

Unified Metadata Model for Services (UMM-S)

Comments to UMM-S Authors

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Executive Summary

Between June and October 2018, NASA MSFC IMPACT performed a comprehensive review of the Unified Metadata Model for Services (UMM-S), Revision 1.2.0. The UMM-S is a metadata model developed for the CMR that makes service-driven data transformations possible in the Earthdata Search Client. The comprehensive review had two goals: (1) to identify gaps, inconsistencies, and errors in the UMM-S documentation and schema and (2) to compile a set of best practices for the DAACs to use when creating and maintaining UMM-S metadata in the CMR. In fulfillment of the first goal, this document was written as feedback to the ESDIS Project. Several overarching themes regarding the purpose, provision, and maintenance of UMM-S metadata emerged from this effort. They are as follows:

Duplication of information and effort

Some areas of UMM-S capture information already provided elsewhere, either in other UMM profiles or in the metadata of self-describing geospatial web services. This raises questions about the costs and risks of a DAAC duplicating information in UMM-S metadata.

- Several UMM-S concepts are already defined in other UMM profiles, such as UMM-C. These concepts include, but are not limited to, platforms, instruments, science keywords, and contact information. As a result, it will be necessary for DAACs to maintain duplicate information across multiple UMM profiles. The cost of maintaining consistency across UMM profiles could be quite high. Inconsistencies across UMM profiles, should they arise, could also reduce the trustworthiness of metadata in the CMR.
- Many geospatial web services are self-describing in that they are purposefully designed to surface information about available data and transformations to both humans and machines. Manually populating service metadata already provided elsewhere could be a resource-intensive task, especially for services with numerous transformation options or datasets with a long period of record. Currently, no auto population solutions are available to populate information from web services into UMM-S metadata records.

Governance of UMM-S metadata

- The UMM-S documentation has not explicitly addressed the granularity at which UMM-S records should be created. A single service may serve data from multiple collections, or a service could potentially be composed of thousands or even millions of unique endpoints. This raises questions for DAAC metadata authors about the minimum number of UMM-S records required to make a service functional in the Earthdata Search Client. Thus, guidance is needed from ESDIS on the expected granularity of UMM-S metadata records.
- The governance of UMM-S metadata for third-party software and online tools has not been explained in the UMM-S documentation. Perhaps DAAC A and DAAC B both wish to register a UMM-S record for a third party software or online tool useful in manipulating data served by each DAAC. A process should be developed on how to prevent a single software or tool from being registered multiple times in the CMR by different DAACs.

Role of the UMM-S in the End-to-End Services vision

End-to-End Services is referenced several times in the UMM-S documentation, but little context is provided on how the UMM-S fits into and partially fulfills the vision of an end-to-end user experience. Providing at least a summary of End-to-End Services in the UMM-S documentation will be beneficial to all CMR data partners using the model.

Maturity of the UMM-S

As of October 2018, use of the UMM-S by the DAACs appears limited as the model continues to evolve to accommodate content population for web service APIs (e.g., OPeNDAP and OGC web services). While Revision 1.2.0 of the UMM-S was released in May 2018, the Metadata Management Tool has not yet implemented this latest revision. This means records created in the tool will not be compliant with the most current version of UMM-S. Metadata authors at the DAACs also seek functional metadata records to serve as a template in writing their own metadata, but functional example records have not yet been provided by ESDIS. Until documentation is improved, example UMM-S metadata records are made available, and the MMT is updated, adoption of the UMM-S by the DAACs is unlikely to be widespread. Consequently, harvesting of UMM-S metadata by other platforms will also not be possible until content population progresses and appropriate translations can be performed by the CMR.

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Purpose

The purpose of this document is to provide feedback to the ESDIS Project on Revision 1.2.0 of the Unified Metadata Model for Services (hereafter, UMM-S v1.2). Use of the UMM-S by CMR data partners is dependent on the provision of accurate and accessible documentation to guide partners in the development of quality service metadata. This document provides recommendations on how to improve the current UMM service model and its accompanying documentation. Adopting these recommendations will aid metadata authors in generating compliant UMM-S metadata and also make UMM-S metadata more easily consumable by external clients.

Structure

This document is structured into three chapters. Chapter 1 provides general comments and recommendations on the UMM-S v1.2 [documentation](#) and [schema](#). Chapter 2 provides a detailed review of individual UMM-S v1.2 elements. This includes, but is not limited to, suspected errors in the v1.2 documentation and schema, which if confirmed, should be resolved as soon as possible. This document references specific page numbers and line numbers in the [original UMM-S v1.2 documentation](#). A copy of the original UMM-S v1.2 documentation with page and line numbers added is provided alongside this document. Finally, Chapter 3 details several relevant UMM-S use cases for web services provided by EOSDIS DAACs. Comments on the selected use cases are provided as well as comments on UMM-S being used as a vehicle to broaden the use of web services serving NASA Earth science data.

Related Documents

Several documents and resources are either referenced in this text or are known to provide supplemental information that may be useful to the reader. They are summarized here.

[1] UMM-S v1.2 documentation

https://wiki.earthdata.nasa.gov/download/attachments/49448405/UMM-S_V1.2_20180530.docx?version=1&modificationDate=1528375678575&api=v2

[2] UMM-S v1.2 schema

<https://git.earthdata.nasa.gov/projects/EMFD/repos/unified-metadata-model/browse/service/v1.2>

[3] EPSG Geodetic Parameter Registry Version 9.4.2

<http://www.epsg-registry.org/>

[4] W3C Spatial Data on the Web Working Group Note: Spatial Data on the Web Best Practices

<https://www.w3.org/TR/sdw-bp/>

[5] ESDSWG Geospatial Web Services Working Group Web Services Inventory

<https://wiki.earthdata.nasa.gov/display/ESDSWG/GWSWG+Deliverable+-+Geospatial+Web+Services+Inventory>

[6] Open Geospatial Consortium Glossary of Terms

<http://www.opengeospatial.org/ogc/glossary>

[7] Global Change Master Directory (GCMD) Keywords

<https://wiki.earthdata.nasa.gov/display/CMR/GCMD+Keyword+Access>

[8] Unified Metadata Model for Services (UMM-S): Best Practices for UMM-S Metadata Authors

Link TBD

1 General Comments

This chapter includes general comments on the UMM-S v1.2 [documentation](#) and [schema](#) that resulted from a comprehensive copy edit. All figures, page numbers, and line numbers refer to the original UMM-S v1.2 documentation unless otherwise specified.

1.1 Terms and definitions

A brief list of terms and definitions are provided on pages 14 and 15 of the documentation. However, metadata authors will benefit from additional terms being defined in the context of UMM-S. Many terms used in UMM-S may be new for metadata authors within EOSDIS, or the terms may have different meanings in other specifications or standards. Many terms appear to originate from ISO, so consistency with ISO definitions should be maintained when appropriate. In addition to those already defined on pages 14 and 15 of the documentation, metadata authors will benefit from the following terms also being defined:

- Coupled resource
- Data resource
- Invocation
- Operation
- Parameter
- Scoped name
- Variable
- Chaining
- Coupling

1.2 Redundancy and association of service records

Several UMM-S concepts are already defined in UMM-C or other UMM profiles. These include, but are not limited to, platforms, instruments, science keywords, and contact information. As a result, it will be necessary for DAACs to maintain duplicate information across multiple UMM profiles. The association of records in the CMR also introduces new opportunities for inconsistent and/or illogical metadata. Some hypothetical situations to consider include:

- Should it be possible for a UMM-S record listing TRMM as the only platform to be associated with a UMM-C record listing TERRA as the only platform? Will there be a need to develop and implement logical restrictions for collection-service associations?
- If there is a change in a GCMD keyword or a DAAC's contact information, what is the added cost of changes having to be applied to associated UMM-C and UMM-S records individually? If the information is updated in one profile and not the other, how will the CMR reconcile the inconsistencies? What are the consequences of allowing these inconsistencies to occur?
- Are there search and discovery consequences if associated UMM-C, UMM-S, and UMM-Var records contain some varying combination of science keywords?

Duplicating information across UMM profiles could be resource-intensive and computationally expensive. If information becomes inconsistent across profiles, users may deem the metadata untrustworthy. Therefore, redundancy across UMM profiles should be avoided whenever possible.

1.3 References to a KMS

Throughout the document there are references to a keyword management system, or KMS, for controlled vocabulary elements. No distinction is made between those elements that are controlled by a schema enumeration and those that are controlled by the GCMD KMS. To reduce ambiguity, we recommend the UMM-S documentation direct metadata authors to the exact GCMD keyword lists that are valid for a given element.

UMM-S Element	Valid GCMD Keywords
Service/RelatedURLs/Type	GCMD URL Content Types Type
Service/RelatedURLs/Subtype	GCMD URL Content Types Subtype
Service/ScienceKeywords	GCMD Earth Science and Earth Science Services where Category is EARTH SCIENCE SERVICES
Service/ServiceKeywords	GCMD Earth Science and Earth Science Services where Category is EARTH SCIENCE
Service/ServiceOrganizations/ShortName	GCMD Data Centers
Service/ServiceOrganizations/LongName	GCMD Data Centers
Service/Platforms/ShortName	GCMD Platforms/Sources
Service/Platforms/LongName	GCMD Platforms/Sources
Service/Platforms/Instruments/ShortName	GCMD Instruments/Sensors
Service/Platforms/Instruments/LongName	GCMD Instruments/Sensors

Where appropriate, consider including text such as that included in Section 2.6.4 of the [UMM-C v1.10 documentation](#):

“All of the sub-elements except for DetailedVariable are controlled and use the GCMD Location Keyword vocabulary. The vocabulary is managed by the Keyword Management System (KMS) and it can be found at this location:
<http://gcmdservices.gsfc.nasa.gov/static/kms/locations/locations.csv>.”

