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**Data Stewardship Maturity Report for NOAA Climate Data Record (CDR) of  
Cloud Properties from AVHRR Pathfinder Atmospheres – Extended (PATMOS-x),  
Version 5.3**

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 - 4.5	Accessibility - 4.5	Usability - 4
Production Sustainability - 4	Data Quality Assurance - 4	Data Quality Control/Monitoring - 2
Data Quality Assessment - 3	Transparency/Traceability - 3.5	Data Integrity - 3.5

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 NOAA Climate Data Record (CDR) of Cloud Properties from AVHRR Pathfinder Atmospheres – Extended (PATMOS-x), Version 5.3

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, NOAA Climate Data Record (CDR) of Cloud Properties from AVHRR Pathfinder Atmospheres – Extended (PATMOS-x), Version 5.3, is assessed based on a reference stewardship maturity framework. The current maturity ratings of NOAA Climate Data Record (CDR) of Cloud Properties from AVHRR Pathfinder Atmospheres – Extended (PATMOS-x), Version 5.3 are at Level 1 or higher for all nine key components with zero Level 1, one Level 2, three Level 3, five Level 4, and zero 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.

## ASSESSMENT REVISION HISTORY

Revision	Description	Date
V01r00	Initial Release	12/27/2021

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Cloud Properties from AVHRR Pathfinder Atmospheres – Extended (PATMOS-x),  
Version 5.3

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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 NOAA Climate Data Record (CDR) of Cloud Properties from AVHRR Pathfinder Atmospheres – Extended (PATMOS-x), Version 5.3**

**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**

This NOAA Climate Data Record (CDR) of cloud products was produced by the University of Wisconsin using the AVHRR Pathfinder Atmospheres - Extended (PATMOS-X) Version 5.3 processing system. The CDR spans from 1979 to the present with daily, global coverage generated from between two and ten NOAA and MetOp satellite passes per day. The source AVHRR data points, with a sensor resolution of 1.09 km near nadir, have been fitted to a 0.1 x 0.1 degree equal-angle grid in ascending and descending files. The four fundamental cloud variables in the CDR include: 1) Cloud Optical Thickness; 2) Cloud Particle Size; 3) Cloud Temperature; and 4) Cloud Emissivity. These cloud products are derived using the ABI (Advanced Baseline Imager) Cloud Height Algorithm (ACHA) and the Daytime Cloud Optical Properties (DCOMP) algorithm. Other variables in this dataset were derived from the four primary variables, or generated through error/quality control assessment in the algorithms.

Not counting the coordinate variables, there are 48 data and ancillary data variables in the netCDF data file to facilitate proper data usage. The file format was converted from HDF to netCDF-4 with metadata following the Climate and Forecast (CF) Conventions and Attribute Convention for Dataset Discovery (ACDD). The dataset is accompanied by algorithm documentation, data flow diagram and source code for the NOAA CDR Program.

