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DSMR-00283 Version 1.0

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Data Stewardship Maturity Report for AVHRR Pathfinder Version 5.3 Level 3 Collated (L3C) Global 4km Sea Surface Temperature

Table 1 Legend				
Level 1	Level 2	Level 3	Level 4	Level 5
Ad Hoc	Minimal	Intermediate	Advanced	Optimal
Little or no management	Limited Management	Defined Management, partially implemented	Well-defined Management, fully implemented	Full Management, audited, measured, controlled

Table 1. Scores for the Nine DSMM Key Components at a Glance		
Preservability - 5	Accessibility - 5	Usability - 4.5
Production Sustainability - 5	Data Quality Assurance - 4	Data Quality Control/Monitoring - 3
Data Quality Assessment - 3	Transparency/Traceability - 2.75	Data Integrity - 3

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Cover Image: Data Stewardship Rating Diagram for AVHRR Pathfinder Version 5.3 Level 3 Collated (L3C) Global 4km Sea Surface Temperature

Shades of green are used to represent level 1 through level 5 ratings; denoting Ad Hoc, Minimal, Intermediate, Advanced, and Optimal stages for each of the nine key components, respectively. The dark green level indicates all the practices are completely satisfied. The lighter green levels indicate only some of the practices are satisfied. The lightest green level indicates none of the practices are satisfied.

The stewardship maturity of NCEI data product, AVHRR Pathfinder Version 5.3 Level 3 Collated (L3C) Global 4km Sea Surface Temperature, is assessed based on a reference stewardship maturity framework. The current maturity ratings of AVHRR Pathfinder Version 5.3 Level 3 Collated (L3C) Global 4km Sea Surface Temperature are at Level 1 or higher for all nine key components with zero Level 1, one Level 2, three Level 3, two Level 4, and three Level 5 key components.

NOAA Technical Information Series NESDIS DSMR-00283 Version 1.0

The National Environmental Satellite, Data, and Information Service (NESDIS) manages the Nation's civil Earth-observing satellite systems, as well as global national data bases for meteorology, oceanography, geophysics, and solar-terrestrial sciences. From these sources, it develops and disseminates environmental data and information products critical to the protection of life and property, national defense, and the national economy, energy development and distribution, global food supplies, and the development of natural resources.

Publication in the NOAA Technical Memorandum series does not preclude later publication in scientific journals in expanded or modified form. The NESDIS series of NOAA Technical Reports is a continuation of the former NESS and EDIS series of NOAA Technical Reports and the NESC and EDS series of Environmental Science Services Administration (ESSA) Technical Reports.

Copies of earlier reports may be available by contacting NESDIS Chief of Staff, NOAA/ NESDIS, 1335 East-West Highway, SSMC1, Silver Spring, MD 20910, (301) 713-3578.

ASSESSMENT REVISION HISTORY

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Data Stewardship Maturity Report for AVHRR Pathfinder Version 5.3 Level 3 Collated (L3C) Global 4km Sea Surface Temperature

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Preface

In response to the President's Open Government Initiative and related policies, NOAA has committed to providing improved public access to all of its environmental information, to enable research and commercial innovation through ease of data discovery and use [*Casey*, 2016].

OneStop supports NOAA's efforts by leveraging existing access technologies and infusing specific innovations to provide improved discover, access, and visualization services for NOAA's data. Also, OneStop is viewed by a NESDIS as a pathfinder effort with an initial focus on selected high-priority datasets from NESDIS and other program data meeting OneStop standards, but eventually scalable across NOAA's data. Lastly, OneStop is implementing the USGEO Common Framework for Earth Observation Data and leveraging/supporting the NOAA Big Data Project (BDP) and Big Earth Data Initiative (BEDI) [*Casey*, 2016].

As with any process of improvement planning, agencies need to find out where they are in terms of their compliance to the federal regulations and what they need to do if any areas of non-compliance are identified. To this end, a unified framework would be beneficial for assessing the current stage of stewardship practices applied to individual datasets and for providing a road map that will guide future investments towards enhanced stewardship of environmental datasets. The value and quality of a dataset depends in part on the stewardship practices applied after its development and production. Therefore, a unified framework providing a holistic view of the quality of stewardship practices applied to individual datasets is beneficial to data stewards and users [*Casey*, 2016].

