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DSMR-00147 Version 1.0**



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**Data Stewardship Maturity Report for World Ocean Atlas 2013 (NCEI Accession
0114815)**

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 - 2	Data Quality Assurance - 4	Data Quality Control/Monitoring - 3.5
Data Quality Assessment - 3	Transparency/Traceability - 2.5	Data Integrity - 3

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National Environmental Satellite, Data, and Information Service

Cover Image: Data Stewardship Rating Diagram for World Ocean Atlas 2013 (NCEI Accession 0114815)

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, World Ocean Atlas 2013 (NCEI Accession 0114815), is assessed based on a reference stewardship maturity framework. The current maturity ratings of World Ocean Atlas 2013 (NCEI Accession 0114815) are at Level 1 or higher for all nine key components with zero Level 1, two Level 2, three Level 3, two Level 4, and two 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 World Ocean Atlas 2013 (NCEI Accession 0114815)

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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 World Ocean Atlas 2013 (NCEI Accession 0114815)

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

World Ocean Atlas 2013 (WOA13) is a set of objectively analyzed (1 degree grid and 1/4 degree grid) climatological fields of in situ temperature, salinity, dissolved oxygen, Apparent Oxygen Utilization, percent oxygen saturation, phosphate, silicate, and nitrate at standard depth levels for annual, seasonal, and monthly compositing periods for the World Ocean. 1/4 degree fields are for temperature and salinity only. It also includes associated statistical fields of observed oceanographic profile data interpolated to standard depth levels on 1/4 degree, 1 degree, and 5 degree grids. Temperature and salinity fields are available for six decades (1955-1964, 1965-1974, 1975-1984, 1985-1994, 1995-2004, and 2005-2012) and an average of all decades representing the period 1955-2012. Nutrient and oxygen fields are available using all quality controlled data for the entire sampling period 1878-2012.