#### **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	NOAA Climate Data Record (CDR) of Cloud Properties from AVHRR Pathfinder Atmospheres – Extended (PATMOS-x), Version 5.3
Dataset Information URL	<a href="https://doi.org/10.7289/V5348HCK">https://doi.org/10.7289/V5348HCK</a>
Data Provider POC (Name; Email; Affiliation)	NOAA National Centers for Environmental Information (NCEI), ncei.orders@noaa.gov
Dataset POC (Name; Email; Affiliation)	NOAA Climate Data Record Program Office, avhrr_patmosx_contacts@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)	06/27/2016
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)	4.5 / 4.5 / 4 / 4 / 4 / 2 / 3 / 3.5 / 3.5
SMM Original Assessment Date (MM/DD/YYYY)	06/03/2016
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)	10/12/2021
SMM Last Modification POC (Name; E-mail; Affiliation)	Lori Hager, lori.hager@noaa.gov, CASE Consultants International
SMM Modified Date (MM/DD/YYYY)	03/14/2018
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
Preservability	<p>Level 4.5</p> <ul style="list-style-type: none"><li>▪ Archived at NOAA NCEI-NC</li><li>▪ Following NOAA Climate Data Record (CDR) Research-2-Operation (R2O) transition process with the Initial Operation Capability (IOC)</li><li>▪ Following OAIS RM</li><li>▪ Conforms to ISO 19115-2 metadata standard</li><li>▪ Conforming to NetCDF CF metadata conventions.</li><li>▪ Conforming to CDR Program (CDRP) guidelines on coding and NCEI Archive Branch (AB) guidance on file and variable naming conventions per Submission Agreement (SA)</li></ul> <p>▪ Plans to transition ISO metadata to newer 19115-1 standard</p> <p>Comments: No known audits of the archiving processes</p>
Accessibility	<p>Level 4.5</p> <ul style="list-style-type: none"><li>▪ Collection level searchable online: <a href="https://data.noaa.gov/onestop/#/">https://data.noaa.gov/onestop/#/</a></li><li>▪ Direct file download available: <a href="https://www.ncei.noaa.gov/data/avhrr-reflectance-cloud-properties-patmos-extended/access/">https://www.ncei.noaa.gov/data/avhrr-reflectance-cloud-properties-patmos-extended/access/</a></li><li>▪ HDSS ordering available, granule searchable: <a href="https://www.ncdc.noaa.gov/has/HAS.FileAppRouter?datasetname=362602&amp;subqueryby=STATION&amp;applname=&amp;outdest=FILE">https://www.ncdc.noaa.gov/has/HAS.FileAppRouter?datasetname=362602&amp;subqueryby=STATION&amp;applname=&amp;outdest=FILE</a></li></ul> <ul style="list-style-type: none"><li>▪ Dissemination reports available internally for the FTP/HTTP servers.</li><li>▪ New technology for OneStop search and discovery planned (i.e. ElasticSearch, Hyrax Servers, etc.) This is part of the CDR data group that will be OneStop ready.</li></ul> <p>Comments: Dissemination reports are available internally, but not externally for the public.</p>
Usability	<p>Level 4</p> <ul style="list-style-type: none"><li>▪ NetCDF-4 data format (CF compliant)</li><li>▪ Data Flow Diagram [Heidinger and NOAA CDR Program, 2014] is available online: <a href="https://www.ncdc.noaa.gov/cdr/atmospheric/avhrr-cloud-properties-patmos-x">https://www.ncdc.noaa.gov/cdr/atmospheric/avhrr-cloud-properties-patmos-x</a></li><li>▪ C-ATBD [Walther, 2014 ] available online here: <a href="https://www.ncdc.noaa.gov/cdr/atmospheric/avhrr-cloud-properties-patmos-x">https://www.ncdc.noaa.gov/cdr/atmospheric/avhrr-cloud-properties-patmos-x</a></li><li>▪ Error estimates available in the C-ATBD [Walther, 2014] available online here: <a href="https://www.ncdc.noaa.gov/cdr/atmospheric/avhrr-cloud-properties-patmos-x">https://www.ncdc.noaa.gov/cdr/atmospheric/avhrr-cloud-properties-patmos-x</a></li><li>▪ Climatology paper [Foster and Heidinger, 2013] available online here: <a href="https://doi.org/10.1175/JCLI-D-11-00666.1">https://doi.org/10.1175/JCLI-D-11-00666.1</a></li><li>▪ Aggregating possible using HDSS ordering system</li></ul> <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
