CEOS

Working Group on Information Systems and Services
Data Stewardship Interest Group

WGISS Data Management and Stewardship Maturity Matrix

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INTENDED AUDIENCE

This document is intended to assist data managers in Earth Observation (EO) data centres in the task of ensuring Earth Observation space data sets long-term preservation, curation, accessibility, discoverability and usability.

The intended audience comprises:

1. Data providers
   - To evaluate and improve the quality and usability of their products
2. Modellers, decision-makers, and scientists
   - To improve their products
   - To make investments and take decision
3. Data managers/stewards of data centres and repositories
   - To validate their compliance or lack of stewardship practice or standards
   - To assess the current state of their data holdings and repositories
   - To create a roadmap to improve or enhance the stewardship maturity of practices applied to all data holdings

BACKGROUND AND SCOPE

This white paper presents a WGISS Data Management and Stewardship maturity assessment model in the form of a matrix for Earth Observation datasets.

In the extended environment of Maturity Matrices and Models, the Maturity Matrix for "Long-Term Scientific Data Stewardship", of Peng, and Jeffrey L. Privette, & Others (2015) [9], represents a systematic assessment model for measuring the status of individual datasets. In general, it provides information on all aspects of the data records, including all activities needed to preserve and improve the information content, quality, accessibility, and usability of data and metadata. This was used as a starting point for the WGISS Data Management and Stewardship Maturity Matrix, presented in this document.

In parallel, the GEO Data Management Principles Task Force was tasked with defining a common set of GEOSS Data Management Principles Implementation Guidelines (DMP-IG) [8]. These principles address the need for discovery, accessibility, usability, preservation, and curation of the resources made available through GEOSS.

The WGISS Data Management and Stewardship Maturity Matrix represents the result of a combined analysis on the "Long-Term Scientific Data Stewardship" Maturity Matrix and DMP-IG performed in consultation by a Data Access and Preservation Working Group at European level and by the WGISS Data Stewardship Interest Group. The resulting Matrix includes also the Research for Data Alliance (RDA) FAIR principles results [10] and the Earthnet Data Assessment Pilot (EDAP) Quality input [11] produced as part of WGISS cooperation with the CEOS Working Group on Data Calibration and Validation (WGCV).

The resulting WGISS Data Management and Stewardship Maturity Matrix fully addresses and covers data preservation, discoverability, accessibility, quality and usability aspects including data use related services and capabilities.

The WGISS Data Management and Stewardship Maturity Matrix is aligned with the following definitions:

- Data stewardship "encompasses all activities that preserve and improve the information content, accessibility, and usability of data and metadata" (National Research Council 2007);
- Data management "includes all activities for planning, execution and oversight of policies, practices and projects that acquire, control, protect, deliver and enhance the value of data and information assets." (Mosely et al. 2009).

The main objective of its application and use is to measure and verify the overall implemented or to be implemented data preservation and stewardship lifecycle. The Matrix can be used as self-assessment tool to create a stewardship maturity scoreboard target for one or more scientific dataset(s), identify actual and potential gaps, and define a roadmap for data stewardship improvement; or to provide data quality and usability information to users, stakeholders, and decision makers. It is flexible and adaptable through a tailoring, with respect to the requirements and objectives of the data owners, highlighted after the initial process foreseen in the CEOS WGISS Data Preservation Workflow [3].

- Use of the WGISS Data Management and Stewardship Maturity Matrix will allow data owners: applying a reference model for stewardship planning and resources allocation;
- Defining goals and target and creating a roadmap for scientific data stewardship improvement;
- Applying detailed guidelines and recommendations for data preservation and stewardship and self-evaluating the levels and results achieved;
- Helping to break down problems related to preservation and stewardship, and to understand the costs associated with each level;
- Providing data quality, usability information to end users, stakeholders, and decision makers.