The Data Stewardship Maturity Matrix (DSMM), jointly developed by domain (data management, technology, and science) subject matter experts from NOAA's National Centers for Environmental Information (NCEI) and Cooperative Institute for Climate and Satellites – North Carolina (CICS-NC), provides such a consistent framework [*Peng et al.,* 2016]. The DSMM, leveraging institutional knowledge and community practices and standards, defines a graduated maturity scale for each of nine key components of scientific data stewardship to enable a consistent assessment of the measureable stewardship practices applied to a given data set or product.

The NOAA Data Stewardship Maturity Technical Series captures stewardship maturity assessment results for individual datasets, provides consistent representation and citable documents of those assessments, ensures transparency, and allows better data quality information integration and content-based search and discovery of NOAA data.

NOAA Technical Information Series NESDIS DSMR-00283 Version 1.0

Data Stewardship Maturity Report for AVHRR Pathfinder Version 5.3 Level 3 Collated (L3C) Global 4km Sea Surface Temperature

1. Introduction

1.1 Purpose

The purpose of this document is to describe the results of stewardship maturity assessment for NOAA Climate Data Record for Mean Layer Temperature (Upper Troposphere & Lower Stratosphere from UCAR, Version 2, utilizing the Scientific Data Stewardship Maturity Matrix or DSMM [Peng, et al, 2016]. DSMM defines levels of stewardship maturity stages for Preservability, Accessibility, Usability, Production Sustainability, Data Quality Assurance, Data Quality Control/Monitoring, Data Quality Assessment, Transparency/Traceability, and Data Integrity key components. Each of these components is ranked from 'Ad hoc' to 'Optimal' (see Appendix I). This report is based on evaluation performed by NOAA OneStop metadata specialists working with Subject Matter Experts and utilizing the DSMM template [Peng, 2016].

1.2 Scope

Assessing stewardship maturity - the current state of how datasets are documented, preserved, stewarded, and made accessible publicly, is a critical step towards meeting U.S. federal regulations, organizational requirements, and user needs [Peng et al., 2016]. The goal of this document is to provide consistent and transparent stewardship maturity information to data users and decision-makers.

1.3 Dataset Abstract

The AVHRR Pathfinder Version 5.3 (PFV53) L3C Sea Surface Temperature dataset is a collection of global, twice-daily (Day and Night) 4km sea surface temperature (SST) data produced by the NOAA National Centers for Environmental Information (NCEI). L3C is generated with measurements combined from a single instrument into a space-time grid. In this process multiple passes/scenes of data are combined. PFV53 was computed with data from the AVHRR instruments on board NOAA's polar orbiting satellite series using an entirely modernized system based on SeaDAS (version 6.4). This system incorporates several key changes from its predecessors (mainly version 5.2: PFV52). The SSTs in PFV53 are now available for all quality levels, including quality '0' which was left out of PFV52 due to a memory issue in the version 5.2 code. The Sun glint regions are better represented in the data. Cloud tree tests for NOAA-7 and NOAA-19 are now consistent with the rest of the sensors in contrast to PFV52 where they were inconsistent. Similar to all previous versions of Pathfinder this

version also includes L3C products. The sst_dtime variable is still not included in L3C (it was not included in PFV52 either). The global and variables attributes in netCDF files are revised, have better CF and ACDD compliance, and are consistent with the NCEI netCDF templates. Anomalous hot-spots at land-water boundaries are better identified and flagged in PFV53. The PFV53 land mask has been updated (based on Global Lakes and Wetlands Database: Lakes and Wetlands Grid Level 3, 2015). Sea ice data over the Antarctic ice shelves are marked as ice and flagged as 100% ice cover. The PFV53 output are netCDF version 4 in "classic" mode, whereas in PFV52 the netCDF-4 files were not explicitly identified as "classic". An extra bit (bit 6) is used under l2p_flags variable to flag out the daytime unrealistic SST values (>39.8°C) that remain in pf_quality_level 4 to 7. Users are recommended to avoid these values.

Importantly, PFV53 data provided in netCDF-4 (classic model, with internal compression and chunking) are nearly 100% compliant with the GHRSST Data Specification Version 2.0 (GDS2.0 revision 5) requirements. However, it must be noted that in L3C data the variables sses_bias, sses_standard_deviation, and sst_dtime are still empty. PFV53 data were collected through the operational periods of the NOAA-7 through NOAA-19 Polar Operational Environmental Satellites (POES), and are available from 1981 through Present. Data for all these years are available as multiple NCEI accessions. PFV5.3 production is running on operational mode and will be updated on quarterly basis.

