The fifty-first session of the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space

Progress of Cal&Val for Quantitative Remote Sensing in China

Presented by Chuanrong Li

Academy of Opto-Electronics (AOE), Chinese Academy of Sciences (CAS)

Feb. 11 2014 Vienna, Austria

Quality Demands of Remote Sensing Product for Application

New Application Requirement:	**Image Interpretation**	→	**Quantitative Analysis**
	Single Satellite	→	**Constellation**
	Single Mission	→	**Multi-Objects**
	National	→	**Global (Data Sharing)**

High quality requirement

- **Accuracy of retrieved information**
- **Consistance and Traceable**
- **Sensor Performance**

On board Calibrating Sensor

Operational Validating Product

Old story

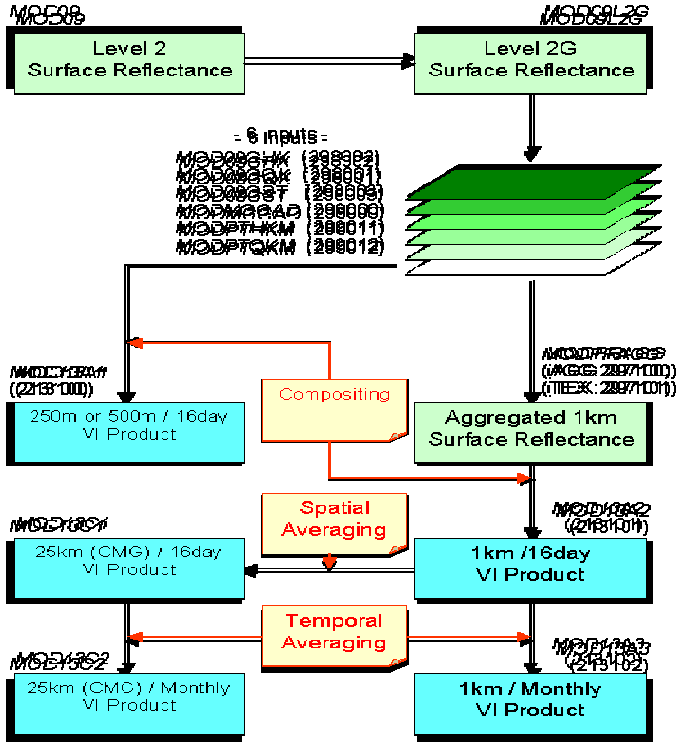
Still a story

Technical Issues

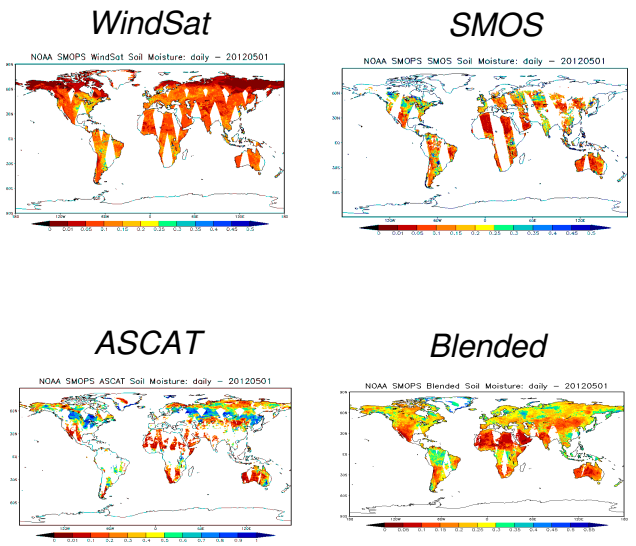
- **Major technical challenges in Cal&Val for quantitative RS:**

Lack of consistent assessment standard, which prevents data sharing, fusion of multi-source data, assimilation…

Product quality indicator based on uncertainty propagation



Fusion application of different RS products



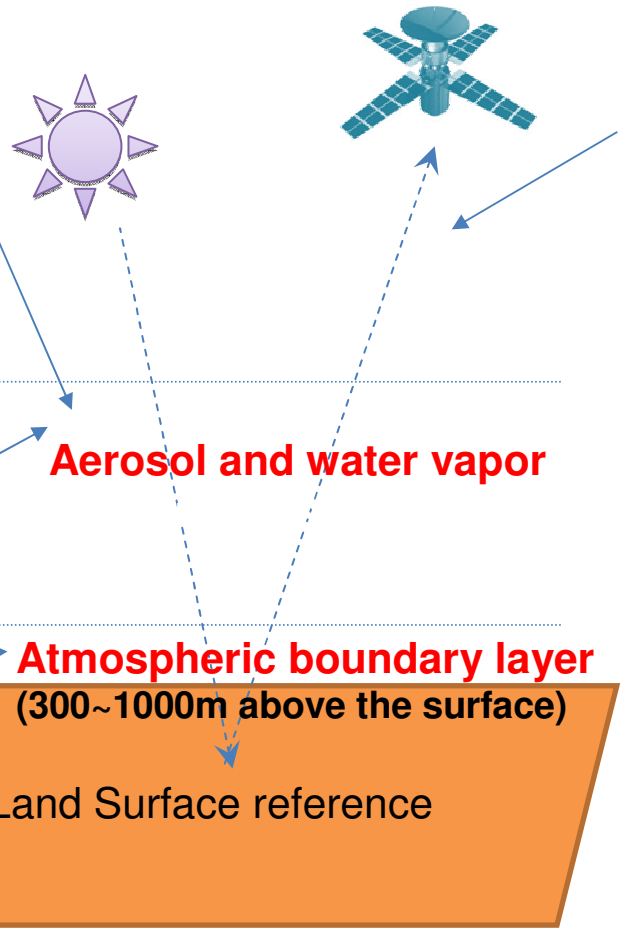
Technical Issues

For onboard satellite payload calibration and performance assessment, uncertainties are introduced by significant atmospheric effect in radiative transfer (RT) simulation.