COMPONENTS AND MAPPING WITH OTHER SOURCES

The WGISS Data Management and Stewardship Maturity Matrix resulting from the above-defined work has twelve components. These components are related and mapped with the Data Management Principles Implementation Guidelines [8] and with the "Long-Term Scientific Data Stewardship" matrix [9] as follows:

WGISS Data Management & Stewardship Maturity Matrix	DMP Implementation Guidelines	Stewardship Maturity Matrix Key Components (GE-PENG)
MMP1: METADATA FOR DISCOVERY	DMP-1: Discoverability	Accessibility
MMP2: ONLINE ACCESS	DMP-2: Accessibility	Accessibility
MMP3: DATA ENCODING	DMP-3: Encoding	Usability
MMP4: DATA DOCUMENTATION	DMP-4: Documentation	Usability
MMP5: DATA TRACEABILITY	DMP-5: Traceability	Transparency /Traceability
MMP6: DATA VALIDATION	DMP-6: Quality	Assessment Data Quality Assurance
MMP7: DATA UNCERTAINTY	DMP-6: Quality	Monitoring Data Quality
MMP8: DATA QUALITY CONTROL	DMP-6: Quality	Data Quality Control
MMP9: DATA PRESERVATION	DMP-7: Preservation	Preservability
MMP10: DATA AND METADATA VERIFICATION	DMP-8: Verification	Data Integrity
MMP11: DATA PROCESSING/REPROCESSING	DMP-9: Review and reprocessing	Production Sustainability
MMP12: PERSISTENT AND RESOLVABLE IDENTIFIERS	DMP-10: Persistent and resolvable identifiers	Transparency /Traceability

A weight has been given to each WGISS Maturity Matrix component, in order to create an incremental order for their implementation. The maturity of data management and stewardship for each component, applied to individual datasets, can be assessed on a four-level measurable maturity scale:

- Level-0: Not Managed
- Level-1: Partially Managed
- Level-2: Managed
- Level-3: Fully Managed

The WGISS Data Management and Stewardship Maturity Matrix is shown in the picture below.