1.4 Provision of sample UMM-S records

Exemplar UMM-S records should be distributed with the UMM-S documentation. Many metadata authors seek fully functional records to serve as a template in drafting their own compliant metadata.

1.5 Atlas of the Cryosphere

NSIDC's Atlas of the Cryosphere was retired on June 29, 2018, but the Atlas of the Cryosphere is used for sample values in the UMM-S v1.2 documentation. These sample values should be replaced and the associated text updated as necessary.

1.6 Readability of figures

Figure 8 on page 20 of the UMM-S v1.2 documentation is not legible. If the figure cannot be made legible in the documentation, we recommend a full size figure be provided as supplemental material.

1.7 Page numbers

It is highly recommended that documentation of this length include page numbers.

1.8 ServiceOptions for self-describing web services

Several of the use cases described in Section 2.1 of the UMM-S v1.2 documentation refer to a user being able to discover, learn about, and apply data transformations. While one purpose of the UMM-S is to document the data transformations offered by a service, it is not clear to what extent this documentation is needed for web services that are already self-describing. Available transformations are described for OGC services at a GetCapabilities endpoint. Guidance should be given to data providers on whether information should be duplicated in the ServiceOptions class or whether the registration of the GetCapabilities endpoint in a UMM-S record is sufficient.

1.9 Provision of OPeNDAP examples

OPeNDAP services have been identified as candidates for web service API UMM-S records. We recommend that the next iteration of UMM-S documentation include functional OPeNDAP examples. Currently, the only reference to an OPeNDAP service in the v1.2 documentation is for the RelatedURLs/URL element.

2 UMM-S v1.2 Comments

This chapter provides a detailed review of individual UMM-S v1.2 elements. The review was performed to ensure the schema and its accompanying documentation is of a quality suitable for use by CMR metadata authors and CMR application developers. Each element's documentation was checked against the UMM-S v1.2 schema, which was used as the authoritative source for this review. Any inconsistencies and suspected errors in the v1.2 documentation and schema are documented here. This chapter also poses questions to UMM-S authors about the purpose and proper use of certain elements that should be answered by expanding the documentation in the next iteration of UMM-S. The numbering of this chapter matches that of the UMM-S v1.2 [documentation](#). Page numbers and line numbers are used as often as possible to specify the exact text being referenced.

2.2 UMM-S Metadata Model

No Comment - Intentionally Left Blank

2.2.1 Service

Page 21, Line 10-28

The ServiceCitation element and the ServiceOptions class are missing from this list.

Page 21, Line 23

ServiceContacts is not required by the v1.2 schema despite the use of [R].

Page 21, Line 25

ServiceQuality is not required by the v1.2 schema despite the use of [R].

2.2.1.1 Name

No Comment - Intentionally Left Blank

2.2.1.2 LongName

No Comment - Intentionally Left Blank

2.2.1.3 Type

Page 22, Line 33 - 34

This enumerated list is not consistent with the schema's ServiceTypeEnum. This discrepancy should be reconciled.

2.2.1.4 Version

Page 23, Line 6

Because this is a required element and not controlled by a schema enumeration, metadata authors would benefit from guidance on what to enter if this element cannot be provided or is

not known. This element is free text in the Metadata Management Tool. The documentation should explicitly state if “NOT PROVIDED” should be used in these cases, as shown in this [screenshot](#) on this [UMM-S Pathfinder - SCIOPS Earthdata Wiki page](#). Many CMR collections list [NOT PROVIDED](#) for the version, but some list [NA](#), [N/A](#) or [NOT AVAILABLE](#).

2.2.1.5 Description

No Comment - Intentionally Left Blank

2.2.1.6 RelatedURLs

Page 24, Line 10

The following statement is incorrect: “These include the following required elements: Name, Description and URL.”

Service/RelatedURLs/Name is not an element specified in the UMM-S v1.2 schema. The three required elements are URL, URLContentType, and Type.

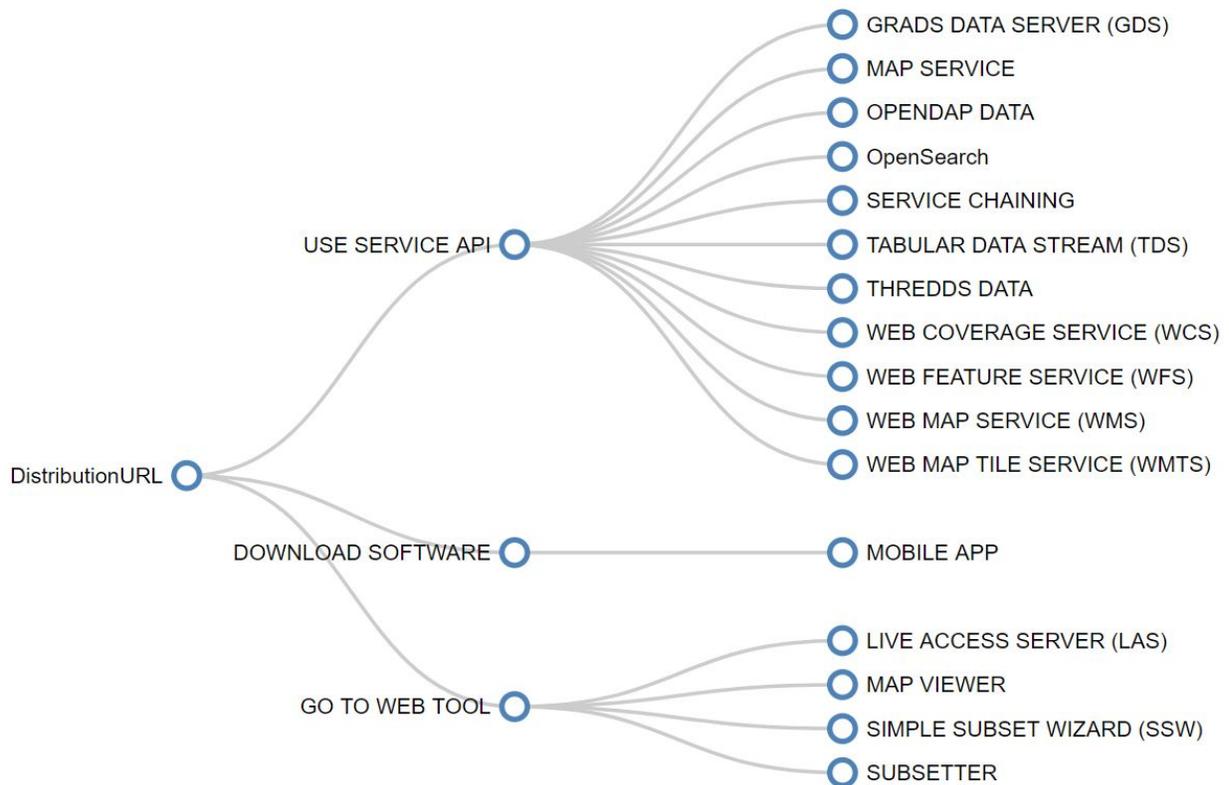
Purpose of the RelatedURLs class

The purpose of the RelatedURLs class is not clear. Because it is the purpose of the OperationMetadata class to capture RESTful service endpoint(s) for the service (Page 20, Line 13), should these endpoints also be captured in the RelatedURLs/URL element? The Types and Subtypes listed on pages 24 and 25 suggest that only service API endpoints should be provided. However, the [UMM-S v1.2 common schema](#) describes the RelatedURLs class as being used for “Internet sites that contain information related to the data, as well as related Internet sites such as project home pages, related data archives/servers, metadata extensions, online software packages, web mapping services, and calibration/validation data.”

The purpose of the RelatedURLs class should also be clarified because it will affect how metadata providers structure their UMM-S records. This is discussed in more detail in [Section 3.2](#).

Controlled vocabulary

If RelatedURLs/Type and RelatedURLs/Subtype will be controlled by the most recent GCMD keyword release, the documentation should be consistent with that release. The UMM-S v1.2 documentation released in June 2018 is not consistent with the GCMD Keyword Version 8.6 that was released in March 2018. Including a hyperlink to the most recent [GCMD URL Content Types](#) in the documentation will reduce confusion around which types are permitted. GCMD Keyword Version 8.6 suggests the following types and subtypes can be used:



OPENDAP DATA is currently the only USE SERVICE API example included in the documentation. If metadata authors need to register their API endpoints in the RelatedURLs class, it is highly recommended that additional examples be included (especially since the RelatedURLs class is required).

2.2.1.7 OperationMetadata

Page 26, Line 21

It is recommended that the description of OperationMetadata be expanded to define operation in the context of the UMM-S (see [Section 1.1](#) of this document).

2.2.1.7.1 OperationName

Page 26, Line 28 - 31

The enumerated list in the v1.2 documentation is not consistent with the v1.2 schema. The schema contains the following values that are not listed in the documentation:

- SPATIAL_SUBSETTING
- TEMPORAL_SUBSETTING
- VARIABLE_SUBSETTING
- VARIABLE_AGGREGATION

Because metadata authors may not be intimately familiar with each of the many web services the UMM-S supports, guidance on which operations correspond to which web service would be

beneficial. For example, documentation should define which of the OperationName enumeration values are to be used an OPENDAP DATA service record, a WMS record, a WCS record, etc.

2.2.1.7.2 DistributedComputingPlatform

Page 27, Line 4 - 5

The enumerated list in the documentation is not consistent with the v1.2 schema. The schema contains “HTTPS” while the documentation does not. This discrepancy should be reconciled.