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	World Ocean Atlas 2013 (NCEI Accession 0114815)
Dataset Information URL	https://www.ncei.noaa.gov/metadata/geoportal/rest/metadata/item/gov.noaa.nodc%3A0114815/html
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)	v01r05
SMM Assessment Date (MM/DD/YYYY)	04/19/2019
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 /2 /4 /3.5 /3 /2.5 /3
SMM Original Assessment Date (MM/DD/YYYY)	09/13/2016
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)	11/04/2021
SMM Last Modification POC (Name; E-mail; Affiliation)	Lori Hager, lori.hager@noaa.gov, CASE Consultants International
SMM Modified Date (MM/DD/YYYY)	04/19/2019
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 4.5</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 ▪ HTTP: https://data.nodc.noaa.gov/woa/WOA13/ ▪ THREDDS: https://ncei.noaa.gov/thredds-ocean/catalog/ncei/archive/data/0114815/catalog.html ▪ FTP: ftp://ftp-oceans.ncei.noaa.gov/nodc/web/woa.data.nodc/WOA13/ ▪ HTTPS: https://www.ncei.noaa.gov/data/oceans/ncei/archive/data/0114815/ ▪ THREDDS: https://ncei.noaa.gov/thredds-ocean/catalog/ncei/archive/data/0114815/catalog.html ▪ HTTPS: https://www.ncei.noaa.gov/archive/accession/download/114815 ▪ FTP: ftp://ftp-oceans.ncei.noaa.gov/nodc/archive/arc0079/0114815/ ▪ Dissemination reports for World Ocean Atlas are not available. ▪ Future technology changes are planned, the data is NetCDF compliant. <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
Usability	<p>Level 4.5</p> <ul style="list-style-type: none"> ▪ The format is interoperable: NetCDF; nc. for granules ▪ Product documentation is available online: <ul style="list-style-type: none"> ▪ [Boyer, 2013] is available online https://data.nodc.noaa.gov/nodc/archive/data/0114815/DOC/woa13documentation.pdf ▪ [Boyer, 2015] is available online https://data.nodc.noaa.gov/nodc/archive/data/0114815/DOC/woa13v2_changes.pdf ▪ User Manual is available: [Johnson, 2013] is available online http://www.nodc.noaa.gov/OC5/WOD13/docwod13.html ▪ Additional information is available on World Ocean Atlas v. 2 website : https://www.nodc.noaa.gov/OC5/woa13/ ▪ Enhanced online capability: World Ocean Atlas collection has enhanced online capability (e.g., visualization, multiple data formats): TDS, DAP (*data servers maintained at NCEI); access from metadata main landing page. ▪ Visualization and multiple data formats are available from WOA 13 Data Access website: http://www.nodc.noaa.gov/OC5/woa13/woa13data.html ▪ *Select every category (Temperature, Salinity, etc). Different formats are available: ASCII, NetCDF, CSV. For example, data access for Statistical mean of salinity on 1° grid for all decades: http://www.nodc.noaa.gov/cgi-bin/OC5/woa13/woa13.pl?parameter=s ▪ Figures can be derived and displayed visually and automatically according to user's requirements: <ul style="list-style-type: none"> ▪ http://www.nodc.noaa.gov/OC5/woa13fv2/index.html (WOA site contains the full data and products of the entire ocean atlas.) ▪ http://www.nodc.noaa.gov/OC5/SELECT/woaselect/woaselect.html (In the WOA Select site, the user can select a particular area, depth, and variable to focus in the data and figures for such subset.) ▪ Community metrics of data characterization (regional, cell, online are met. Any info about spatial data is in NetCDF and external documentation. Temporal span is covered in NetCDFs as well. ▪ No external ranking ▪ <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>Production Sustainability</p>	<ul style="list-style-type: none"> ▪ Level 4 ▪ Over 20-years institutional support for WOA, demonstrated by the continuous support of the WOA products development and releases https://www.nodc.noaa.gov/OC5/indprod.html ▪ The dataset is archived and available publicly and considered as high scientific quality by NCEI and high impact dataset (over 400 citations in the literature). ▪ Product improvement is in place ▪ The current version for WOA13 is v2 which appears to be released in July 2015: https://www.nodc.noaa.gov/OC5/woa13/ ▪ WOA started as early as 1994 (WOA94) and gone through a number of releases prior to 2013 https://www.nodc.noaa.gov/OC5/indprod.html <p>Comments: The World Ocean Atlas 17 is planned for release in 2017.</p>
