traceability of in-orbit payloads through benchmark transfer.
- Benchmark platform: **Ground, Airborne, Near space aerostats and satellite**

![Diagram showing benchmark payloads and platforms: Radiation source, EO Sensor, Near space aerostats, and satellite. NIST and NPL sites are connected as benchmark points. Other satellite sensors are calibrated. Sites include Dome C, Dunhuang, La Crau, Iyyanpah Playa, and Baotou site.]
Proposal on spaceborne radiation benchmark system

• **Planning (2016~2025):**
  - ~2020: The principle prototypes devices
  - ~2023: The engineering prototype system, tested onboard Near space aerostats
  - ~2025: In operation onboard satellite

• **Work arranged (2015~2017):**
  - High-precision spaceborne infrared radiation source
    - Emissivity: $\geq 0.997$
    - Temperature controlling stability: $\leq 0.01K$
    - Temperature uncertainty: $<0.15K$
  - High-precision spaceborne solar spectral radiation benchmark with SI traceability
    - Uncertainty of space cryogenic radiometer: $\leq 0.03\%$
    - Spectral range: 300nm-2500nm
    - Uncertainty of solar spectral radiation benchmark: 0.2% ($<1600nm$); 0.5% ($>1600nm$)
Key Laboratory of Quantitative Remote Sensing Information Technology, Chinese Academy of Sciences (CAS) was established in 2014.

- Performance assessment for Optical and SAR sensors
- Opening site in accordance with international standards

A excellent R&D platform for EO scientific research
Dragon programme

Background:

- ESA, together with the NRSCC, had cooperated in the field of Earth observation application development for more than 17 years. In 2004, The cooperation taken on a new momentum called Dragon.

Objectives:

- The Dragon cooperation is targeted towards land, ocean, cryosphere, geodesy, climate and atmospheric investigations in China.

Development of Dragon:

- Dragon 3 (2012-2016): further expanded to a third phase with 51 projects exploiting ESA, TPM and Chinese EO data.
- Dragon 4: TBD
In Chengdu, China from 26-29 May 2014, more than 300 European and Chinese EO scientists attend the symposium.

AOE, CAS cooperated with University of Ulster, UK and National Institute of Parasitic Diseases (NIPD), Chinese Center for Diseases Control and Prevention (CCDC) developed the Epidemics’ monitoring research project named “Monitoring and Early Warning of Vector-borne Diseases in China by Earth Observation Data Mining (MWVDEODM)”.

Experiment results

1990-2010 dynamic monitoring results of snail spatial distribution

(a) 1990
(b) 1995
(c) 2000
(d) 2007
(e) 2010

Low: 0
High: 0.1354

2014 dragon 3 Mid-Term results symposium
Present new research results and young scientist best paper
• Adopt the universal standards for aerospace data acquisition and exchange, including its metadata, storage format, product generation order and observation programming order etc., which ensure the efficient operation for 15 aerospace remote sensing data acquisition systems.

• Analyze the requirements of acquiring task based on disaster states, make the task plans for satellite and aerial system collaboratively.
Aerospace application coordination system for emergency response and data sharing (ArcSer)

- Disaster experts, government officials, and spatial data application users can have conference with each other under the support of the system, which uses 3D technology as disaster information comprehensive display platform.

- The system increases the speed of acquiring aerospace data of disaster area, reduces the time for end user to acquire spatial data for disaster reduction, which improve the efficiency of aerospace resources of China for disaster reduction dramatically.
In LuDian Earthquake, which occurred at 16:30, August 3, 2014, UAV was dispatched to a quake lake area on NiuLan River. The high resolution data over the area was obtained at 15:00, August 4. Then the information extracted from the data was used to guide quake lake’s disaster rescue and relief.
• Acquire the first batch of high resolution remote sensing data (GF-1, KZ-1) within 24 hours after the earthquake.
• Collect a huge amount of aerospace remote sensing data acquired before and after the earthquake.
• Distribute the data to more than 38 institutions, which are affiliated with 20 different Ministries (more than 90 batches, data volume up to 2.05TB).

