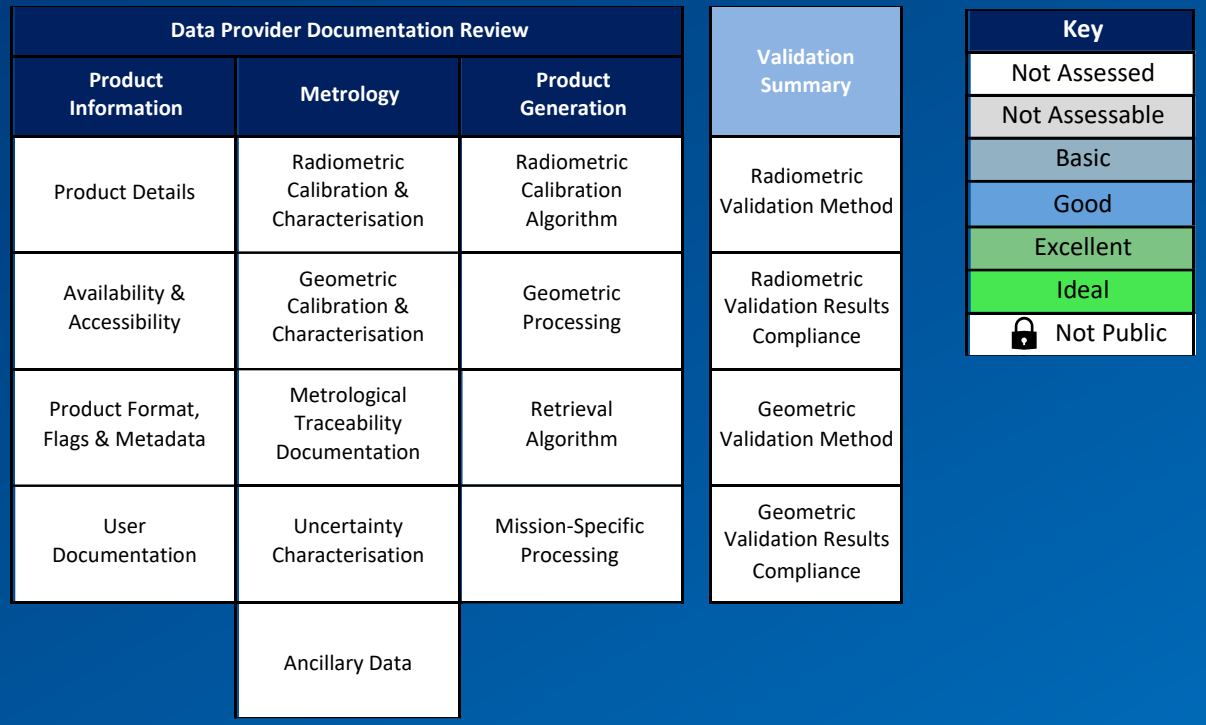
National Physical Laboratory

ESA/NASA QA Framework for EO Products

Sam Hunt[1], Clément Albinet[2], Jaime Nickeson[3], Batuhan Osmanoglu[3], Alfreda Hall[3], Guoqing Lin[3], Leonardo De Laurentiis[2], Philippe Goryl[2], Dana Ostrenga[3], Nigel Fox[1]

(1) NPL, (2) ESA, (3) NASA



Outline

- Motivation for a QA Framework for EO Products
- ESA/NASA QA Framework
- Future – Automated Performance Monitoring

Commercial Satellite Sector Growth

Currently there are around 1000 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-Intelligency 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.
- …

QA Standards

Developing increasingly comprehensive definition of mission quality:

- Analysis ready data & interoperability – CEOS ARD
- Fiducial reference measurements – CEOS FRM
- Traceability – CLARREO, TRUTHS, Chinese missions
- Uncertainty evaluation e.g. Sentinel-2 Uncertainty Tool – QA4EO

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

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 and piloted in numerous ESA/NASA assessments