<p>Data Quality Assurance</p>	<p>Level 4</p> <ul style="list-style-type: none"> ▪ DQA procedure well documented, fully implemented and available online with master reference data based on the publications: ▪ Product documentation is available online: ▪ [Boyer, 2013] is available online https://data.nodc.noaa.gov/nodc/archive/data/0114815/DOC/woa13documentation.pdf ▪ [Johnson, 2013] is available online http://www.nodc.noaa.gov/OC5/WOD13/docwod13.html ▪ [Locarnini, 2013] is available online https://data.nodc.noaa.gov/woa/WOA13/DOC/woa13_vol1.pdf ▪ [Zweng, 2013] is available online https://data.nodc.noaa.gov/woa/WOA13/DOC/woa13_vol2.pdf ▪ [Garcia, 2013] is available online https://data.nodc.noaa.gov/woa/WOA13/DOC/woa13_vol3.pdf ▪ [Garcia, 2013] is available online https://data.nodc.noaa.gov/woa/WOA13/DOC/woa13_vol4.pdf ▪ General link to World Ocean Atlas publications. Includes documents on Temperature, Salinity, Oxygen, and Nutrients. http://www.nodc.noaa.gov/OC5/woa13/pubwoa13.html ▪ File level quality flags exist which can be considered limited data quality assurance metadata. <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>Data Quality Control/Monitoring</p>	<ul style="list-style-type: none"> ▪ Level 3.5 ▪ Anomaly detection procedure well-documented and fully implemented using community metrics, automatic, tracked and reported based on Quality Control sections of World Ocean Atlas 13 publications: ▪ General link to World Ocean Atlas publications. Includes documents on Temperature, Salinity, Oxygen, and Nutrients. http://www.nodc.noaa.gov/OC5/woa13/pubwoa13.html ▪ [Locarnini, 2013] is available online https://data.nodc.noaa.gov/woa/WOA13/DOC/woa13_vol1.pdf ▪ [Zweng, 2013] is available online https://data.nodc.noaa.gov/woa/WOA13/DOC/woa13_vol2.pdf ▪ [Garcia, 2013] is available online https://data.nodc.noaa.gov/woa/WOA13/DOC/woa13_vol3.pdf ▪ [Garcia, 2013] is available online https://data.nodc.noaa.gov/woa/WOA13/DOC/woa13_vol4.pdf <p>Comments: World Ocean Database and World Ocean Atlas are part of IQUOD, International Quality Controlled Ocean Database http://www.iquod.org/documents.html *IQUOD – international effort to QC data. They produce new and QC flags.</p>
<p>Data Quality Assessment</p>	<p>Level 3</p> <ul style="list-style-type: none"> ▪ Algorithm is available in World Ocean Atlas 13 publications: ▪ [Locarnini, 2013] is available online https://data.nodc.noaa.gov/woa/WOA13/DOC/woa13_vol1.pdf ▪ [Zweng, 2013] is available online https://data.nodc.noaa.gov/woa/WOA13/DOC/woa13_vol2.pdf ▪ [Garcia, 2013] is available online https://data.nodc.noaa.gov/woa/WOA13/DOC/woa13_vol3.pdf ▪ [Garcia, 2013] is available online https://data.nodc.noaa.gov/woa/WOA13/DOC/woa13_vol4.pdf ▪ Algorithm is based on publications by ▪ [Barnes, 1964] is available online <a href="http://doi.org/10.1175/1520-0450(1964)003<0396:ATFMDI>2.0.CO;2">http://doi.org/10.1175/1520-0450(1964)003<0396:ATFMDI>2.0.CO;2 ▪ [Cressman, 1959] is available online <a href="http://doi.org/10.1175/1520-0493(1959)087<0367:AOOAS>2.0.CO;2">http://doi.org/10.1175/1520-0493(1959)087<0367:AOOAS>2.0.CO;2 ▪ Research and Operational products are assessed based on the above publications. World Ocean Atlas 13 is a community product. It is cited by 400+ peer-reviewed papers. <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>Transparency / Traceability</p>	<p>Level 2.5</p> <ul style="list-style-type: none"> ▪ Product information and algorithm are available in multiple literature publications, including: ▪ Algorithm is available in World Ocean Atlas 13 publications: ▪ [Locarnini, 2013] is available online https://data.nodc.noaa.gov/woa/WOA13/DOC/woa13_vol1.pdf ▪ [Zweng, 2013] is available online https://data.nodc.noaa.gov/woa/WOA13/DOC/woa13_vol2.pdf ▪ [Garcia, 2013] is available online https://data.nodc.noaa.gov/woa/WOA13/DOC/woa13_vol3.pdf ▪ [Garcia, 2013] is available online https://data.nodc.noaa.gov/woa/WOA13/DOC/woa13_vol4.pdf ▪ Algorithm is based on publications by ▪ [Barnes, 1964] is available online <a href="http://doi.org/10.1175/1520-0450(1964)003<0396:ATFMDI>2.0.CO;2">http://doi.org/10.1175/1520-0450(1964)003<0396:ATFMDI>2.0.CO;2 ▪ [Cressman, 1959] is available online <a href="http://doi.org/10.1175/1520-0493(1959)087<0367:AOOAS>2.0.CO;2">http://doi.org/10.1175/1520-0493(1959)087<0367:AOOAS>2.0.CO;2 ▪ A DOI has been assigned and minted for the WOA13 dataset: 10.7289/V5F769GT ▪ Dataset is not under Configuration management. <p>Comments:</p>
<p>Data Integrity</p>	<p>Level 3</p> <ul style="list-style-type: none"> ▪ Data archive integrity verifiable - Checksum technology is available, each WOA_2013 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/arc0079/0114815/0114815.1.1.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>

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4. References

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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.

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Boyer, T., and A. Mishonov (2013), World Ocean Atlas 2013 Product Documentation, Ocean Climate Laboratory, NODC/NESDIS/NOAA. Silver Spring, MD, retrieved online <https://data.nodc.noaa.gov/nodc/archive/data/0114815/DOC/woa13documentation.pdf> (Accessed 21 February 2017)

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doi:10.1175/1520-0493(1959)087<0367:aoas>2.0.co;2

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