<b>Production Sustainability</b>	<p>Level 4</p> <ul style="list-style-type: none"> <li>▪ Under NOAA CDR Operation &amp; Maintenance (O&amp;M)</li> <li>▪ Updated annually</li> <li>▪ Funding is allocated yearly</li> <li>▪ Product improvement process in place</li> <li>▪ CDR program is managed by NCEI</li> </ul> <p>Comments: No comments</p>
<b>Data Quality Assurance</b>	<p>Level 4</p> <ul style="list-style-type: none"> <li>▪ Agile development procedure in place with defined/fixed set of analysis metrics</li> <li>▪ Master reference data are included in the source code package which is available online: <a href="https://www.ncdc.noaa.gov/cdr/atmospheric/avhrr-cloud-properties-patmos-x">https://www.ncdc.noaa.gov/cdr/atmospheric/avhrr-cloud-properties-patmos-x</a></li> <li>▪ Cloud mask, data/no data, snow, ice, sea, quality flags included in each granule</li> </ul> <p>Comments: No known external reviews.</p>
<b>Data Quality Control/Monitoring</b>	<p>Level 2</p> <ul style="list-style-type: none"> <li>▪ DQC is done after each data processing</li> <li>▪ Sampling is regular in time and space but is not systematic or automatic</li> <li>▪ Procedure not documented or available</li> </ul> <p>Comments: No data quality information in the metadata record.</p>
<b>Data Quality Assessment</b>	<p>Level 3</p> <ul style="list-style-type: none"> <li>▪ Research product assessed in literature [Heidinger, Foster, Walther, _et al_, 2013] available online here: <a href="https://doi.org/10.1175/BAMS-D-12-00246.1">https://doi.org/10.1175/BAMS-D-12-00246.1</a></li> <li>▪ Operational product assessed in this paper [Foster, Heidinger, Hiley, _et al_, 2016] available online here: <a href="https://doi.org/10.3390/rs8050424">https://doi.org/10.3390/rs8050424</a></li> <li>▪ Assessment carried out in the NCEI CDR R2O process</li> <li>▪ CDR Initial Operational Capability (IOC) stage</li> <li>▪ Product Maturity Matrix assessment [Heidinger and NOAA CDR Program, 2014] is available and online here: <a href="https://www.ncdc.noaa.gov/cdr/atmospheric/avhrr-cloud-properties-patmos-x">https://www.ncdc.noaa.gov/cdr/atmospheric/avhrr-cloud-properties-patmos-x</a></li> </ul> <p>Comments: No data quality information in the metadata record. No known external ranking</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
<b>Transparency / Traceability</b>	<p>Level 3.5</p> <ul style="list-style-type: none"> <li>▪ Multiple peer-reviewed publications including those from outside investigators; Products used in industry (aviation/solar energy)</li> <li>▪ C-ATBD [Walther, 2014] available online here: <a href="https://www.ncdc.noaa.gov/cdr/atmospheric/avhrr-cloud-properties-patmos-x">https://www.ncdc.noaa.gov/cdr/atmospheric/avhrr-cloud-properties-patmos-x</a></li> <li>▪ DOI assigned: <a href="https://doi.org/10.7289/V5348HCK">https://doi.org/10.7289/V5348HCK</a></li> <li>▪ NCEI OID: DSI 3626_02</li> <li>▪ Dataset Configuration Management is EIA-649-B standard compliant and diagramed in this presentation document [Hutchins, 2015] available online here: <a href="http://www1.ncdc.noaa.gov/pub/data/sds/cdr/conferences/2015%20PI%20Annual%20Meeting%20-%20Presentations/Day_1/(A-2)%20Operations%20and%20Maintenance%20(O_M)%20of%20NOAA%20IOC%20CDRs%20-%20(Hutchins).pdf">http://www1.ncdc.noaa.gov/pub/data/sds/cdr/conferences/2015%20PI%20Annual%20Meeting%20-%20Presentations/Day_1/(A-2)%20Operations%20and%20Maintenance%20(O_M)%20of%20NOAA%20IOC%20CDRs%20-%20(Hutchins).pdf</a></li> </ul> <p>Comments: No OAD available</p>
<b>Data Integrity</b>	<p>Level 3.5</p> <ul style="list-style-type: none"> <li>▪ Checksums generated at ingest which verifies ingest integrity.</li> <li>▪ Using standard-based technology for generating checksum at ingest.</li> <li>▪ Checksum verified when customer orders data.</li> </ul> <p>Comments: No comments</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.

