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**Data Stewardship Maturity Report for NOAA Next Generation Radar (NEXRAD)
Level II Base Data**

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 - 5	Usability - 4.5
Production Sustainability - 5	Data Quality Assurance - 3.5	Data Quality Control/Monitoring - 3.5
Data Quality Assessment - 3	Transparency/Traceability - 4.5	Data Integrity - 5

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National Oceanic and Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Cover Image: Data Stewardship Rating Diagram for NOAA Next Generation Radar (NEXRAD) Level II Base Data

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 Next Generation Radar (NEXRAD) Level II Base Data, is assessed based on a reference stewardship maturity framework. The current maturity ratings of NOAA Next Generation Radar (NEXRAD) Level II Base Data are at Level 1 or higher for all nine key components with zero Level 1, zero Level 2, three Level 3, three Level 4, and three Level 5 key components.

The National Environmental Satellite, Data, and Information Service (NESDIS) manages the Nation's civil Earth-observing satellite systems, as well as global national data bases for meteorology, oceanography, geophysics, and solar-terrestrial sciences. From these sources, it develops and disseminates environmental data and information products critical to the protection of life and property, national defense, and the national economy, energy development and distribution, global food supplies, and the development of natural resources.

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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 NOAA Next Generation Radar (NEXRAD)
Level II Base Data

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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 Next Generation Radar (NEXRAD)
Level II Base Data**

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 dataset consists of Level II weather radar data collected from Next-Generation Radar (NEXRAD) stations located in the contiguous United States, Alaska, Hawaii, U.S. territories and at military base sites. NEXRAD is a network of 160 high-resolution Doppler weather radars operated by the NOAA National Weather Service (NWS), the Federal Aviation Administration (FAA), and the U.S. Air Force (USAF). Doppler radars detect atmospheric precipitation and winds, which allow scientists to track and anticipate weather events, such as rain, ice pellets, snow, hail, and tornadoes, as well as some non-weather objects like birds and insects. NEXRAD stations use the Weather Surveillance Radar - 1988, Doppler (WSR-88D) system. This is a 10 cm wavelength (S-Band) radar that operates at a frequency between 2,700 and 3,000 MHz. The radar system operates in two basic modes: a slow-scanning Clear Air Mode (Mode B) for analyzing air movements when there is little or no precipitation activity in the area, and a Precipitation Mode (Mode A) with a faster scan for tracking active weather.

The two modes employ nine Volume Coverage Patterns (VCPs) to adequately sample the atmosphere based on weather conditions. A VCP is a series of 360 degree sweeps of the antenna at pre-determined elevation angles and pulse repetition frequencies completed in a specified period of time. The radar scan times 4.5, 5, 6 or 10 minutes depending on the selected VCP. The NEXRAD products are divided into multiple data processing levels. The lower Level II data contain the three meteorological base data quantities at original resolution: reflectivity, mean radial velocity, and spectrum width. With the advent of dual polarization beginning in 2011, additional base products of differential reflectivity, correlation coefficient and differential phase are available. Level II data are recorded at all NWS and most USAF and FAA WSR-88D sites. From the Level II quantities, computer processing generates numerous meteorological analysis Level 3 products. NEXRAD data are acquired by the NOAA National Centers for Environmental Information (NCEI) for archiving and dissemination to users. Data coverage varies by station and ranges from June 1991 to 1 day from present. Most stations began observing in the mid-1990s, and most period of records are continuous.