	DISCOVERABILITY	ACCESSIBILITY	USABILITY						PRESERVATION		CURATION	
	MMP1 Metadata for Discovery	MMP2 Online Access	MMP3 Data Encoding	MMP4 Data Documentation	MMP5 Data Traceability	MMP6 Data Validation	MMP7 Data Uncertainty	MMP8 Data Quality Control	MMP9 Data Preservation	MMP10 Data Verification	MMP11 Data Processing/Reprocessing	MMP12 Persistent & Resolvable Identifier
Level-0 Not Managed	1) No catalogue available 2) No advertising available	Data and metadata are not accessible online	1) Data Not Structured 2) Non-standard or proprietary data format, or, poorly-documented standard file format.	Partial and incomplete mission documentation	Limited product information available (not online)	1) Reference Data Representativeness - No validation 2) Reference Data Quality - No validation 3) Validation Method - No validation 4) Validation Results - No validation	1) Uncertainty Method: Uncertainty characterisation not performed, or method not documented. 2) Uncertainty Sources: Uncertainty characterisation not performed, or sources analysed not documented. 3) Uncertainty Values: No uncertainty information provided.	1) No control and monitoring check 2) No quality indicator in metadata 3) No procedures documentation	1) Uncontrolled storage location. 2) Only data are stored 3) Data Records archiving not managed 4) Relevant information on Product Details Assessment not made available	No Data/Associated Information integrity, authenticity and readability check	1) No reprocessing activities planned 2) Pre-flight calibration & characterisation not documented or information not available. 3) Post-launch calibration & characterisation not documented or not available. 4) Processing: Additional processing steps not documented.	No persistent and resolvable identifiers available
Level-1 Partially Managed	1) Advertising available 2) Catalogue search available at product level	Basic online services available for data and metadata access	1) Basic schema for automated data use 2) Data in documented standard file format. Non-standard naming conventions used.	1) Already existent mission documentation available and preserved for the long term 2) No link between mission documentation and data records	Product information available (not online)	1) Reference Data Representativeness: measurements assessed to be mostly representative of the satellite measurements 2) Reference Data Quality: single uncertainty for the entire dataset. 3) Validation Method: simple uncertainty estimated 4) Validation Results: Validation results show good agreement between satellite and reference measurements within uncertainties in most cases.	1) Uncertainty Method: Limited use of GUM approach, and/or, an expanded comparison to measurements by other sensors. 2) Uncertainty Sources: Most important sources of uncertainty included. 3) Uncertainty Values: Single uncertainty value provided for subsets of data	1) Basic data quality control and monitoring check 2) Minimal set of quality control procedures documented and available	1) Basic archiving for original data records preservation 2) Assessment of SW preservation 3) Product Details Assessment: Any required information missing	Data Records/Associated Information integrity basic check	1) Minor updates and bugs corrections of data records implemented 2) Data Records repackaging and/or reformatting 3) Pre-flight calibration & characterisation misses some important aspects 4) Post-launch calibration & characterisation misses some important aspects of instrument behaviour and/or is not entirely of a level of quality to be judged fit for purpose. 5) Additional processing steps documented. Some important additional processing steps may not be fit for stated purpose.	1) Persistent identifier assignment only for particular Data Records Collections 2) Basic landing pages management
Level-2 Managed	1) Detailed catalogue search available at product level 2) Product metadata oriented towards an international standard 3) Data Collection and Associated Information searchable. 4) International standard for Collection metadata	1) Simple Access Architecture through metadata 2) Data access system oriented towards an international standard	1) Use of non-proprietary international standards encodings for syntactic interoperability. 2) Periodically repackaging/ reformatting of archived data. 3) Data in well-documented standard file format, community naming convention standards.	1) Documentation produced, published and well described 2) Link between mission documentation and data records created and managed	Dataset tested for presence of correct provenance metadata. Well described product information available online	1) Reference Data Representativeness: measurements assessed to be well representative of the satellite measurements 2) Reference Data Quality: full uncertainty information 3) Validation Methods assess satellite measurements 4) Validation Results show excellent agreement between satellite and reference measurements, within uncertainties.	1) Uncertainty Method: GUM approach to estimate measurement uncertainty with full breakdown of components and separated as Type A or B classification. 2) Uncertainty Sources: All important sources of uncertainty included. 3) Uncertainty Values: Total uncertainty per pixel is provided, with basic breakdown of key components no error-covariance.	1) Quality indicator post-processing available 2) Quality control procedures documented and available online	1) Preservation repository certified internally 2) Community-standard for archiving metadata 3) Product Details Assessment: All required information available, any recommended information missing	1) Data Records/Associated Information content integrity check and verification 2) Media readability and accessibility testing	1) Reprocessing for calibration and/or algorithm improvement 2) Pre-flight calibration & characterisation covers all reasonable aspects 3) Post-launch calibration & characterisation covers all reasonable aspects of instrument behaviour to a quality that is "fit for purpose" in terms of the mission's stated performance and uses appropriate community infrastructure/methods (CEOS/FRMs). 4) Additional processing steps documented.	1) Persistent identifier assignment to all disseminated Data Records Collections and metadata 2) Automatic landing page generation and extensive management of landing pages
Level-3 Fully Managed	1) International standard for Product metadata 2) International standard for Collection metadata 3) Catalogue accessible via international or community agreed standards protocol 4) Data policy available in metadata 5) Periodic updates of metadata in the catalogue 6) Quality indicator metadata available and discoverable 7) Search results relevancy. 8) Seamless transition from discovery to access	1) International standard for Data and metadata access system 2) Data policy available in the metadata. 3) Visualisation services 4) Reporting system 5) Hosted processing 6) Quick adoption to new technologies and standards evolution 7) Data and metadata accessible through a free and open access protocol	1) Accepted and Available semantic encoding standards for complete interoperability 2) Data and metadata uses FAIR-compliant vocabularies 3) Analysis Ready Data standard	1) Standards based metadata for documentation 2) Link between mission documentation and data records published	1) Automatic metadata generation for provenance documentation 2) Complete and updated data provenance available online	1) Reference Data Representativeness: Reference measurements independently assessed to be fully representative of the satellite measurements, covering the satellite's full range of measurements and with full assessment of uncertainties and carried out on a regular basis determined by product performance. 2) Reference Data Quality: full uncertainty and error-correlation information, assessed following the GUM and traceable to SI 3) Validation Methods assess satellite measurements and reference data w.r.t. their error- covariance and validates those uncertainties. 4) Validation Results show excellent agreement between satellite and reference measurements, within uncertainties.	1) Uncertainty Method: GUM approach to estimate measurement uncertainty, including a treatment of error-covariance. 2) Uncertainty Sources: All reasonable sources of uncertainty included. 3) Uncertainty Values: Uncertainties per pixel provided with error-covariance information for all appropriate components.	1) Data quality control fully compliant with an international standard 2) Quality indicator pre and post processing available in the metadata 3) Quality metadata assessed	1) Preservation repository officially certified 2) Periodic technology refreshment 3) Identify and manage the basic preservation of relevant mission SW, ensuring that preserved data can be recreated. 4) Continuity of service availability 5) Product Details Assessment: All required and recommended information available	1) Automatic Data Records/Associated Information content integrity check and verification 2) Data authenticity verifiable internally and by the final user 3) Automatic verification process, including monitoring and reporting	1) Reprocessing for time-series creation 2) Roadmap for technology evolution 3) Plurality of accurate and relevant attributes are provided to allow reuse 4) Metadata includes information about the licence 5) Pre-Flight: As Level-2, additionally calibration and characterisation includes the measurements needed to assess uncertainties at component level and their impact on the final product. 6) Post-launch calibration & characterisation covers all reasonable aspects of instrument behaviour to a quality that is "fit for purpose" in terms of the mission's stated performance. 7) All additional processing steps fully documented and state-of-the-art.	1) Persistent identifier created for all accessible data records and metadata 2) Metadata includes the identifier for the data 3) Metadata is offered in such a way that it can be harvested and indexed

