

**NOAA Technical Information Series NESDIS
DSMR-00240 Version 1.0**



doi: 10.25923/472n-jg67

Data Stewardship Maturity Report for GHRSSST Level 2P Global 1m Sea Surface Temperature from the Advanced Very High Resolution Radiometer (AVHRR) on the MetOp-A satellite produced by NAVO (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 - 3
Data Quality Assessment - 0	Transparency/Traceability - 2	Data Integrity - 3

NOAA National Centers for Environmental Information January 2020



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 1m Sea Surface Temperature from the Advanced Very High Resolution Radiometer (AVHRR) on the MetOp-A satellite produced by NAVO (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 1m Sea Surface Temperature from the Advanced Very High Resolution Radiometer (AVHRR) on the MetOp-A satellite produced by NAVO (GDS versions 1 and 2), is assessed based on a reference stewardship maturity framework. The current maturity ratings of GHRSSST Level 2P Global 1m Sea Surface Temperature from the Advanced Very High Resolution Radiometer (AVHRR) on the MetOp-A satellite produced by NAVO (GDS versions 1 and 2) are at Level 1 or higher for all nine key components with zero Level 1, one Level 2, three 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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ASSESSMENT REVISION HISTORY

Revision	Description	Date
V01r00	Initial Release	12/27/2021

NOAA Technical Information Series NESDIS DSMR-00240

Version 1.0

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Recommended Citation

Paul Lemieux III, Katy Luquire. (2021), Data Stewardship Maturity Report for GHRSSST Level 2P Global 1m Sea Surface Temperature from the Advanced Very High Resolution Radiometer (AVHRR) on the MetOp-A satellite produced by NAVO (GDS versions 1 and 2), NOAA Technical Information Series NESDIS DSMR-00240 Version 1.0, 20pp., doi: 10.25923/472n-jg67

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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 GHRSSST Level 2P Global 1m Sea Surface Temperature from the Advanced Very High Resolution Radiometer (AVHRR) on the MetOp-A satellite produced by NAVO (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

A global Group for High Resolution Sea Surface Temperature (GHRSSST) Level 2P dataset containing multi-channel Sea Surface Temperature (SST) retrievals derived in real-time from the Advanced Very High Resolution Radiometer (AVHRR) level-1B data from the Meteorological Operational-A (MetOp-A) satellite. The SST data in this dataset are used operationally in oceanographic analyses and forecasts by the US Naval Oceanographic Office (NAVO). The MetOp satellite program is a European multi-satellite program to provide weather data services for monitoring climate and improving weather forecasts. MetOp-A, MetOp-B and Metop-C were respectively launched on 19 Oct 2006, 17 September 2012 and 7 November 2018. The program was jointly established by the European Space Agency (ESA) and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) with the US National Oceanic and Atmospheric Administration (NOAA) contributing the AVHRR sensor. AVHRR instruments measure the radiance of the Earth in 5 (or 6) relatively wide spectral bands.

The first two are centered around the red (0.6 micron) and near-infrared (0.9 micron) regions, the third one is located around 4 (3.6) micron, and the last two sample the emitted thermal radiation, around 11 and 12 micron, respectively. The legacy 5 band instrument is known as AVHRR/2 while the more recent version, the AVHRR/3 (first carried on the NOAA-15 platform), acquires data in a 6th channel located at 1.6 micron. Typically, the 11 and 12 micron channels are used to derive SST sometimes in combination with the 3.5 micron channel. The swath of the AVHRR sensor is a relatively large 2400 km. All MetOp platforms are sun synchronous and generally view the same earth location twice a day (latitude dependent). The ground native resolution of the AVHRR instruments is approximately 1.1 km at nadir and degrades off nadir. This particular dataset is produced from legacy Global Area Coverage (GAC) data that are derived from a sample averaging of the full resolution global AVHRR data. Four out of every five samples along the scan line are used to compute on average value and the data from only every third scan line are processed, yielding an effective 4 km spatial resolution at nadir. The v2.0 is the updated version from current v1.0 with extensive algorithm improvements and upgrades. The major improvements include: 1) Significant changes in contaminant/cloud detection; 2) Increased the spatial resolution from 9 km to 4 km; 3) Updated compliance with GDS2, ACDD 1.3, and CF 1.6; and 4) Removed the dependency on the High-resolution Infrared Radiation Sounder (HIRS) sensor (only available to MetOp-A/B), thus allowing for the consistent inter-calibration and the processing of MetOp-A/B/C data.