1.4 Document Maintenance

This document is generated and maintained by NOAA's National Centers for Environmental Information. More on policy is available at https://www.ncei.noaa.gov/.

2. Results

The data stewardship maturity assessment information is summarized in Table 1. Each component is displayed along with its corresponding score in a color-coded table.

Table 2. Dataset and Data Stewardship Maturity Assessment Metadata	
Dataset Title	AVHRR Pathfinder Version 5.3 Level 3 Collated (L3C) Global 4km Sea Surface Temperature
Dataset Information URL	https://doi.org/10.7289/v52j68xx
Data Provider POC (Name; Email; Affiliation)	National Centers for Environmental Information, NESDIS, NOAA, U.S. Department of Commerce, 301-713-3277, NCEI. Info@noaa.gov
Dataset POC (Name; Email; Affiliation)	National Centers for Environmental Information, NESDIS, NOAA, U.S. Department of Commerce, 301-713-3277, NCEI. Info@noaa.gov
SMM Version (Document ID and Version Number)	NCDC-CICS-SMM_0001_Rev.1 12/09/2014
SMM POC (Name; E-mail; Affiliation)	Ge Peng, ge.peng@uah.edu, University of Alabama-Huntsville
SMM Template Version (Document ID and Version Numbers)	NCDC-CICS-SMM_0001_Rev.1 v4.0 06/23/2015
SMM Template POC	Ge Peng, ge.peng@uah.edu, University of Alabama-Huntsville
SMM Assessment Version (v<nn>r<mm>, e.g., v01r00)	v01r03
SMM Assessment Date (MM/DD/YYYY)	04/15/2019
SMM Assessment POC (Name; E-mail; Affiliation)	Raisa Ionin; raisa.ionin@noaa.gov; NOAA's National Centers of Environmental Information (NCEI)
Stewardship Maturity Ratings (each key component) (kc1/kc2/kc3/kc4/kc5/kc6/kc7/kc8/kc9)	5 /5 /4.5 /5 /4 /3 /3 /2.75 /3
SMM Original Assessment Date (MM/DD/YYYY)	03/13/2017
SMM Original Assessment POC (Name; E-mail; Affiliation)	Raisa Ionin; raisa.ionin@noaa.gov; NOAA's National Centers of Environmental Information (NCEI)
SMM Last Modified Date (MM/DD/YYYY)	10/13/2021
SMM Last Modification POC (Name; E-mail; Affiliation)	Katy Luquire, catherine.luquire@noaa.gov , CASE Consultants International
SMM Modified Date (MM/DD/YYYY)	04/15/2019
SMM Modification POC (Name; E-mail; Affiliation)	Raisa Ionin; raisa.ionin@noaa.gov; NOAA's National Centers of Environmental Information (NCEI)

Table 3. Stewardship Maturity Levels and Detailed Justifications for Each of Nine DSMM Key Components for the Dataset.	
DSMM Key Component	Stewardship Maturity Rating, Justification, and Comments
Preservability	Level 5 ▪ Archived by NCEI, which is NOAA designated repository. NOAA is compliant to NARA standards ▪ Metadata following ISO 19115-2 standards. ▪ Compliant to OIAS RM ▪ Plans to update metadata to ISO 19115-1 at a later date ▪ Using NCEI Silver Spring Archive Management System, AMS. Comments:
Accessibility	Level 5 ▪ Collection level searchable online ▪ Granule level is searchable online ▪ Additional search options available from collection level site ▪ Direct file download available from ▪ THREDDS:https://www.ncei.noaa.gov/thredds-ocean/catalog/pathfinder/Version5.3/L3C/catalog.html ▪ HTTP:https://data.nodc.noaa.gov/pathfinder/Version5.3/L3C/https://www.ncei.noaa.gov/data/oceans/pathfinder/Version5.3/L3C/ ▪ FTP:ftp://ftp-oceans.ncei.noaa.gov/pub/data.nodc/pathfinder/Version5.3/L3C/ ▪ Dissemination reports are available to the public https://www.nodc.noaa.gov/SatelliteData/pathfinder/logs/ ▪ Future technology changes are planned Comments: About AVHRR Pathfinder 5.3: https://www.nodc.noaa.gov/satellitedata/pathfinder4km53/ Link to NOAA CDR Sea Surface Temperature – Pathfinder Page https://www.ncdc.noaa.gov/cdr/oceanic/sea-surface-temperature-pathfinder Climate Data Records Factsheet https://www1.ncdc.noaa.gov/pub/data/sds/rsad-brochure-revised-01-13-09.pdf