Before earthquake
- GF-1
- ZY1-02C/ZY3
- HJ-1A/1B/1C
- SJ-9
- HY1B
- TH01
- RISAT-1

After earthquake
- KZ-1
- GF-1
- ZY1-02C/ZY3
- HJ-1A/1B/1C
- SJ-9
- HY1B
- TH01
- RISAT-1
- SB-1
- DB-1
- UAV airborne image

Fast data acquisition and sharing

Acquisition at 12:04

Data sharing on the internet at 13:30
The requirements of RadCalNet:
• To establish an automated land radiometry measurement network
• To generate sensor-independent TOA radiance/reflectance
• To provide worldwide consistent sensor calibration service

Baotou site is now one of the four first demonstration sites of RadCalNet.

To meet the needs of RadCalNet, an automated reflectance spectrum measurement system is designed and will be installed on the artificial permanent targets of Baotou site.
The characteristic of Automated Ref. Spec. Measurement System

- Hyperspectral measurement, to match with different sensors more conveniently and accurately.
- Measure the hemispherical down-welling radiance and ground reflected radiance with the same detector.
- Automatically adjust the working status according to the weather condition.

The core measurement instrument:
USB2000+ spectrometer (Ocean Optics)
Spectral resolution: 1.5nm@(350-1000 nm)
The system is designed to observe the solar, sky and ground in sequence every 10 minutes.

The surface reflectance at certain observing direction is calculated with hemispherical-conical reflectance and the BRDF of the surface target.

The sensor-independent hyperspectral TOA radiance/reflectance is acquired with the surface reflectance and atmospheric parameters, and then the channel TOA radiance/reflectance is carried out by the convolution with the SRF.
Totally, three systems will be installed beside three gray-scale targets, and the radiometric calibration can be carried out with the 3 channel TOA radiance/reflectances.

- The support units (an upright post) has a height of ~1.5m with a beam of approximately 0.5m for observation.
The landscape of Baotou site is sand and grass, and it has low back-scattering coefficient (-13~-15dB) for deploying SAR calibrators.

45 triangular trihedral corner reflectors and 1 active calibrator for UAV-borne Ku/X-band SAR Cal&Val were previously developed.

To enhance routine Cal&Val capability

- New types of corner reflectors (CRs) have been manufactured for long-wavelength /spaceborne SAR Cal&Val.
- Corner reflector bases have been developed for quick deployment of corner reflectors and avoiding repeated position measurement.
- Microwave bar-pattern targets have been developed for intuitive and accurate assessment of SAR image resolution.
Activities on Cal&Val (2)
Enhance SAR Cal&Val Capability for the Baotou Site

- **Corner reflectors R&D:**
  - **Self-illuminating CRs**
    - **Square Trihedral CRs**
      - Total number: 16
      - Leg length: 0.1m to 0.6m
    - **Hexagon Trihedral CRs**
      - Total number: 8
      - Panel area: 1.7, 1, 0.8 m²

- **Extended bottom trihedral CRs**
  - To avoid uncertain panel-ground interaction

- **Dihedral reflectors** for polarimetric SAR calibration

There are 100 corner reflectors in total at the Baotou site
Reflector bases

For quickly deploying corner reflectors and avoiding repeated measurement of position information, 15 corner reflector bases were constructed and distributed across the site.

The bases in east-west direction are generally used for antenna pattern verification; while the bases in south-north direction are used for radiometric calibration.

Distribution direction (east-west) is 95° to North, with compromise of transportation convenience and SAR flight direction:

$$\beta = \arcsin \frac{\pm \cos \alpha}{\cos \xi} \approx 10°$$

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Inclination</th>
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<tbody>
<tr>
<td>TerraSAR</td>
<td>97.44°</td>
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<tr>
<td>Radarsat-2</td>
<td>98.6°</td>
</tr>
<tr>
<td>Sentinel-1</td>
<td>98.18°</td>
</tr>
<tr>
<td>SkyMed</td>
<td>97.86°</td>
</tr>
<tr>
<td>ALOS/PALSAR</td>
<td>98.16°</td>
</tr>
<tr>
<td>HJ-1-C</td>
<td>97.37°</td>
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Bar-pattern target

It draws the inspiration from optical three-bar pattern target, and exploits the roughness dependence of radar backscattering: concrete flat plate for low backscattering and gravel for high backscattering.