Page 27, Line 8

The description should be expanded to define distributed computing platforms in the context of the UMM-S. The [OGC glossary of terms](#) defines a distributed computing platform as:

“The foundation technology that enables access to and exploitation of physically distributed information and services. Examples include CORBA, COM/OLE, SQL, Java, and Internet services from the World Wide Web Consortium (W3C) such as HTTP, SOAP and XML.”

Metadata authors will benefit from knowing how this element will be used by application or client developers. An explanation for the the 3 sample values on page 27 would also be helpful. I.e., please explain why XML and WEBSERVICES were chosen for the GetCapabilities, DescribeCoverage, and GetCoverage operations. Also state whether or not multiple values are to be provided as a comma-separated list.

2.2.1.7.3 OperationDescription

No Comment - Intentionally Left Blank

2.2.1.7.4 InvocationName

Page 28, Line 6

The description should be expanded to define invocation in the context of the UMM-S (see [Section 1.1](#) of this document).

Page28, Line 16-18

The Atlas of the Cryosphere was retired on June 29, 2018. This sample value should be updated (see [Section 1.5](#) of this document).

2.2.1.7.5 ConnectPoint

Page 28, Line 29

The documentation currently states a cardinality of (1..*), but the [R] nomenclature is not used and the and tag on Page 29, Line 15 reads “Recommended.” Also, nothing in the schema suggests that this is a required element. The cardinality of the ConnectPoint element should be reconciled between the schema and the documentation.

Page 28, Line 35 - Page 29, Line 12

Sample values are given for ConnectPoint, but in the v1.2 schema, the ConnectPoint class is only a container for the ResourceName, ResourceLinkage, and ResourceDescription elements. Thus, it does not seem appropriate to provide sample values when a value cannot be provided for ConnectPoint.

2.2.1.7.5.1 ResourceName

Page 29, Line 22

The term “resource” is used extensively throughout the OperationMetadata class and should be more clearly defined in the context of the UMM-S (see [Section 1.1](#) of this document). In particular, the documentation should make clear what a resource is in the context of the ConnectPoint resource, the CoupledResource, the DataResource, and the resource CouplingType.

2.2.1.7.5.2 ResourceLinkage

For the ResourceLinkage element, sample values are hardcoded service URLs which include the various parameters (crs, bbox, time, etc.) needed for a server to fulfill an OGC operation request. On page 35, line 10, the documentation states that only the REST endpoint root URL should be provided in the ResourceLinkage element. This could be confusing for metadata authors since the sample values do not appear to be root URLs. It is recommended that the ResourceLinkage section of the documentation be revised to explain what constitutes a root URL.

For example, the documentation should make clear which of the following would be the root ResourceLinkage URL for the NSIDC WMS GetCapabilities operation:

- A. <https://nsidc.org/api/mapservices/NSIDC/ows?>
- B. <https://nsidc.org/api/mapservices/NSIDC/ows?service=WMS&version=1.3.0&request=GetCapabilities>
- C. Something not listed

The documentation should make clear which of the following would be the root ResourceLinkage URL for the ORNL WMS GetMap operation:

- A. <https://webmap.ornl.gov/ogcbroker/wms?>
- B. <https://webmap.ornl.gov/ogcbroker/wms?service=wms&version=1.1.1&request=GetMap>
- C. Something not listed

The documentation should provide examples of root ResourceLinkage URLs that correspond to each of the following operation names:

- SPATIAL_SUBSETTING
- TEMPORAL_SUBSETTING
- VARIABLE_SUBSETTING
- VARIABLE_AGGREGATION

Page 36, Line 7

Replace “Recommended” with “Required.” ResourceLinkage has an [R] tag on page 30, line 17. The UMM-S v1.2 schema also specifies ResourceLinkage as a required element.

2.2.1.7.5.3 ResourceDescription

No Comment - Intentionally Left Blank

2.2.1.7.6 OperationChainedMetadata

Page 36, Line 32

Replace “OperationChainMetadata” with “OperationChainedMetadata” to align with the v1.2 schema.

Page 36, Line - 34

“Service/OperationMetadata/OperationName” should be replaced with “Service/OperationMetadata/OperationChainedMetadata” to align with the v1.2 schema. To be consistent with other areas of the documentation, we also recommend including the entire element specification as follows:

Service/OperationMetadata/OperationChainedMetadata (0..*)

Service/OperationMetadata/OperationChainedMetadata/OperationChainName (1)

Service/OperationMetadata/OperationChainedMetadata/OperationChaindescription (0..1)

This will also help clarify the fact that OperationChainName is only required when the parent OperationChainedMetadata class is included in the UMM-S record.

Page 36, Line 37

It is highly recommended that chained operations be described in more detail for metadata authors who may be unfamiliar with this terminology (see [Section 1.1](#) of this document).

Page 37, Line 1

Please provide more information about the Data Transformation Working Group including the goals of the working group and references to relevant online resources or deliverables."

2.2.1.7.6.1 OperationChainName

No Comment - Intentionally Left Blank

2.2.1.7.6.2 OperationChainDescription

No Comment - Intentionally Left Blank

2.2.1.7.7 CoupledResource

Page 38, Line 10

The terms “resource coupling” and “coupled resource” are not defined (see [Section 1.1](#) of this document). Please consider explaining what constitutes a resource and what it means to couple a resource to a service.

2.2.1.7.7.1 ScopedName

Page 38, Line 20

“ScopedName” is not defined (see [Section 1.1](#) of this document). In addition, the descriptions of ResourceName (page 29, line 22) and ScopedName are identical:

“This element contains the name of the resource(s) coupled to this service.”

Please provide details as to how a scoped name differs from other names in the UMM-S profile, such as ResourceName. Metadata authors will also benefit from knowing the scoped name’s purpose as well as whether or not the element will be exposed to a user interface.

2.2.1.7.7.2 DataResourceDOI

Page 38, Line 35

The documentation should explicitly state whether or not the “doi:” prefix should be provided or if that choice is left to the discretion of the metadata author.

2.2.1.7.7.3 DataResource

Page 39, Line 4

Here, the cardinality is listed as (0..*) but as [0..1] on page 39, line 13. This discrepancy should be reconciled.

Page 39, Line 13 - 30

The DataResource/DataResourceTemporalType element is missing from this list.

Page 39, Line 15 - 16

DataResource/DataResourceType is not an element in the v1.2 schema. Page 39, line 15 - 16 should be replaced with DataResource/DataResourceSourceType and its corresponding enumeration to align with the v1.2 schema.

Page 39, Line 18

DataResource/DataResourceSpatialExtentType is not an element in the v1.2 schema. The text should be replaced with DataResource/DataResourceSpatialType to align with the v1.2 schema.

Page 39, Line 20

The DataResource/DataResourceSpatialExtent/Uuid element does not exist in the v1.2 schema.

Page 39, Line 25

“DataResource/DataResourceTemporalExtent/DataResourceTimePoints/Time [R]” should be changed to
“DataResource/DataResourceTemporalExtent/DataResourceTimePoints/TimeFormat [R]” to match the v1.2 schema.

Page 39, Line 26

“DataResource/DataResourceTemporalExtent/DataResourceTimePoints/Value [R]” should be changed to “DataResource/DataResourceTemporalExtent/DataResourceTimePoints/TimeValue [R]” to match the v1.2 schema.

Page 39, Line 34 - Page 40, Line 27

All instances of “DataResourceTemporalExtent” should be replaced with “DataResourceSpatialExtent.”

Page 40, Line 11 - 22

All instances of “SpatialExtent” should be replaced with “DataResourceSpatialExtent.” In addition, these 12 lines need to be revised for accuracy. For example, the GridLabel, UOM, Minimum, and Maximum elements do not exist in the v1.2 schema.

Page 40, Line 12

The DataResource/SpatialExtent/GeneralGrid/CRSIdentifier element is not included in any of the general grid examples in [Section 2.2.1.7.7.6](#).

Page 40, Line 13

In the DataResource/SpatialExtent/GeneralGrid/Axes element, “Axes” should read “Axis” to align with the v1.2 schema. The error occurs again on Page 43, Line 31.

2.2.1.7.7.4 DataResourceIdentifier

No Comment - Intentionally Left Blank

2.2.1.7.7.5 DataResourceType

Page 41, Line 16 - 26

DataResourceType is not an element in the v1.2 schema. This entire section should use DataResourceSourceType to align with the v1.2 schema.

2.2.1.7.7.6 DataResourceSpatialExtent

Purpose of providing spatial extent

The purpose of providing spatial extent information should be specified in the documentation. It is unclear whether spatial extent information is meant to support geographic searches, operation requests made to the web service, or both.

Consider a metadata author referencing a WMS 1.3.0 GetCapabilities XML when drafting UMM-S metadata. He or she may see that a layer has an <EX_GeographicBoundingBox> element and several <BoundingBox> elements. The former is meant to support geographic searches via the minimum bounding rectangle in decimal degrees of the area covered by the layer, and the latter describes the coordinate ranges for the layer in specified coordinate reference systems. Guidance should be provided on how spatial extent information will be used so that DAAC metadata authors can discern what information is appropriate to provide.

Page 42, Line 21

This SpatialBoundingBox example does not align with the v1.2 schema. The following errors need to be corrected:

1. The BBox class does not exist the v1.2 schema.
2. The required CRSIdentifier element is missing from the example.

In addition, the CRSIdentifierTypeEnum, which governs the SpatialBoundingBox/CRSIdentifier element, is not likely to meet the needs of DAACs in its current form. See [Section 2.2.2.3.6](#) for a more detailed discussion on elements constrained by the CRSIdentifierTypeEnum.

Page 42, Line 36

All GeneralGrid examples need to be updated so that elements are consistent with the v1.2 schema.

Page 43, Line 7 - 15

All instances of “SpatialExtent” should be replaced with “DataResourceSpatialExtent” to match the v1.2 schema.