Table 3. Stewardship Maturity Levels and Detailed Justifications for Each of Nine DSMM Key Components for the Dataset.	
DSMM Key Component	Stewardship Maturity Rating, Justification, and Comments
Usability	Level 4.5 ▪ The format is interoperable: netCDF for granules ▪ User guide [GHRSST, 2011] is available online https://www.nodc.noaa.gov/archive/arc0072/0123222/1.1/data/0-data/GHRSSTUserGuidev91.pdf ▪ User Manual [GHRSST, 2011] is available online https://www.nodc.noaa.gov/archive/arc0072/0123222/1.1/data/0-data/GDS20r5.pdf ▪ All GHRSST collections have error estimate. ▪ Error estimates/error budget for AVHRR Pathfinder can be found in [Baker-Yeboah, 2016] and are available online https://www1.ncdc.noaa.gov/pub/data/sds/cdr/CDRs/Sea_Surface_Temperature_Pathfinder/AlgorithmDescription.pdf ▪ All GHRSST collections have enhanced online capability (e.g., visualization, multiple data formats): TDS, DAP; access from metadata main landing page. ▪ A GHRSST User Guide, Quick Start Guide, GHRSST Data Specification (GDS) manual, and other relevant documents describing GHRSST data sets can be found in the archive accession, Documentation for The Group for High Resolution Sea Surface Temperature (GHRSST) data archived at NODC (NODC Accession 0123222), https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.nodc:0123222 ▪ Data flow diagram is available: https://www1.ncdc.noaa.gov/pub/data/sds/cdr/CDRs/Sea_Surface_Temperature_Pathfinder/DataFlowDiagram.pdf ▪ Algorithm documents are available: ▪ [Sea Surface Temperature - Pathfinder - Climate Algorithm Theoretical Basis Document, 2016] available online https://www.ncei.noaa.gov/sites/default/files/2020-04/AlgorithmDescription.pdf ▪ [Casey, 2010] available online https://www.nodc.noaa.gov/SatelliteData/pathfinder4km/OFS_21_Cas_09Dec2009.pdf ▪ No external ranking ▪ *Ranking was done for the previous version, Found previous version, 4 km AVHRR Pathfinder Version 5.2 Public Review Results: https://www.ncei.noaa.gov/products/avhrr-pathfinder-sst Comments: About AVHRR Pathfinder 5.3:https://www.nodc.noaa.gov/satellitedata/pathfinder4km53/
Production Sustainability	Level 5 ▪ The dataset is currently supported. ▪ Pathfinder is an Ad Hoc product. It receives updates with every version change. ▪ Changes for technology planned ▪ This is a NOAA NCEI product, under long-term institutional/national commitment Comments:

