

**NOAA Technical Information Series NESDIS  
DSMR-00293 Version 1.0**



doi: 10.25923/9gkj-0x21

**Data Stewardship Maturity Report for NOAA Climate Data Record (CDR) of  
AVHRR Polar Pathfinder Extended (APP-X) Cryosphere**

| 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 - 2               | 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 AVHRR Polar Pathfinder Extended (APP-X) Cryosphere

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 AVHRR Polar Pathfinder Extended (APP-X) Cryosphere, is assessed based on a reference stewardship maturity framework. The current maturity ratings of NOAA Climate Data Record (CDR) of AVHRR Polar Pathfinder Extended (APP-X) Cryosphere are at Level 1 or higher for all nine key components with zero Level 1, two Level 2, three Level 3, four 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

| <b>Revision</b> | <b>Description</b> | <b>Date</b> |
|-----------------|--------------------|-------------|
| V01r00          | Initial Release    | 12/27/2021  |

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Data Stewardship Maturity Report for NOAA Climate Data Record (CDR) of  
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Lori Hager, Paul Lemieux III

NOAA's National Centers of Environmental Information (NCEI)

151 Patton Avenue, Asheville, NC 28801, (828) 271-4800

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## **Table of Contents**

|   |    |
|---|----|
| List of Tables  | 7  |
| Preface   | 8  |
| 1. Introduction   | 9  |
| 2. Results  | 10 |
| 3. Acknowledgment   | 15 |
| 4. References   | 16 |
| Appendix I The Scientific Data Stewardship Maturity Matrix (DSMM) | 18 |

## **List of Tables**

|   |    |
|---|----|
| Table 1. Scores for the Nine DSMM Key Components at a Glance  | 1  |
| Table 2. Dataset and Data Stewardship Maturity Assessment Metadata  | 11 |
| Table 3. Stewardship Maturity Levels and Detailed Justifications for Each of Nine DSMM Key Components for the Dataset | 12 |

## 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 AVHRR Polar Pathfinder Extended (APP-X) Cryosphere**

**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**

NOAA Climate Data Record (CDR) of the extended AVHRR Polar Pathfinder (APP-x) cryosphere contains 19 geophysical variables over the Arctic and Antarctic for the period 1982 - present. All of them have undergone various degrees of validation, though not all are considered CDR quality. The variables are (those considered by the developers to be CDR-quality are identified with an asterisk): Surface temperature, all-sky, snow, ice, and land\* Surface albedo, all-sky\* Sea ice thickness\* Surface type Cloud mask\* Cloud particle thermodynamic phase Cloud optical depth Cloud particle effective radius Cloud temperature Cloud pressure Cloud type Downwelling shortwave radiation at the surface\* Downwelling longwave radiation at the surface\* Upwelling shortwave radiation at the surface\* Upwelling longwave radiation at the surface\* Upwelling shortwave radiation at the TOA\* Upwelling longwave radiation at the TOA\* Shortwave cloud radiative forcing at the surface Longwave cloud radiative forcing at the surface APP-x data products are mapped to a 25 km EASE grid at two local solar times: 04:00 and 14:00 for the Arctic, and 02:00 and 14:00 for the Antarctica. Using local solar time rather than standard UTC times provides better information on diurnal differences at all locations.