EARTH OBSERVATION DOMAIN APPLICABILITY

The WGISS Data Management and Stewardship Maturity Matrix may be adopted to facilitate and improve CEOS Agencies Data Management and Stewardship activities and achievements. It can be further tailored to take into account specific Earth Observation requirements and already existing Best Practices available internationally or at Agency level.

A dataset appraisal activity should initially define the desired level to be reached for each maturity matrix component, for a specific mission/dataset, for example based on:

- Mapping versus final user exploitation capabilities;
- Mapping w.r.t. data preservation commitments, budgets, responsibilities and preservation requirements.

Different missions' datasets can have different targets and varying maturity level ratings.

More details on the different maturity matrix components and levels are provided in the sections below.

WGISS MATURITY MATRIX COMPONENTS AND ASSOCIATED MATURITY LEVELS

DOMAIN: DISCOVERABILITY

MMP-1: METADATA FOR DISCOVERY

Data and all associated metadata will be discoverable through catalogues and search engines. Data access and use conditions, including licenses, will be clearly indicated.

Level-0	1) No catalogue available 2) No advertising available
Level-1	1) Advertising available. 2) Catalogue search available at product level with minimum set of metadata.
Level-2	1) Detailed catalogue search available at product level. 2) Product metadata oriented towards an international standard (e.g. ISO, OGC, INSPIRE, etc.) 3) Data Records Collection and Associated Information searchable [3], [4]. 4) Collection metadata oriented towards an international standard (e.g. ISO, OGC, INSPIRE, etc.)
Level-3	1) Product rich metadata fully compliant with an international standard (e.g. ISO, OGC, INSPIRE, etc.) 2) Collection metadata fully compliant with an international standard (e.g. ISO, OGC, INSPIRE, etc.) 3) Catalogue accessible via an accepted international or community agreed upon standards protocol. 4) Data policy on the use conditions/restrictions and legal constraints of the data, available in metadata. 5) Periodic updates of metadata in the catalogue (e.g. contact point). 6) Quality indicator metadata available and discoverable. 7) Search results ordered by relevancy. 8) Seamless transition from discovery to access.

DOMAIN: ACCESSIBILITY

MMP-2: ONLINE ACCESS

Data will be accessible via online services, including, at a minimum, direct download, but preferably user customizable services for access, visualization and analysis.

Level-0	Data and metadata not accessible online.
Level-1	Basic online services available for data and metadata access (e.g. FTP/HTTP direct download).
Level-2	1) Simple Access Architecture through metadata - e.g. Data Access through a catalogue service.

