

Group on Earth Observations (GEO)/ Committee on Earth Observation Satellites (CEOS)

A Quality Assurance Framework for Earth Observation (QA4EO)

Implementation Strategy and Work Plan

March 2012

Version 0.4

This document was prepared and compiled by CEOS Working Group on Calibration and Validation (WGCV) and is in review by CEOS WGCV and the GEO QA4EO board members, as shown later in the document.

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1 QA4EO Background

This effort is a result of the GEO need for comprehensive, timely data and knowledge to be delivered via the Global Earth Observation System of Systems (GEOSS) as information products with defined quality indicators to meet the needs of its nine “societal benefit areas”. This can only be achieved through the synergistic and interoperable use of data derived from a variety of sources (satellite, airborne and in situ) and the coordination of the resources and efforts of the GEO members to follow common quality assurance (QA) methods in the decision process.

To accomplish this vision, starting from a system of disparate systems that were built for a multitude of applications, requires the establishment of an internationally coordinated operational framework to facilitate interoperability and harmonisation. The success of this framework, in terms of data, is dependent upon the successful implementation of two key principles: 1) Accessibility / Availability *and* 2) Suitability / Reliability. This success also requires effective communication of these principles to all GEO and CEOS stakeholders.

To implement these principles in a harmonised manner, CEOS (the space arm of GEO), through discussion with calibration and validation experts from around the world, established baseline QA methods to facilitate interoperability of GEOSS and GEO. The baseline methods and processes were established as the GEO/CEOS Quality Assurance Framework for Earth Observation (QA4EO), as a direct response to GEO Task DA-06-02, follow-on TASK-DA-09-01a: GEOSS Quality Assurance Strategy, and under the new GEO 2012-2015 work plan under the Infrastructure area, **IN-02 Earth Data Sets C1: Advances in Life-cycle Data Management**, <http://www.grouponearthobservations.org/>.

The QA4EO effort and baseline documents were endorsed by the Working Group for Calibration and Validation (WGCV) at their 29th plenary meeting in 2008 and via the CEOS plenary meeting in November 2008. Based on this approval and the acceptance of these QA4EO principle and guidelines and the subsequent agreement by GEO, the next step was adoption of QA4EO guiding principles, which are implemented through a set of key operational guidelines derived from best practices, for implementation by the GEO community. Although these guidelines were originally developed to meet the needs of the space community, they have been written with the aid of national metrology institutes of the UK and the USA, and where appropriate, are based on best practices of the wider non-EO community. Therefore, they are readily adoptable by all GEO communities as a top-level framework that can be translated and implemented to serve each specialist need. The documents are considered “living documents” and will be updated as needed.

The QA4EO has been promoted and reviewed via standard science peer review processes and workshops. The QA4EO effort has also been promoted and refined via four (4) workshops to-date. The fourth workshop, titled “Providing Harmonised Quality Information for 2015”, was held in the United Kingdom (UK) in October 2011 and was the capstone to laying out GEO Secretariat and CEOS QA4EO implementation milestones. The workshop was directly facilitated to show strong requirements across key earth observation domains and provide recommended implementation details and timelines.

All QA4EO output from the previous four QA4EO workshops are listed below, and QA4EO efforts and presentations can be found at <http://qa4eo.org>.

CEOS Working Group on Calibration and Validation (WGCV) has worked with many agencies/organizations to lead and support development of the QA4EO principles and operational implementation details for CEOS and GEO during four previous QA4EO workshops; such as, list.

2 QA4EO Activities / Tasks

The following QA4EO principles will be established within activities and tasks in the GEO community:

- It is critical that data and derived products are easily accessible in an open manner and have associated with them an indicator of their quality traceable to reference standards (preferably SI) to enable users to assess its suitability for their application i.e. its “fitness for purpose”.
- This Quality Indicator needs to be unequivocal in its interpretation and derivation, yet sufficiently flexible, to be implemented across the full range of EO activities which are coordinated through GEO.

The strategy to achieve the goal of incorporating QA4EO across the GEO community is complex and requires efforts from different perspectives and at different levels. Both a top-down and a bottom-up implementation 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. These issues must be developed in parallel as they are interdependent with each other. For instance, an important matter is the allocation of resources for implementing the guidelines within individual agencies and the facilitation of essential international cooperation and coordination. Concurrently, it is necessary to develop a set of case studies to facilitate and demonstrate the QA4EO process.

