QA4EO | A QUALITY ASSURANCE FRAMEWORK FOR EARTH OBSERVATION

Overview of progress towards a data quality assurance strategy to facilitate interoperability

Presentation by CEOS WGCV

Pascal Lecomte (ESA) / Greg Stensaas (USGS)

for the

GSICS Executive Meeting – June 3, 2009

GEO QA4EO A QUALITY ASSURANCE FRAMEWORK FOR EARTH OBSERVATION CEOS

Overview

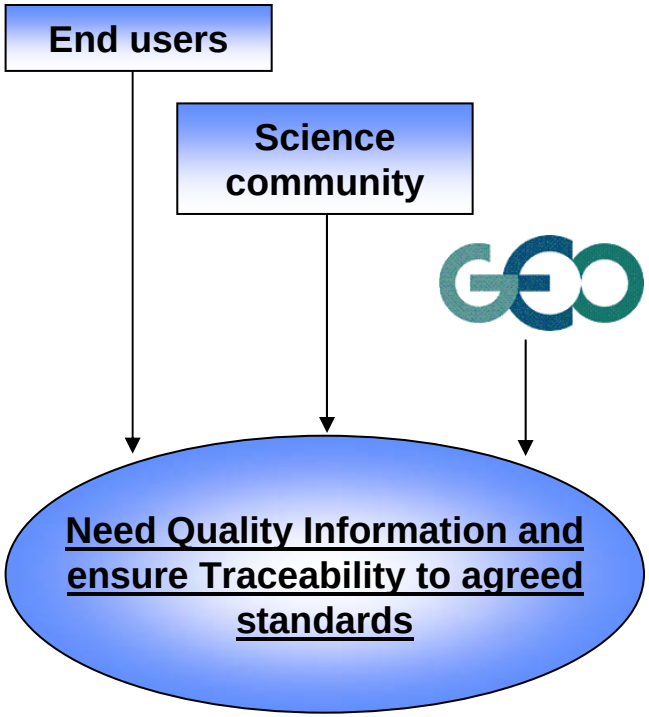
- Origin of QA4EO and current status
- What QA4EO is …and what is not
- Key Guidelines of QA4EO
- Future implementation and governance

Origin of QA4EO

EO end-users → need to access **quality information**; e.g., accuracy and precision on the products they use

Scientific community and Value-added Companies → maintain the **traceability of all processing steps**; i.e., from acquisition to delivery to allow:
1) error propagation,
2) reprocessing,
3) development of new products,
4) multi sensor inter-calibration,
5) long-term studies, etc.

GEO → Data shall be Available/Accessible and Suitable/Reliable. Overall intent to **maximise interoperability**. A specific task (DA-06-02) to develop a **"GEOSS Quality Assurance Strategy"**.



Maximise the correct APPLICABILITY and INTEROPERABILITY

Requirement

- **The Group on Earth Observations (GEO)'s Global Earth Observation System of Systems (GEOSS) must deliver comprehensive "knowledge/information products" worldwide and in a timely manner to meet the needs of its nine "societal themes".**

- **This will be achieved through the synergistic use and combination of data derived from a variety of sources (satellite, airborne and *in situ*) through the coordinated resources and efforts of the GEO members.**

- **Achieving this vision requires the establishment of an operational framework to facilitate interoperability and harmonisation.**

Origin of QA4EO

Committee on Earth Observation Satellites (CEOS)
Working Group on Calibration and Validation (WGCV)

- **Coordinate, standardise, & advance cal/val of EO missions and their data.**
- **"space arm" of GEO**

Prioritised task DA-06-02 in its implementation plan and facilitating its development

***DA-06-02_2** Data QA Framework and Guidelines:*

1) *Develop and deliver a consensus documentary framework and guidelines on cal/val for data quality control/assurance and best practices;*
2) *Develop a consolidated worldwide cal/val site database to be included in the CEOS cal/val portal;*
3) *Further expand the cal/val portal in both content and functionality.*

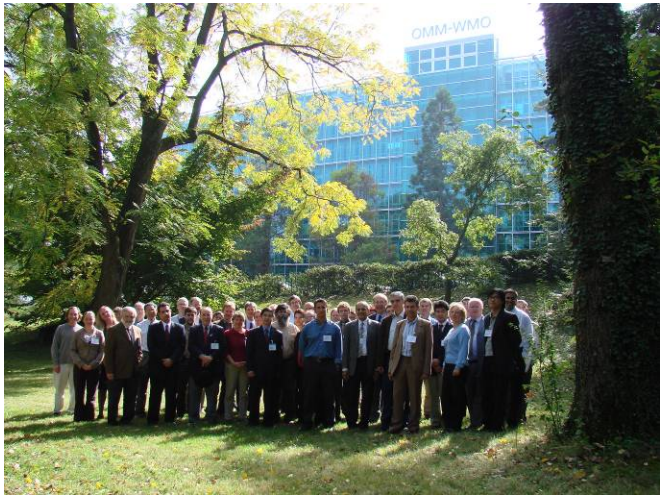
Origin of QA4EO

To perform that GEO task, **CEOS WGCV** proposed two workshops

Geneva - October 2007 → ***Guiding principles***

- *Hosted by GEO secretariat*
- *45 participants*

In conclusion, the workshop participants enthusiastically endorsed the outcomes as a milestone towards achieving the GEOSS goal of harmonising the quality assurance processes. The first step towards harmonisation across the global EO Cal/Val community is the development of a dedicated CEOS WGCV Cal/Val portal. This will facilitate the implementation of these activities on behalf of GEOSS.