Page 43, Line 31

In the DataResource/SpatialExtent/GeneralGrid/Axes element, “Axes” should read “Axis” to align with the v1.2 schema. The error also occurs on Page 40, Line 13.

Page 43, Line 31 - 41

All instances of “SpatialExtent” should be replaced with “DataResourceSpatialExtent” to match the v1.2 schema.

2.2.1.7.7.7 DataResourceSpatialExtentType

Page 44, Line 26

All instances of “DataResourceSpatialExtentType” need to be replaced with “DataResourceSpatialType” to align with the v1.2 schema.

2.2.1.7.7.8 SpatialResolution

No Comment - Intentionally Left Blank

2.2.1.7.7.9 SpatialResolutionUnit

No Comment - Intentionally Left Blank

2.2.1.7.7.10 DataResourceTemporalExtent

Purpose of providing temporal extent

The purpose of providing temporal extent information should be specified in the documentation. It is unclear whether temporal extent information is meant to support temporal searches, operation requests made to the web service, or both. Guidance should discuss the circumstances under which a beginning and ending timestamp be provided. It should also discuss the circumstances in which every unique timestamp would need to be provided. The documentation should also address how a metadata author would model irregular temporal information.

Example of an irregular temporal dimension

This example references the `nsidc_0051_ratster_n` layer in the [NSIDC WMS](#). The time dimension includes 12,355 unique timestamps with irregular gaps occurring throughout. Thus, the temporal extent of this layer cannot be modeled as a regular interval over a specific range (i.e., a beginning timestamp, an ending timestamp, and an increment for the sequence). All 12,355 time stamps would need to be registered in the UMM-S record if temporal extent information is meant to support the GetMap and GetFeatureInfo operations. Otherwise, it seems more appropriate that a client simply use the GetCapabilities response to obtain the 12,355 time stamps.

2.2.1.7.7.11 DataResourceTemporalExtentType

Page 46, Line 11

All instances of “DataResourceTemporalExtentType” need to be replaced with “DataResourceTemporalType” to align with the v1.2 schema.

Defining values of the DataResourceTemporalTypeEnum

Each value in the DataResourceTemporalTypeEnum (TIME_STAMP, TIME_SERIES, TIME_AVERAGE, TIME_RANGE) should be defined with examples illustrating under what circumstances each should be used. The documentation should also elaborate on any cardinality constraints for the DataResourceTimePoints element. Metadata authors will need to know how many DataResourceTimePoints elements are permitted for a TIME_STAMP, a TIME_RANGE, a TIME_SERIES, etc.

2.2.1.7.7.12 TemporalResoultion

No Comment - Intentionally Left Blank

2.2.1.7.7.13 TemporalResolutionUnit

Page 46, Line 38

The enumerated list in the v1.2 documentation is not consistent with the v1.2 schema. The schema contains the following value that is not listed in the documentation: TWICE_PER_DAY.

2.2.1.7.7.14 RelativePath

No Comment - Intentionally Left Blank

2.2.1.7.7.15 CouplingType

No Comment - Intentionally Left Blank

2.2.1.7.8 Parameter

No Comment - Intentionally Left Blank

2.2.1.7.8.1 ParameterName

No Comment - Intentionally Left Blank

2.2.1.7.8.2 ParameterDirection

Page 48, Line 37

The documentation suggests that this element is governed by a schema enumeration (IN, OUT, IN/OUT). However, no such enumeration is present in the actual v1.2 schema. This discrepancy should be reconciled.

2.2.1.7.8.3 ParameterDescription

Page 48, Line 10 lists a cardinality of (0..1) for this element, but Page 49, Line 9 lists a cardinality of (1). The v1.2 schema states that this elements is required. These discrepancies should be reconciled.

2.2.1.7.8.4 ParameterOptionality

Page 49, Line 22

The documentation suggests that this element is governed by a schema enumeration (TRUE, FALSE). However, no such enumeration is present in the actual v1.2 schema. This discrepancy should be reconciled.

Page 49, Line 25

Please provide more details as to what the term "optionality" means within the context of the UMM-S. Additional guidance should be provided as to when to provide TRUE or FALSE values.

2.2.1.7.8.5 ParameterRepeatability

Page 49, Line 35

The documentation suggests that this element is governed by a schema enumeration (TRUE, FALSE). However, no such enumeration is present in the actual v1.2 schema. This discrepancy should be reconciled.

2.2.1.8 OnlineAccessURLPatternMatch

No Comment - Intentionally Left Blank

2.2.1.9 OnlineAccessURLPatternSubstitution

No Comment - Intentionally Left Blank

2.2.1.10 ScienceKeywords

The UMM supports the provision of science keywords in UMM-C, UMM-S, and UMM-Var. As DAAC metadata authors prepare to manage science keywords across multiple UMM profiles, they will benefit from knowing of any inheritance will occur when collection-service-variable associations are performed in the CMR. They will also benefit from documentation describing the implications of a science keyword being provided in one profile and not the other. See [Section 1.2](#) of this document for more on redundancy across UMM profiles.

2.2.1.11 ServiceKeywords

Page 51, Line 21 - 22

For metadata authors who may be unfamiliar with GCMD Service Keywords, we recommend stating that the KMS being referenced is the [GCMD Earth Science and Earth Science Services keyword list](#). Valid hierarchies are those in which the Category is EARTH SCIENCE SERVICES.

2.2.1.12 ServiceOrganizations

Much of this information should already be provided in associated UMM-C records. However, the ServiceOrganizations class is required, which may force DAACs to duplicate contact information and maintain it across multiple UMM profiles. See [Section 1.2](#) of this document for more on redundancies across the metadata models.

2.2.1.13 ServiceContacts

Page 53, Line 36

The documentation states that the required ServiceContacts class serves as the parent to ContactPersons and ContactGroups, but a ServiceContacts class is not included in the v1.2 schema. In other words, the two child classes, ContactPersons and ContactGroups, have no parent. In the v1.2 schema, neither ContactPersons nor ContactGroups are required. Discrepancies in the documentation and the schema should be reconciled.

Additionally, we recommend clarifying when one should use ContactPersons and ContactGroups over ServiceOrganizations/ContactPersons and ServiceOrganizations/ContactGroups.

2.2.1.13.1 ContactPersons

No Comment - Intentionally Left Blank

2.2.1.13.2 ContactGroups

No Comment - Intentionally Left Blank

2.2.1.14 Platforms

No Comment - Intentionally Left Blank

2.2.1.14.1 Instruments

Page 56, Line 17

The cardinality of the Instruments class is inconsistent. On page 55, line 43, the cardinality is listed as (1..*), but on page 56, line 17, it is listed as (0..*). The v1.2 schema shows Instruments as being optional. These discrepancies need to be reconciled.

2.2.1.15 ServiceQuality

No Comment - Intentionally Left Blank

2.2.1.16 ServiceCitation

No Comment - Intentionally Left Blank

2.2.1.17 AccessConstraints

No Comment - Intentionally Left Blank

2.2.1.18 UseConstraints

No Comment - Intentionally Left Blank

2.2.1.19 AncillaryKeywords

Explicit guidance should be provided as to whether or not this element should be provided as a comma-separated list.

2.2.2 Options

Page 58, Line 25

In the UMM-S v1.2 schema, this class is named “ServiceOptions.” All instances of “Options” should be replaced with “ServiceOptions” in the documentation.

Page 58, Line 29

The cardinality of this set is listed as [0..N]. The value of N is not defined. We recommend defining N or changing the cardinality to infinite [0..*].

Page 58, Line 29 - 38

The list of elements is incomplete and does not align with the ServiceOptions class in the v1.2 schema. The documentation should be updated to be consistent with the schema.

Consequences of the ServiceOptions and DataResource classes being independent

See also [Section 3.1](#) of this document for more on this topic. It is recommended that the documentation elaborate on the consequences of the ServiceOptions class being independent of the DataResource metadata. It appears that the ServiceOptions metadata must be global, or all-encompassing. That is, the projections, formats, etc. must be true to each of the DataResource elements in the UMM-S record. For example, the `nsidc_0051_raster_n` and `nsidc_0051_raster_s` layers in the [NSIDC WMS](#) are distributed in two different native coordinate reference systems, EPSG:3413 and EPSG:3031, respectively. The `nsidc_0051_raster_n` layer should not be output in EPSG:3031, and as a consequence, these layers are not suited to be registered in the same UMM-S record. Elaborating on this type of situation and proposing alternate approaches should help ensure metadata authors write valid UMM-S records.

Consequences of the ServiceOptions class being optional

The ServiceOptions class is optional in cardinality, but the documentation offers no guidance on when/if the class is necessary to support EDSC functionality. The documentation should state if the ServiceOptions class is optional because these elements may not be applicable to all UMM-S records, such as a tool that does not perform data transformations. It should also address if the ServiceOptions class is optional when data transformations are already described elsewhere, say at an OGC GetCapabilities endpoint.

Address in the above ambiguities will impact metadata author decisions when creating UMM-S records for services that are already self-describing (e.g., an OGC web service). Coordinate reference system information can be extracted from a service's GetCapabilities endpoint and may already be captured, in part, within DataResource/DataResourceSpatialExtent. An author may therefore be inclined to skip the optional ServiceOptions class unless the documentation states otherwise.

Page 59, Line 6

Aggregation is spelled incorrectly.

Page 59, Line 10

The ServiceOptions class (Page 58, Line 25) does not have a "Tags" section in the documentation. We suggest "Recommended" be listed given the optional cardinality of the ServiceOptions class.

2.2.2.1 SubsetTypes

No Comment - Intentionally Left Blank

2.2.2.2 VariableAggregation

Page 59, Line 29

In the UMM-S v1.2 schema, this class is named “VariableAggregationSupportedMethods.” All instances of “VariableAggregation” should be replaced with “VariableAggregationSupportedMethods” to align with the v1.2 schema.