2.1 QA4EO Activities

The following list is a result of the GEO QA4EO workshop held in October 2011 to define the way forward in the form of Actions, Timelines, and Recommended Focus:

2.1.1 QA4EO Action Timeline

2.1.1.1 QA4EO presentation for GEO plenary

- 2011 – Ensure that QA4EO is included in the CEOS report to GEO plenary.
 - Introduce the principles/guidelines of QA4EO, as a part of the CEOS report to the CEOS Plenary Chair
- 2012 - Draft a QA4EO document (~20-page) for GEO plenary 2012 (Giovanni Rum / Yasukini Okubo to lead this). This will:
 - Present solid examples of benefit, display cooperation with tasks, and present some kind of plan to implement QA4EO across GEO activities.
 - Implicit task to establish a GEO *ad hoc* working group (include all SBA science areas) to be led by the GEO secretariat and to include non-space and space members.
 - Draft document due June 2012; Final document due September 2012.
- 2013 – Aim for a ministerial discussion at GEO plenary 2013.

2.1.2 QA4EO implementation examples (called (at this meeting) QA4EO Implementation Pilots – (QIPs):

- GEO Secretariat SBA leads to identify GEO tasks as candidates for QIPs
- GEO task co-leads of GEO QA4EO task to coordinate with the GEO secretariat on appropriate criteria to define the tasks (both space and non-space based).
- A GEO-level QA4EO working group would need to be established as stated in 2.1.1.1 above.
- Investigate options to have QA4EO as a subtask to the AIP, or at least to establish connectivity.
- The development of QIPs as test cases for the benefit of QA4EO should be pursued.
- The development of supporting tools (metadata, requirements, templates, etc.) is required.

2.1.3 Promotion events (workshops)

- QA4EO needs to be routinely addressed at user (GEO, community, etc.) workshops. If a specific session is not appropriate, then an agenda item should be included at each meeting as a minimum.
- Connection to the UIC – user interface committee. The UIC canvass and connect with the users and are a good forum to target for QA4EO involvement.
- Establish additional QA4EO implementation and training workshops, define involvement at other workshops and conferences, as suggested by the new GEO-level QA4EO working group (as suggested in 2.1.1.1 above)
- Develop an ad-hoc working group create connections to other science groups/committees, and promote greater awareness of QA4EO.
- Suggest use and strong participation through the Science implementation Group within GEO. This group is already aware of QA4EO and the need for quality assurance mechanisms in GEO, but there is a need to ensure there is a link with QA4EO to ensure a direct connection and to promote greater awareness of QA4EO.

2.1.4 Implement QA4EO focus within CEOS working groups

- Engage activities within all the CEOS working groups including the new Working Groups on Capacity Building and Data Democracy (WGCBDD) and Working Group on Climate (WGC).
- Work with the CEOS Virtual Constellations (VCs) to ensure quality assurance and promote QA4EO.
- Continue to work on the CEOS QA4EO showcases and QIPs.

2.1.5 QA4EO needs a working focus across CEOS and GEO:

- Refinement and extension of the generic guidelines.
- Test case development for promotion of QA benefits.
- Planning for outreach and education.
- Development of supporting tools (metadata requirements, templates, etc.).

2.2 QA4EO Tasks

A prioritised list of tasks has been devised from the workshop and previous strategic planning efforts. A single item may contain more than one task because each item may cover different subject matters and can therefore be tackled simultaneously:

2.2.1 Task 1: Strategic Implementation

- 2.2.1.1** Define and agree the structure of the QA4EO and present it through the WGCV to all others that have a role to play in these activities.
- 2.2.1.2** Link QA4EO to Global Earth Observation System of Systems (GEOSS) and exemplify it through case studies linked to GEOSS at large and managed by someone not in the space-borne remote sensing community.
- 2.2.1.3** Define case studies and identify project managers responsible for the application of QA4EO.
- 2.2.1.4** Define a QA4EO contact point to whom modifications / comments on the key guidelines can be sent whilst the case studies are being developed.
- 2.2.1.5** Define QA4EO contact points to which questions and clarifications on the key guidelines can be asked. These should include people familiar with the practical implementation procedure of the key guidelines and people with the technical knowledge needed to carry out QA activities.
- 2.2.1.6** Identify a team to implement an approved dictionary and set a deadline for its development.
- 2.2.1.7** Agree on who should initially review and accept the procedures developed during the case studies.
- 2.2.1.8** Organise a presentation of QA4EO to each of the case study managers and teams if necessary.
- 2.2.1.9** Organise presentations of QA4EO to other CEOS subgroups.
- 2.2.1.10** Organise presentations of QA4EO (including case study scenarios) in conferences and internally to all agencies.
- 2.2.1.11** Organise presentations of QA4EO at GEO level.
- 2.2.1.12** Engage WGCBDD to help with outreach and training.

