

A Framework for EO Product Quality Assurance

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Data Provider Documentation Review			Validation Summary
Product Information	Metrology	Product Generation	
Product Details	Radiometric Calibration & Characterisation	Radiometric Calibration Algorithm	Radiometric Validation Method
Availability & Accessibility	Geometric Calibration & Characterisation	Geometric Processing	Radiometric Validation Results Compliance
Product Format, Flags & Metadata	Metrological Traceability Documentation	Retrieval Algorithm	Geometric Validation Method
User Documentation	Uncertainty Characterisation	Mission-Specific Processing	Geometric Validation Results Compliance
	Ancillary Data		

Key
Not Assessed
Not Assessable
Basic
Good
Excellent
Ideal
 Not Public



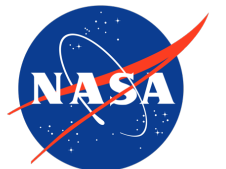
Commercial Satellite Sector Growth

Currently there are nearly 750 commercial satellites in orbit in the electro-optical, SAR, hyperspectral, AIS/RF, and hybrid domains from the US, China and other nations.

In 2030, it is projected that there will be over 8000, with the most explosive growth in the hyperspectral and hybrid sensor domains.

The need for systematic evaluation of commercial satellite data will only grow.

(source: the US National Geospatial-Intelligence Agency)



The Value of QA

Mission success is dependent upon quality assurance. Evidencing data quality adds significantly to the value of datasets.

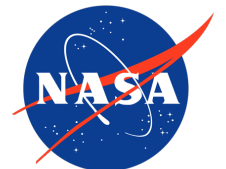
- Gives potential customers the confidence data is *fit for their purpose*.
- Many aspects of data quality are aimed at facilitating communication to users → required for e.g. to interoperability.
- ...

ESA EDAP Project

- To perform an Early Data Assessment on various existing, new and future EO missions that fall into one of the following instrument domains:
 - Very High Resolution (VHR), High Resolution (HR) and Medium Resolution (MR) Optical
 - Low Resolution (LR) Optical
 - Synthetic Aperture Radar (SAR)
 - Atmospheric
- To undertake specific multi-mission studies, which contribute to interoperability across existing and future missions and help foster synergies between these missions.
- To provide support for the organisation of ESA Workshops that focus on data quality assessment of different types and groups of EO mission sensors, with the aim to provide a forum for assessing and discussing the data quality of existing and future TPMs
- Provide a focus on the generation of methodologies and guidelines for training and capacity building, with the relevant Mission / Data Providers, particularly for the commercial missions with regards to efficient data quality assessments in the preparation for future missions.

Commercial Smallsat Data Acquisition Program

- NASA has been providing access to Maxar data for NASA-funded investigations since 2011 under the NextView license. There are over 68 studies published using Maxar data via this access mechanism.
- In 2017 NASA launched a Pilot activity to perform an evaluation of data from 3 operational commercial small-satellite constellations to assess their suitability for research and applied science activities.
- The Pilot was focused more on the use and application of the commercial data, with preliminary radiometric and geometric quality assessment conducted. The results from these evaluations were published in the [Commercial Smallsat Data Acquisition Program Pilot Evaluation Report](#).
- In 2020 Pilot program and the Maxar data distribution effort both transitioned into the CSDA Program. Research and application results using CSDA acquired data can be found at <https://earthdata.nasa.gov/esds/csdap/smallsat-data-publications>.
- Future commercial data procurements will include a coordinated data quality assessment using the matrices developed in concert with EDAP.