2.2.2.3 SupportedInputProjections

Providing accurate CRS information can be tricky, especially if the metadata author is not familiar with geospatial data. Some web services will return an error if not provided accurate CRS information. Thus, the UMM-S should make every effort to ensure CRS information is modeled consistently and accurately. It is highly recommend that UMM-S leverage an official registry or namespace for CRS information whenever possible, rather than asking CRS information be manually entered by a metadata author.

The current schema enumerations used in the SuportedInputProjections and SupportedOutputProjections classes are insufficient in that they are either not exhaustive, contain invalid values, or both.

UMM-S v1.2 Element	Enum
ProjectionName	"Geographic", "Military Grid Reference", "MODIS Sinusoidal System", "Sinusoidal", "World Mollweide", "Mercator", "Space Oblique Mercator", "Transverse Mercator", "Universal Transverse Mercator", "UTM Northern Hemisphere", "UTM Southern Hemisphere", "State Plane Coordinates", "Albers Equal-Area Conic", "Lambert Conic Conformal", "Lambert Equal Area", "Lambert Azimuthal Equal Area", "Cylindrical", "Cylindrical Equal Area", "Polar Stereographic", "EASE-Grid", "EASE-Grid 2.0", "WGS 84 / UPS North (N,E)", "WGS84 - World Geodetic System 1984", "NSIDC EASE-Grid North", "NSIDC EASE-Grid Global", "NSIDC Sea Ice Polar Stereographic North", "WGS 84 / NSIDC Sea Ice Polar Stereographic North", "NSIDC EASE Grid North and South (Lambert EA)", "WGS 84 / North Pole LAEA Bering Sea", "WGS 84 / North Pole LAEA Alaska", "WGS 84 / North Pole LAEA Canada", "WGS 84 / North Pole LAEA Atlantic", "WGS 84 / North Pole LAEA Europe", "WGS 84 / North Pole LAEA Russia", "WGS 84 / NSIDC EASE-Grid North", "WGS 84 / NSIDC EASE-Grid Global", "WGS 84 / UTM zone 24N", "Spherical Mercator", "WGS 84 / Pseudo-Mercator -- Spherical Mercator, Google Maps, OpenStreetMap, Bing, ArcGIS, ESRI", "Google Maps Global Mercator -- Spherical Mercator", "WGS 84 / Antarctic Polar Stereographic", "NSIDC EASE-Grid South", "NSIDC Sea Ice Polar Stereographic South", "WGS 84 / NSIDC EASE-Grid South", "WGS 84 / NSIDC Sea Ice Polar Stereographic South", "WGS 84 / UPS South (N,E)", "NSIDC EASE Grid Global", "EASE Grid 2.0 N. Polar", "Plate Carree", "WELD Albers Equal Area", "Canadian Albers Equal Area Conic", "NAD83 / UTM zone 17N"
ProjectionAuthority	"4326", "3395", "3785", "9807", "2000.63", "2163", "3408", "3410", "6931", "6933", "3411", "9822", "54003", "54004", "54008", "54009", "26917", "900913"
ProjectionUnit	"Meters", "Degrees"

ProjectionDatumName	"North American Datum (NAD) 1927", "North American Datum (NAD) 1983", "World Geodetic System (WGS) 1984"
---------------------	--

2.2.2.3.1 ProjectionName

Consistency and/or interoperability issues are likely to arise by using the above ProjectionName enum. These issues include, but are not limited to:

- Both "NSIDC EASE Grid Global" and "NSIDC EASE-Grid Global" being included.
- "WGS 84 / Pseudo-Mercator -- Spherical Mercator, Google Maps, OpenStreetMap, Bing, ArcGIS, ESRI" being listed when the official EPSG name appears to be just "WGS 84 / Pseudo-Mercator" (see [EPSG:3857](#))
- The corresponding EPSG code ([32624](#)) for "WGS 84 / UTM zone 24N" is not being listed in the CRSIdentifierTypeEnum

The use of standardized names from an official registry or namespace may reduce confusion or ambiguity surrounding the available CRS options.

2.2.2.3.2 ProjectionLatitudeOfCenter

No Comment - Intentionally Left Blank

2.2.2.3.3 ProjectionLongitudeOfCenter

No Comment - Intentionally Left Blank

2.2.2.3.4 ProjectionFalseEasting

No Comment - Intentionally Left Blank

2.2.2.3.5 ProjectionFalseNorthing

No Comment - Intentionally Left Blank

2.2.2.3.6 ProjectionAuthority

This element is constrained by the CRSIdentifierTypeEnum and is defined as containing EPSG codes. Some of the values are not EPSG codes and some are not coordinate reference systems (see comments in the table below).

Label	Identifier	Type	Name	Comments
EPSG	4326	Geographic 2D CRS	WGS 84	
EPSG	3395	Projected CRS	WGS 84 / World Mercator	
EPSG	3785	Area of Use	New Zealand - South Island - Marlborough mc	This is an area of use , not a coordinate reference system. The 3785 that UMM-S authors may have been

				referring to has been deprecated and replaced with 3857 (see the EPSG::2008.114 change ID).
EPSG	9807	Coordinate Operation Method	Transverse Mercator	This is a coordinate operation method , not a coordinate reference system.
	2000.63			Unable to validate as a CRS identifier.
EPSG	2163	Projected CRS	US National Atlas Equal Area	
EPSG	3408	Projected CRS	NSIDC EASE-Grid North	
EPSG	3410	Projected CRS	NSIDC EASE-Grid Global	
EPSG	6931	Projected CRS	WGS 84 / NSIDC EASE-Grid 2.0 North	
EPSG	6933	Projected CRS	WGS 84 / NSIDC EASE-Grid 2.0 Global	
EPSG	3411	Projected CRS	NSIDC Sea Ice Polar Stereographic North	
EPSG	9822	Coordinate Operation Method	Albers Equal Area	This is a coordinate operation method , not a coordinate reference system.
ESRI	54003	Projected CRS	World_Miller_Cylindrical	Not a valid EPSG code. ESRI is the authority for this identifier. See https://support.esri.com/en/technical-article/000011199 .
ESRI	54004	Projected CRS	World_Mercator	Not a valid EPSG code. ESRI is the authority for this identifier. See https://support.esri.com/en/technical-article/000011199 .
ESRI	54009	Projected CRS	World_Mollweide	Not a valid EPSG code. ESRI is the authority for this identifier. See https://support.esri.com/en/technical-article/000011199 .
EPSG	26917	Projected CRS	NAD83 / UTM zone 17N	
	900913			Not a valid EPSG identifier. The value 900913 was chosen as it appears to spell "Google." It is unlikely to appear in any official CRS registry.

In addition, EOSDIS DAACs distribute data in a number of coordinate reference systems not in this enumerated list. For example, the [GetMap request](#) for Figure 11 on page 33 of the UMM-S v1.2 documentation includes EPSG:2264, which is not included in the CRSIdentifierTypeEnum.

If detailed CRS information is needed in UMM-S records, we recommend the model support the use of HTTP URIs for CRS definitions when they are available. For example:

- All information pertaining to EPSG:4326 can be obtained via <http://www.opengis.net/def/crs/EPSSG/0/4326>.
- All information pertaining to CRS:27 can be obtained via <http://www.opengis.net/def/crs/OGC/1.3/CRS27>.

ESRI WKIDs for projected coordinate systems, such as 54003, 54004, and 54009 above, are defined at

<https://developers.arcgis.com/rest/services-reference/projected-coordinate-systems.htm>.

2.2.2.3.7 ProjectionUnit

Currently, the options are meters and degrees. In the future, the model should consider whether or not other units of measure should be supported. For example, the State Plane Coordinate System of 1927 uses the U.S. survey foot as the unit of measure (see [EPSSG:2204](#) as an example).

2.2.2.3.8 ProjectionDatumName

Allowing the ProjectionDatumName to be specified regardless of the projection could lead to inaccurate metadata. When specifying an EPSG code, the datum is already defined by that code. For example:

- The [EPSSG:4326](#) projected CRS uses the [EPSSG:6326](#) geodetic datum.
- The [EPSSG:3410](#) projected CRS uses the [EPSSG:6053](#) geodetic datum.

2.2.2.4 SupportedOutputProjections

No Comment - Intentionally Left Blank

2.2.2.4.1 ProjectionName

No Comment - Intentionally Left Blank

2.2.2.4.2 ProjectionLatitudeOfCenter

No Comment - Intentionally Left Blank

2.2.2.4.3 ProjectionLongitudeOfCenter

No Comment - Intentionally Left Blank

2.2.2.4.4 ProjectionFalseEasting

No Comment - Intentionally Left Blank

2.2.2.4.5 ProjectionFalseNorthing

No Comment - Intentionally Left Blank

2.2.2.4.6 ProjectionAuthority

No Comment - Intentionally Left Blank

2.2.2.4.7 ProjectionUnit

No Comment - Intentionally Left Blank

2.2.2.4.8 ProjectionDatumName

No Comment - Intentionally Left Blank

2.2.2.5 InterpolationTypes

Page 69, Line 3

The enumerated list in the documentation does not match the v1.2 schema enumeration for this element. The documentation lists “Cubic Convolution” while the schema enumeration lists “Bicubic Interpolation” instead. This discrepancy should be reconciled.