2.2.2 Task 2: Case Study Guidance and Infrastructure Resourcing

2.2.2.1 Provide guidance (it will also be important to exactly identify who will be responsible to provide such guidance) on which procedures for each of the case studies are to be detailed following the key guidelines. This guidance should be the starting point for the project managers of the case studies. This will allow them to identify the number of documents that will have to be developed and allocate the resources required.

2.2.2.2 Develop a strategy to coordinate, at international level, resourcing of infrastructure development and maintenance.

2.2.3 Task 3: Implementation Support and Program Management

- 2.2.3.1** Support the implementation of case studies, such as, the CEOS Showcases for Forest Carbon Tracking (FCT), Air Quality/Atmospheric Composition, and Global Elevation suggested by WGCV /WGISS joint meeting in 2010. Also develop follow-on studies called QA4EO Implementation Pilots (QIPS).
- 2.2.3.2** The same people responsible for providing guidance, should deliver (as a final outcome of the various case studies) training material for the application of the key guidelines. The training material should allow any user to identify which are the procedures of his/her activities to be described following the QA4EO guidelines and what level of detail is requested. This would subsequently allow the user to define costs and efforts required.
- 2.2.3.3** Agree on a strategy that would allow the fast implementation of any suggested modifications to the key guidelines (i.e. do modified key guidelines need to be re-approved by CEOS WGCV? Who is in charge of accepting and implementing received modifications / comments? If a new key guideline is suggested, who manages it?)
- 2.2.3.4** Produce a special issue of the Cal/Val portal newsletter dedicated to QA4EO, which could coincide with the launch of the QA4EO website.
- 2.2.3.5** Establish a searchable database (on the QA4EO portal) based on the document identifiers, on which all “operational guidelines/procedures” developed in the case studies and future ones can be stored and accessed.
- 2.2.3.6** Allow the option to send (and track) comments to whoever generates the operational guidelines/procedures as a necessary on-going review process.

2.2.4 Task 4: GEO QA4EO Implementation Support and Program Management

- 2.2.4.1** Establish GEO QA4EO Implementation Board and ad hoc working team - - - GEO SEC along with CEOS.
- 2.2.4.2** Support the prioritization and implementation plans for QA4EO across GEO Work Plan efforts - - - GEO SEC along with CEOS.
- 2.2.4.3** Support the implementation of case studies and QIPs - - - GEO SEC along with CEOS.

2.2.5 Task 5: CEOS QA4EO Implementation Support and Program Management

- 2.2.5.1** Establish CEOS QA4EO Implementation Board and working team - - - WGCV and CEOS Management.
- 2.2.5.2** Support the prioritization and implementation plans for QA4EO across GEO Work Plan efforts - - - GEO SEC along with CEOS.
- 2.2.5.3** Support the implementation of case studies and QIPs - - - GEO SEC along with CEOS.
- 2.2.5.4** Complete data quality parameter definitions, System quality parameters and definition, etc., - - - WGCV sub groups and WGISS (NASA ESDWG).
- 2.2.5.5** Provide fit for purpose documentation related to system/data/and product capability and accuracy - - - WGCV sub groups with support from WGC and WGCBD.
- 2.2.5.6** Quality parameter measurement and process guidelines for each quality definition - - - WGCV sub groups and WGISS.
- 2.2.5.7** An overall quality survey to determine state of quality analysis completed for dataset and product – WGCV and QA4EO ad hoc working group.
- 2.2.5.8** Develop of a QA4EO self-evaluation process and associated QA4EO quality evaluation indication - - - QA4EO ad hoc working group.
- 2.2.5.9** Provided for incorporation of information in the process and definitions above into CEOS electronic database for all CEOS data and

information QA flags and data/metadata fields - - - WGISS and NASA ESDWG.

2.2.5.10 Define QIPs for high priority CEOS future efforts as examples - - - GEO and CEOS QA4EO teams and management groups.

2.2.5.11 LTDP and Data Management teams shall help to develop data and record archive and metadata requirements - - - WGISS.