Origin of QA4EO

Gaithersburg, MD - May 2008 → ***Establishing an operational framework***

- *Hosted by NIST*
- *60 participants*

Quality Control / Assurance and Best practice Guidelines on Calibration & Validation Processes - A Documentary Framework.

The title was later changed to:

*A **Q**uality **A**ssurance Framework*

For

***E**arth **O**bservation*

QA4EO

Operational framework:

Principles and scope

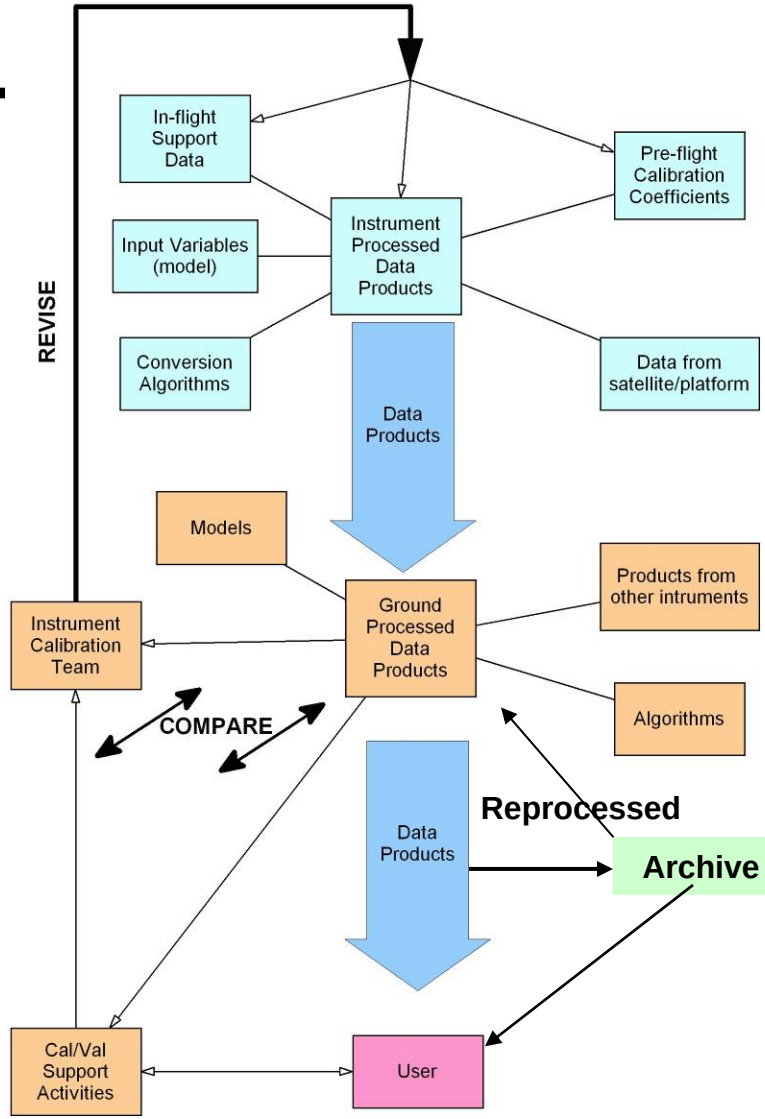
This framework in the context of data and derived products is dependent on the successful implementation of two principles:

- **Accessibility/Availability**
- **Suitability/Reliability**

And the means to efficiently communicate these attributes to all stakeholders.

Its scope encompasses the whole EO sector:

- **All sensor types & operational domains**
- **Data collection**
- **Processing (Level 1 to Level n)**
- **Distribution**



Operational framework:

Structure

To enable these principles to be implemented in an harmonised manner, the CEOS, the space arm of GEOSS, following discussion at two international workshops of Cal/Val experts, has established a quality assurance (QA) framework

This framework consists of a set of operational guidelines derived from "best practices" for implementation by the community. These guidelines have been collated into three theme areas:

- **Data Quality**,
- **Data Policy** *and*
- **Communication & Education**

Each theme has an overarching "guiding principle" towards achieving interoperability with a minimal set of "key guidelines" to aid harmonisation.

Data Quality

'All data and derived products must have associated with them a Quality Indicator (QI) based on documented quantitative assessment of its traceability to community agreed reference standards. This requires all steps in the data and product delivery chain (collection, archiving, processing and dissemination) to be documented with evidence of their traceability.' **(001)**

Traceability: *property of a measurement result relating the result to a stated metrological reference through an unbroken chain of calibrations of a measuring system or comparisons, each contributing to the stated measurement uncertainty* **(ISO guide 99:2007)**

- **Guidelines are generic in scope to cover all Data related "activities".**
- **Provide guidance (and indicative template) on how to establish a QI and means to obtain and document associated evidence.**

- **Content/writing of a "Procedure" (002)**
- **Selecting "Reference Standards" (003)**
- **Organising & Analysing Comparisons (004)**
- **Validating Models & Algorithms (005)**
- **Evaluating Uncertainties (006)**
- **Evidence of Traceability (007)**

Data Policy

The data must be freely and readily available / accessible / useable in an unencumbered manner for the good of the GEOSS community, for both current and future users. This necessitates that all Cal/Val data and associated support information (metadata, processing methodologies, Quality Assurance, etc.) is associated with the means to effectively implement a Quality Indicator. In return, the data provider must be consistently acknowledged.