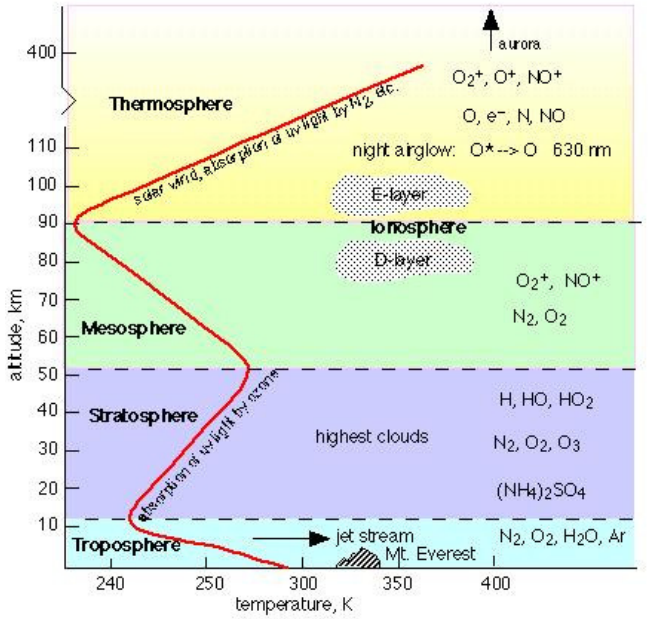
Aerosol:
Key factor affects the RT.
Varies significantly in both spatial and temporal scales.

Atmospheric water vapor:
Key factors affects the RT.
Varies significantly (0~4%) in both spatial and temporal scales.

Surface-atmospheric coupling effect in boundary layer:
Great uncertainties in the measurements of atmosphere for the surface-atmosphere coupled effects.



Temperature and atmospheric components varied in altitude, **precise atmospheric profiles** are needed in rigorous RT calculation.

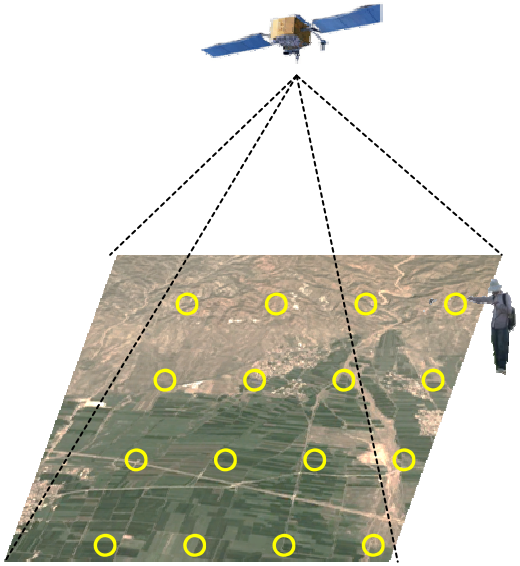


Technical Issues

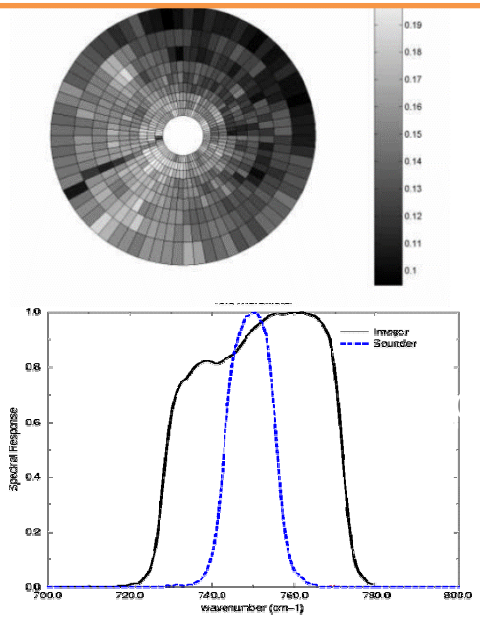
There is no true "synchronous" measurements between satellite and field observation, which brings in the significant scaling bias.

Temporal: Difficult to finish the in situ measurement just when the satellite overpass, resulting in errors of solar illumination and circumstance.

Angular: Difficult to acquire the in situ measurement from exactly the direction as satellite to take account for the non-lambertian surface.



Miss-matching in different scales



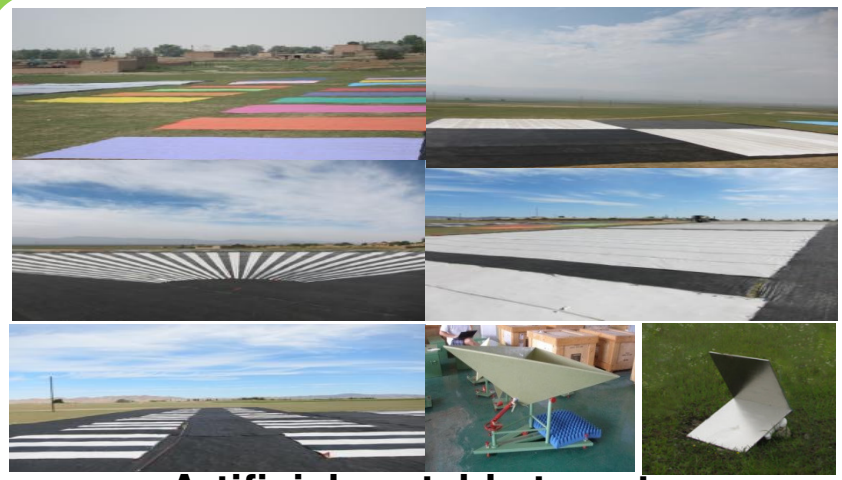
Spatial: Difficult to obtain the pixel-scale "truth" from the in situ measurements only taken in some samples, leading to transforming error.

