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**Data Stewardship Maturity Report for GHRSSST Level 2P Global Skin Sea
Surface Temperature from the Moderate Resolution Imaging Spectroradiometer
(MODIS) on the NASA Aqua satellite (GDS versions 1 and 2)**

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 - 3.5	Data Quality Control/Monitoring - 1
Data Quality Assessment - 2	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 GHRSSST Level 2P Global Skin Sea Surface Temperature from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the NASA Aqua satellite (GDS versions 1 and 2)

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, GHRSSST Level 2P Global Skin Sea Surface Temperature from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the NASA Aqua satellite (GDS versions 1 and 2), is assessed based on a reference stewardship maturity framework. The current maturity ratings of GHRSSST Level 2P Global Skin Sea Surface Temperature from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the NASA Aqua satellite (GDS versions 1 and 2) are at Level 1 or higher for all nine key components with one Level 1, two Level 2, two Level 3, one Level 4, and three Level 5 key components.

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.

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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.

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Data Stewardship Maturity Report for GHRSSST Level 2P Global Skin Sea Surface Temperature from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the NASA Aqua satellite (GDS versions 1 and 2)

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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.

Data Stewardship Maturity Report for GHR SST Level 2P Global Skin Sea Surface Temperature from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the NASA Aqua satellite (GDS versions 1 and 2)

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

NASA produces skin sea surface temperature (SST) products from the Infrared (IR) channels of the Moderate-resolution Imaging Spectroradiometer (MODIS) onboard the Aqua satellite. Aqua was launched by NASA on May 4, 2002, into a sun synchronous, polar orbit with a daylight ascending node at 1:30 pm, formation flying in the A-train with other Earth Observation Satellites (EOS), to study the global dynamics of the Earth atmosphere, land and oceans. MODIS captures data in 36 spectral bands at a variety of spatial resolutions. Two SST products can be present in these files. The first is a skin SST produced for both day and night (NSST) observations, derived from the long wave IR 11 and 12 micron wavelength channels, using a modified nonlinear SST algorithm intended to provide continuity of SST derived from heritage and current NASA sensors. At night, a second SST product is generated using the mid-infrared 3.95 and 4.05 micron wavelength channels which are unique to MODIS; the SST derived from these measurements is identified as SST4. The SST4 product has lower uncertainty, but due to sun glint can only be used at night. MODIS L2P SST data have a 1 km spatial resolution at nadir and are stored in 288 five minute granules per day.

Full global coverage is obtained every two days, with coverage poleward of 32.3 degree being complete each day. The production of MODIS L2P SST files is part of the Group for High Resolution Sea Surface Temperature (GHRSSST) project and is a joint collaboration between the NASA Jet Propulsion Laboratory (JPL), the NASA Ocean Biology Processing Group (OBPG), and the Rosenstiel School of Marine and Atmospheric Science (RSMAS). Researchers at RSMAS are responsible for SST algorithm development, error statistics and quality flagging, while the OBPG, as the NASA ground data system, is responsible for the production of daily MODIS ocean products. JPL acquires MODIS ocean granules from the OBPG and reformats them to the GHRSSST L2P netCDF specification with complete metadata and ancillary variables, and distributes the data as the official Physical Oceanography Data Archive (PO.DAAC) for SST. The R2019.0 supersedes the previous R2014.0 datasets.