2.2.2.6 SupportedInputFormats

No Comment - Intentionally Left Blank

2.2.2.7 SupportedOutputFormats

No Comment - Intentionally Left Blank

2.2.2.8 MaxGranules

No Comment - Intentionally Left Blank

3 Use Cases

This chapter discusses the process of creating sample UMM-S metadata for select web services at EOSDIS DAACs. NASA MSFC IMPACT initially attempted to create UMM-S v1.2 records using the Metadata Management Tool (MMT), but discovered that the tool had not yet implemented UMM-S v1.2. Therefore, sample UMM-S metadata was authored manually. Because most all of the examples provided in UMM-S v1.2 documentation were OGC web services, we chose author records for an OGC Web Map Service and Web Coverage Service. We also chose services for popular Level 3 collections that contain data for a long period of record. Several questions arose when authoring the sample records, particularly in areas where the UMM-S v1.2 documentation is unclear or inconsistent.

3.1 WMS 1.3.0 for NSIDC-0051

Background

The [Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSM/I-SSMIS Passive Microwave Data, Version 1](#) dataset (short name NSIDC-0051) was selected as an NSIDC use case to test the process of creating a service record with the UMM-S v1.2 schema. Within [NSIDC's WMS](#), this particular dataset is composed of an Arctic subset (`nsidc_0051_raster_n`) and an Antarctic subset (`nsidc_0051_raster_s`). Each layer has a unique spatial extent and coordinate reference system.

Questions

Should the content of a UMM-S record be governed by the associated collection or the parent service?

The UMM-S documentation seems to suggest that whenever possible, a service record should only contain data tied to a single collection (Method 1). For example, a metadata author should create different UMM-S records for [NSIDC-0051](#) and [NSIDC-0477](#), even though maps for both collections are served by the same [NSIDC WMS](#). It is not unnatural to consider making a single UMM-S record for the entire [NSIDC WMS](#) and then associate that UMM-S record with multiple collections (Method 2). Based on the intended use of UMM-S for application development, is one method considered correct or preferred? If so, we recommend elaborating in the documentation.

Are there limits to which data resources can be described in a single UMM-S record?

The ServiceOptions class appears to be a primary factor in determining which data resources can be described in a record, particularly SupportedInputProjections and SupportedOutputProjections. Because the ServiceOptions class is independent of the OperationMetadata class, information within ServiceOptions must be global, or true, to all data resources within OperationMetadata. In the case of NSIDC-0051, the Arctic layer and the Antarctic layer are defined by different CRSs. If both layers and the corresponding service options are registered in the same UMM-S record, there is no way to connect the service options back to the corresponding DataResource in OperationMetadata (Figure 1). Thus,

nsidc_0051_raster_n and nsidc_0051_raster_s must each be described in its own UMM-S record (Figures 2 and 3) and each record then associated with the [NSIDC-0051 UMM-C record](#).

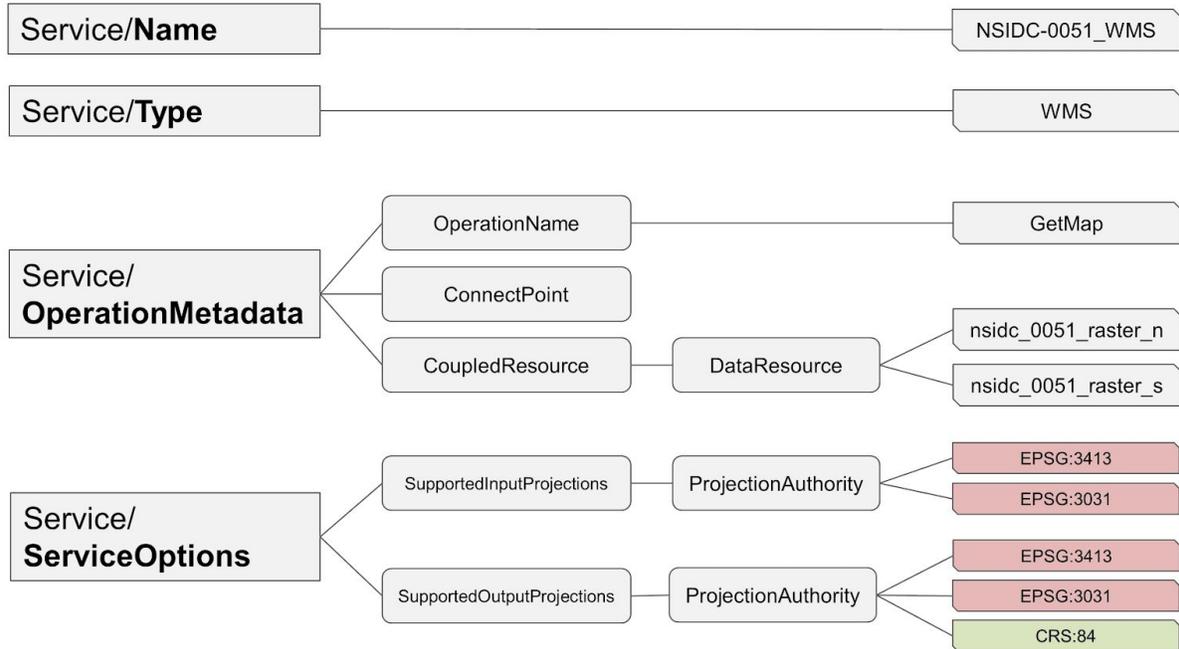


Fig. 1. Schematic of an abridged UMM-S record for the NSIDC-0051 WMS. Service options that are valid for all data resources are green. Those that are not are red.

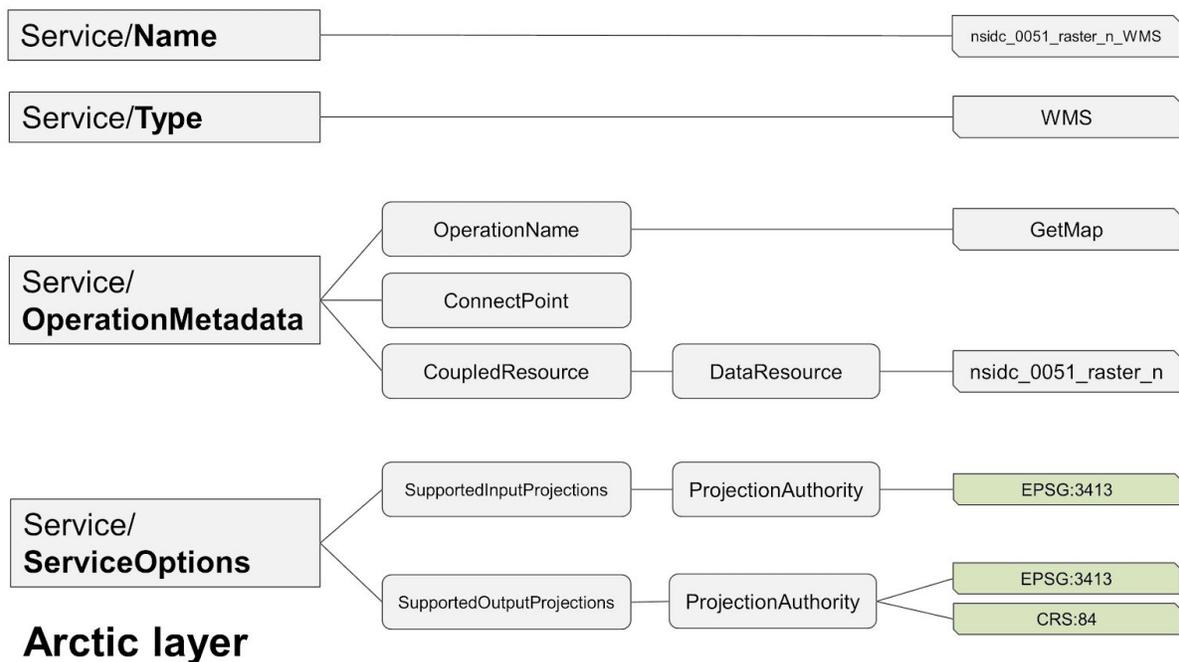


Fig. 2. Schematic of a separate UMM-S record for the NSIDC-0051 Arctic layer. Service options that are valid for all data resources are green.

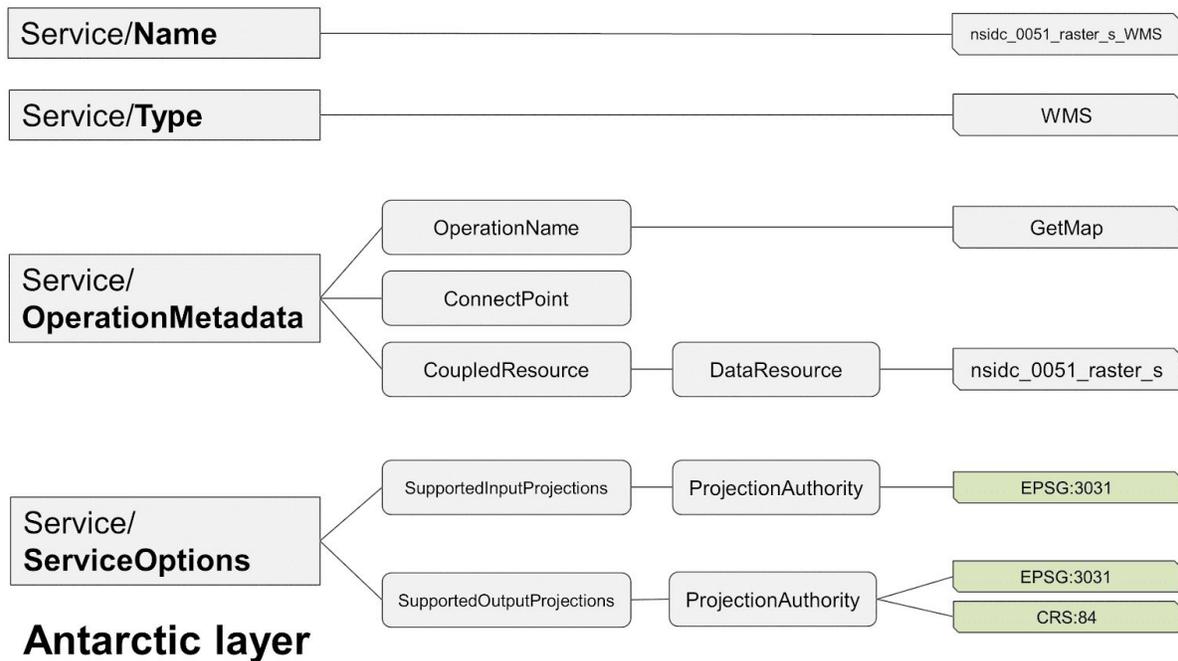


Fig. 3. Schematic of a separate UMM-S record for the NSIDC-0051 Antarctic layer. Service options that are valid for all data resources are green.