Guidelines are based on the adoption of existing "best" and commonly used practises

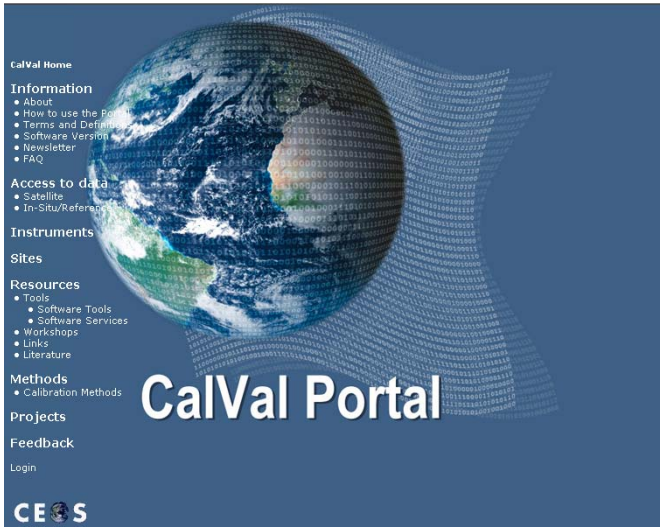
- **"Code of Practise" for Cal/Val Data Providers & Users (001)**
- **Harmonised Formats & Common Metadata for Data Exchange (002)**

Communication and Education

'Interoperability requires all stakeholders to have a clear understanding of the adequacy of the information that they are accessing and using for their specific application, i.e. its "fitness for purpose". The evidence for this clarity will be accessible through a single portal (http://calvalportal.ceos.org) and will be fully traceable to its origins. The traceability and interoperability process must be understandable by any appropriately trained individual throughout GEOSS and efforts must be made to encourage the wider usage of information and facilitate the training of GEOSS users.'

Documentary system for QA4EO (001):

- **Dictionary of Terminology**
- **Maintenance / evolution & utilisation of a GEO Cal/Val Portals for all EO sensor domains**
- **Education and capacity building activities to promote the QA4EO**



QA4EO Status

- Framework & Key Guideline documents were peer-reviewed by representatives from the different cal/val communities
  - Approved by WGCV **(Plenary Meeting, Oct. 2008)**
  - Endorsed by CEOS **(22nd CEOS Plenary, Nov. 2008)**

- A thorough review has been made by GSICS (Global Space-Based Inter-Calibration System)
  - Resulting in version 3.0 of the guidelines

- A guide was issued in order to provide a new user with an overview and guidance on getting started with QA4EO
  - QA4EO documents including the framework, key guidelines, and the guide can be found at on the QA4EO web site:

http://qa4eo.org/documentation.html

What is QA4EO ...and what is not

10 "key guidelines"

that respond to **3 guiding principles** for generic processes and activities
(Data Quality – Data Policy – Comm. & Edu.)

The "key guidelines" will lead to more **detailed technical procedures** developed by experts and individual organisations

It also includes **coordinated comparisons** for inter-calibration efforts

…not a **certification** body

…not a set of **standards** for QA/QC activities and processes

…not a framework developed with a **top-down** approach

3 Guiding Principles

1) Data Quality

All data and derived products must have associated with them a **Quality Indicator (QI)** based on **documented quantitative assessment** of its **traceability to community agreed reference standards**.

2) Data Policy

Cal/Val data must be **freely and readily available / accessible / useable**. This necessitates that **all Cal/Val data and associated support information (metadata, processing methodologies, QA, etc.) is associated with the means to effectively implement a quality indicator.** In return, the provider must be consistently acknowledged.

3) Communication and Education

All stakeholders must have a **clear understanding** of the adequacy of the information, which should be **accessible through a single portal** and should be **fully traceable to its origins**.

10 Key Guidelines

The Key Guidelines **may evolve** in time and **refinements** could be applied

e.g. Recent contribution and review by Global Space-Based Inter-Calibration System (GSICS) and WMO.

QA4EO website: http://qa4eo.org/

Detailed procedures and activities

QA4EO encourages the development of more detailed documents (following the key guidelines) on technical procedures and activities by appropriate technical experts and individual organisations

QA4EO-WGCV-IVO-CLP-001 T. Stone Use of the Moon for in-flight calibration stability monitoring

QA4EO-WGCV-IVO-CLP-002 N. Fox Protocol for the CEOS WGCV Comparison of techniques and instruments used for surface IR radiance/brightness temperature measurements

Their endorsement and encouragement will lead to **improved coordination between agencies** and a **common-set of well-established procedures**

They will also represent a **guidance for newcomers**

A QA4EO User Guide has been issued

Compliance and Implementation

Compliance is a **long-term objective** that that requires efforts and strong coordination at an international level

It requires **activities from different perspectives and at different levels** to respond to the 3 guiding principles on Data Quality, Data Policy, Communication and Education.

Both a **top-down and a bottom-up** approach must be followed simultaneously in order to **close the gap between the high level QA4EO guidelines and their practical applicability**.

The overall implementation mechanism can be divided into three main aspects: **practical, policy and financial**.

