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**Data Stewardship Maturity Report for NOAA Climate Data Record (CDR) for
Mean Layer Temperature (Lower Stratosphere) from UCAR, Version 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 - 4.5	Accessibility - 2	Usability - 4.5
Production Sustainability - 4	Data Quality Assurance - 3.5	Data Quality Control/Monitoring - 2
Data Quality Assessment - 3	Transparency/Traceability - 2.75	Data Integrity - 3.5

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Cover Image: Data Stewardship Rating Diagram for NOAA Climate Data Record (CDR) for Mean Layer Temperature (Lower Stratosphere) from UCAR, Version 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, NOAA Climate Data Record (CDR) for Mean Layer Temperature (Lower Stratosphere) from UCAR, Version 2, is assessed based on a reference stewardship maturity framework. The current maturity ratings of NOAA Climate Data Record (CDR) for Mean Layer Temperature (Lower Stratosphere) from UCAR, Version 2 are at Level 1 or higher for all nine key components with zero Level 1, three Level 2, three Level 3, three 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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Data Stewardship Maturity Report for NOAA Climate Data Record (CDR) for Mean Layer Temperature (Lower Stratosphere) from UCAR, Version 2

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Preface

In response to the President's Open Government Initiative and related policies, NOAA has committed to providing improved public access to all of its environmental information, to enable research and commercial innovation through ease of data discovery and use [Casey, 2016].

OneStop supports NOAA's efforts by leveraging existing access technologies and infusing specific innovations to provide improved discover, access, and visualization services for NOAA's data. Also, OneStop is viewed by a NESDIS as a pathfinder effort with an initial focus on selected high-priority datasets from NESDIS and other program data meeting OneStop standards, but eventually scalable across NOAA's data. Lastly, OneStop is implementing the USGEO Common Framework for Earth Observation Data and leveraging/supporting the NOAA Big Data Project (BDP) and Big Earth Data Initiative (BEDI) [Casey, 2016].

As with any process of improvement planning, agencies need to find out where they are in terms of their compliance to the federal regulations and what they need to do if any areas of non-compliance are identified. To this end, a unified framework would be beneficial for assessing the current stage of stewardship practices applied to individual datasets and for providing a road map that will guide future investments towards enhanced stewardship of environmental datasets. The value and quality of a dataset depends in part on the stewardship practices applied after its development and production. Therefore, a unified framework providing a holistic view of the quality of stewardship practices applied to individual datasets is beneficial to data stewards and users [Casey, 2016].

The Data Stewardship Maturity Matrix (DSMM), jointly developed by domain (data management, technology, and science) subject matter experts from NOAA's National Centers for Environmental Information (NCEI) and Cooperative Institute for Climate and Satellites – North Carolina (CICS-NC), provides such a consistent framework [Peng *et al.*, 2016]. The DSMM, leveraging institutional knowledge and community practices and standards, defines a graduated maturity scale for each of nine key components of scientific data stewardship to enable a consistent assessment of the measureable stewardship practices applied to a given data set or product.

The NOAA Data Stewardship Maturity Technical Series captures stewardship maturity assessment results for individual datasets, provides consistent representation and citable documents of those assessments, ensures transparency, and allows better data quality information integration and content-based search and discovery of NOAA data.

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Data Stewardship Maturity Report for NOAA Climate Data Record (CDR) for Mean Layer Temperature (Lower Stratosphere) from UCAR, Version 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

The Temperatures in the Lower Stratosphere (TLS) (AMSU channel 9 and MSU channel 4) CDR is generated by using National Oceanic and Atmospheric Administration (NOAA), National Aeronautics and Space Administration (NASA), and Europe METeorological Operational satellite-A (Metop/A) satellites which have been calibrated using coincident Global Positioning System (GPS) Radio Occultation (RO) temperature profile measurements from Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC) and Challenging Mini-satellite Payload (CHAMP), and Gravity Recovery And Climate Experiment (GRACE) from 2001 to the current. The 'adjusted' MSU/AMSU data in the period of 2001 to 2014 were used as reference data to calibrate other overlapped MSU/AMSU data from 1980 to 2001.