Spectral: Differences in the spectral response between satellite and in situ instrument, causing the band matching error.

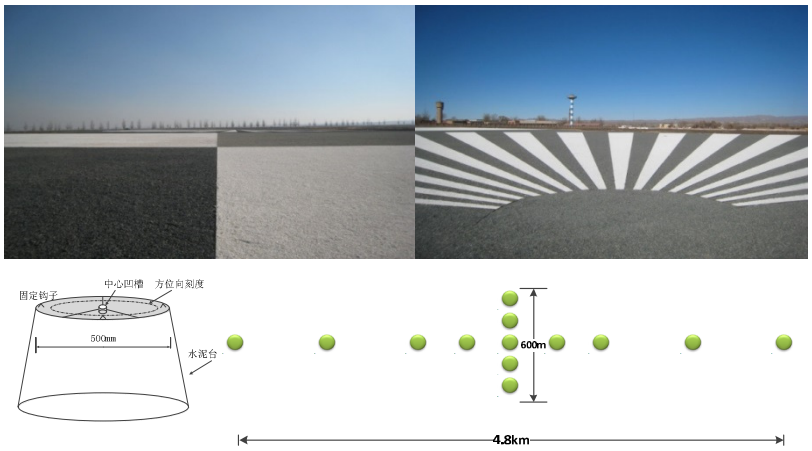
Efforts made to promoting Cal&Val capacity for Qua. RS

- **Progress in Developing Cal&Val Site**

Various TARGETS with different functions are integrated in one site.