QA4EO Implementation & Governance

- **QA4EO Implementation Meeting**
  - May 24, 2009 (Prior to WGCV 30)
- **QA4EO Implementation Workshop**
  - Hosted by Tubitak Uzay
    - Antalya, Turkey
    - Sep. 29th – Oct. 1st, 2009
  - Chaired by GEO
  - Organized by GSICS and CEOS WGCV
  - POC: secretariat@qa4eo.org
- **A joint WGCV/GSICS QA4EO Workshop Agenda is required**
  - Main output – an implementation strategy for GEO
- **QA4EO Implementation for GEO is an agenda item for the GEO Plenary meeting in November**

Draft QA4EO Workshop Agenda

	Tues 29 Sept 09	Wed 30 Sept 09	Thurs 01 Oct 09
Morning	QA4EO Status & Overview Summary of the Guidelines	Current & near-term examples of implementation (e.g. DMCii, IVOS intercomparisons, NPP/NPOESS, EARTHCARE, Bird/Butterfly monitoring, …)	Impediments to QA4EO implementation (e.g. iTAR, GPS, …)
Afternoon	Current & near-term examples of implementation (including a prototype demonstration system)	New proposed examples for implementation (emphasis on non-EO specific e.g. Disease mapping, EPAs, GMES, INSPIRE, …)	The way forward for QA4EO (e.g. Data access, Support for users, Application drivers, …) Conclusion, Wrap up & Actions

GSICS QA4EO

- **Many GSICS processes and procedures addressing Quality information and traceability are already for QA4EO**
- **GSICS Executive Panel and Governance already in place could easy adapt to include QA4EO**
- **Example GSICS Contributions to QA4EO**
  - GSICS Procedure for Product Acceptance (GPPA)
    - Registration of GPPA supporting documents & materials
  - Complete supporting documentation requested in the GSICS Product Application Form (GPAF)
  - Developing calibration/validation best practice protocols for the GSICS community
  - Providing guidance regarding application of methodologies to determine uncertainties estimates for GSICS products
  - Best Practice Guidelines for Pre-Launch Characterization and Calibration of Instruments for Remote Sensing
    - e.g., **QA4EO-GSIC-NST-CLG-00X or QA4EO-CEOS-NST-CLG-00X**
- **Governance and proposed QA4EO documents can easily be available by workshop**

WGCV is in agreement with GSICS Comments

QA4EO Review by GSICS

Revision of Key Guidelines: Can any organization from the EO community enlist necessary changes to the Key Guideline documents?

Recommendation from GSICS reviewers:

- Make the documents as living as possible
- Create a clear process by which this can happen

Recommendation from GSICS reviewers:

- Need POC for framing GSICS requirements into CEOS QA4EO?
- Need support in implementing QA4EO (e.g., FAQ on website)

QA4EO Review by GSICS

Endorsement process: Is CEOS to endorse quality assurance plans of the whole EO community on behalf of GEO?

Recommendations from GSICS reviewers:

- Treat the QA4EO as community guidelines that CEOS WGCV can encourage organizations to adopt, and advise them in implementing.
- Need a QA4EO review panel, composed of members within and beyond the CEOS community.