Framework Structure

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

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

Key
Not Assessed
Not Assessable
Basic
Good
Excellent
Ideal
Not Public

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

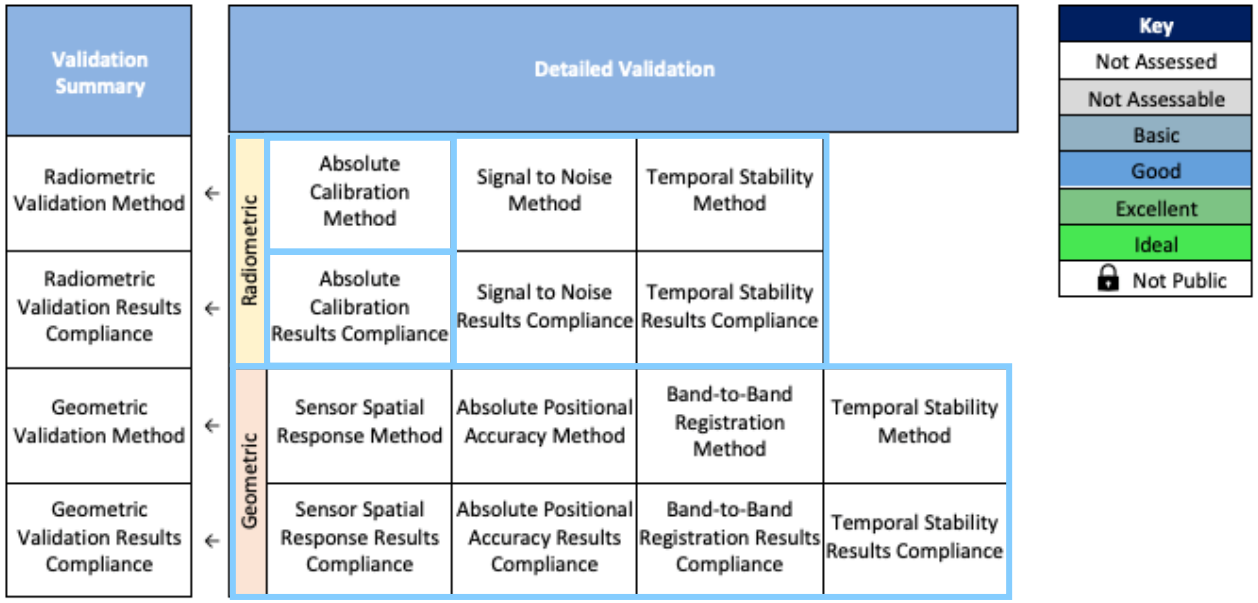
Metrology

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	←	Radiometric	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	←	Geometric	Sensor Spatial Response Results Compliance	Absolute Positional Accuracy Results Compliance	Band-to-Band Registration Results Compliance	Temporal Stability Results Compliance

Key
Not Assessed
Not Assessable
Basic
Good
Excellent
Ideal
Not Public

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

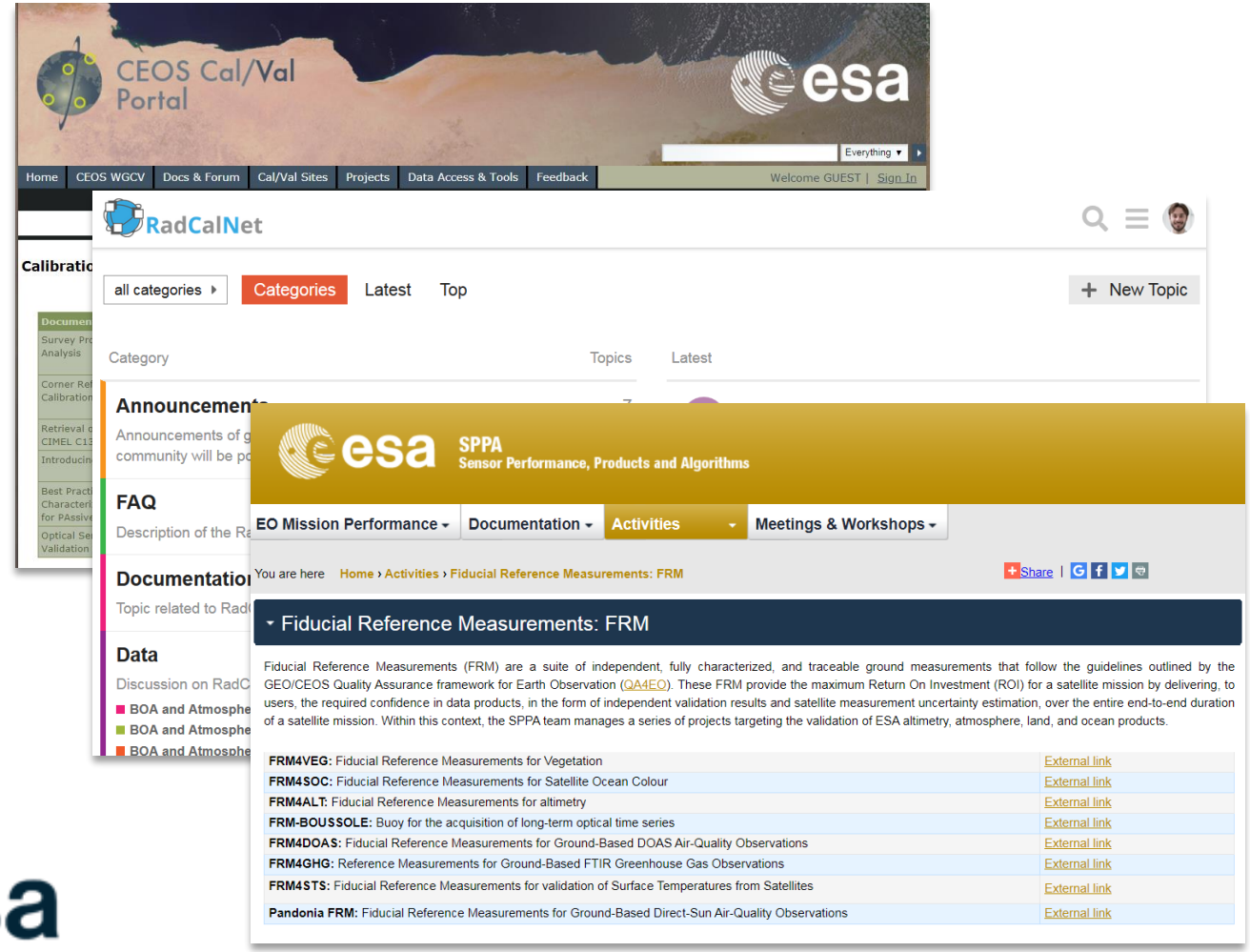
Method

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

Compliance

Comparison of validation result and claimed performance

Example of Best Practice



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. Space Agencies are justifying their data buys on this!

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

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

Key
Not Assessed
Not Assessable
Basic
Good
Excellent
Ideal
Not Public

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 Compli

Summary

- 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.
- Has been piloted in numerous ESA/NASA commercial mission QA evaluations.

NPL

National Physical Laboratory

npl.co.uk

Department for Business, Energy & Industrial Strategy

FUNDED BY BEIS

The National Physical Laboratory is operated by NPL Management Ltd, a wholly-owned company of the Department for Business, Energy and Industrial Strategy (BEIS).