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DSMR-00259 Version 1.0

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Data Stewardship Maturity Report for NOAA Next Generation Radar (NEXRAD) Level III Products

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 - 4	Data Quality Control/Monitoring - 3.5
Data Quality Assessment - 3	Transparency/Traceability - 2.75	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 III Products

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

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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.

Publication in the NOAA Technical Memorandum series does not preclude later publication in scientific journals in expanded or modified form. The NESDIS series of NOAA Technical Reports is a continuation of the former NESS and EDIS series of NOAA Technical Reports and the NESC and EDS series of Environmental Science Services Administration (ESSA) Technical Reports.

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

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Data Stewardship Maturity Report for NOAA Next Generation Radar (NEXRAD) Level III Products

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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 Next Generation Radar (NEXRAD) Level III Products

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 3 weather radar products 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. During 2008, the WSR-88D radars were upgraded to produce increased spatial resolution data, called Super Resolution. The earlier Legacy Resolution data provides radar reflectivity at 1.0 degree azimuthal by 1 km range gate resolution to a range of 460 km, and Doppler velocity and spectrum width at 1.0 degree azimuthal by 250 m range gate resolution to a range of 230 km. The upgraded Super Resolution data provides radar reflectivity at 0.5 degree azimuthal by 250 m range gate resolution to a range of 460 km, and Doppler velocity and spectrum width at 0.5 degree azimuthal by 250 m range gate resolution to a range of 300 km. Super resolution makes a compromise of slightly decreased noise reduction for a large gain in resolution. In 2010, the deployment of the Dual Polarization (Dual Pol) capability to NEXRAD sites began with the first operational Dual Pol radar in May 2011. Dual Pol radar capability adds vertical polarization to the previous horizontal radar waves, in order to more accurately discern the return signal. This allows the radar to better distinguish between types of precipitation (e.g., rain, hail and snow), improves rainfall estimates, improves data retrieval in mountainous terrain, and aids in removal of non-weather artifacts. The NEXRAD products are divided in two data processing levels. The lower Level 2 data are base products at original resolution. Level 2 data are recorded at all NWS and most USAF and FAA WSR-88D sites. From the Level 2 quantities, computer processing generates numerous meteorological analysis Level 3 products. The Level 3 data consists of reduced resolution, low-bandwidth, base products as well as many derived, post-processed products. Level 3 products are recorded at most U.S. sites, though non-US sites do not have Level 3 products. There are over 40 Level 3 products available from the NCDC. General products for Level 3 include the base and composite reflectivity, storm relative velocity, vertical integrated liquid, echo tops and VAD wind profile. Precipitation products for Level 3 include estimated ground accumulated rainfall amounts for one and three hour periods, storm totals, and digital arrays. Estimates are based on reflectivity to rainfall rate (Z-R) relationships. Overlay products for Level 3 are alphanumeric data that give detailed information on certain parameters for an identified storm cell. These include storm structure, hail index, mesocyclone identification, tornadic vortex signature, and storm tracking information. Radar messages for Level 3 are sent by the radar site to users in order to know more about the radar status and special product data. NEXRAD data are provided to the NOAA National Climatic Data Center for archiving and dissemination to users. Data coverage varies by station and ranges from May 1992 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 III Products
Dataset Information URL	https://www.ncei.noaa.gov/metadata/geoportal/rest/metadata/item/gov.noaa.ncdc%3AC00708/html
Data Provider POC (Name; Email; Affiliation)	DOC/NOAA/NESDIS/NCEI > National Centers for Environmental Information, NESDIS, NOAA, U.S. Department of Commerce, ncei.orders@noaa.gov
Dataset POC (Name; Email; Affiliation)	DOC/NOAA/NESDIS/NCEI > National Centers for Environmental Information, NESDIS, NOAA, U.S. Department of Commerce, ncei.orders@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)	v03r03
SMM Assessment Date (MM/DD/YYYY)	12/21/2016
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 / 4 / 3.5 / 3 / 2.75 / 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, NOAA National Centers for Environmental Information (NCEI)
SMM Last Modified Date (MM/DD/YYYY)	11/04/2021
SMM Last Modification POC (Name; E-mail; Affiliation)	Lori Hager, lori.hager@noaa.gov, CASE Consultants International
SMM Modified Date (MM/DD/YYYY)	04/25/2019
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
Preservability	Level 4.5 ▪ 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. Comments: No known external audits of the archiving processes.
Accessibility	Level 5 ▪ Collection and granule searchable via NCEI Common Access available at this website: https://www.ncei.noaa.gov/access/search/data-search/weather-radar-level-iii ▪ 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. Comments: No comments.
Usability	Level 4.5 ▪ NEXRAD Community standard is Native Binary, NCEI provides software for format interoperability (Weather and Climate Toolkit). ▪ Data visualization capability available online at this website: https://www.ncei.noaa.gov/maps/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, 2000] available online here: https://www.ofcm.noaa.gov/publications/fmh/allfmh2.htm Comments: No comments.
Production Sustainability	Level 5 ▪ 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 and slated to be added to current products. ▪ WSR-88D Service Life Extension Program (SLEP) in place that outlines IT modernization/upgrades as well as upgrades to radar hardware. Comments: No comments.

