A Framework to Assess Commercial Satellite Mission Quality

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EDAP Project Activities

- 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.

Contents

Motivation & Background

Development of EO QA Frameworks

An EO QA Framework for commercial missions

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Organisation of World Metrology

- The Convention of the Metre 1875
- International System of Units (SI) 1960
- Mutual Recognition Arrangement (CIPM-MRA) 1999

Bureau International des Poids et Mesures

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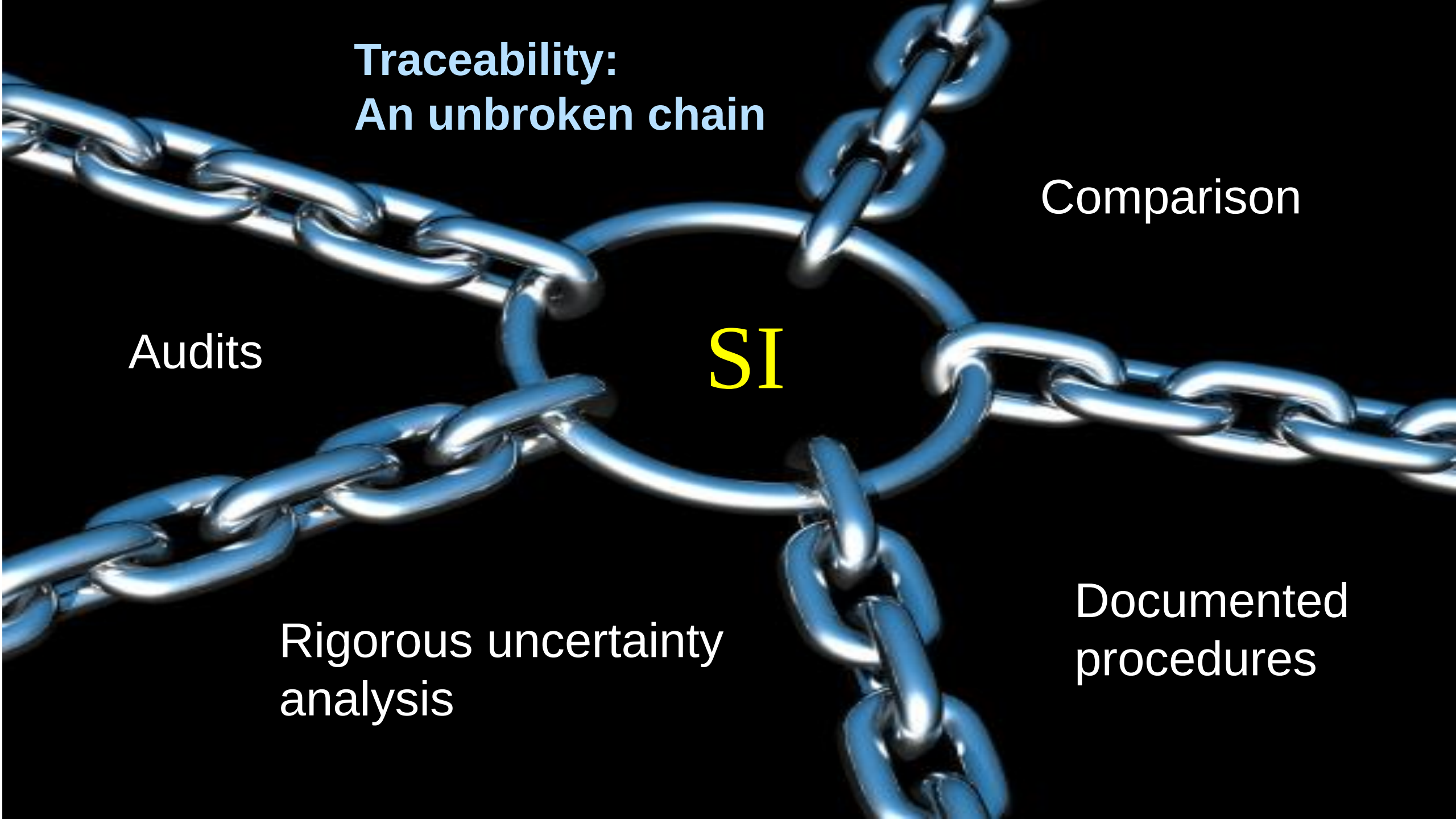
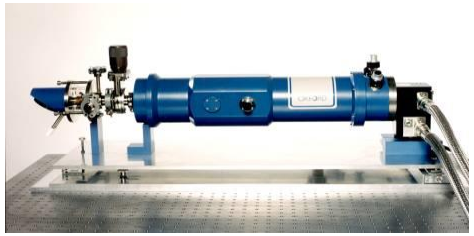
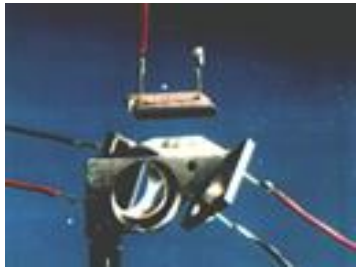
How do we make sure a wing built in one country fits a fuselage built in another?