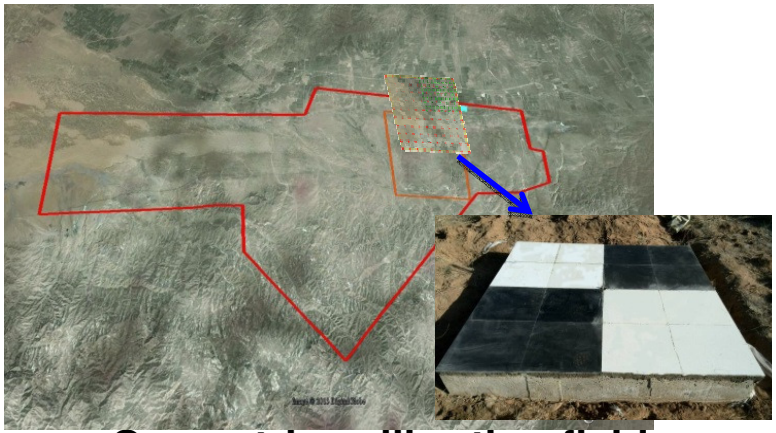


Artificial portable targets



Artificial permanent targets

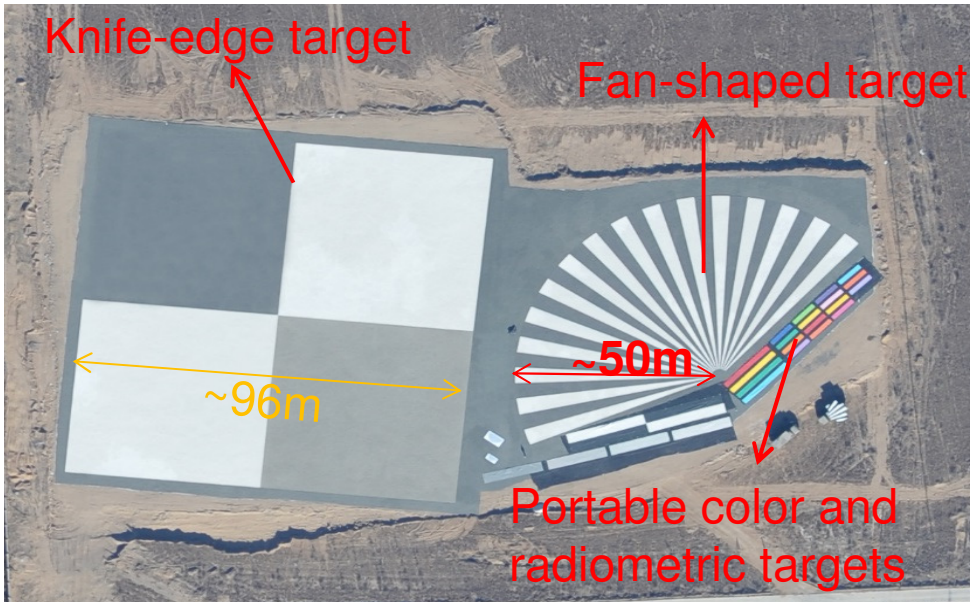
Natural ground scenes



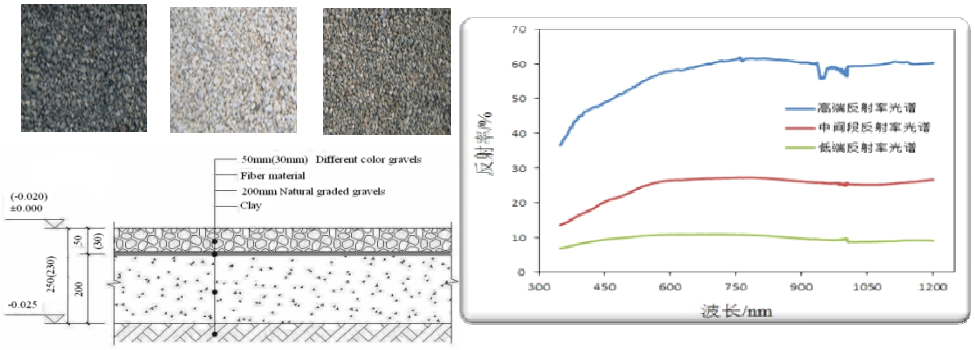
Geometric calibration field

Efforts made to promoting Cal&Val capacity for Qua. RS

Artificial Permanent Targets

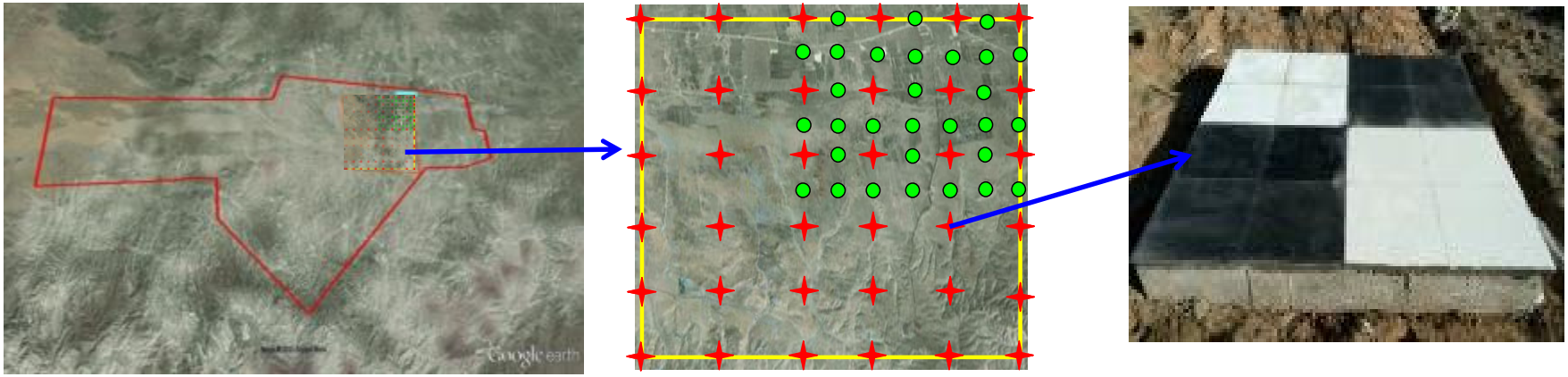


Aerial image of the artificial permanent targets



Efforts made to promoting Cal&Val capacity for Qua. RS

Geometric calibration field with permanent control points



Artificial Portable Targets

Three bars | Knife-edge | Color targets | Fan-shaped | Grayscale

Efforts made to promoting Cal&Val capacity for Qua. RS

Natural Ground Scenes

- The landscape of the site mainly includes **lake**, **bare soil**, **sand**, **grassland** and different types of **farmland**.