Do I have to provide ServiceOptions for a self-describing web service?

[Section 1.8](#) of this document also raises this question. In this WMS use case, the provision of ServiceOptions metadata is largely duplicating the metadata available as the [NSIDC WMS GetCapabilities endpoint](#). The cardinality of ServiceOptions is optional (0..N). As a metadata author, I may be inclined to skip the ServiceOptions metadata because the transformations can be read directly from the GetCapabilities operation. Thus, we recommend clarifying the ServiceOptions documentation to explain whether or not ServiceOptions must be filled out for self-describing web services. If not, the previous question on whether `nsidc_0051_raster_n` and `nsidc_0051_raster_s` can be registered in the same record is void.

Recommendation to improve UMM-S documentation

The above nuances could be easily overlooked by metadata authors and has the potential to impact the creation of functional UMM-S records for web services. Therefore, we highly recommend answering the above questions so metadata authors can make informed decisions when authoring UMM-S metadata.

3.2 THREDDS WCS 1.0.0 for Daymet_V3_Monthly_Climatology_1345 Background

The [Daymet: Monthly Climate Summaries on a 1-km Grid for North America, Version 3](#) dataset (short name Daymet_V3_Monthly_Climatology_1345) was selected as an ORNL use case to test the process of creating a service record with the UMM-S v1.2 schema. The collection contains 912 granules, 456 of which can be accessed via a [THREDDS Data Server](#). Each granule is defined by a variable, a year, and a geographic region:

- 4 variables (tmin, tmax, prcp, vp)
- 38 years (January 1980 - December 2017)
- 3 geographic regions (NA, PR, HI)

Each granule has a THREDDS landing page (example [here](#)), which provides 8 different access methods (OPENDAP, HTTPServer, WCS, WMS, NCML, NetcdfSubset, ISO, and UDDC). For this use case, we focus on the WCS access method. If one were to create a WCS UMM-S record for each granule, 456 UMM-S records would result. This could be a resource-intensive task, and therefore, we comment on some of the issues a metadata author might face.

Questions

At what granularity should UMM-S records be created?

For this particular collection, the author could create 456 WCS UMM-S records, one for each granule, or the author could attempt to create 1 WCS UMM-S record describing all 456 granules. The latter would require OperationMetadata classes be created for each operation (GetCapabilities, DescribeCoverage, GetCoverage) as they pertain to each of the 456 granules. This would lead to the burden of creating and maintaining 1,368 OperationMetadata classes, each with a unique ResourceLinkage pointing to each granule's OGC operation endpoints. So this UMM-S record would have 456 GetCapabilities operations, 456 DescribeCoverage operations, and 456 GetCoverage operations.

The UMM-S documentation offers no guidance on which of these approaches should be pursued or if both are equally valid. Is one method considered correct or preferred? If so, why?

What is the purpose of the RelatedURLs class?

Another decision the metadata author must make is what to provide in the RelatedURLs class (see also [Section 2.2.1.6](#) of this document). If the operation endpoints are already provided in the OperationMetadata class, what should be provided in the RelatedURLs class? In this case, the [top level THREDDS directory](#) is an option, but the documentation offers no guidance for web services beyond the single OPENDAP DATA example on page 26. Would there be consequences if the Service/Type is WCS but the RelatedURLs/Subtype is THREDDS DATA as shown in the table below?

UMM-S v1.2 Element	Proposed Value
Service/Type	WCS
Service/RelatedURLs/URL	https://thredds.daac.ornl.gov/thredds/catalog/ornl/daac/1345/catalog.html

Service/RelatedURLs/URLContentType	DistributionURL
Service/RelatedURLs/Type	USE SERVICE API
Service/RelatedURLs/Subtype	THREDDS DATA

Recommendation to improve UMM-S documentation

For web services in which each data resource has a unique ResourceLinkage, such as this ORNL use case, metadata authors need guidance on how to approach record creation. The cost of creating and maintaining hundreds or thousands of service records for a single web service could be quite high. If this is necessary, it is important metadata authors be aware of it from the outset. In addition, RelatedURLs should be more clearly defined and differentiated from the URLs provided in the OperationMetadata class.

3.3 Interoperability Beyond the Earthdata Search Client

The web service endpoints provided in UMM-S to be leveraged by the Earthdata Search Client (EDSC) have high reuse value. The EDSC use cases are crafted around the concept of a user never having to manipulate, or even see, the web service URL itself. However, it is well known that surfacing the endpoints could enable them to be more easily retrieved and plugged in to external software, platforms, or code. Examples include ArcMap, QGIS, NCL, R, and Python, to name a few. More information on these examples is provided in Appendix B. If DAACs can use UMM-S as a vehicle for surfacing these endpoints, they will benefit from guidance detailing how to ensure they are surfaced to the user in the EDSC.

GeoPlatform.gov

UMM-S may also have reuse value in extending the reach of DAAC services to GeoPlatform.gov. At the time of this writing, data being served through the following web services can be registered at GeoPlatform.gov:

- ESRI REST Feature Service
- ESRI REST Image Service
- ESRI REST Map Service
- ESRI REST Tile Service
- GeoPlatform GeoJSON Feed Service
- OGC Keyhole Markup Language (KML)
- OGC Web Catalog Service (CSW)
- OGC Web Coverage Service (WCS)
- OGC Web Map Service (WMS)
- OGC Web Feature Service (WFS)
- OGC Web Map Tile Service (WMTS)
- OGC WMS-T Service

GeoPlatform.gov accepts the URL for the entire service (i.e., the root service endpoint). Should these root endpoints be registered in UMM-S metadata, they could someday be ingested into GeoPlatform via the CMR. It would therefore be beneficial for UMM-S documentation to answer the root endpoint questions raised in [Section 2.2.1.7.5.2](#) of this document.

Appendix A Abbreviations and Acronyms

API	Application Programming Interface
CMR	Common Metadata Repository
CRS	Coordinate Reference System
DAAC	Distributed Active Archive Center
DOI	Digital Object Identifier
EDSC	Earthdata Search Client
EOSDIS	Earth Observing System Data and Information System
EPSG	European Petroleum Survey Group
ESDIS	Earth Science Data and Information System
ESRI	Environmental Systems Research Institute
GCMD	Global Change Master Directory
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
IMPACT	Interagency Implementation and Advanced Concepts
ISO	International Organization for Standardization
KMS	Keyword Management System
LP DAAC	Land Processes Distributed Active Archive Center
MERRA-2	Modern-Era Retrospective analysis for Research and Applications, Version 2
MMT	Metadata Management Tool
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NCL	NCAR Command Language
NSIDC	National Snow and Ice Data Center
OGC	Open Geospatial Consortium
OPeNDAP	Open-source Project for a Network Data Access Protocol
ORNL	Oak Ridge National Laboratory
REST	Representational State Transfer

SEDAC	Socioeconomic Data and Applications Center
SE TIM	Systems Engineering Technical Interchange Meeting
THREDDS	Thematic Real-time Environmental Distributed Data Services
UMM	Unified Metadata Model
UMM-C	Unified Metadata Model for Collections
UMM-Common	Unified Metadata Model for Common Elements
UMM-S	Unified Metadata Model for Services
UMM-Var	Unified Metadata Model for Variables
URL	Uniform Resource Locator
URI	Uniform Resource Identifier
WCS	Open Geospatial Consortium Web Coverage Service
WFS	Open Geospatial Consortium Web Feature Service
WMS	Open Geospatial Consortium Web Map Service
XML	Extensible Markup Language

Appendix B Additional Use Case Information

ArcMap

A user discovering the [MODIS/Terra+Aqua Land Cover Type Yearly L3 Global 500m SIN Grid V006](#) collection may wish to access the MODIS:MCD12Q1.2016001.006.LandCover layer in the LP DAAC WMS. That user will need the following URL surfaced for use in ArcMap (Figures 4 and 5): <https://lpdaacsvc.cr.usgs.gov/ogc/wms?>

The screenshot shows the 'Add WMS Server' dialog box in ArcMap. The URL field is populated with 'https://lpdaacsvc.cr.usgs.gov/ogc/wms?'. The Version dropdown is set to '1.3.0'. The Custom Parameters section is empty. The Server Layers section shows a list of layers, with 'MCD12Q1.2016001.006.LandCover' selected. The details for this layer are shown on the right: Name: MODIS:MCD12Q1.2016001.006.LandCover, Abstract: Not available, LatLongBoundingBox: -180.000000, -90.000001, 180.000003, 90.000000, Scale range: Minimum:0.000000, Maximum:0.000000, Supported SRS: EPSG:4326, CRS:84, AUTO:42001. The Account (Optional) section has empty fields for User and Password, and the 'Save Password' checkbox is checked. The OK and Cancel buttons are at the bottom right.

Fig. 4. Adding the LP DAAC WMS to ArcMap.