	2) Data and metadata access system oriented towards an international standard (e.g. OpenSearch, ISO).
Level-3	1) Data and metadata access system fully compliant with an international standard (e.g. OpenSearch, ISO). 2) Data policy regarding use conditions and restrictions of the data, available in the metadata. 3) Visualisation services allowing a user to view images of data (e.g. Web Map Services for geospatial data, browse image services). 4) Reporting system available (e.g. user statistics, data access reports, system availability reports, etc.). 5) Hosted processing (e.g. on the fly processing). 6) Quick adoption to new technologies and standards evolution. 7) Data and metadata are accessible through a free and open access protocol

DOMAIN: USABILITY

MMP-3: DATA ENCODING

Data should be structured using encodings that are widely accepted in the target user community and aligned with organizational needs and observing methods, with preference given to non-proprietary international standards.

Level-0	1) Data Not Structured. 2) Non-standard or proprietary data format, or, poorly-documented standard file format.
Level-1	1) Basic schema for automated data use. 2) Data in documented standard file format; Non-standard naming conventions used.
Level-2	1) Use of non-proprietary international standards encodings for syntactic interoperability. If a proprietary format is used, it has to be formally and semantically described. 2) Periodically repackaging/ reformatting of archived data. 3) Data in well-documented standard file format, meeting community naming convention standards.
Level-3	1) Accepted and Available semantic encoding standards for complete interoperability. 2) Data and metadata use FAIR-compliant vocabularies 3) Analysis Ready Data standard if applicable, else as Level-2.

MMP-4: DATA DOCUMENTATION

Data will be comprehensively documented, including all elements necessary to access, use, understand, and process, preferably via formal structured metadata, based on international or community approved standards. To the extent possible, data will also be described in peer-reviewed publications and referenced in the metadata record.

Level-0	Partial and incomplete mission documentation (satellite, data and product documentation).

Level-1	1) Already existent mission documentation available and preserved for the long term. 2) No link between mission documentation and data records.
Level-2	1) Documentation produced, published and well described (covering the format, metadata, and methods used in creating and validating the data). 2) Link between mission documentation and data records created and managed (internal use only).
Level-3	1) Standards based metadata for documentation (e.g. to support the reproducibility of science). 2) Link between mission documentation and data records published.

MMP-5: DATA TRACEABILITY

Data will include provenance metadata, indicating the origin and processing history of raw observations and derived products, to ensure full traceability of the product chain.

Level-0	Limited product information available (not online).
Level-1	Product information available (not online).
Level-2	Dataset tested for presence of correct provenance metadata (presence, completeness and correctness). Well described product information available online.
Level-3	1) Automatic metadata generation for provenance documentation. 2) Complete and updated data provenance available online.

MMP-6: DATA VALIDATION

Data will be validated and assessed in terms of consistency between both the data values and their uncertainties with those of independent reference data.

Level-0	1) Reference Data Representativeness: No validation activity performed. 2) Reference Data Quality: No validation activity performed. 3) Validation Method: No validation activity performed. 4) Validation Results: No validation activity performed.
Level-1	1) Reference Data Representativeness: Reference measurements assessed to be mostly representative of the satellite measurements, covering a primary range satellite of measurements and at ad-hoc opportunities (no formal documented regular timescale). 2) Reference Data Quality: Reference data comes a single uncertainty for the entire dataset. 3) Validation Method: Methodology assess satellite measurements, simple uncertainty estimated (e.g. from statistical spread for results). 4) Validation Results: Validation results show good agreement between satellite and reference measurements within uncertainties in most cases.
Level-2	1) Reference Data Representativeness: Reference measurements assessed to be well representative of the satellite measurements, covering a reasonable range of the satellite's measurements and carried