2.2.6 Task 6: Enabling Data and Information Interoperability and Harmonisation in CEOS and GEO

- 2.2.6.1** Support the implementation of case studies and QIPs - - - GEO Tasks and CEOS data, products, and efforts.
- 2.2.6.2** Complete data quality parameter definitions, System quality parameters and definition, etc., - - - WGCV sub groups and WGISS (NASA ESDWG).
- 2.2.6.3** Provide fit for purpose documentation related to system/data/and product capability and accuracy - - - WGCV sub groups with support from WGC and WGCBD.
- 2.2.6.4** Quality parameter measurement and process guidelines for each quality definition to include - - - WGCV sub groups and WGISS.
- 2.2.6.5** Define detailed guidelines for measurement process, reference sites, and reporting - - - WGCV and WGClimate.
- 2.2.6.6** Define and support intercomparison and quality assurance assessment processes and examples - - - WGCV and WGClimate.
- 2.2.6.7** An overall quality survey to determine state of quality analysis completed for dataset and product – WGCV and QA4EO ad hoc working group.
- 2.2.6.8** Develop of a QA4EO self-evaluation process and associated QA4EO quality evaluation indication - - - QA4EO ad hoc working group.
- 2.2.6.9** CEOS quality data information structure that provides for incorporation of information in the process and definitions above into CEOS electronic database for all CEOS data and information QA flags and data/metadata fields - - - WGISS and NASA ESDWG.
- 2.2.6.10** Define QIPs for high priority CEOS future efforts as examples - - - GEO and CEOS QA4EO teams and management groups.
- 2.2.6.11** LTDP and Data Management teams shall help to develop data and record archive and metadata requirements - - - WGISS.

3 Management and Authorising Structure of GEO QA4EO

The following table details the bodies / groups involved in the management and / or authorising of QA4EO and their expected roles / responsibilities in the overall GEO Scientific Societal Benefit Areas. The CEOS, as the space arm of GEO, and WMO, will support the space efforts,

Table 1 – GEO QA4EO Management and Authorisation Matrix

Body / Group	Role / Responsibility
GEO	Requirement specification and overall authority for implementing a QA structure for GEO
CEOS	Authority for space element QA processes documentation for data/ information
CEOS WGCV/ WGISS	<p>GEO Task Leaders</p> <ul style="list-style-type: none"> • Delegated operational authority for administration / management / evolution and international coordination of QA4EO. In effect, acting as a “standardising body” • Approval of key principles / guidelines / reference standards etc. • Harmonisation of inter-regional and agency operation of QA4EO. • Coordination and focus for infrastructure and implementation resourcing.
QA4EO secretariat	<p>Administration and day to day management of QA4EO:</p> <ul style="list-style-type: none"> • Documentation registrar • Documentation distribution and follow-up • Documentation maintenance • Interface to databases/portals • Communication link (help start-point) • Promotion
QA4EO GEO Implementation Task Force	<p>Delegated management from CEOS and GEO, responsible for recommending and proposing to GEO</p> <p>Detailed promotion and management of QA4EO at technical and scientific domain level.</p> <ul style="list-style-type: none"> • Evolution of QA4EO, scope and guidelines • Development of Implementation Strategy • Focal point for guidance on key guidelines • Review technical input and approve or recommend; approve procedures/comparisons as

	<p>appropriate.</p> <ul style="list-style-type: none"> • Provide scheduled actions and work as need <p>Management of GEO QA4EO Implementation:</p> <ul style="list-style-type: none"> • Develop and define implementation prioritization of QA4EO needs in GEO • Create the implementation requests to obtain resource in GEO and present to GEO management • Support management and integration across GEO • Create Ad hoc Working Groups for Implementation needs <p>Members:</p> <ul style="list-style-type: none"> • GEO Secretariat - QA4EO POC • GEO IN-02, C1 task team - CEOS WGCV/WGISS • CEOS SEO • WMO • FAO • GSICS • Metrological Standards bodies (2 minimum) • GEO SBA Leads • QA4EO Secretariat • GEO Infrastructure Implementation Board (IIB) • GEO Data Sharing Working Group <ul style="list-style-type: none"> • Observing Members: • INSPIRE • OGC • GMES • GCOS • ISPRS • Others as needed <ul style="list-style-type: none"> • The taskforce membership called upon key members of CEOS Space Agencies and GEO members for input.
GEO Members	<p>Implement QA4EO process</p> <ul style="list-style-type: none"> • Specify its usage to partners and contractors. • Establish appropriate infrastructure to administer and implement.

	<ul style="list-style-type: none"> • Provide implementation intent matrix. • Provide resource for demonstrating evidence of traceability. • Review existing key procedures / processes in context of QA4EO.
<p>Original GEO QA4EO “Strategic Development” taskforce</p>	<ul style="list-style-type: none"> • Evolution of QA4EO, scope and guidelines • Development of Implementation Strategy • Focal point for guidance on key guidelines <p>Members:</p> <ul style="list-style-type: none"> • ESA (Pascal Lecomte, supported by Giuseppe Ottavianelli and Bojan Bojkov) • USGS (Greg Stensaas, supported by Gyanesh Chander) • DMCii (Steve Mackin) • WMO/GSICS (Jerome Lafeuille) • NPL (Nigel Fox) • NIST (Carol Johnson) • QA4EO Secretariat (Marie-Claire Greening) • CEOS WGCV members <p>The taskforce membership called upon key members of CEOS Space Agencies and GEO members for input. This group may be able to support reference information and previous efforts.</p>

4 Management and Authorising Structure of CEOS QA4EO

The following table details the bodies / groups involved in the management and / or authorising of QA4EO and their expected roles / responsibilities.