## **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.

| <b>Table 2. Dataset and Data Stewardship Maturity Assessment Metadata</b>                      |  |
|--|--|
| <b>Dataset Title</b>   | NOAA Climate Data Record (CDR) of AVHRR Polar Pathfinder Extended (APP-X) Cryosphere |
| <b>Dataset Information URL</b>   | <a href="https://doi.org/10.7289/V5MK69W6">https://doi.org/10.7289/V5MK69W6</a>      |
| <b>Data Provider POC (Name; Email; Affiliation)</b>  | NOAA National Centers for Environmental Information (NCEI), ncei.orders@noaa.gov     |
| <b>Dataset POC (Name; Email; Affiliation)</b>  | NOAA Climate Data Record Program Office, app_contacts@noaa.gov                       |
| <b>SMM Version (Document ID and Version Number)</b>  | NCDC-CICS-SMM_0001_Rev.1 12/09/2014  |
| <b>SMM POC (Name; E-mail; Affiliation)</b>   | Ge Peng, ge.peng@uah.edu, University of Alabama-Huntsville                           |
| <b>SMM Template Version (Document ID and Version Numbers)</b>                                  | NCDC-CICS-SMM_0001_Rev.1 v4.0 06/23/2015   |
| <b>SMM Template POC</b>  | Ge Peng, ge.peng@uah.edu, University of Alabama-Huntsville                           |
| <b>SMM Assessment Version (v&lt;nn&gt;r&lt;mm&gt;, e.g., v01r00)</b>                           | v02r02   |
| <b>SMM Assessment Date (MM/DD/YYYY)</b>  | 03/14/2018   |
| <b>SMM Assessment POC (Name; E-mail; Affiliation)</b>  | Paul Lemieux III, paul.lemieux@noaa.gov, Earth Resources Technology, Inc.            |
| <b>Stewardship Maturity Ratings (each key component) (kc1/kc2/kc3/kc4/kc5/kc6/kc7/kc8/kc9)</b> | 4.5 / 2 / 4 / 4 / 4 / 2 / 3 / 3.5 / 3.5  |
| <b>SMM Original Assessment Date (MM/DD/YYYY)</b>   | 06/03/2016   |
| <b>SMM Original Assessment POC (Name; E-mail; Affiliation)</b>                                 | Paul Lemieux III, paul.lemieux@noaa.gov, Earth Resources Technology, Inc.            |
| <b>SMM Last Modified Date (MM/DD/YYYY)</b>   | 10/12/2021   |
| <b>SMM Last Modification POC (Name; E-mail; Affiliation)</b>                                   | Lori Hager, lori.hager@noaa.gov, CASE Consultants International                      |
| <b>SMM Modified Date (MM/DD/YYYY)</b>  | 03/14/2018   |
| <b>SMM Modification POC (Name; E-mail; Affiliation)</b>  | 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><b>Preservability</b></p> | <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:<br/>No comments</p>  |
| <p><b>Accessibility</b></p>  | <p>Level 2</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-polar-pathfinder-extended/access/">https://www.ncei.noaa.gov/data/avhrr-polar-pathfinder-extended/access/</a></li> <li>▪ THREDDS Catalog for APP-X data: <a href="https://www.ncei.noaa.gov/thredds/catalog/avhrr-polar-pathfinder-ext-files/catalog.html">https://www.ncei.noaa.gov/thredds/catalog/avhrr-polar-pathfinder-ext-files/catalog.html</a></li> <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:<br/>Dissemination reports are unavailable to the public.<br/>No granule/file level search capabilities.</p>   |
| <p><b>Usability</b></p>      | <p>Level 4</p> <ul style="list-style-type: none"> <li>▪ NetCDF-4 data format (CF compliant)</li> <li>▪ Data Flow Diagram [Key and NOAA CDR Program, 2015] available online: <a href="https://www.ncdc.noaa.gov/cdr/atmospheric/extended-avhrr-polar-pathfinder-app-x/">https://www.ncdc.noaa.gov/cdr/atmospheric/extended-avhrr-polar-pathfinder-app-x/</a></li> <li>▪ C-ATBD [Key and Wang, 2015] is available online: <a href="https://www.ncdc.noaa.gov/cdr/atmospheric/extended-avhrr-polar-pathfinder-app-x/">https://www.ncdc.noaa.gov/cdr/atmospheric/extended-avhrr-polar-pathfinder-app-x/</a></li> <li>▪ Error estimates available in the C-ATBD [Key and Wang, 2015] available online here: <a href="https://www.ncdc.noaa.gov/cdr/atmospheric/extended-avhrr-polar-pathfinder-app-x/">https://www.ncdc.noaa.gov/cdr/atmospheric/extended-avhrr-polar-pathfinder-app-x/</a></li> <li>▪ Climatology paper [Hüsler, Jonas, Riffler, _et al_, 2014] available in literature and online here: <a href="https://doi.org/10.5194/tc-8-73-2014">https://doi.org/10.5194/tc-8-73-2014</a></li> <li>▪ THREDDS allows aggregations of granules by virtually stacking files/timestamps as a single huge file.</li> </ul> <p>Comments:<br/>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   |
|---|--|
| <p><b>Production Sustainability</b></p>       | <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:<br/>No comments</p>  |
| <p><b>Data Quality Assurance</b></p>          | <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="http://www1.ncdc.noaa.gov/pub/data/sds/cdr/CDRs/AVHRR_Extended_Polar_Pathfinder/">http://www1.ncdc.noaa.gov/pub/data/sds/cdr/CDRs/AVHRR_Extended_Polar_Pathfinder/</a></li> <li>▪ Cloud mask, data/no data, snow, ice, sea, quality flags included in each granule which may be considered limited data quality assurance metadata</li> </ul> <p>Comments:<br/>No known external reviews.</p>   |
| <p><b>Data Quality Control/Monitoring</b></p> | <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:<br/>No data quality information in the metadata record.</p>  |
| <p><b>Data Quality Assessment</b></p>         | <p>Level 3</p> <ul style="list-style-type: none"> <li>▪ Research product assessed in this paper [Key, Wang, Liu, _et al), 2016] available online here: <a href="https://doi.org/10.3390/rs8030167">https://doi.org/10.3390/rs8030167</a></li> <li>▪ Numerous operational assessments available in literature</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 [Key and NOAA CDR Program, 2015] is available and online here: <a href="https://www.ncdc.noaa.gov/cdr/atmospheric/extended-avhrr-polar-pathfinder-app-x/">https://www.ncdc.noaa.gov/cdr/atmospheric/extended-avhrr-polar-pathfinder-app-x/</a></li> </ul> <p>Comments:<br/>No data quality assessment information in the metadata record.<br/>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   |
|---|--|
| <p><b>Transparency / Traceability</b></p> | <p>Level 3.5</p> <ul style="list-style-type: none"> <li>▪ Multiple peer-reviewed publications including those from outside investigators</li> <li>▪ C-ATBD [Key and Wang, 2015] available online here: <a href="https://www.ncdc.noaa.gov/cdr/atmospheric/extended-avhrr-polar-pathfinder-app-x/">https://www.ncdc.noaa.gov/cdr/atmospheric/extended-avhrr-polar-pathfinder-app-x/</a></li> <li>▪ DOI assigned: <a href="https://doi.org/10.7289/V5MK69W6">https://doi.org/10.7289/V5MK69W6</a></li> <li>▪ NCEI OID: DSI 3710_01</li> <li>▪ Dataset Configuration Management is EIA-649-B standard compliant and diagramed in this presentation document [Hutchins, 2015] available online here:</li> <li>▪ <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:<br/>No OAD available</p> |
| <p><b>Data Integrity</b></p>              | <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:<br/>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.