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	GHRSSST Level 2P Global Skin Sea Surface Temperature from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the NASA Aqua satellite (GDS versions 1 and 2)
Dataset Information URL	https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.nodc:GHRSSST-MODIS_A-JPL-L2P
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)	Edward Armstrong; edward.m.armstrong@jpl.nasa.gov NASA/JPL/PODAAC; Physical Oceanography Distributed Active Archive Center, Jet Propulsion Laboratory, NASA
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)	v02r03
SMM Assessment Date (MM/DD/YYYY)	04/18/2019
SMM Assessment POC (Name; E-mail; Affiliation)	Raisa Ionin, raisa.ionin@noaa.gov, Earth Resources Technology, Inc.
Stewardship Maturity Ratings (each key component) (kc1/kc2/kc3/kc4/kc5/kc6/kc7/kc8/kc9)	5 /5 /4.5 /5 /3.5 /1 /2 /2.75 /3
SMM Original Assessment Date (MM/DD/YYYY)	08/23/2016
SMM Original Assessment POC (Name; E-mail; Affiliation)	Raisa Ionin, raisa.ionin@noaa.gov, Earth Resources Technology, Inc.
SMM Last Modified Date (MM/DD/YYYY)	11/10/2021
SMM Last Modification POC (Name; E-mail; Affiliation)	Lori Hager, lori.hager@noaa.gov, CASE Consultants International
SMM Modified Date (MM/DD/YYYY)	04/18/2019
SMM Modification POC (Name; E-mail; Affiliation)	Raisa Ionin, raisa.ionin@noaa.gov, Earth Resources Technology, Inc.

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
<p>Preservability</p>	<p>Level 5</p> <ul style="list-style-type: none"> ▪ 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. <p>Comments:</p>
<p>Accessibility</p>	<p>Level 5</p> <ul style="list-style-type: none"> ▪ Collection level searchable online ▪ Granule level is searchable online ▪ Additional search options available from collection level site ▪ Direct file download available from ▪ https://www.ncei.noaa.gov/thredds-ocean/catalog/ghrsst/L2P/MODIS_A/JPL/catalog.html ▪ HTTP: https://data.nodc.noaa.gov/ghrsst/L2P/MODIS_A/JPL/ ▪ FTP: ▪ ftp://ftp-oceans.ncei.noaa.gov/pub/data.nodc/ghrsst/L2P/MODIS_A/JPL/ ▪ Data citation is also available from NASA PODAAC site: https://podaac.jpl.nasa.gov/dataset/JPL-L2P-MODIS_A ▪ Dissemination reports are available to the public https://www.ncei.noaa.gov/access/ghrsst-long-term-stewardship-and-reanalysis-facility/ ▪ Future technology changes are planned <p>Comments:</p>

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
<p>Usability</p>	<p>Level 4.5</p> <ul style="list-style-type: none"> ▪ The format is interoperable: NetCDF (.nc for granules) ▪ User Guide [GHRSSST, 2011] is available online https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.nodc:0123222 ▪ User Manual [GHRSSST, 2011] is available online ▪ https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.nodc:0123222 ▪ All GHRSSST collections have error estimate. ▪ All GHRSSST collections have enhanced online capability (e.g., visualization, multiple data formats): TDS, DAP (*data servers maintained at NCEI); access from metadata main landing page. ▪ A GHRSSST User Guide, Quick Start Guide, GHRSSST Data Specification (GDS) manual, and other relevant documents describing GHRSSST data sets can be found in the archive accession, Documentation for The Group for High Resolution Sea Surface Temperature (GHRSSST) data archived at NODC (NODC Accession 0123222), ▪ https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.nodc:0123222 ▪ Algorithm documentation [Brown, 1999] is available online https://modis.gsfc.nasa.gov/data/atbd/atbd_mod25.pdf ▪ No external ranking <p>Comments:</p>
<p>Production Sustainability</p>	<p>Level 5</p> <ul style="list-style-type: none"> ▪ The dataset is currently supported, according to LTSRF Table: https://www.ncei.noaa.gov/access/ghrsst-long-term-stewardship-and-reanalysis-facility/ ▪ Long-term institutional commitment through NASA/JPL/PODAAC; Physical Oceanography Distributed Active Archive Center, Jet Propulsion Laboratory, NASA ▪ Long-term international commitment (GHRSSST is an international group) ▪ Changes for technology are available from individual dataset producers. <p>Comments:</p> <p>Changes for technology are available from individual dataset producers. NOAA does not have them documented.</p> <p>From LTSRF page, the product is listed under JPL, then MODIS_A</p>
<p>Data Quality Assurance</p>	<p>Level 3.5</p> <ul style="list-style-type: none"> ▪ Data quality procedure defined, documented and partially implemented. ▪ Error validation is addressed in the algorithm document: [Brown, 1999] is available online https://modis.gsfc.nasa.gov/data/atbd/atbd_mod25.pdf ▪ File level quality flags exist which can be considered limited data quality assurance metadata. More information on SST quality flags: ▪ https://oceancolor.gsfc.nasa.gov/atbd/sst/flag/ <p>Comments:</p>