Table 3. Stewardship Maturity Levels and Detailed Justifications for Each of Nine DSMM Key Components for the Dataset.	
DSMM Key Component	Stewardship Maturity Rating, Justification, and Comments
Data Quality Assurance	Level 4 ▪ DQA procedure defined, documented and fully implemented based on the following documentation: ▪ [Sea Surface Temperature - Pathfinder - Climate Algorithm Theoretical Basis Document, 2016] available online https://www.ncei.noaa.gov/sites/default/files/2020-04/AlgorithmDescription.pdf ▪ [Casey, 2010] is available online https://www.ncei.noaa.gov/products/avhrr-pathfinder-sst ▪ [Kilpatrick , 2001] is available online https://doi.org/10.1029/1999jc000065 ▪ File level quality flags exist which can be considered limited data quality assurance metadata. Comments: Public review results for previous version only:https://www.nodc.noaa.gov/SatelliteData/pathfinder4km/pfv52_public_review_results.html
Data Quality Control/ Monitoring	Level 3 ▪ Limited Quality Control metrics are available based on publications ▪ [Sea Surface Temperature - Pathfinder - Climate Algorithm Theoretical Basis Document, 2016] available online https://www.ncei.noaa.gov/sites/default/files/2020-04/AlgorithmDescription.pdf ▪ [Casey, 2010] is available online https://www.ncei.noaa.gov/products/avhrr-pathfinder-sst ▪ [Kilpatrick , 2001] is available online https://doi.org/10.1029/1999JC000065 ▪ Sampling and analysis are frequent and systematic but not automatic ▪ Procedure documented and available online ▪ Community metrics defined and partially implemented Comments: NCEI Product description page:https://www.nodc.noaa.gov/satellitedata/pathfinder4km53/
Data Quality Assessment	Level 3 ▪ Algorithm Based Documentation (ATBD) ▪ [Sea Surface Temperature - Pathfinder - Climate Algorithm Theoretical Basis Document, 2016] available online https://www.ncei.noaa.gov/sites/default/files/2020-04/AlgorithmDescription.pdf ▪ Research product assessed in literature: ▪ [Sea Surface Temperature - Pathfinder - Climate Algorithm Theoretical Basis Document, 2016] available online https://www.ncei.noaa.gov/sites/default/files/2020-04/AlgorithmDescription.pdf ▪ [Casey, 2010] is available online https://www.ncei.noaa.gov/products/avhrr-pathfinder-sst ▪ [Kilpatrick , 2001] is available online https://doi.org/10.1029/1999JC000065 ▪ Operational product is assessed based on this publication: ▪ [Kilpatrick , 2001] and is available online https://doi.org/10.1029/1999JC000065 Comments:

Table 3. Stewardship Maturity Levels and Detailed Justifications for Each of Nine DSMM Key Components for the Dataset.	
DSMM Key Component	Stewardship Maturity Rating, Justification, and Comments
Transparency / Traceability	Level 2.75 ▪ Limited product information available, metadata only on the AVHRR_Pathfinder_L3C_V5.3landing page: https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.nodc:AVHRR_Pathfinder-NCEI-L3C-v5.3 ▪ GHRSST datasets are under Configuration Management principles: https://doi.org/10.5281/zenodo.4700465 ▪ Product information is available in literature: ▪ [Baker-Yeboah , 2016] ▪ [Casey, 2010] is available online https://www.ncei.noaa.gov/products/avhrr-pathfinder-sst ▪ [Kilpatrick , 2001] is available online https://doi.org/10.1029/1999JC000065 ▪ [Sea Surface Temperature - Pathfinder - Climate Algorithm Theoretical Basis Document, 2016] available online https://www.ncei.noaa.gov/sites/default/files/2020-04/AlgorithmDescription.pdf ▪ DOI is assigned - 10.7289/V52J68XX Comments:
Data Integrity	Level 3 ▪ Data archive integrity verifiable - Checksum technology is available, each AVHRR Pathfinder package is accompanied by a manifest in XML format containing hash digests generated using various algorithms, including MD5, SHA-1, SHA-384, etc. That includes checksums (.md5) for every file package. https://www.nodc.noaa.gov/archive/arc0095/0129789/0129789.1.1.xml ▪ Data authenticity is verifiable (since data can be downloaded via HTTPS and HTTPS uses certificates to prove site authenticity) ▪ NCEI-MD does not provide digital signatures for data dissemination Comments:

3. Acknowledgment

This work is supported by the NOAA OneStop Project.

We thank the dataset POCs for their valuable input, as well as the collaborative efforts of the OneStop teams, especially the Metadata team. We would also like to show appreciation to Ge Peng for her contributions.

The draft of this data stewardship maturity report is systematically generated by a tool created by Kieran Hodnett and populated with the stewardship maturity assessment done by the author(s) of this report. The tool was developed based on a Word template created collaboratively by Robert Partee II, Raisa Ionin, Paul Lemieux III, Ge Peng, Don Collins, and Sonny Zinn with helpful input from the NOAA Central Library and the NCEI Communication Team.

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Appendix I: The Scientific Data Stewardship Maturity Matrix (DSMM)

Table A1: This matrix (Version: NCDC-CICS-SMM-0001-Rev.1. 12/09/2014) describes the criterion used to evaluate data stewardship maturity for each of the nine DSMM key components [*Peng et al.*, 2015].