Traceability:
An unbroken chain
Comparison
Audits
SI
Rigorous uncertainty analysis
Documented procedures

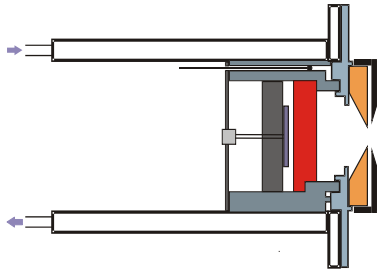
Example of Radiometric Traceability Chain



Cryogenic Radiometer



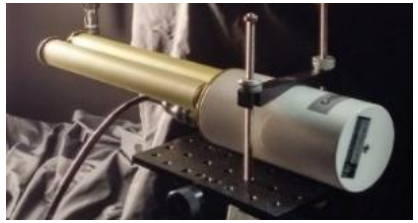
Trap Detector



Filter Radiometer

Blackbody

Lamp



Field Radiometer

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QA4EO Principle

"It is critical 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."

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QA Framework Heritage

QA4EO

QA4ECV Project
J. Nightingale *et al., Remote Sens.*, vol. 10, no. 8, Aug. 2018.

C3S EQC Project
J. Nightingale *et al., Remote Sens.*, vol. 11, no. 8, Aug. 2019.

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C3S Climate Data Store
Evaluation and Quality Control for Observations

Details	Generation	Quality flags	Uncertainty Characterisation	Validation	Inter-comparison
Product Information	Input data and uncertainties	Quality Flags	Uncertainty Characterisation Method	Reference data representativeness	Scale of inter-comparison activities
Product Description	Sensor Calibration		Uncertainty sources included	Reference data uncertainty inclusion	Inter-comparison method
Coverage and Resolution	Algorithm method		Uncertainty values provided	Validation method	Product uncertainties inclusion
Data gaps	Algorithm tuning		Temporal stability	Validation results	Discrepancy between products identified and, if possible, resolved
Data set limitations and target applications	Sensitivity analysis		Geolocation uncertainty		
Documentation	Internal Processes				
	Traceability				

Quality Assessment Matrix

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Example Product

Quality Evaluation

Each stage of the production of this data set has been independently evaluated. This judgement is based on the methods used and also the degree of quality information which is provided. The results of this are illustrated in the following matrix showing the evaluation by section.

To find out more detail about these sections, click on the sub-section.

Details	Generation	Quality flags	Uncertainty Characterisation	Validation	Inter-comparison
Product Information	Input data and uncertainties	Quality Flags	Uncertainty Characterisation Method	Reference data representativeness	Scale of inter-comparison activities
Product Description	Sensor Calibration		Uncertainty sources included	Reference data uncertainty inclusion	Inter-comparison method
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Documentation	Internal Processes				
	Traceability				

Key
Basic
Intermediate
Good
Excellent

Full Quality Assurance Report | PDF

Contact

copernicus-support@ecmwf.int

License

GHG-CCI Licence

Related data

Carbon dioxide data from 2002 to present derived from satellite sensors

EDAP Framework Principles

- Should describe high-level principles and activities common for assessment of all EO missions.
- Starting point is to describe the “ideal” case for a given category – aspiration which may not often be met.
- Grading based on mission fitness for purpose based on stated performance and application area.
- Assessment itself is the “ideal” case. Some aspects of assessment may be out of scope within EDAP.