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 Next Generation Radar (NEXRAD) Level II Base Data
Dataset Information URL	https://doi.org/10.7289/V5W9574V
Data Provider POC (Name; Email; Affiliation)	Customer Engagement Branch, ncei.orders@noaa.gov, DOC/NOAA/NESDIS/NCEI > National Centers for Environmental Information, NESDIS, NOAA, U.S. Department of Commerce
Dataset POC (Name; Email; Affiliation)	Customer Engagement Branch, ncei.orders@noaa.gov, DOC/NOAA/NESDIS/NCEI > National Centers for Environmental Information, NESDIS, NOAA, U.S. Department of Commerce
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)	v02r04
SMM Assessment Date (MM/DD/YYYY)	11/28/2016
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 / 5 / 4.5 / 5 / 3.5 / 3.5 / 3 / 4.5 / 5
SMM Original Assessment Date (MM/DD/YYYY)	06/15/2016
SMM Original Assessment POC (Name; E-mail; Affiliation)	Paul Lemieux III, paul.lemieux@noaa.gov, Earth Resources Technology, Inc.; Steve Ansari, steve.ansari@noaa.gov, DOC/NOAA/NESDIS/NCEI > National Centers for Environmental Information, NESDIS, NOAA, U.S. Department of Commerce
SMM Last Modified Date (MM/DD/YYYY)	10/08/2021
SMM Last Modification POC (Name; E-mail; Affiliation)	Lori Hager, lori.hager@noaa.gov, CASE Consultants International
SMM Modified Date (MM/DD/YYYY)	04/25/2019
SMM Modification POC (Name; E-mail; Affiliation)	Paul Lemieux III, paul.lemieux@noaa.gov, Riverside 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 by NCEI which is a NOAA designated archive compliant to NARA standards. ▪ Metadata following ISO 19115-2. ▪ Compliant to OIAS RM. ▪ Plans to update metadata to ISO 19115-1 at a later date and will be a pilot dataset for the OneStop initiative. ▪ Using Amazon Cloud for hosting data in addition to NCEI holdings. ▪ Multiple access points provide several layers of redundancy. <p>Comments: No known external audits on the archiving processes</p>
<p>Accessibility</p>	<p>Level 5</p> <ul style="list-style-type: none"> ▪ Publically available with direct file download via Amazon Cloud: https://s3.amazonaws.com/noaa-nexrad-level2/index.html ▪ Collection and granule searchable via NCEI Common Access available at this website: https://www.ncei.noaa.gov/access/search/data-search/weather-radar-level-ii ▪ Amazon Web Services Explorer, NCEI Climate Data Online Search, and ArcGIS REST Services Directory qualify for enhanced data server performance. ▪ Dissemination reports available online at this website: https://www.ncdc.noaa.gov/nexradinv/stats.jsp ▪ New technology for OneStop search and discovery planned (i.e. ElasticSearch, Hyrax Servers, etc.) This is part of the NEXRAD data group that will be OneStop ready. <p>Comments: No comments.</p>
<p>Usability</p>	<p>Level 4.5</p> <ul style="list-style-type: none"> ▪ NEXRAD community standard is Native Binary, NCEI provides software for format interoperability (Weather & Climate Toolkit). ▪ Data visualization capability available at this website: https://gis.ncdc.noaa.gov/maps/ncei/radar/radar ▪ NCEI Climate Data Online Search allows aggregating granules for download as one large compressed file. ▪ Error estimates outlined in product and algorithm handbook [OFCM, 2006] available online here: https://www.ofcm.noaa.gov/publications/fmh/allfmh2.htm <p>Comments: No 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
Production Sustainability	<p>Level 5</p> <ul style="list-style-type: none"> ▪ Long-term institutional commitment in place as evidenced by funding allocated for Amazon Web Hosting for current and future archiving needs. ▪ There is commitment nationally and internationally from research community and demand is high for historical NEXRAD data for severe weather analysis and prediction. ▪ Radar Operation Center is constantly providing product improvements; phased array and volume scan patterns are in development for future addition into current products. ▪ WSR-88D Service Life Extension Program (SLEP) in place that outlines IT modernization/upgrades as well as upgrades to radar hardware. <p>Comments: No comments</p>
Data Quality Assurance	<p>Level 3.5</p> <ul style="list-style-type: none"> ▪ DQA procedures well documented and fully implemented. See the product and algorithm documentation [OFCM, 2006] available online here: https://www.ofcm.noaa.gov/publications/fmh/allfmh2.htm <p>Comments: Level 2 data does not come with any data quality metadata but Level 3 does.</p>
Data Quality Control/Monitoring	<p>Level 3.5</p> <ul style="list-style-type: none"> ▪ Anomaly detection procedure well-documented and fully implemented and is automatically tracked and reported to users. ▪ DQ control and monitoring procedures documented [OFCM, 2006] and available online here: https://www.ofcm.noaa.gov/publications/fmh/allfmh2.htm <p>Comments: No data quality information in the metadata record. NWS has a user feedback process in place for the public and for WFOs.</p>
Data Quality Assessment	<p>Level 3</p> <ul style="list-style-type: none"> ▪ Numerous publications on research and operational products exist for NEXRAD data. Too many to list here. ▪ Algorithm documentation [OFCM, 2006] available online here: https://www.ofcm.noaa.gov/publications/fmh/allfmh2.htm <p>Comments: No data quality information in the metadata record. No metadata assessments.</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 4.5</p> <ul style="list-style-type: none"> ▪ Product information available in literature [Crum & Alberty, 1993] online here: https://doi.org/10.1175/1520-0477(1993)074%3C1669:TWATWO%3E2.0.CO;2 ▪ ATBD/OAD [OFCM, 2006] documentation available online here: https://www.ofcm.noaa.gov/publications/fmh/allfmh2.htm ▪ DOI assigned: https://doi.org/10.7289/V5W9574V ▪ NCEI OID: DSI 6500_12-15 ▪ NEXRAD data is under configuration management (CM) and the document [Berkowitz, 2000] is available online here: https://www.roc.noaa.gov/wsr88d/PublicDocs/CM/ccbchrt.pdf ▪ System Info Online – ICD at ROC provides system information with networking, software, and hardware information, available online here: https://www.roc.noaa.gov/wsr88d/BuildInfo/Files.aspx <p>Comments: No comments.</p>
<p>Data Integrity</p>	<p>Level 5</p> <ul style="list-style-type: none"> ▪ NCEI can certify data for a fee. Information regarding this process is available at this website: https://www.ncdc.noaa.gov/customer-support/certification-data ▪ NCEI data integrity is verified at ingest. ▪ Conforms to data integrity technology standards. ▪ NCEI does not verify checksum automatically when user requests data, but the checksum is provided for users to do their own verification. The user has to download it separately from their data download. ▪ Data integrity is monitored at ingest and if it fails then NCEI teams are automatically notified. <p>Comments: No comments.</p>

3. Acknowledgment

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