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 Control/ Monitoring	<p>Level 1</p> <ul style="list-style-type: none"> ▪ No Quality Control metrics are available. Some information can be found at ftp://podaac.jpl.nasa.gov/allData/modis/docs/modis_sst.gd.html <p>Comments:</p>
Data Quality Assessment	<p>Level 2</p> <ul style="list-style-type: none"> ▪ Algorithm documentation [Brown, 1999] is available online https://modis.gsfc.nasa.gov/data/atbd/atbd_mod25.pdf ▪ Research product is assessed [Brown, 1999] and is available online https://modis.gsfc.nasa.gov/data/atbd/atbd_mod25.pdf ▪ Information on Long-Wave Sea Surface Temperature (SST):https://oceancolor.gsfc.nasa.gov/atbd/sst/ ▪ Information on Short-Wave Sea Surface Temperature (SST): https://oceancolor.gsfc.nasa.gov/atbd/sst4 ▪ Operational product is not assessed. <p>Comments:</p> <p>Related article { { Kilpatrick, , 2015 } Kilpatrick, K., G. Podestá, S. Walsh, E. Williams, V. Halliwell, M. Szczodrak, O. Brown, P. Minnett, and R. Evans (2015), A decade of sea surface temperature from MODIS, <i>Remote Sensing of Environment</i>, 165, 27–41, doi: 10.1016/j.rse.2015.04.023 } is available online http://doi.org/10.1016/j.rse.2015.04.023</p>
Transparency / Traceability	<p>Level 2.75</p> <ul style="list-style-type: none"> ▪ Limited product information available, metadata only on GHRSSST_L2P_GSSST_MODIS_NASA_AQUA_S landing page https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.nodc:GHRSSST-MODIS_A-JPL-L2P ▪ Product information available in literature: <ul style="list-style-type: none"> ▪ [Kilpatrick, , 2015] is available online http://doi.org/10.1016/j.rse.2015.04.023 ▪ [Brown, 1999] is available online https://modis.gsfc.nasa.gov/data/atbd/atbd_mod25.pdf ▪ ATBD document online: [Brown, 1999] is available online https://modis.gsfc.nasa.gov/data/atbd/atbd_mod25.pdf ▪ GHRSSST datasets are under Configuration Management principles: ftp://ftp.nodc.noaa.gov/nodc/archive/arc0072/0123222/2.2/data/0-data/governance-documents/ ▪ DOI assigned from NOAA PODAAC site: 10.5067/GHMDA-2PJ01 <p>Comments:</p>
Data Integrity	<p>Level 3</p> <ul style="list-style-type: none"> ▪ Data archive integrity verifiable - Checksum technology is available, each GHRSSST_L2P_GSSST_MODIS_NASA_AQUA_S 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/arc0020/0052677/0052677.1.1.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 ▪ <p>Comments:</p>

3. Acknowledgment

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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 <i>Ad hoc</i> Little or no management	Level 2 <i>Minimal</i> Limited management	Level 3 <i>Intermediate</i> Defined management, partially implemented	Level 4 <i>Advanced</i> Well-defined management, fully implemented	Level 5 <i>Optimal</i> Full management, audited, measured, controlled
<i>Preservability</i> <i>(The state of being preservable)</i>	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
<i>Accessibility</i> <i>(The state of being searchable and accessible publicly)</i>	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

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

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

<p>Data Integrity</p> <p><i>(The state of data integrity being verifiable)</i></p>	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