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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].

| <b>DSMM Component</b>   | <b>Level 1<br/><i>Ad hoc</i><br/>Little or no management</b> | <b>Level 2<br/><i>Minimal</i><br/>Limited management</b>  | <b>Level 3<br/><i>Intermediate</i><br/>Defined management, partially implemented</b>   | <b>Level 4<br/><i>Advanced</i><br/>Well-defined management, fully implemented</b>   | <b>Level 5<br/><i>Optimal</i><br/>Full management, audited, measured, controlled</b>  |
|---|--|---|--|---|---|
| <b><i>Preservability</i></b><br><br><i>(The state of being preservable)</i>                       | Any storage location<br><br>Data only                        | Non-designated repository<br><br>Redundancy<br><br>Limited archiving metadata   | Designated archive<br><br>Redundancy<br><br>Community-standard archiving metadata<br><br>Conforming to limited archiving standards                   | Level 3 +<br><br>Conforming to community archiving standards  | Level 4 +<br><br>Archiving process performance controlled, measured, and audited<br><br>Future archiving standard changes planned |
| <b><i>Accessibility</i></b><br><br><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)<br><br>Collection or dataset level searchable online | Level 2 +<br><br>Non-standard data service<br><br>Limited data server performance<br><br>Granule/file level searchable<br><br>Limited search metrics | Level 3 +<br><br>Community-standard data service<br><br>Enhanced data server performance<br><br>Conforming to community search metrics<br><br>Dissemination report metrics defined and implemented internally | Level 4 +<br><br>Dissemination reports available online<br><br>Future technology and standard changes planned                     |

|   |   |  |   |  |  |
|---|---|--|---|--|--|
| <p><b>Usability</b></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 &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> |
| <p><b>Production Sustainability</b></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><b>Data Quality Assurance</b></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 &amp; standards</p> <p>External review</p>  |

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| <p><b>Data Quality Control/Monitoring</b></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 &amp; 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 &amp; spatial characteristics</p> <p>Physical consistency check</p> <p>Conforming to community quality metadata &amp; standards</p> |
| <p><b>Data Quality Assessment</b></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 &amp; standards</p> <p>External ranking</p>                            |
| <p><b>Transparency/Traceability</b></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) &amp; 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>   |

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| <p><b>Data Integrity</b></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)<br>Level 2 +<br>Data archive integrity verifiable | Level 3 +<br>Data access integrity verifiable<br>Conforming to community data integrity technology standard | Level 4 +<br>Data authenticity verifiable (e.g., data signature technology)<br>Performance of data integrity check monitored and reported |