	out using FRM or community approved methods. Carried out on a regular timescale of approximately annual basis but not necessarily based on need. 2) Reference Data Quality: Reference data comes with full uncertainty information, assessed following the GUM and traceable to community reference or SI (e.g. FRM) 2) Validation Method: Methodology assesses satellite measurements and reference data w.r.t. their uncertainties 3) Validation Results: Validation results show excellent agreement between satellite and reference measurements, within uncertainties. Analysis performed independently of satellite mission owner.
Level-3	1) Reference Data Representativeness: Reference measurements independently assessed to be fully representative of the satellite measurements, covering the satellite's full range of measurements and with full assessment of uncertainties and carried out on a regular basis determined by product performance. 2) Reference Data Quality: Reference data comes with full uncertainty and error-correlation information, assessed following the GUM and traceable to SI (e.g. FRM). 3) Validation Method: Methodology assess satellite measurements and reference data w.r.t. their error- covariance and validates those uncertainties. 4) Validation Results: Validation results show excellent agreement between satellite and reference measurements, within uncertainties. Uncertainty validated. Analysis performed independently of satellite mission owner.

MMP-7: DATA UNCERTAINTY

To ensure measurements are both meaningful and defensible it is crucial that they come with rigorously evaluated uncertainty estimates. This section of the mission quality assessment evaluates the methodology used to estimate uncertainty values for a given mission, the extent of the mission's analysis and how the values are provided.

Level-0	1) Uncertainty Method: Uncertainty characterisation not performed, or method not documented. 2) Uncertainty Sources: Uncertainty characterisation not performed, or sources analysed not documented. 3) Uncertainty Values: No uncertainty information provided.
Level-1	1) Uncertainty Method: Limited use of GUM approach, and/or, an expanded comparison to measurements by other sensors. 2) Uncertainty Sources: Most important sources of uncertainty included. 3) Uncertainty Values: Single uncertainty value provided for subsets of data, e.g. per product.
Level-2	1) Uncertainty Method: GUM approach to estimate measurement uncertainty with full breakdown of components and separated as Type A or B classification.

	2) Uncertainty Sources: All important sources of uncertainty included. 3) Uncertainty Values - Total uncertainty per pixel is provided, with basic breakdown of key components no error-covariance.
Level-3	1) Uncertainty Method: GUM approach to estimate measurement uncertainty, including a treatment of error-covariance. 2) Uncertainty Sources: All reasonable sources of uncertainty included. 3) Uncertainty Values: Uncertainties per pixel provided with error-covariance information for all appropriate components.

MMP-8: DATA QUALITY-CONTROL

Data will be quality-controlled and the results of quality control shall be indicated in the metadata; data made available in advance of quality control will be flagged in metadata as unchecked.

Level-0	1) No control and monitoring check. 2) No quality indicator in metadata. 3) No procedures documentation.
Level-1	1) Basic data quality control and monitoring check. 2) Minimal set of quality control procedures documented and available.
Level-2	1) Quality indicator post-processing available. 2) Quality control procedures documented and available online.
Level-3	1) Data quality control fully compliant with an international standard 2) Quality indicator pre and post processing available in the metadata [6]. 3) Quality metadata assessed.

DOMAIN: PRESERVATION

MMP-9: DATA PRESERVATION

Data will be protected from loss and preserved for future use; preservation planning will be for the long term, and include guidelines for loss prevention, retention schedules, and disposal or transfer procedures.

Level-0	1) Uncontrolled storage location. 2) Only data are stored. 3) Data Records archiving not managed. 4) Product Details Assessment: Relevant information not made available
Level-1	1) Basic archiving for original data records preservation: - The entity in charge of data long term preservation is identified and designated; - Minimal redundancy and metadata preservation; 2) Assessment of SW preservation. 3) Product Details Assessment: Any required information missing

Level-2	1) Preservation repository certified internally: - Documented storage procedures (planning of periodic media refreshment) - Redundancy managed (e.g. back-up, different media technology) - Basic archiving processes measured and controlled 2) Community-standard for archiving metadata (e.g. AIP). 3) Product Details Assessment: All required information available, any recommended information missing
Level-3	1) Preservation repository officially certified (e.g. ISO 19363, CoreTrustSeal) 2) Periodic technology refreshment 3) Identify and manage the basic preservation of relevant mission SW, ensuring that preserved data can be recreated. 4) Continuity of service availability (Business Continuity, Disaster and Recovery, etc.). 5) Product Details Assessment: All required and recommended information available

MMP-10: DATA AND METADATA VERIFICATION

Data and associated metadata held in data management systems will be periodically verified to ensure integrity, authenticity and readability.