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) for Mean Layer Temperature (Lower Stratosphere) from UCAR, Version 2
Dataset Information URL	https://doi.org/10.7289/V5XP72XZ
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, uah_msu_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)	V02r02
SMM Assessment Date (MM/DD/YYYY)	03/14/2018
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 / 2 / 4.5 / 4 / 3.5 / 2 / 3 / 2.75 / 3.5
SMM Original Assessment Date (MM/DD/YYYY)	12/06/2016
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)	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)	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
<p>Preservability</p>	<p>Level 4.5</p> <ul style="list-style-type: none"> ▪ Archived at NOAA NCEI-NC ▪ Following NOAA Climate Data Record (CDR) Research-2-Operation (R2O) transition process with the Initial Operation Capability (IOC) ▪ Following OAIS RM ▪ Conforms to ISO 19115-2 metadata standard ▪ Conforming to NetCDF CF metadata conventions. ▪ Conforming to CDR Program (CDRP) guidelines on coding and NCEI Archive Branch (AB) guidance on file and variable naming conventions per Submission Agreement (SA) <p>▪ Plans to transition ISO metadata to newer 19115-1 standard</p> <p>Comments: No known external audits of the archive performed at this time</p>
<p>Accessibility</p>	<p>Level 2</p> <ul style="list-style-type: none"> ▪ Collection level searchable online: https://data.noaa.gov/onestop/#/ ▪ Direct file download available: https://www.ncei.noaa.gov/data/mean-layer-temperature-ucar-lower-stratosphere/access/ ▪ THREDDS Catalog: https://www.ncei.noaa.gov/thredds/catalog/mean-layer-temperature-ucar-lower-stratosphere/catalog.html ▪ Dissemination reports available internally for the FTP/HTTP servers ▪ 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. <p>Comments: Dissemination reports are available internally, but not publicly No granule/file level search capability.</p>
<p>Usability</p>	<p>Level 4.5</p> <ul style="list-style-type: none"> ▪ NetCDF-4 data format (CF compliant) ▪ Data Flow Diagram [Ben Ho and NOAA CDR Program, 2015] is available online here: https://www.ncdc.noaa.gov/cdr/fundamental/mean-layer-temperature-ucar-lower-stratosphere ▪ C-ATBD [Ben Ho, 2015] is available online here: https://www.ncdc.noaa.gov/cdr/fundamental/mean-layer-temperature-ucar-lower-stratosphere ▪ THREDDS allows aggregations of granules by virtually stacking files/timestamps as a single huge file ▪ Climatology paper [Wang and Zou, 2014] is available online here: https://dx.doi.org/10.1175/JTECH-D-13-00134.1 ▪ Visualization tool available: https://www.ncei.noaa.gov/maps-and-geospatial-products <p>Comments: No known external rankings Error estimates not available in the C-ATBD {Ben Ho, 2015}</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 4</p> <ul style="list-style-type: none"> ▪ Under NOAA CDR Operation & Maintenance (O&M) ▪ Updated annually ▪ Funding is allocated yearly ▪ Product improvement process in place ▪ CDR program under management by NCEI <p>Comments: No comments</p>
Data Quality Assurance	<p>Level 3.5</p> <ul style="list-style-type: none"> ▪ Agile development procedure in place with defined/fixed set of analysis metrics ▪ Master reference data are included in the source code package which is available online: https://www.ncdc.noaa.gov/cdr/fundamental/mean-layer-temperature-ucar-lower-stratosphere ▪ There are bad data quality flags at the file level which could be considered data quality assurance metadata <p>Comments: No known external reviews</p>
Data Quality Control/Monitoring	<p>Level 2</p> <ul style="list-style-type: none"> ▪ DQC is done after each data processing ▪ Sampling and analysis are regular in limited times and locations <p>Comments: No data quality information in the metadata record.</p>
Data Quality Assessment	<p>Level 3</p> <ul style="list-style-type: none"> ▪ Research product assessed in literature [Ben Ho, Goldberg, Kuo, _et al_, 2009] available online here: https://doi.org/10.3319/TAO.2007.12.06.01(F3C) ▪ Numerous papers exist assessing the operational product ▪ Assessment carried out in the NCEI CDR R2O process ▪ CDR Initial Operational Capability (IOC) stage ▪ Product Maturity Matrix assessment [Ben Ho and NOAA CDR Program, 2015] is available online here: https://www.ncdc.noaa.gov/cdr/fundamental/mean-layer-temperature-ucar-lower-stratosphere <p>Comments: No data quality assessment 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
<p>Transparency / Traceability</p>	<p>Level 2.75</p> <ul style="list-style-type: none"> ▪ CDR Program literature [Bates, Privette, Kearns, Glance, & Zhao, 2015] available online here: https://doi.org/10.1175/BAMS-D-15-00015.1 ▪ C-ATBD [Ben Ho, 2015] available online here: https://www.ncdc.noaa.gov/cdr/fundamental/mean-layer-temperature-ucar-lower-stratosphere ▪ NCEI OID: DSI 3688_02 ▪ Dataset Configuration Management is EIA-649-B standard compliant and diagramMed in this presentation document [Hutchins, 2015] available online here: 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 <p>Comments: No DOI No OAD</p>
<p>Data Integrity</p>	<p>Level 3.5</p> <ul style="list-style-type: none"> ▪ Checksums generated at ingest which verifies ingest integrity. ▪ Using standard-based technology for generating checksum at ingest. ▪ Checksum verified when customer orders data. <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

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Appendix I: The Scientific Data Stewardship Maturity Matrix (DSMM)

Table A1: This matrix (Version: NCDC-CICS-SMM-0001-Rev.1. 12/09/2014) describes the criterion used to evaluate data stewardship maturity for each of the nine DSMM key components [Peng *et al.*, 2015].

DSMM Component	Level 1 <i>Ad hoc</i> Little or no management	Level 2 <i>Minimal</i> Limited management	Level 3 <i>Intermediate</i> Defined management, partially implemented	Level 4 <i>Advanced</i> Well-defined management, fully implemented	Level 5 <i>Optimal</i> Full management, audited, measured, controlled
<i>Preservability</i> <i>(The state of being preservable)</i>	Any storage location Data only	Non-designated repository Redundancy Limited archiving metadata	Designated archive Redundancy Community-standard archiving metadata Conforming to limited archiving standards	Level 3 + Conforming to community archiving standards	Level 4 + Archiving process performance controlled, measured, and audited Future archiving standard changes planned
<i>Accessibility</i> <i>(The state of being searchable and accessible publicly)</i>	Not publically available person-to-person	Publically available direct file download (e.g., via anonymous FTP server) Collection or dataset level searchable online	Level 2 + Non-standard data service Limited data server performance Granule/file level searchable Limited search metrics	Level 3 + Community-standard data service Enhanced data server performance Conforming to community search metrics Dissemination report metrics defined and implemented internally	Level 4 + Dissemination reports available online Future technology and standard changes planned

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

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

<p>Data Integrity</p> <p><i>(The state of data integrity being verifiable)</i></p>	Unknown or no data ingest integrity check	Data ingest integrity verifiable (e.g., checksum technology)	(DOI system) Level 2 + Data archive integrity verifiable	Level 3 + Data access integrity verifiable Conforming to community data integrity technology standard	Level 4 + Data authenticity verifiable (e.g., data signature technology) Performance of data integrity check monitored and reported