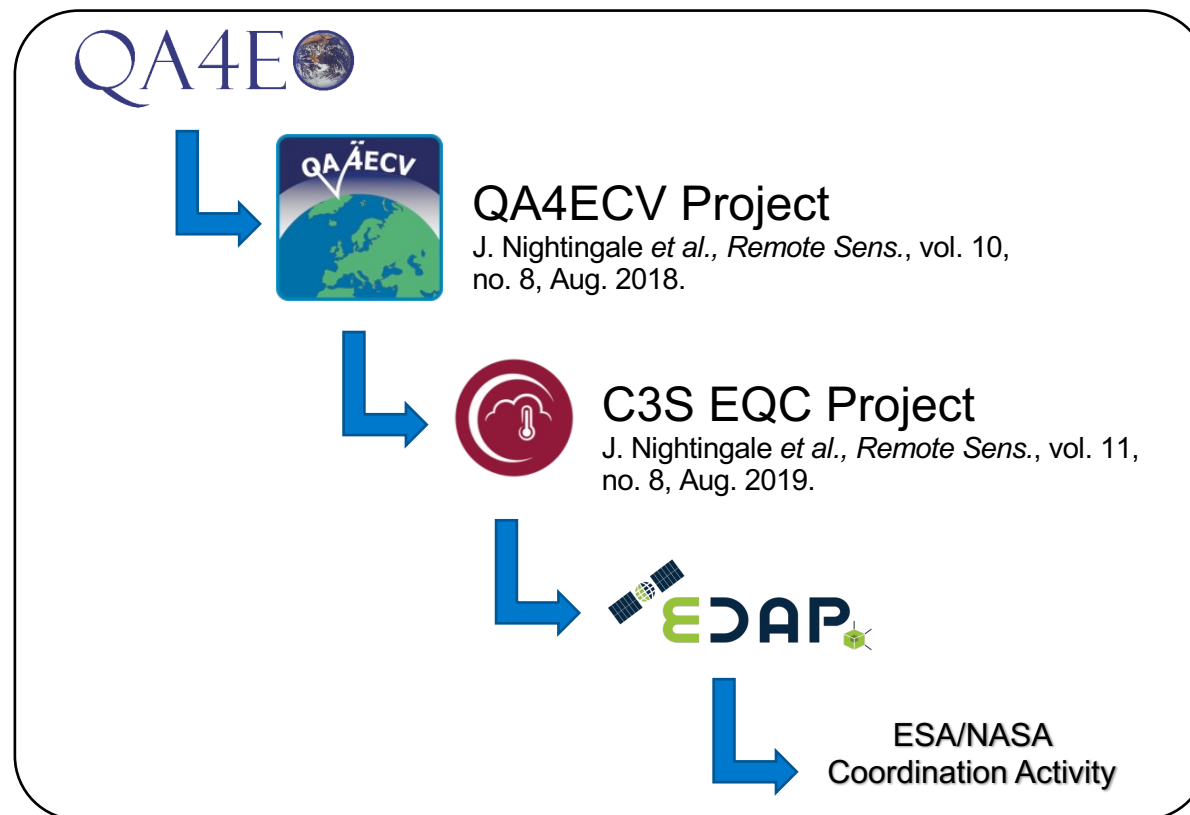
QA Standards

Developing increasingly comprehensive definition of mission quality:

- Analysis ready data & interoperability
- Fiducial reference measurements
- Traceability – CLARREO, TRUTHS, Chinese missions
- Uncertainty evaluation e.g. Sentinel-2 Uncertainty Tool

Need identified to define a coordinated, systematic approach to EO QA, to keep up with pace of development, by implementing a QA standard

European Heritage



Assessment Philosophy

- The assessment framework is aimed at verifying claimed mission performance and adheres, where applicable, to community best practices to an extent that is “fit for purpose”.
- Assessment divided into two parts
 - Review of mission quality as evidenced by its documentation
 - Validation analysis performed by mission quality assessor

QA Framework Definition


Coordinated NASA/ESA activity to define such a standard:

- Generic Guidelines developed to define general framework for satellite mission quality analysis. Results of analysis reported in maturity matrices.
- Specific implementations are generated from this framework for separate sensor type requiring different approaches for those specific mission domains
- Drafts of optical and SAR domain guidelines have been prepared

Framework Structure

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	Ancillary Data	

Validation Summary
Measurement Validation Method
Measurement Validation Results Compliance
Geometric Validation Method
Geometric Validation Results Compliance