Summary

- **Maximise APPLICABILITY & INTEROPERABILITY of data through >>>>**

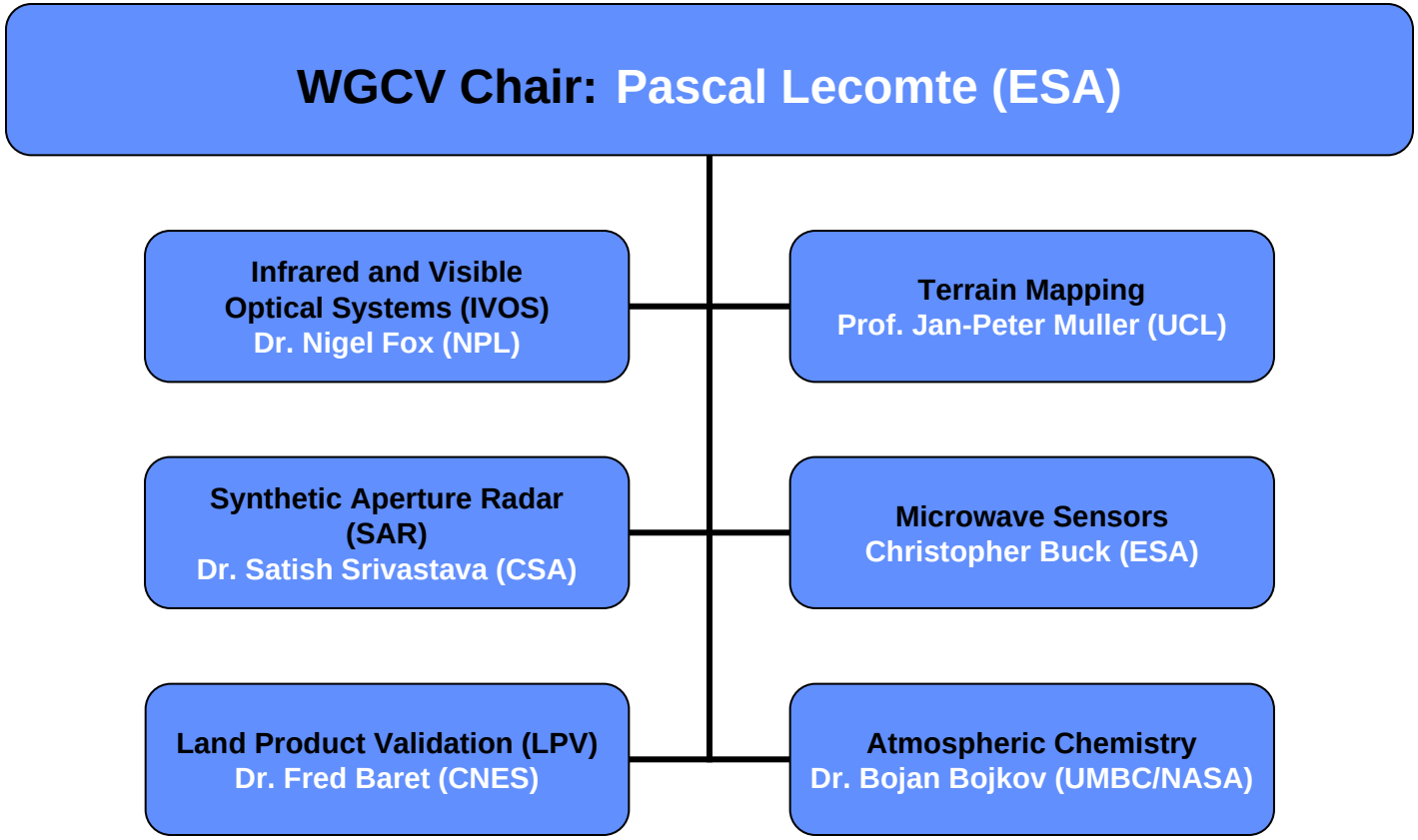
  QUALITY INFORMATION and TRACEABILITY

  - The key guidelines have been established.
  - Subsequent procedures & “best practises” are being written.
  - QA4EO will be evolved as necessary to take in account any additional requirements of the wider GEOSS community.

- **Implementation Achievements and Governance will be presented in the GEO chaired, CEOS WGCV/GSICS organized workshop in Sept.**
- **Major CEOS WGCV and GSCIS role in QA4EO standards, guides, processes, and procedures**

Additional Slides

CEOS WGCV Subgroups



CEOS WGCV Website at: http://www.ceos.org/ (click WGCV tab)

Cal/val portal: http://calvalportal.ceos.org/CalValPortal/welcome.do

Coordination and cooperation to achieve the GEOSS space segment

- **National and regional Earth Observation will continue to dominate space agency spending.**

- **CEOS promotes coordination between member organizations and cooperation in the development of Earth observing satellites.**

- **A** “CEOS Virtual Constellations” **concept is an approach to facilitate agreements, develop standards, and address shortcomings in the international planning process. The results will help secure resources from space agencies for space-based implementation of Earth observations, all without eroding the independence of individual agencies.**

CEOS Constellation history

- CEOS recommended 4 constellation pilot studies in late 2005. The formal work plans for each constellation team was approved in late 2006

  Atmospheric Composition (NASA)

  Precipitation (NASA/JAXA)

  Ocean Surface Topography (NOAA/EUMETSAT)

  Land Surface Imaging (USGS/ISRO)

  LSI portal http://wgiss.ceos.org/lsip/

- Additional approved constellations by CEOS
  - **Ocean Surface Vector Wind Constellation (OSVW)** (*NOAA, EUMETSAT, ISRO)*
  - **Ocean Colour Radiometry Constellation (OCR)(**

- Promotes contribution to GEO observational requirements (GEOSS 10-year Implementation Plan)
- Promotes synergies among national and regional satellite programs
- Promotes common systematic guidelines and standards
- Promotes coordinated user requirements for future system architectures and optimal end-to-end capabilities

CEOS GEO Actions Table

New 2009-2011 CEOS-GEO Action Number	Former 2007-2009 CEOS-GEO Action Number	GEO 2009-2011 new Task Id	GEO Task Description	CEOS SBA Team Allocation	Action Status (OPEN / CLOSED)	CEOS Action Category: (1 to 4) TO BE CONSOLIDATED	Action Description
AG-06-02 _2	NEW	AG-06-02	AG-06-02: Data Utilization in Fisheries and Aquaculture	Agriculture	OPEN	4	Publish an IOCCG monograph on "Applications of Remote Sensing in Fisheries and Aquaculture "
AG-06-02 _3	NEW	AG-06-02	AG-06-02: Data Utilization in Fisheries and Aquaculture	Agriculture	OPEN	4	Development of EO tools for Ecosystem-based Marine Management
AG-07-03a _4	NEW	AG-07-03a	AG-07-03a: Global Agricultural Monitoring System	Agriculture	OPEN	4	Integrating remote sensing data into selected models to enhance operational decision support for crops, drought and agricultural water management
AG-07-03c _1	AG-06-07 _1	AG-07-03c	AG-07-03c: Expanding EO Applications in Agriculture and Promoting Capacity Building in Developing Countries	Transverse	OPEN	4	Preparation and delivery of training resources for GEO CBC activities. This is dependent on development of GEO portal and GEO NETcast services This is a continuous task achieved via an assortment of training actions and courses conducted by several CEOS
AR-09-01a _2	NEW	AR-09-01a	AR-09-01a: Enabling Deployment of a GEOSS Architecture	Transverse	CLOSED	1	Complete Version 1 of the LSI Constellation Portal for Mid-Resolution Optical LSI Satellite System Information and Enhanced Data Access.