DSMM Component	**Level 1** ***Ad hoc*** Little or no management	**Level 2** ***Minimal*** Limited management	**Level 3** ***Intermediate*** Defined management, partially implemented	**Level 4** ***Advanced*** Well-defined management, fully implemented	**Level 5** ***Optimal*** Full management, audited, measured, controlled
Preservability *(The state of being preservable)*	Any storage location Data only	Non-designated repository Redundancy Limited archiving metadata	Designated archive Redundancy Community-standard archiving metadata Conforming to limited archiving standards	Level 3 + Conforming to community archiving standards	Level 4 + Archiving process performance controlled, measured, and audited Future archiving standard changes planned
Accessibility *(The state of being searchable and accessible publicly)*	Not publically available person-to-person	Publically available direct file download (e.g., via anonymous FTP server) Collection or dataset level searchable online	Level 2 + Non-standard data service Limited data server performance Granule/file level searchable Limited search metrics	Level 3 + Community-standard data service Enhanced data server performance Conforming to community search metrics Dissemination report metrics defined and implemented internally	Level 4 + Dissemination reports available online Future technology and standard changes planned

Usability *(The state of being easy to use)*	Extensive product-specific knowledge required No documentation online	Non-standard data format Limited documentation (e.g., user's guide online)	Community standard-based interoperable format & metadata Documentation (e.g. source code, product algorithm document, processing or/and data flow diagram) online	Level 3 + Basic capability (e.g., subsetting, aggregating) & data characterization overall/global, e.g., climatology, error estimates) available online	Level 4 + Enhanced online capability (e.g., visualization, multiple data formats) Community metrics of data characterization (regional/cell) online External ranking
Production Sustainability *(The state of data production being sustainable and extendable)*	Ad Hoc or Not applicable To obligation or deliverable requirement	Short-term Individual PI's commitment (grant obligations)	Medium-term Institutional commitment (contractual deliverables with specs and schedule defined)	Long-term Institutional commitment Product improvement process in place	Level 4 + National or international commitment Changes for echnology planned
Data Quality Assurance *(The state of data quality being assured)*	Data quality assurance (DQA) procedure unknown or none	Ad Hoc and random QA procedure not defined and documented	DQA procedure defined and documented and partially implemented	DQA procedure well documented, fully implemented and available online with master reference data Limited data quality assurance metadata	Level 4 + DQA procedure monitored and reported Conforming to community quality metadata & standards External review

Data Quality Control/ Monitoring *The state of data quality being controlled and monitored*	None or Sampling unknown or spotty Analysis unknown or random in time	Sampling and analysis are regular in time and space Limited product-specific metrics defined & implemented	Level 2 + Sampling and analysis are frequent and systematic but not automatic Community metrics defined and partially implemented Procedure documented and available online	Level 3 + Anomaly detection procedure well-documented and fully implemented using community metrics, automatic, tracked and reported Limited quality monitoring metadata	Level 4 + Cross-validation of temporal & spatial characteristics Physical consistency check Conforming to community quality metadata & standards
Data Quality Assessment *(The state of data quality being assessed)*	Algorithm/ method/model Theoretical basis assessed (methods and results online)	Level 1 + Research product assessed (methods and results online)	Level 2 + Operational product assessed (methods and results online)	Level 3 + Quality metadata assessed Limited quality assessment metadata	Level 4 + Assessment performed on a recurring basis Conforming to community quality metadata & standards External ranking
Transparency/ Traceability *(The state of being transparent, trackable, and traceable)*	Limited product information available Person-to-person	Product information available in literature	Algorithm Theoretical Basis Document (ATBD) & source code online Dataset configuration managed (CM) Unique Object Identifier (OID) assigned (dataset, documentation, source code) Data citation tracked (e.g., utilizing Digital Object Identifier	Level 3 + Operational Algorithm Description (OAD) online, OID assigned, and under CM	Level 4 + System information online Complete data provenance online

Data Integrity *(The state of data integrity being verifiable)*	Unknown or no data ingest integrity check	Data ingest integrity verifiable (e.g, checksum technology)	(DOI) system) Level 2 + Data archive integrity verifiable	Level 3 + Data access integrity verifiable Conforming to community data integrity technology standard	Level 4 + Data authenticity verifiable (e.g., data signature technology) Performance of data integrity check monitored and reported