Heidinger, A., and NOAA CDR Program, (2014), PATMOS-x high level flowchart for the main executable clavr\_xorb, \_Rep. CDRP-DIA-0279 Rev 3\_, NOAA National Centers for Environmental Information, Asheville, NC., retrieved online: <https://www.ncdc.noaa.gov/cdr/atmospheric/avhrr-cloud-properties-patmos-x> (Accessed 01 December 2016).

Walther, A., (2014), Climate Algorithm Theoretical Basis Document (C-ATBD) AVHRR Cloud Properties - PATMOS-x Daytime Cloud Optical and Microphysical Properties (COMP), \_Rep. CDRP-ATBD-0523\_, NOAA National Centers for Environmental Information, Asheville, NC., retrieved online: <https://www.ncdc.noaa.gov/cdr/atmospheric/avhrr-cloud-properties-patmos-x> (Accessed 01 December 2016).

Foster, M., and Heidinger, A., (2013), PATMOS-x: results from a diurnally corrected 30-yr satellite cloud climatology, \_Bulletin of the American Meteorological Society\_, 26(1), 414—425, doi:10.1175/JCLI-D-11-00666.1.

Heidinger, A., Foster, M., Walther, A., and Zhao, X., (2013), The Pathfinder Atmospheres Extended (PATMOS-x) AVHRR climate data set, \_Bulletin of the American Meteorological Society\_, 95(7), 909—922, doi:10.1175/BAMS-D-12-00246.1.

Foster, M., Heidinger, A., Hiley, M., Wanzong, S., Walther, A., Botambekov, D., (2016), PATMOS-x cloud climate record trend sensitivity to reanalysis products, \_Remote Sensing\_, 8(5), 424—441, doi:10.3390/rs8050424.



Hutchins, C. (2015), Operations and Maintenance (O&M) of NOAA IOC CDRs, [http://www1.ncdc.noaa.gov/pub/data/sds/cdr/conferences/2015%20PI%20Annual%20Meeting%20-%20Presentations/Day\\_1/\(A-2\)%20Operations%20and%20Maintenance%20\(O\\_M\)%20of%20NOAA%20IOC%20CDRs%20-%20\(Hutchins\).pdf](http://www1.ncdc.noaa.gov/pub/data/sds/cdr/conferences/2015%20PI%20Annual%20Meeting%20-%20Presentations/Day_1/(A-2)%20Operations%20and%20Maintenance%20(O_M)%20of%20NOAA%20IOC%20CDRs%20-%20(Hutchins).pdf) (Accessed 01 December 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].

<b>DSMM Component</b>	<b>Level 1 <i>Ad hoc</i> Little or no management</b>	<b>Level 2 <i>Minimal</i> Limited management</b>	<b>Level 3 <i>Intermediate</i> Defined management, partially implemented</b>	<b>Level 4 <i>Advanced</i> Well-defined management, fully implemented</b>	<b>Level 5 <i>Optimal</i> Full management, audited, measured, controlled</b>
<b><i>Preservability</i></b> <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
<b><i>Accessibility</i></b> <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

<b><i>Usability</i></b> <i>(The state of being easy to use)</i>	<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 &amp; 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) &amp; 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>
<b><i>Production Sustainability</i></b> <i>(The state of data production being sustainable and extendable)</i>	<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</p> <p>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>
<b><i>Data Quality Assurance</i></b> <i>(The state of data quality being assured)</i>	<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 &amp; standards</p> <p>External review</p>

<b>Data Quality Control/Monitoring</b>  <i>The state of data quality being controlled and monitored</i>	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
<b>Data Quality Assessment</b>  <i>(The state of data quality being assessed)</i>	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
<b>Transparency/Traceability</b>  <i>(The state of being transparent, trackable, and traceable)</i>	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

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