- **CEOS-GEO Actions Table 27 May 2009 .xls**
- **Covers all CEOS GEO Tasks**
- **Provides updates and work plan linkage**
- **Provides linkage to previous tasks and closed tasks**

GEO task DA-09-01a & action items

CEOS WGCV Tasks

- **Task DA-09-01a (Lecomte, Stensaas, Fox)**
- **Action DA-09-01a_5: Benchmark Mission Coordination (Fox)**
- **Action DA-09-01a_6: Ground-based Cal/Val Campaign (Fox)**
- **Action DA-09-01a_7: DOME C Experiment (Cao)**
- **Action DA-09-01a_8: Cal/Val & Post-launch Test Sites (Chander)**
- **Action DA-09-01a_9: Radiometric Standards (Fox)**
- **Action DA-09-01a_11: Reference Test Site Data Collaboration &**
- **Comparison (Fox / Chander / Cao)**

Other GEO task actions being led by the WGCV & its subgroups

- **Action DA-09-01b_1: Land Product Harmonisation (Baret)**
- **Action DA-09-01b_2: Data, Metadata & Product Harmonisation; Interactions between WGCV & WGISS (Apaphant)**
- **Action DA-09-03d_3: Global DEM (Muller)**
- **Action DA-09-03d_4: Global DEM (Muller)**

QA4EO

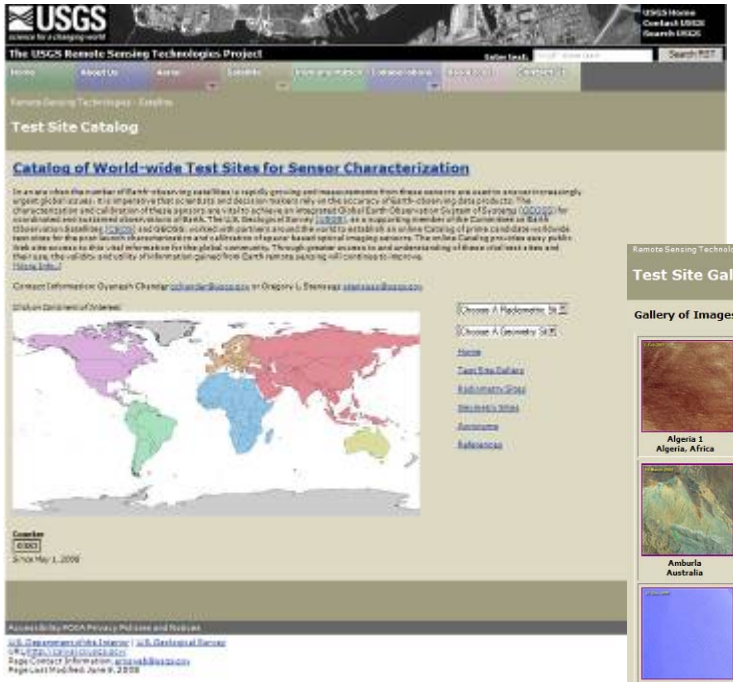
- **Action DA-09-01a_10: QA4EO (Lecomte / Stensaas)**

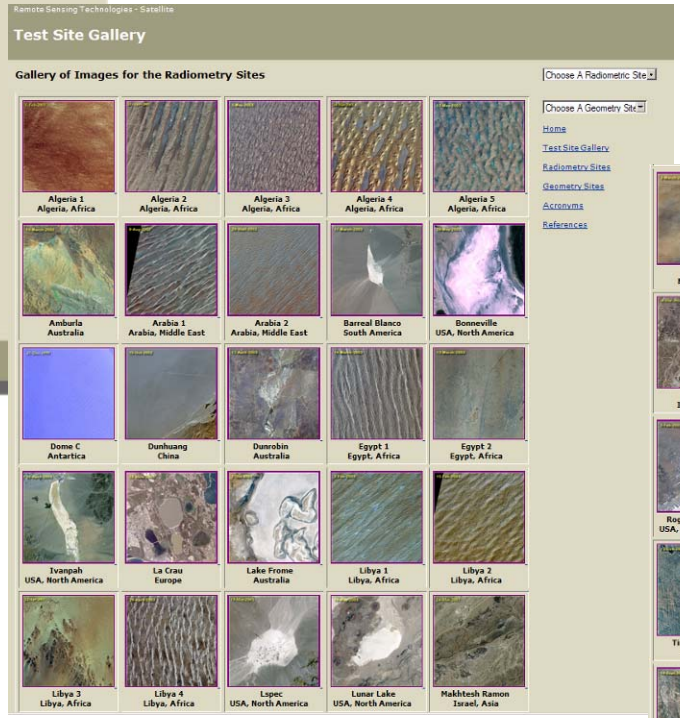
Proposed involvement of WGCV in new GEO task activities **(Stensaas)**

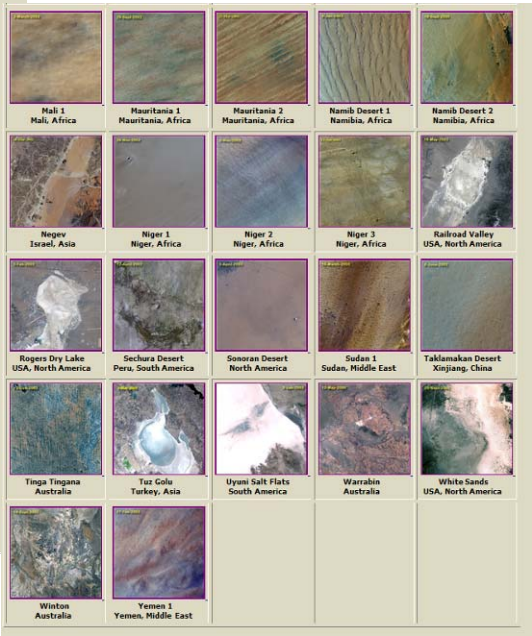
- **AR-09-01c: GEOSS Best Practices Registry**
- **DA-09-03a: Global Land Cover**
- **DA-06-01: GEOSS Data Sharing Principles**
- **EC-09-01a: Ecosystem Classification and Mapping**
- **EC-09-01c: Regional Networks for Ecosystems**
- **ST-09-02: Promoting Awareness and Benefits of GEO in the Science and Technology Community**
- **US-09-03c: Bio-geophysical, Soil & Land Surface Data**
- **US-09-03d: Global Phenology Data**