Ulansuhai lake

Bare soil

sunflower

pumpkin

Sand

Grassland

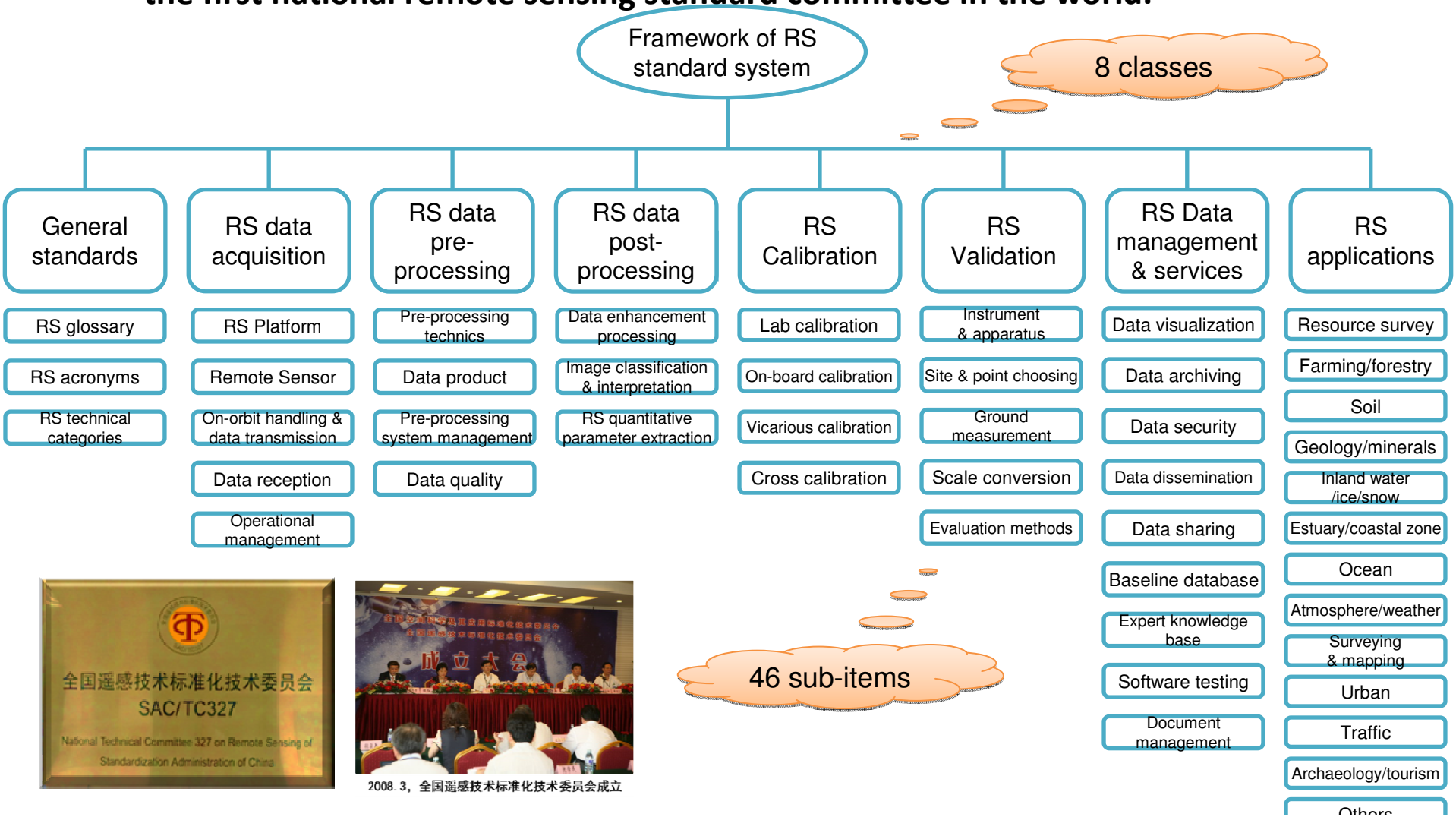
potato

maize

Farmland

Efforts made to promoting Cal&Val capacity for Qua. RS

- **Progress in Remote Sensing Standardization**
  - **To promote the standardization of remote sensing technique, China established the first national remote sensing standard committee in the world.**



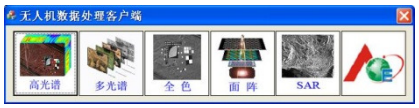
2008.3，全国遥感技术标准化技术委员会成立

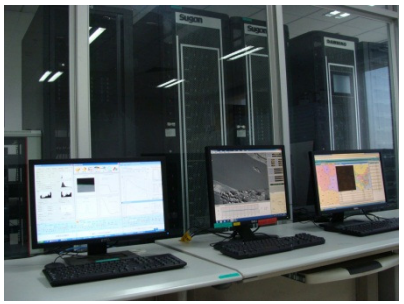
Efforts made to promoting Cal&Val capacity for Qua. RS

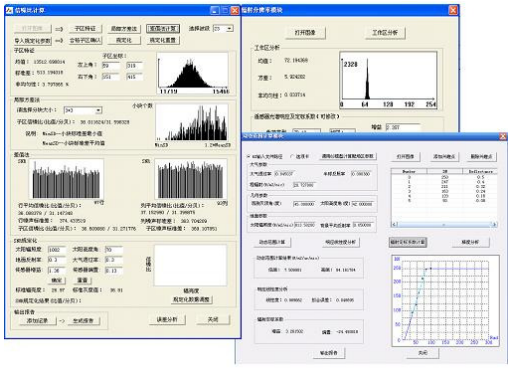
- **Progress in Remote Sensing Standardization**

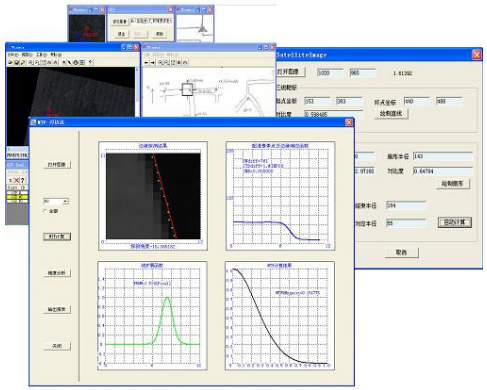
Data Processing/Analyzing System

Data processing	Radiometric performance assessment	Geometric Performance Assessment	Spectral Performance Assessment
• Radiometric correction • Geometric correction • Spectral correction • Reflectance retrieval • Vegetation index retrieval • SAR data processing	• Absolute radiometric calibration • Signal to Noise Ratio, SNR • Dynamic range • Response linear degree • Radiometric resolution, NEΔ ρ	• Ground resolution • MTF • Band registration precision	• Hyperspectral camera: central bandwidth; FWHM • Multispectral camera: spectral response function