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	GHR SST Level 2P Global 1m Sea Surface Temperature from the Advanced Very High Resolution Radiometer (AVHRR) on the MetOp-A satellite produced by NAVO (GDS versions 1 and 2)
Dataset Information URL	https://www.ncei.noaa.gov/metadata/geoportal/rest/metadata/item/gov.noaa.nodc%3AGHRSSST-AVHRRMTA_G-NAVO-L2P/html
Data Provider POC (Name; Email; Affiliation)	NOAA National Centers for Environmental Information (NCEI), NCEI.Info@noaa.gov
Dataset POC (Name; Email; Affiliation)	Doug May, doug.may@navy.mil, Naval Oceanographic Office (NAVO)
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)	V01r06
SMM Assessment Date (MM/DD/YYYY)	04/23/2019
SMM Assessment POC (Name; E-mail; Affiliation)	Paul Lemieux III, Paul.Lemieux@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 / 3 / 0 / 2 / 3
SMM Original Assessment Date (MM/DD/YYYY)	08/17/2016
SMM Original Assessment POC (Name; E-mail; Affiliation)	Paul Lemieux III, Paul.Lemieux@noaa.gov, Earth Resources Technology, Inc.
SMM Last Modified Date (MM/DD/YYYY)	10/05/2021
SMM Last Modification POC (Name; E-mail; Affiliation)	Katy Luquire, catherine.luquire@noaa.gov , CASE Consultants International
SMM Modified Date (MM/DD/YYYY)	04/23/2019
SMM Modification POC (Name; E-mail; Affiliation)	Paul Lemieux III, Paul.Lemieux@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 a NOAA designated archive compliant to NARA standards. ▪ Metadata following ISO 19115-2. ▪ Compliant to OIAS RM. ▪ Plans to update metadata to ISO 19115-1 at a later date and will be a pilot dataset for the OneStop initiative. ▪ Multiple access points provide several layers of redundancy. ▪ Using NCEI Silver Spring Archive Management System, AMS. <p>Comments: No 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 ▪ FTP: ftp://ftp-oceans.ncei.noaa.gov/pub/data.nodc/ghrsst/L2P/AVHRRMTA_G/NAVO/ ▪ HTTP: https://www.ncei.noaa.gov/data/oceans/ghrsst/L2P/AVHRRMTA_G/NAVO/ ▪ THREDDS: https://www.ncei.noaa.gov/thredds-ocean/catalog.html ▪ Dissemination reports are available to the public https://www.ncei.noaa.gov/access/ghrsst-long-term-stewardship-and-reanalysis-facility/ ▪ New technology for OneStop search and discovery planned (i.e. ElasticSearch, Hyrax Servers, etc.) This is part of the GHRSSST data group that will be OneStop ready. ▪ Additional enhanced data server performance (LAS, TDS, DAP) are maintained by NCEI and accessible from the metadata landing page. <p>Comments: No comments</p>
<p>Usability</p>	<p>Level 4.5</p> <ul style="list-style-type: none"> ▪ Community standard interoperable format: NetCDF ▪ GHRSSST User’s guide [GHRSSST, 2011] is available online at: https://www.nodc.noaa.gov/archive/arc0072/0123222/1.1/data/0-data/GHRSSSTUserGuidev91.pdf ▪ 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 ▪ Aggregating granules is possible via THREDDS server. ▪ All GHRSSST collections have error estimates. ▪ All GHRSSST collections have enhanced online capability (e.g., visualization, multiple data formats) : TDS, DAP, LAS (*data servers maintained at NCEI); access from metadata main landing page <p>Comments: No known external rankings.</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
Production Sustainability	<p>Level 5</p> <ul style="list-style-type: none"> ▪ NOAA NCEI-MD supporting long term stewardship of GHRSSST collections as part of LTSRF: https://www.ncei.noaa.gov/access/ghrsst-long-term-stewardship-and-reanalysis-facility/ ▪ Long-term international commitment (GHRSSST is an international collaboration). ▪ MetOp satellites are fully funded by the ESA and EUMETSAT <p>Comments: Changes for technology are available from individual dataset producers. NOAA does not have them documented.</p>
Data Quality Assurance	<p>Level 3.5</p> <ul style="list-style-type: none"> ▪ DQA procedure defined and documented in the GHRSSST Data Specification user’s guide [GHRSSST, 2011] available online here https://www.nodc.noaa.gov/archive/arc0072/0123222/1.1/data/0-data/GHRSSSTUserGuidev91.pdf ▪ L2 and L3 File level quality flags exist which can be considered limited data quality assurance metadata. <p>Comments: No known external reviews</p>
Data Quality Control/ Monitoring	<p>Level 3</p> <ul style="list-style-type: none"> ▪ Limited Quality Control metrics are available: https://www.star.nesdis.noaa.gov/sod/sst/squam/ ▪ Sampling and analysis are frequent and systematic but not automatic ▪ General GHRSSST procedure documented and available online in the data specification user’s guide [GHRSSST, 2011] available online here: https://www.nodc.noaa.gov/archive/arc0072/0123222/1.1/data/0-data/GHRSSSTUserGuidev91.pdf <p>Comments:</p>
Data Quality Assessment	<p>Level 0</p> <ul style="list-style-type: none"> ▪ The PI’s have the algorithm documentation, but it isn’t available online. <p>Comments: MetOp-A AVHRR SST is assessed in this paper {{Liang and Ignatov, 2013} Liang, X., and Ignatov, A., (2013), AVHRR, MODIS, and VIIRS radiometric stability and consistency in SST bands, <i>Journal of Geophysical Research Oceans</i>, 118(6), 3161—3171, doi:10.1002/jgrc.20205.} with comparisons between AVHRR, MODIS, and VIIRS SST performance. Paper is available online here: https://doi.org/10.1002/jgrc.20205</p>
Transparency / Traceability	<p>Level 2</p> <ul style="list-style-type: none"> ▪ The PI’s have the algorithm documentation, but it isn’t available online. ▪ MetOp-A SST information available in literature [Liang and Ignatov, 2013] available online here: https://doi.org/10.1002/jgrc.20205 ▪ OID Assigned: GHRSSST-AVHRRMTA-G-NAVO-L2P ▪ GHRSSST datasets are under configuration management principles: https://doi.org/10.5281/zenodo.4700465 <p>Comments: No DOI assigned No OAD available</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 Integrity	<p>Level 3</p> <ul style="list-style-type: none"> ▪ Data archive integrity verifiable - Checksum technology is available, each GHR SST_L2P_GSSST_TRMM_MI 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/arc0042/0086756/0086756.1.1.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: Checksum file available for download from PODAAC FTP: ftp://podaac-ftp.jpl.nasa.gov/allData/ghrsst/data/GDS2/L2P/AVHRRMTA_G/NAVO/v1/</p>