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
Data Quality Assurance	Level 4 ▪ DQA procedures well documented and fully implemented. See algorithm documentation [OFCM, 2000] available online here: https://www.ofcm.noaa.gov/publications/fmh/allfmh2.htm ▪ Level 3 data does have some data quality flags at the file level unlike level 2 data. These quality flags cam be considered limited data quality assurance metadata. Comments: No known external reviews on the data quality.
Data Quality Control/ Monitoring	Level 3.5 ▪ Anomaly detection procedure well-documented and fully implemented and is automatically tracked and reported to users. ▪ DQ control and monitoring procedures documented in the algorithm documentation [OFCM, 2000] available online here: https://www.ofcm.noaa.gov/publications/fmh/allfmh2.htm Comments: No data quality information in the metadata record.
Data Quality Assessment	Level 3 ▪ Numerous publications on research and operational products exist for NEXRAD data. Too many to list here. ▪ Algorithm documentation [OFCM, 2000] available online here: https://www.ofcm.noaa.gov/publications/fmh/allfmh2.htm Comments: No data quality information in the metadata record. No metadata assessments. No known external rankings.
Transparency / Traceability	Level 2.75 ▪ Product information available in literature [Crum & Alberty, 1993] available online here: https://doi.org/10.1175/1520-0477(1993)074<1669:TWATWO>2.0.CO;2 ▪ ATBD/OAD [OFCM, 2000] available online here: https://www.ofcm.gov/publications/fmh/allfmh2.htm ▪ NCEI OID: DSI 7000 ▪ NEXRAD data is under configuration management (CM) and the document [Berkowitz, 2000] is available online here: Data Certification | National Centers for Environmental Information (NCEI) (noaa.gov) Comments: No DOI assigned. System Info Online – ICD at ROC provides sys info with networking, software, and hardware information. Available here: https://www.roc.noaa.gov/wsr88d/BuildInfo/Files.aspx

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
Data Integrity	Level 5 ▪ NCEI can certify data for a fee. Information regarding this process is available online here: 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. Comments: No comments.

3. Acknowledgment

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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** ***Ad hoc*** Little or no management	**Level 2** ***Minimal*** Limited management	**Level 3** ***Intermediate*** Defined management, partially implemented	**Level 4** ***Advanced*** Well-defined management, fully implemented	**Level 5** ***Optimal*** Full management, audited, measured, controlled
Preservability *(The state of being preservable)*	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
Accessibility *(The state of being searchable and accessible publicly)*	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

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

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

Data Integrity *(The state of data integrity being verifiable)*	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