

Data Management and Stewardship Maturity Matrix: User Guide



Main Concepts



DMSMM defines all activities needed to preserve and improve the information content, quality, accessibility, and usability of data and metadata.

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).

CEOS WGISS Data Management & Stewardship Maturity Matrix



	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 with minimum set of metadata	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, covering a primary range of satellite of measurements and at ad hoc opportunities 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 of instrument behaviour and/or is not entirely of a level of quality to be judged fit for purpose 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 Records Collection and Associated Information searchable. 4) Collection metadata oriented towards an international standard	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, covering a reasonable range of the satellite's measurements and carried out using FRM or community approved methods. 2) Reference Data Quality: full uncertainty information, assessed following the GUM and traceable to community reference or SI 3) Validation Methods assess satellite measurements and reference data w.r.t. their uncertainties 4) Validation Results show excellent agreement between satellite and reference measurements, within uncertainties. Analysis performed independently of satellite mission owner.	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 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) 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.	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) Product rich metadata fully compliant with an international standard 2) Collection metadata fully compliant with an international standard 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 6) Quality indicator metadata available and discoverable 7) Search results ordered by relevancy. 8) Seamless transition from discovery to access	1) Data and metadata access system fully compliant with an international standard 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 4) Reporting system available 5) Hosted processing 6) Quick adoption to new technologies and standards evolution 7) Data and metadata accessible through a free 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. Uncertainty validated. Analysis performed independently of satellite mission owner.	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 under which the data can be reused 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. 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: 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

http://ceos.org/document_management/Working_Groups/WGISS/Interest_Groups/Data_Stewardship/White_Papers/WGISS%20Data%20Management%20and%20Stewardship%20Maturity%20Matrix.pdf

5 Areas

- Discoverability
- Accessibility
- Usability
- Preservation
- Curation

4 Level of Maturity

- L0 Not Managed
- L1 Partially Managed
- L2 Managed
- L3 Fully Managed

12 Components

- Metadata for Discovery
- Online Access
- Data encoding
- Data Documentation
- Data Traceability
- Data Validation
- Data Metrology (e.g. Uncertainty)
- Data Quality Control
- Product Details
- Data Preservation
- Data Verification
- Data Processing/Reprocessing
- Persistent & Resolvable Identifier

Step by step in DMSMM

For each component go through the checklist



PRESERVATION	
MMP9 Data Preservation	MMP10 Data Verification
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	integrity, authenticity and readability check
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) 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) 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



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Perform a verification for each task putting in green the tasks already implemented.

L0

L1

L2

L3

For each component go through the checklist



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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	integrity, authenticity and readability check
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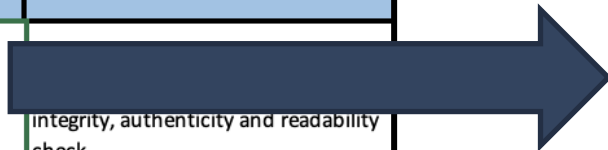
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L0

L1

L2

L3



Perform this kind of verification for each task in the maturity level under analysis.

For each component go through the checklist



PRESERVATION	
MMP9 Data Preservation	MMP10 Data Verification
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	integrity, authenticity and readability check
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
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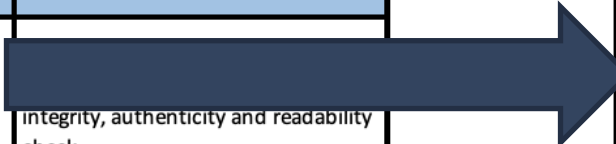
PRESERVATION	
MMP9 Data Preservation	MMP10 Data Verification
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L0

L1

L2

L3



When all tasks in the analysed maturity level are fully covered, fill with a colour the whole cell in green.

For each component go through the checklist



L0

PRESERVATION	
MMP9 Data Preservation	MMP10 Data Verification
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

L1

1) Basic archiving for original data record preservation 2) Assessment of SW preservation 3) Product Details Assessment: Any required information missing	Data Records/Associated Information integrity basic check
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L2

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
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L3

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
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PRESERVATION	
MMP9 Data Preservation	MMP10 Data Verification
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
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The analysis continues going on to the next level of maturity.

For each component go through the checklist



L0

L1

L2

L3

PRESERVATION	
MMP9 Data Preservation	MMP10 Data Verification
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
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When a task is not already implemented it remains in black and at the end the cell, partially covered, becomes in light colour.

Score compilation



PRESERVATION	
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L0

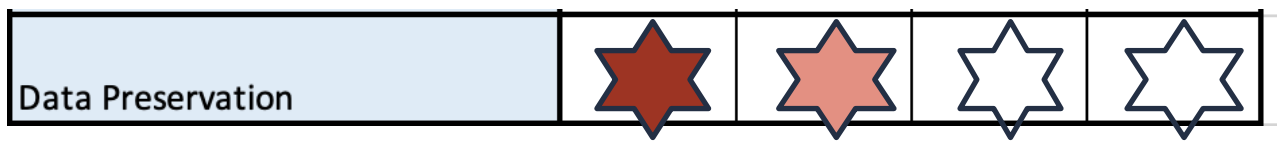
L1

L2

L3



L0 L1 L2 L3



Example of final view of the DMSMM and Score



	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) Uncollected storage location. 2) Only data are stored 3) Data Records archiving not managed 4) Relevant information on Product Details Assessment not made	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) Catalogue search 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	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'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	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

COMPONENTS	L0	L1	L2	L3
Metadata for Discovery	★	★	★	★
Online Access	★	★	★	★
Data Encoding	★	★	★	★
Data Documentation	★	★	★	★
Data Traceability	★	★	★	★
Data Validation	★	★	★	★
Data Uncertainty	★	★	★	★
Data Quality Control	★	★	★	★
Data Preservation	★	★	★	★
Data Verification	★	★	★	★
Data Processing/Reprocessing	★	★	★	★
Persistent & Resolvable Identifier	★	★	★	★