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EDAP Quality Assessment Matrix

Product Information	Product Generation	Ancillary Information	Uncertainty Characterisation	Validation
Product Details	Sensor Calibration & Characterisation Pre-Flight	Product Flags	Uncertainty Characterisation Method	Reference Data Representativeness
Availability & Accessibility	Sensor Calibration & Characterisation Post-Launch	Ancillary Data	Uncertainty Sources Included	Reference Data Quality
Product Format	Retrieval Algorithm Method	If target mission data product is Level 2	Uncertainty Values Provided	Validation Method
User Documentation	Retrieval Algorithm Tuning		Geolocation Uncertainty	Validation Results
Metrological Traceability Documentation	Additional Processing			

Key
Not Assessed
Not Assessable
Basic
Intermediate
Good
Excellent
Information Not Public

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Example Assessment: Oceansat-2

Product Details	Product Generation	Ancillary Information	Uncertainty Characterisation	Validation
Product Information	Sensor Calibration & Characterisation Pre-Flight	Product Flags	Uncertainty Characterisation Method	Reference Data Representativeness
Availability & Accessibility	Sensor Calibration & Characterisation Post-Launch	Ancillary Data	Uncertainty Sources Included	Reference Data Quality
Product Format	Retrieval Algorithm Method	If target mission data product is Level 2	Uncertainty Values Provided	Validation Method
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Metrological Traceability Documentation	Additional Processing			

Key
Not Assessed
Not Assessable
Basic
Intermediate
Good
Excellent
Information Not Public

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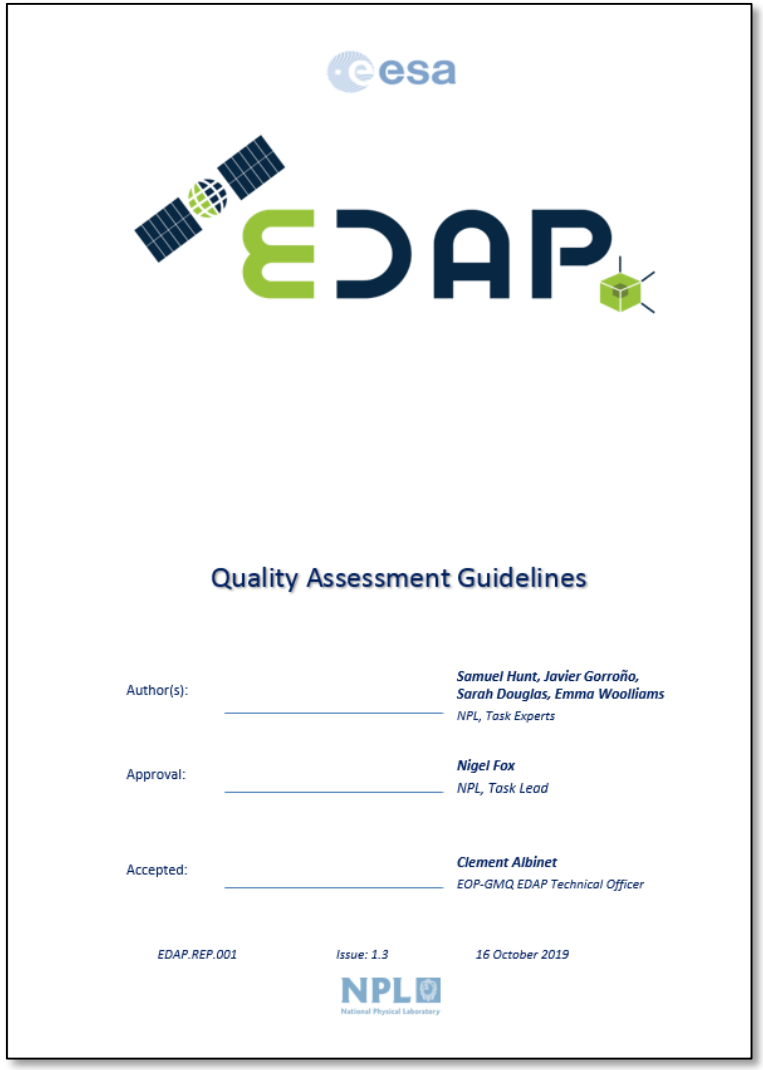
Mission Assessment Guidelines

Guidelines prepared to describe generic assessment criteria per matrix cell.