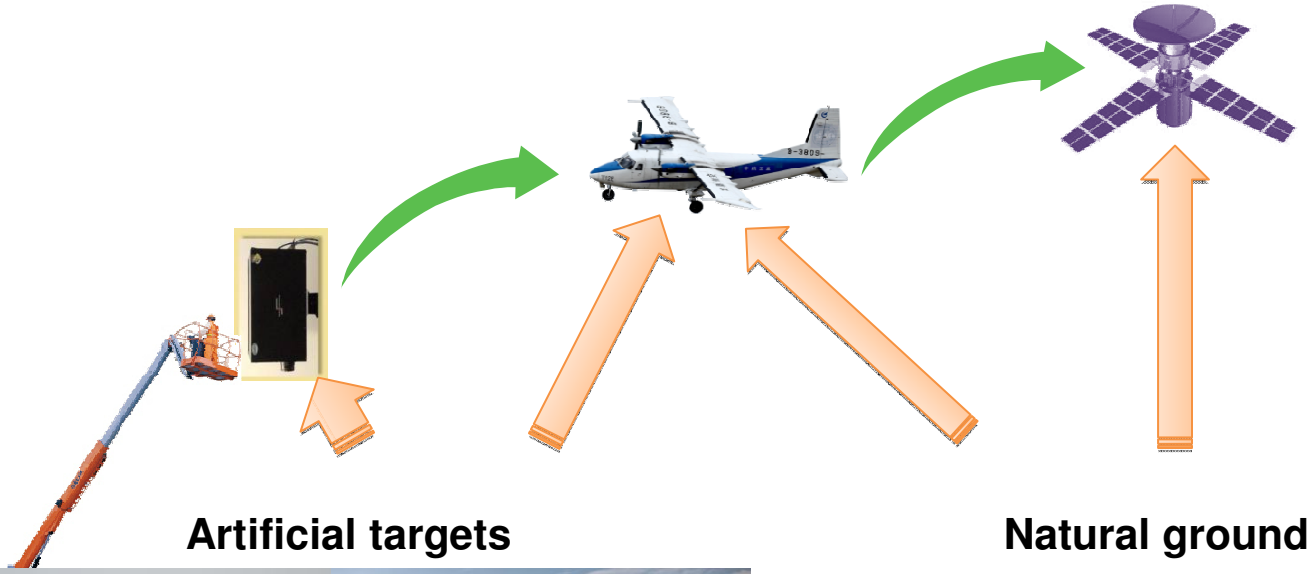






Efforts made to promoting Cal&Val capacity for Qua. RS

- **Progress in Developing Stepwise Cal&Val System**
  - **To reduce the scale bias in linking the field measurement and RS data, and uncertainties of atmospheric RT simulation in the boundary layer.**

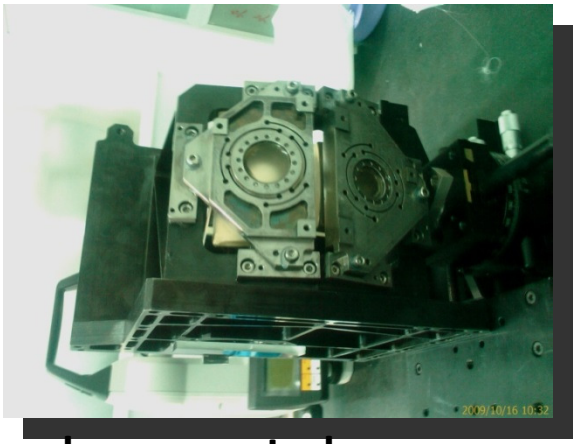


Artificial targets

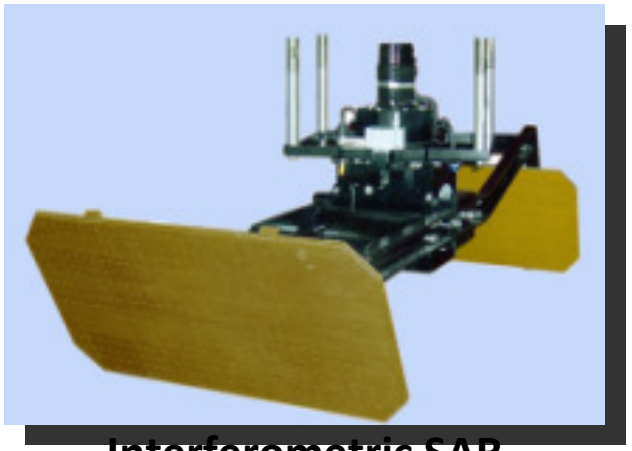
Natural ground scenes

Efforts made to promoting Cal&Val capacity for Qua. RS

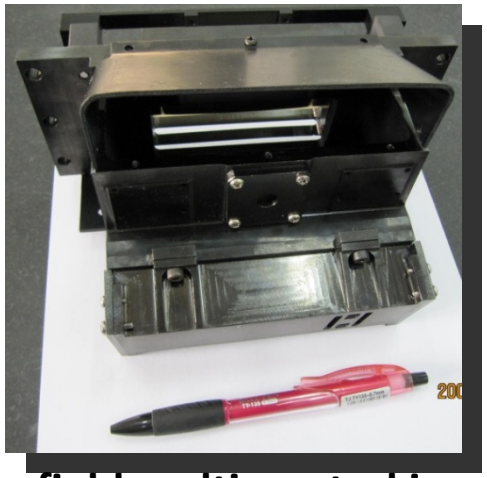
Standard airborne Payloads



hyperspectral camera



Interferometric SAR



Large field multispectral imager

Polarimetric SAR

Efforts made to promoting Cal&Val capacity for Qua. RS

Ground measurement technical system

VIS-IR Field Spectrometers

Total station and GPS

Water-leaving radiance measurement system

Multi-angle Observation System

3-D geometric calibration system

Efforts made to promoting Cal&Val capacity for Qua. RS

- **Progress in Automatic In-situ Calibration Exploration**

Automatic Atmospheric Parameters Acquisition system

Sun-photometer Cimel CE318

- Aerosol optical depth
- Total water vapor column

Automatic Meteorological Station

- Surface temperature
- Surface pressure
- Surface wind
- Down welling irradiance

Upper-air meteorological radar system

- Atmospheric profile of wind
- Pressure
- Temperature
- Humidity.