Table 1 – CEOS QA4EO Management and Authorisation Matrix

Body / Group	Role / Responsibility
CEOS Plenary	Requirements specification and overall authority for the developing a quality framework for implementation (as appropriate) by the CEOS members
CEOS WGCV	<ul style="list-style-type: none"> • Delegated operational authority for administration / management / evolution and international coordination of QA4EO. In effect, acting as a “standardising body”, for CEOS. • Approval of key principles / guidelines / reference standards etc. • Harmonisation of inter-regional and agency operation of QA4EO. • Coordination and focus for infrastructure and implementation resourcing.
CEOS Implementation Management Team	<p>Delegated management of QA4EO from CEOS, responsible for recommending and proposing to CEOS</p> <p>Members: Delegates from CEOS, responsible for recommending and proposing direction to CEOS Management and QA4EO Implementation Team</p> <p>Voting Members:</p> <ul style="list-style-type: none"> • CEOS SEO • WGCV chair • WGCV vice-chair • WGISS Chair or Delegate • WGC Chair or Delegate • WGCBDD Chair or Delegate • LTDP Task Lead • WMO (GSICS) • Metrological Standards bodies • CEOS SIT Representative • CEOS SEC Representative

	<ul style="list-style-type: none"> • Supporting Members: • GEO Advisory Member -1 • QA4EO Secretariat -1 • WGCV Subgroup Chairs or Delegates (6) • Virtual Constellation Delegates – 7 • CEOS Societal Benefit Area (SBA) Coordinator Delegates - 9 (Agriculture, Climate, Disasters, Ecosystems, Energy, Health, Water, Weather, and Cross-Cutting) • GEO QA4EO Board Chair- 1 • WGCV Sec -1 • Invited Space Agency, Science, and Quality Expertise as required – 2 • and/or others as process evolves and as needed for interim basis by determined of the group.
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Body/Group	Role/responsibility
<p>CEOS QA4EO Implementation Taskforce</p>	<p>Management of CEOS QA4EO Implementation:</p> <ul style="list-style-type: none"> • Evolve QA4EO, scope and guidelines • Develop and refine of Implementation Strategy • Focal point for guidance on key guidelines and implementation • Team/Effort requirements and tasks needed in CEOS for QA4EO • Develop and define implementation prioritization of QA4EO needs in CEOS • Create the implementation requests to obtain resource in CEOS and present to CEOS management • Support management and integration across CEOS • Create Ad hoc Working Groups for Implementation of new tasks or efforts in accordance with on-going CEOS efforts <p>Members:</p> <ul style="list-style-type: none"> • WGCV Chair/Vice Chair • WGCV Subgroup Chairs and delegates • WMO (GSICS) • Metrological Standards bodies (2 minimum) • QA4EO Secretariat • WGClimat, WGCapD, WGISS delegates • Virtual Constellation and CEOS effort leads and/or delegates <p>All members of the CEOS QA4EO Management Team will be invited and considered as support and maybe called upon as needed by the taskforce.</p>
<p>Agencies</p>	<p>Implement QA4EO process</p> <ul style="list-style-type: none"> • Specify its usage to partners and contractors. • Establish appropriate infrastructure to administer and implement. • Provide implementation intent matrix. • Provide resource for demonstrating evidence of traceability. • Review existing key procedures / processes in context of QA4EO.
<p>QA4EO secretariat</p>	<p>Administration and day to day management of QA4EO:</p> <ul style="list-style-type: none"> • Documentation registrar • Documentation distribution and follow-up

	<ul style="list-style-type: none"> • Documentation maintenance • Interface to databases/portals • Communication link (help start-point) • Promotion
<p>QA4EO ad hoc Working Groups</p>	<p>Detailed day-to-day promotion, management, and implementation of QA4EO at technical domain level.</p> <ul style="list-style-type: none"> • Review technical input and approve or recommend; approve procedures/comparisons as appropriate. • Establish and recommend reference standards and/or other evidence. • Establish definitions and “dictionaries” as appropriate.

5 Key near-term QA4EO Pilots efforts within CEOS

The following areas with the CEOS infrastructure and on-going tasks that are supporting QA4EO will be used to highlight needs within GEO.