Roughness could be inferred by the Rayleigh criterion

\[ h > \frac{\lambda}{8 \cdot \cos \theta} \]

Designing scheme
Activities on Cal&Val (2)
Enhance SAR Cal&Val Capability for the Baotou Site

- Bar-pattern target
Activities on Cal&Val (3)
—Enhance Infrared Cal&Val Capability for the Baotou Site

➤ Stepwise Cal&Val system design for infrared sensors

The severe spatial and temporal variations of surface parameters (temperature, emissivity)

➤ Synchronous measurement: reduce the temporal mismatching—Time discrepancy needs to be less than 10 minutes for thermal sensors

➤ Large-area “truth” acquisition: high efficiently acquire measurements in pixel size to decrease the scaling effects in Cal&Val
Design of Standard hyperspectral imagers for Stepwise Cal&Val System

Airborne hyperspectral imagers

- VNIR imager
  - Spectral range: 400-1050 nm
  - Spectral resolution: 3.5 nm

- SWIR imager
  - Spectral range: 1000-2500 nm
  - Spectral resolution: 10 nm

- TIR imager
  - Spectral range: 8-12.5 μm
  - Spectral resolution: 80 nm

Ground hyperspectral imagers

- VNIR imager
  - Spectral range: 400-1050 nm
  - Spectral resolution: 2 nm

- SWIR imager
  - Spectral range: 1000-2500 nm
  - Spectral resolution: 5 nm

- TIR imager
  - Spectral range: 8-12.5 μm
  - Spectral resolution: 40 nm
Self-developed artificial infrared targets and ground measurement instruments

- **High-emissivity target with automatic temperature controlling**, providing the same reference to transfer the benchmark.
- **Low-emissivity target** made of aluminum plate, used to obtain the atmospheric down-welling radiances.

- **Multi-angle automatic emissivity measurement system** with a self-developed rotating platform
- **Water-leaving radiance measurement system** to measure temperature of water body as low temperature target for Cal & Val
Activities on Cal&Val

- Great contribution to RS application
- Open platform for R&D

Field & Meteorological Data Measurement
- An omni-directional and multi-angle automatic observing systems
- SVC Spectroradiometer
- Automatic sun tracking photometer, CE318
- LAI-2000 Plant Canopy Analyzer
- Dynagmet Weather Station
- Leica TCR1202 Total Station

Aerial Data Acquisition
- Campaign Planning and Management
- Flying platform
- High Accuracy Standard Sensors

Artificial and Natural Targets

Payload/Calibration Performance Analysis and Product Validation
- Data Processing and Analyzing System
- Scientific Analysis Reports of Payload Performance

Not only Cal&Val facility, but also a scientific research platform
**Future Plan**

**Continue supporting on-going EO projects**
- Intensity correlation imaging
- TANSAT—Global CO2 observation and Monitoring
- ChinaGEOSS...

**Plan and launch new EO projects**
- Spaceborne radiation benchmark system
- Low-cost and quick-response micro-satellite network
- ...

As the general department of NRSCC, continue to provide technical support in areas like the China GEOSS, which has great demand for product quality.

Based on the Key Laboratory, develop EO data quality assurance and advanced RS information retrieval and service technology.

Based on the Baotou site, establish open international research platform for Cal&Val:
- In Oct. 2014, carry out UAV flight experiment with SAR, visible-infrared multispectral payloads onboard, validating the performance assessment capability of Baotou site.
- Carry out performance analysis experiments for spaceborne sensors, including TerraSAR, Worldview/Geoeye, GF-1, ZY-02C, ZY-3.
- Install and test the target characteristic automatic measurement instruments in Baotou site.
Thank you for attention!