Available:
https://earth.esa.int/web/sppa/activities/edap-best-practice-guidelines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Quality Assessment Guidelines

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EDAP.REP.001 Issue: 1.3 16 October 2019

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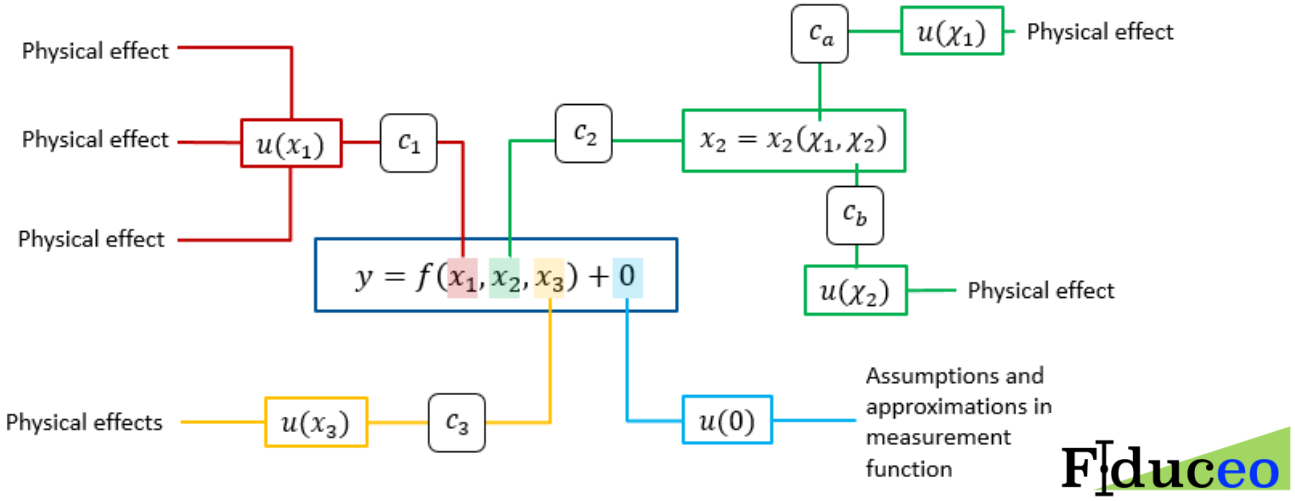
Example: Uncertainty Characterisation



Description of Best Practice

Earth observation metrology techniques developed within the H2020 FIDUCEO project.

www.fiduceo.eu

Grading Criteria

Based on the extent to which application of the Guide to the Expression of Uncertainty is applied, wrt fitness for purpose in the context of the assessed mission

Grade	Criteria
Not Assessed	Assessment outside the scope of study.
Not Assessable	Uncertainty characterisation not performed or method not documented.
Basic	Uncertainty established by limited comparison to measurements by other sensor/s Not by independent assessment and then comparison.
Intermediate	Limited use of GUM approach, and/or, an expanded comparison to measurements by other sensors.
Good	GUM approach to estimate measurement uncertainty with full breakdown of components and separated as Type A or B classification.
Excellent	GUM approach to estimate measurement uncertainty, including a treatment of error-covariance.

Optical Mission Assessment Guidelines

New guidelines prepared to describe more specific optical assessment criteria.

Include more information for optical sensors where required and reference appropriate additional material.

Available Soon:
https://earth.esa.int/web/sppa/activities/edap-best-practice-guidelines

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Optical Mission Quality Assessment Guidelines

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EDAP.REP.002 Issue: 1.0 16 October 2019

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Example of Best Practice

Sensor Characterisation and Calibration Post-Launch & Validation

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

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Reporting Assessments

- Generic template report for EDAP quality assessments, to provide consistent output across to project and ease comparison.
- Intended to not be overly prescriptive. Provides a location to summarise findings and reference more detailed reports.
- Contains completed quality assessment matrix.

Conclusions

- There is a need in EO to provide users with independent quality assessments of satellite missions, so they may assess if data is *fit for their purpose*.

- ARD producers can benefit from standardised quality assessment information to ensure traceability and trustworthiness of their data products.

- The EDAP Mission Quality Assessment Framework provides as rigorous approach to achieve this, based on the QA4EO principle.

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