Catalog of World-wide Test Sites

http://calval.cr.usgs.gov/sites_catalog_map.php







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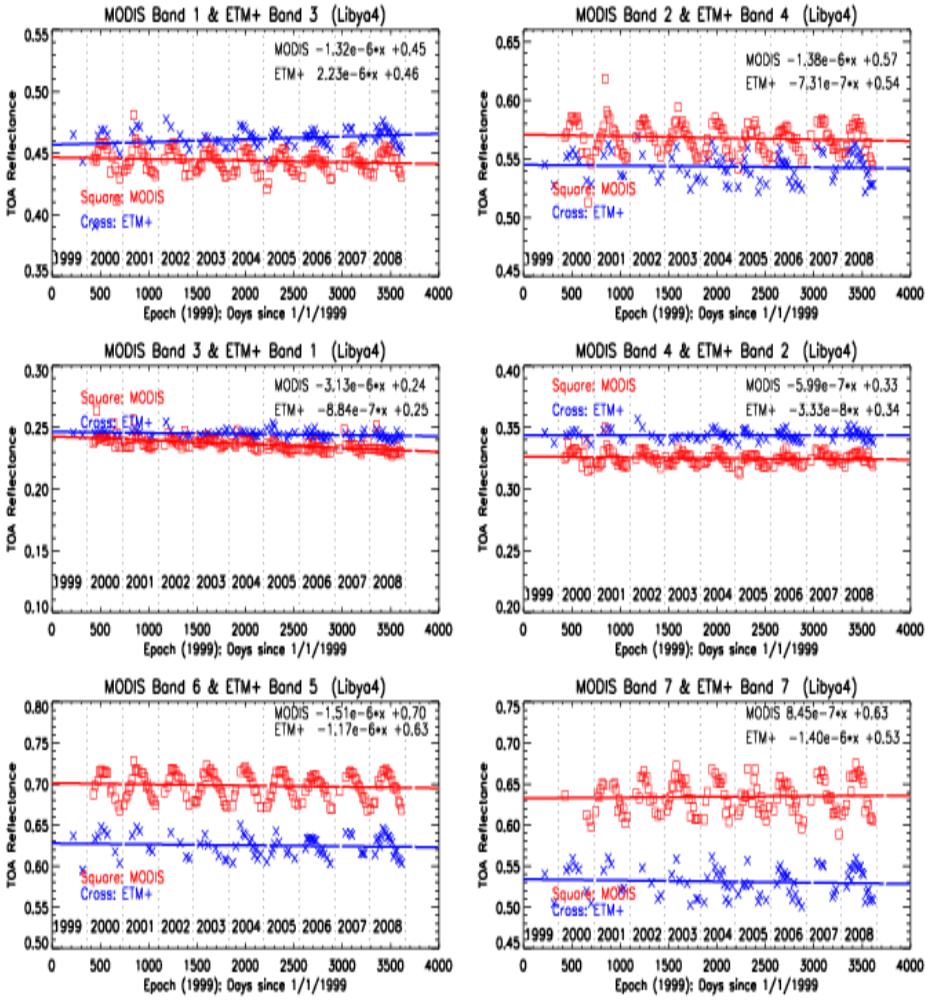
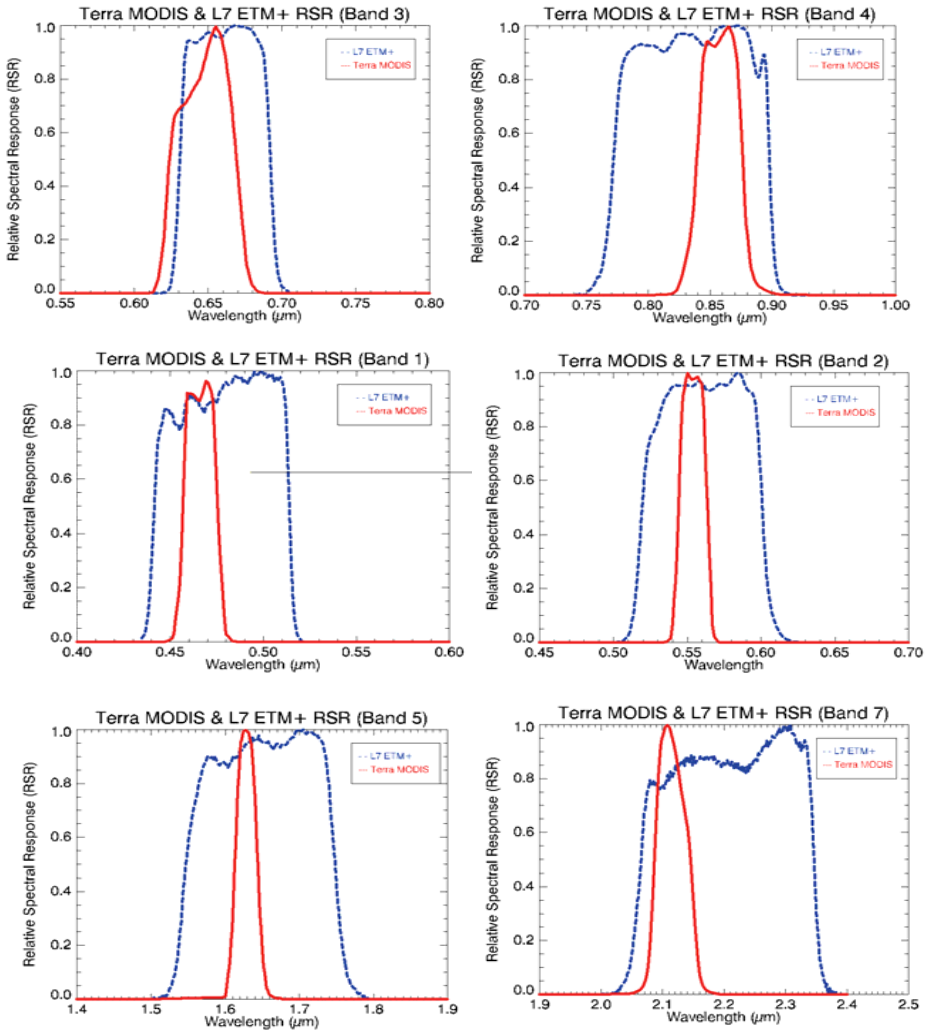
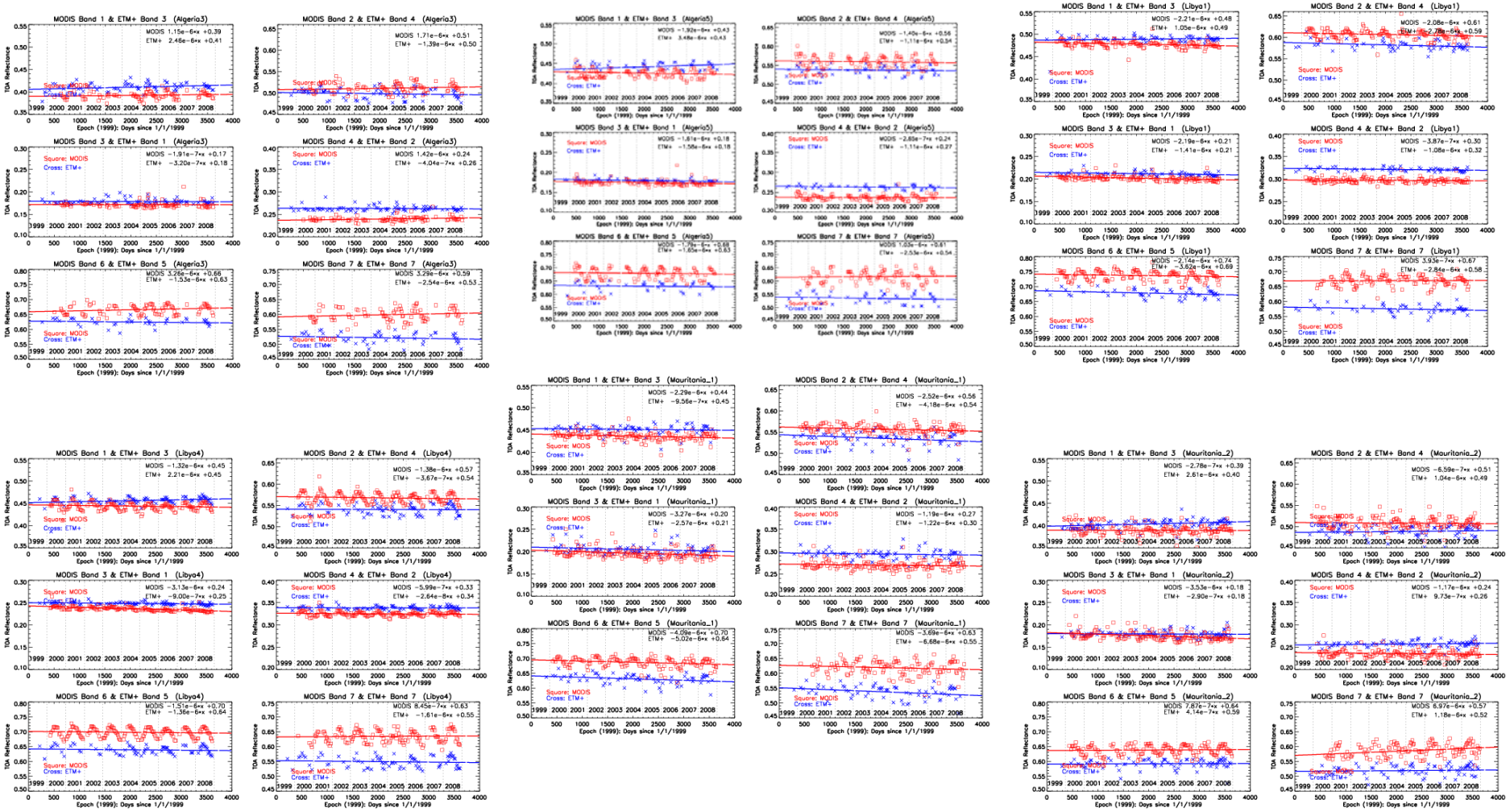




TOA Reflectance Trending (CEOS sites)
(MODIS and Landsat and others)



Ideas

- Common documentation processes
- Common calibration databases
- Data terminology and dictionary
- Satellite data portals
- Common RSR tools
- Standard Test sites and cal/val processes per instrument via working group
- Common cal/val tools
- Cross calibration orbit tools – with NASA SEO
- Work common GEO tasks
- Help work the QA4EO process
- Many other areas