Efforts made to promoting Cal&Val capacity for Qua. RS

- **Progress in Automatic In-situ Calibration Exploration**

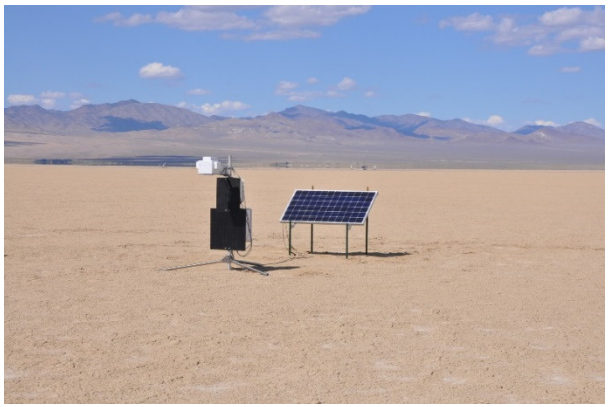
Participate in the form of RADCALNET

Aims at an prototype of "global calibration" traceable toSI, CEOS /IVOS WG agreed to set up the RADCALNET (Radiometric Calibration Network of Automated Instruments). The first RADCALNET WG meeting took place at ESTEC on 13th and 14th of January 2014.

- **Four sites to provide data to RADCALNET:**
  - ✓ **AOE Baotou site (China)**
  - ✓ **La Crau site(France)**
  - ✓ **Railroad Valley Playa site (US)**
  - ✓ **ESA Site TBD (ESA/CNES)**
- **NPL (UK) provides support in harmonization, traceability, instrument calibration and QA4EO**

AOE Baotou site

La Crau site



Railroad Valley Playa site

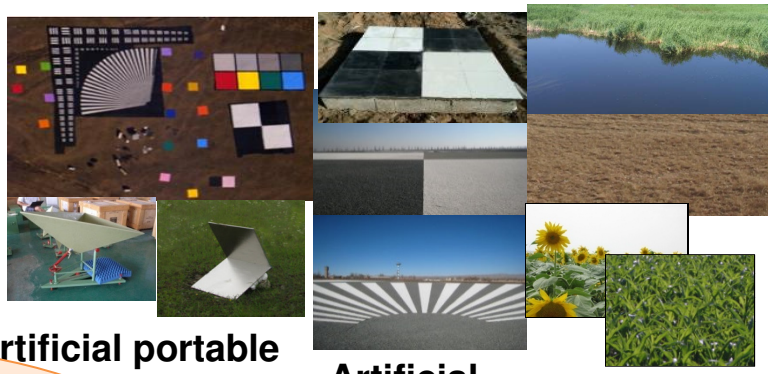
Efforts made to promoting Cal&Val capacity for Qua. RS

Stepwise Cal&Val technical system

Airborne standard sensors

Ground test equipment

Comprehensive Cal&Val site with artificial target and natural scene reasonably matching



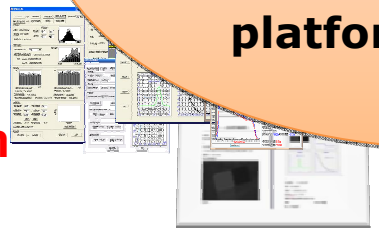
Artificial portable targets

Artificial permanent targets

Natural scenes

- Advanced Cal&Val system
- Great contribution to RS application
- International platform for R&D