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.

4. References

Casey, K. (2016), The NOAA OneStop data discover and access framework project, Version: June 3, 2016. <https://cdn.ioos.noaa.gov/media/2017/12/OneStop-IOOS-DMAC-03-June-2016.pdf>

Peng, G. (2015) The scientific data stewardship maturity assessment model template, Version: NCDC-CICS-SMM-0001-Rev.1 v4.0 6/23/2015. doi:10.6084/m9.figshare.1211954.

Peng, G., J.L. Privette, E.J. Kearns, N.A. Ritchey, and S. Ansari (2015), A unified framework for measuring stewardship practices applied to digital environmental datasets, *Data Science Journal*, 13, 231-253, doi: 10.2481/dsj.14-049.

Peng, G., J. Lawrimore, V. Toner, C. Lief, R. Baldwin, N. Ritchey, D. Brinegar, and S. A. Delgreco (2016) assessing stewardship maturity of the global historical climatology network-monthly (GHCN-M) dataset: use case study and lessons learned, *D-Lib Magazine*, 22, doi:10.1045/november2016-peng.

GHRSSST User Guide version 9.1, (2011), retrieved online: <https://www.nodc.noaa.gov/archive/arc0072/0123222/1.1/data/0-data/GHRSSSTUserGuidev91.pdf>
(Accessed December 22, 2016)

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