Level-0	No Data/Associated Information integrity, authenticity and readability check.
Level-1	Data Records/Associated Information integrity basic check (e.g. checksum).
Level-2	1) Data Records/Associated Information content integrity check and verification. 2) Media readability and accessibility testing.
Level-3	1) Automatic Data Records/Associated Information content integrity check and verification. 2) Data authenticity verifiable internally and by the final user. 3) Automatic verification process, including monitoring and reporting.

DOMAIN: CURATION

MMP-11: DATA PROCESSING/REPROCESSING

Data will be managed to perform corrections and updates in accordance with reviews, and to enable reprocessing as appropriate; where applicable, this shall follow established and agreed procedures.

Level-0	1) No reprocessing activities planned. 2) Processing & Calibration (Pre-Flight): Pre-flight calibration & characterisation not documented or information not available. 3) Processing & Calibration (Post-Flight): Post-launch calibration & characterisation not documented or not available. 4) Processing: Additional processing steps not documented.

Level-1	1) Minor updates and bugs corrections of data records implemented. 2) Data Records repackaging and/or reformatting. 3) Processing & Calibration (Pre-Flight): Pre-flight calibration & characterisation misses some important aspects of instrument behaviour and/or is not entirely of a level of quality to be judged fit for purpose 4) Processing & Calibration (Post-Flight): Post-launch calibration & characterisation misses some important aspects of instrument behaviour and/or is not entirely of a level of quality to be judged fit for purpose. 5) Processing: Additional processing steps documented. Some important additional processing steps may not be fit for stated purpose.
Level-2	1) Reprocessing for calibration and/or algorithm improvement. 2) Processing & Calibration (Pre-Flight): Pre-flight calibration & characterisation covers all reasonable aspects of instrument behaviour to a quality that is "fit for purpose" in terms of the mission's stated performance. Calibration traceable to SI or community reference, characterisation meets good practice. 3) Processing & Calibration (Post-Flight): Post-launch calibration & characterisation covers all reasonable aspects of instrument behaviour to a quality that is "fit for purpose" in terms of the mission's stated performance and uses appropriate community infrastructure/methods (CEOS/FRMs). 4) Processing: Additional processing steps documented. All additional processes steps fit for stated purpose.
Level-3	1) Reprocessing for time-series creation (e.g. FDR for ECV). 2) Roadmap for technology evolution. 3) Plurality of accurate and relevant attributes are provided to allow reuse 4) Metadata includes information about the licence under which the data can be reused 5) Processing & Calibration (Pre-Flight): As Level-2, additionally calibration and characterisation includes the measurements needed to assess uncertainties at component level and their impact on the final product. 6) Processing & Calibration (Post-Flight): Post-launch calibration & characterisation covers all reasonable aspects of instrument behaviour to a quality that is "fit for purpose" in terms of the mission's stated performance. Measurements fully traceable to SI or community reference at an uncertainty commensurate with the product specification and carried out regularly across the full range of observational conditions of the product and dynamic range. 7) Processing: Additional processing - All additional processing steps fully documented and state-of-the-art.

MMP-12: PERSISTENT AND RESOLVABLE IDENTIFIERS

Data will be assigned appropriate persistent, unique and resolvable identifiers to enable documents to cite the data used and to enable data providers to receive Information for the use of their data.

Level-0	No persistent and resolvable identifiers available
Level-1	1) Persistent identifier assignment only for particular Data Records Collections. 2) Basic landing pages management (e.g. manual generation and updates, no common template).
Level-2	1) Persistent identifier assignment to all disseminated Data Records Collections and relevant metadata. 2) Automatic landing page generation and extensive management of landing pages.
Level-3	Persistent identifier [7] created for all accessible data records. and metadata 2) Metadata includes the identifier for the data 3) Metadata is offered in such a way that it can be harvested and indexed

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4. http://tinyurl.com/DSMM-FlowChart

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