Architecture of national RS standards and quality evaluation processing system

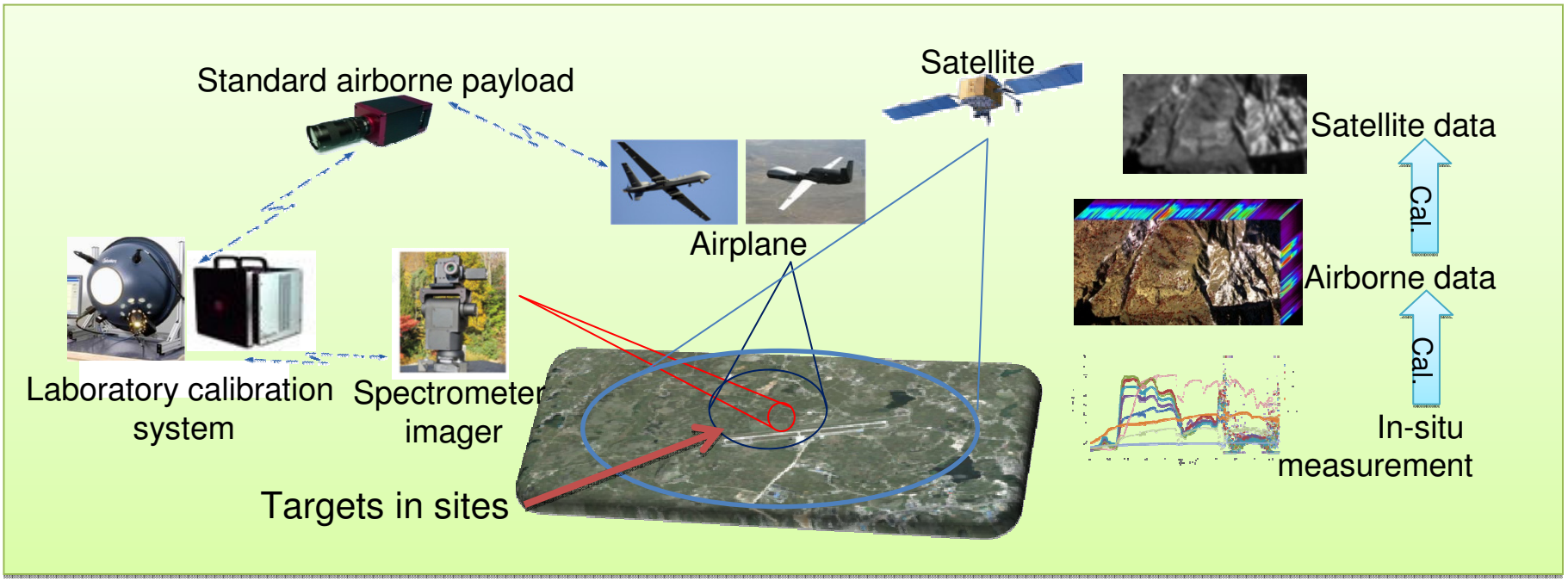


Exploration of Automatic in-situ calibration mode

Way Forward

1. Improvement of the Cal&Val technical system

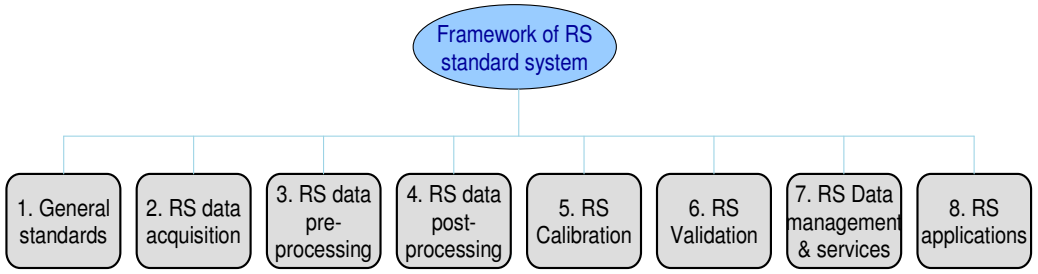
- **Developing more type of standard targets and measurement approach to improve Cal&Val function and capability .**
- **Completing the construction of auto-measurement to provide precision Cal&Val service in an operational way.**



Way Forward

2. Promotion of national and international remote sensing standardization

- **As secretary of National Technical Committee 327 on Remote Sensing of Standardization Administration of China (SAC/TC327) , develop remote sensing technical standards system in China**
- **Participate in international standardization work, and promote to establish ISO/TC or SC for remote sensing to benefit whole world**

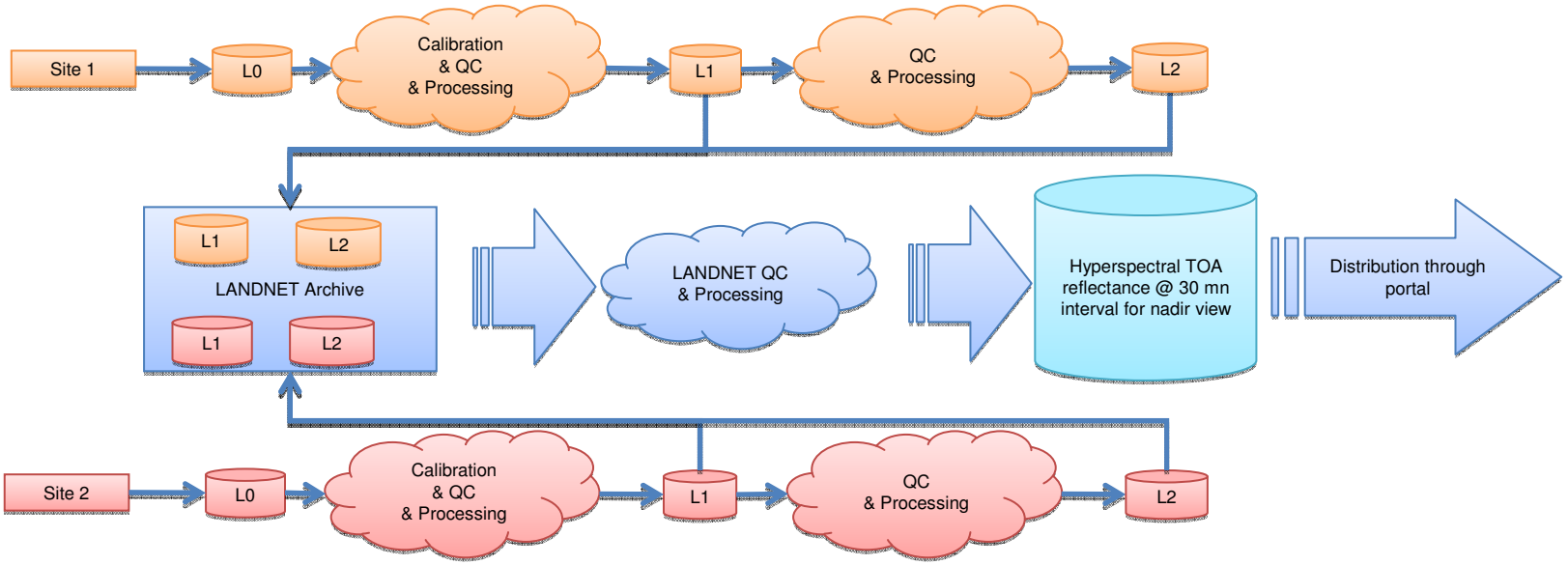


Participate in the 37th ISO/TC 211 meeting in Redlands

Way Forward

3. Contribution to the "global calibration" concept and practice by promoting the running of RALCALNET

- **Participate the RADCALNET activities, including the inter-calibration of the instrument, technique support for making the guideline or standards, and collaboration with other networks, so as to demonstrate the feasibility of the concept for "global calibration" traceable to SI.**
- **Promote RADCALNET to be an operational network used for calibration, intercalibration and validation for the benefit of GEOSS for the 2 coming years.**



The shared vision of RADCALNET

L0: raw instrument data
L1: instrument data in physical unit
L2: surface or atmosphere parameters retrieved from L1


Thank you !