Key
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Validation Summary

Summarises validation activity undertaken by assessor

Data Provider Documentation Review

Review of mission quality as evidenced by its documentation

Product Information

Review of descriptive information accompanying products

Metrology

Review of underpinning evidence for observation quality

Product Generation

Review of “fitness for purpose” of product generation

Detailed Validation Matrix – Optical

Validation Summary	Detailed Validation				
Radiometric Validation Method	Radiometric	Absolute Calibration Method	Signal to Noise Method	Temporal Stability Method	
Radiometric Validation Results Compliance		Absolute Calibration Results Compliance	Signal to Noise Results Compliance	Temporal Stability Results Compliance	
Geometric Validation Method	Geometric	Sensor Spatial Response Method	Absolute Positional Accuracy Method	Band-to-Band Registration Method	Temporal Stability Method
Geometric Validation Results Compliance		Sensor Spatial Response Results Compliance	Absolute Positional Accuracy Results Compliance	Band-to-Band Registration Results Compliance	Temporal Stability Results Compliance

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Provides the expert user more detailed validation information, metrics domain-specific

Validation Areas

Divides been validation activities e.g. radiometric, geometric

Validation Metric

Highlights key metrics in each validation area

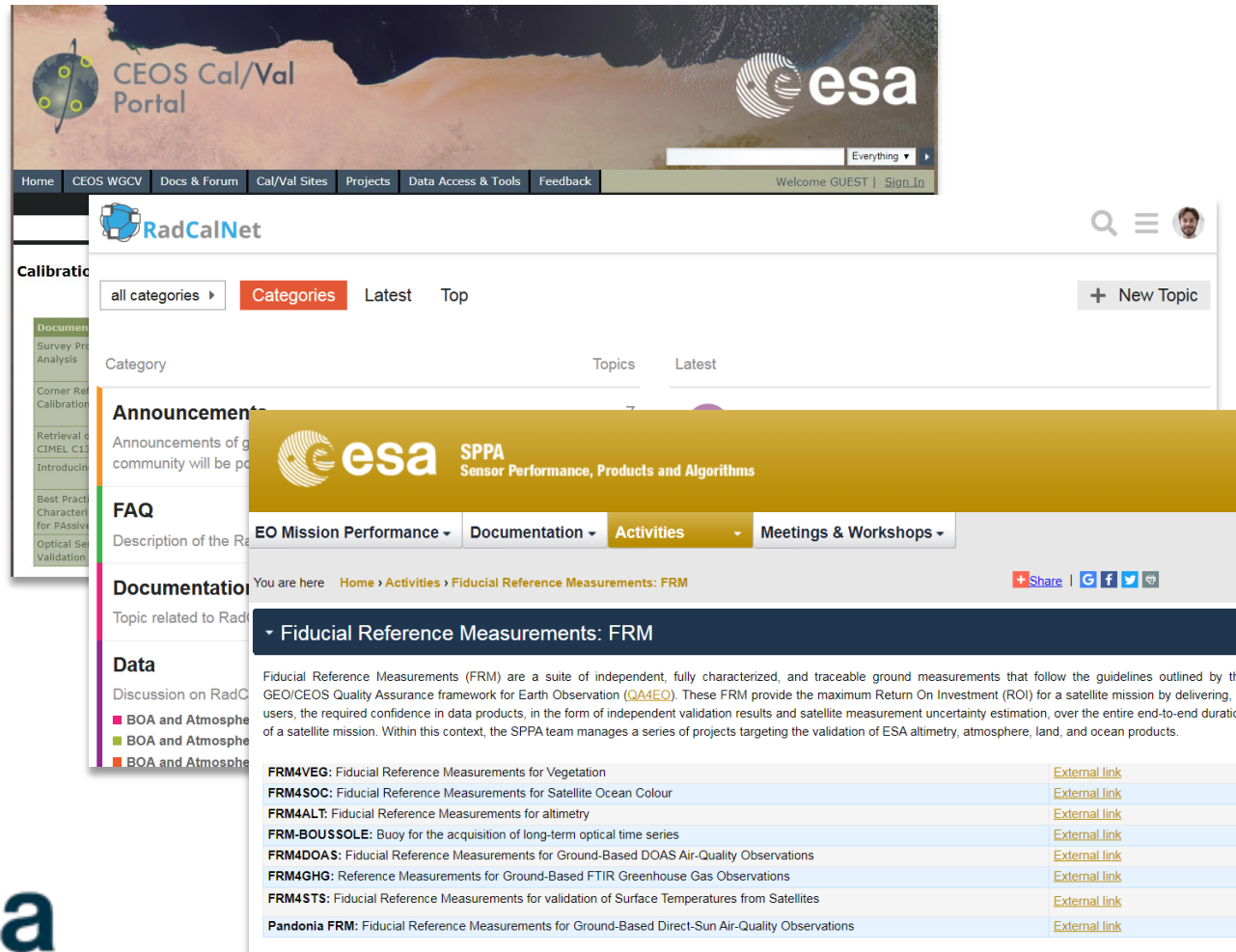
Method

Review of quality of method e.g. reference data quality

Compliance

Comparison of validation result and claimed performance

Example of Best Practice



The image shows a screenshot of the CEOS Cal/Val Portal and RadCalNet website. The top navigation bar includes links for Home, CEOS WGCV, Docs & Forum, Cal/Val Sites, Projects, Data Access & Tools, and Feedback. The main content area features a search bar and a navigation menu with options like EO Mission Performance, Documentation, Activities, and Meetings & Workshops. A prominent yellow banner highlights the 'Fiducial Reference Measurements: FRM' section. Below this, a table lists various FRM projects with external links.

FRM Project Name	Description	External Link
FRM4VEG	Fiducial Reference Measurements for Vegetation	External link
FRM4SOC	Fiducial Reference Measurements for Satellite Ocean Colour	External link
FRM4ALT	Fiducial Reference Measurements for altimetry	External link
FRM-BOUSSOLE	Buoy for the acquisition of long-term optical time series	External link
FRM4DOAS	Fiducial Reference Measurements for Ground-Based DOAS Air-Quality Observations	External link
FRM4GHG	Reference Measurements for Ground-Based FTIR Greenhouse Gas Observations	External link
FRM4STS	Fiducial Reference Measurements for validation of Surface Temperatures from Satellites	External link
Pandonia FRM	Fiducial Reference Measurements for Ground-Based Direct-Sun Air-Quality Observations	External link

Sensor Characterisation and Calibration

Link to good practice material available from a variety of sources:

- CEOS Cal/Val portal, e.g. definition of PICS
- RadCalNet portal
- ESA FRM Projects
- Scientific literature

Approach to Assessments



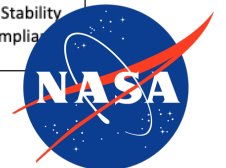
This framework is something data producers can refer to as they define products and evidence themselves.

Assessment process is an interactive activity between assessors and missions.

Not an academic exercise – provides real value to customers.

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Product Format, Flags & Metadata	Metrological Traceability Documentation	Retrieval Algorithm	Measurement Validation Results Compliance	Good
User Documentation	Uncertainty Characterisation	Mission-Specific Processing	Geometric Validation Method	Excellent
	Ancillary Data			Geometric Validation Results Compliance
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Detailed Validation			
Radiometric		Geometric	
Absolute Calibration Method	Absolute Calibration Results Compliance	Sensor Spatial Response Method	Sensor Spatial Response Results Compliance
Signal to Noise Method	Signal to Noise Results Compliance	Absolute Positional Accuracy Method	Absolute Positional Accuracy Results Compliance
Temporal Stability Method	Temporal Stability Results Compliance	Band-to-Band Registration Method	Band-to-Band Registration Results Compliance
		Temporal Stability Method	Temporal Stability Results Compliance



Conclusion

- Comprehensive standard for mission quality defined by ESA & NASA.
- Generic Assessment Framework implemented in detailed domain-specific guidelines. So far there is a draft of optical and SAR guidelines.
- Use being trialled in upcoming ESA/NASA commercial mission QA evaluations.



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