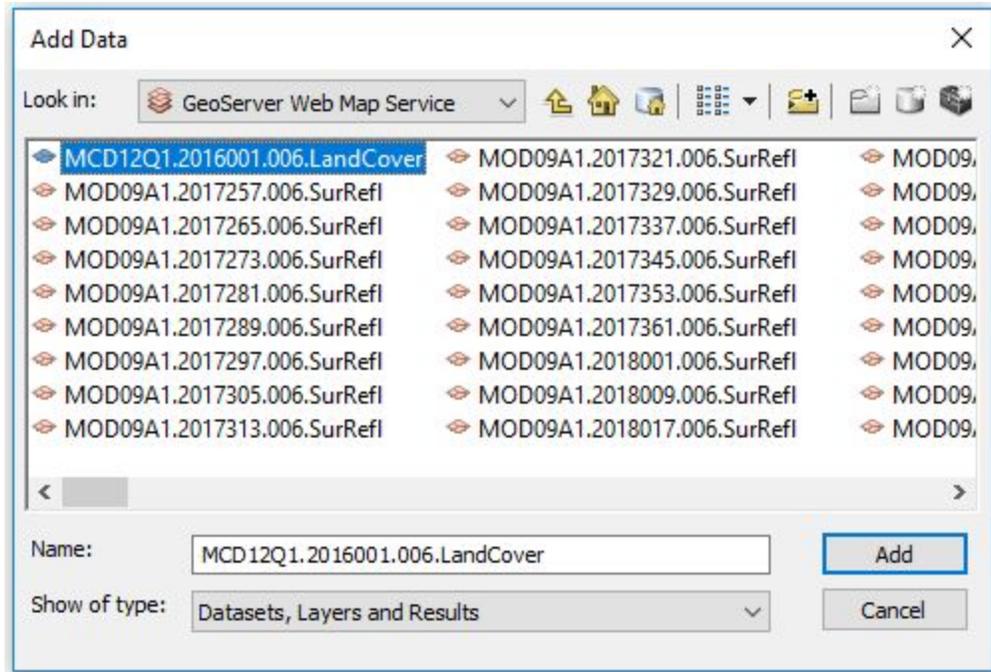


Fig. 5. Selecting the MCD12Q1.2016001.006.LandCover layer from the LP DAAC WMS in ArcMap.

QGIS

A user wanting to access the [Global Landslide Hazard Distribution](#) coverage from the SEDAC WCS will need the following URL surfaced for use in QGIS (Figures 6 and 7):

<http://sedac.ciesin.org/geoserver/ows?service=wcs&version=1.1.0&request=GetCapabilities>.

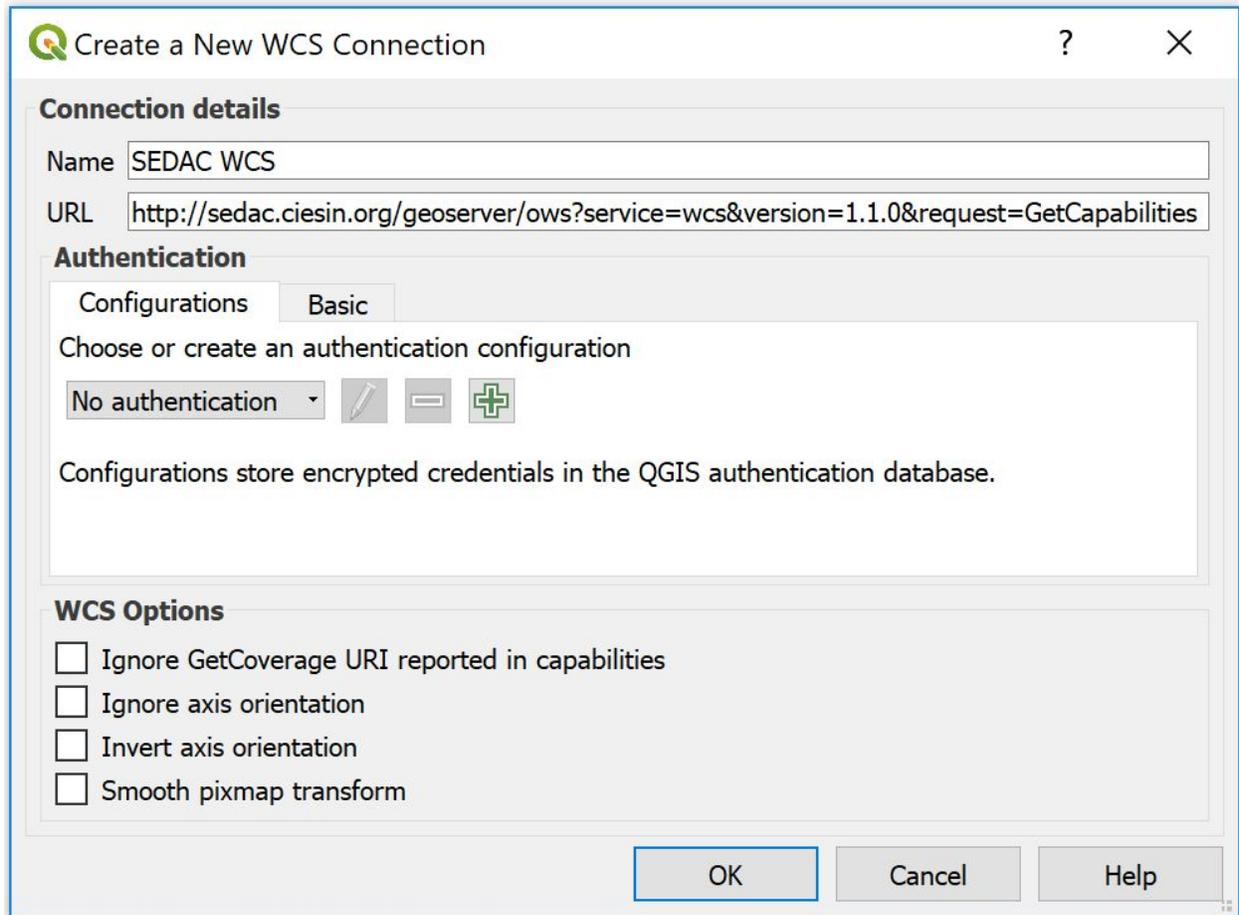


Fig. 6. Creating a connection to the SEDAC WCS in QGIS.

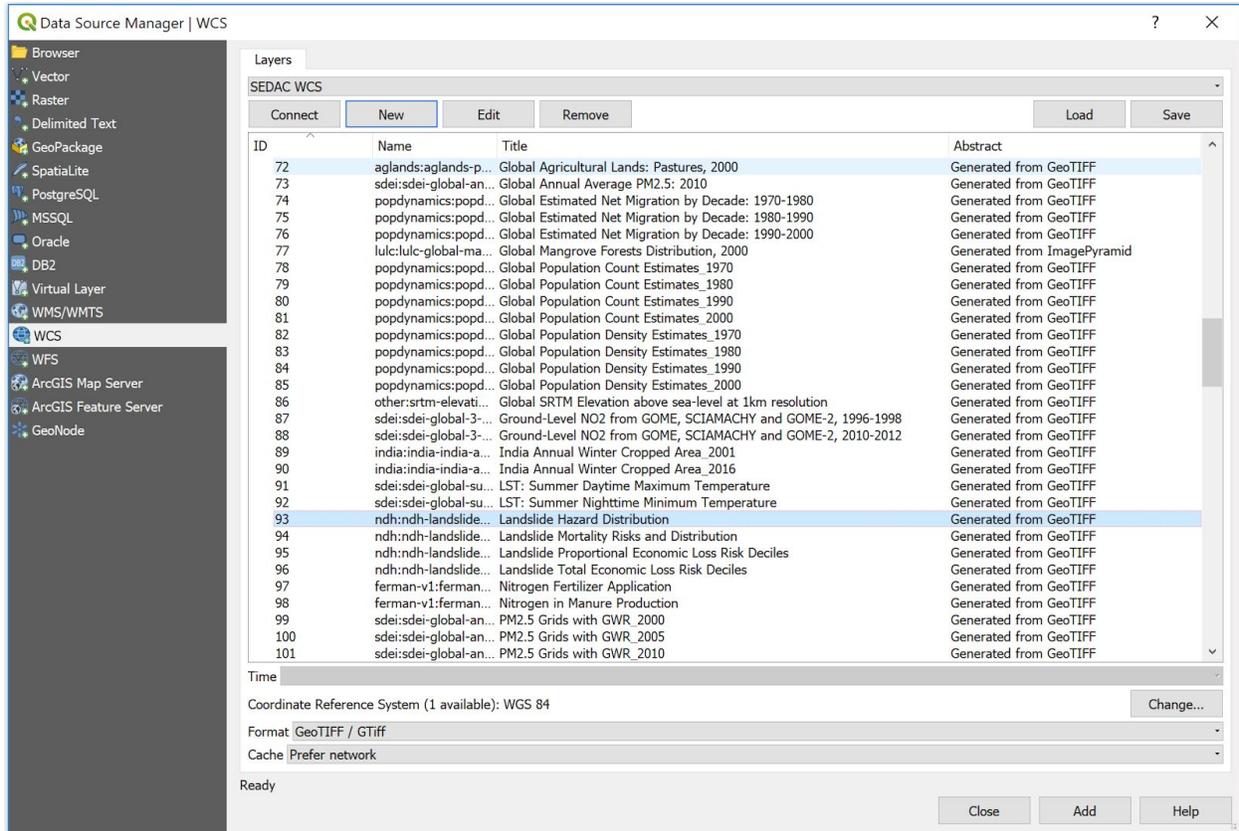


Fig. 7. Selecting the Landslide Hazard Distribution coverage from the SEDAC WCS in QGIS.

NCL

A user wanting to access 2005-01-01 [DMSP 5D-2/F14 SSM/I data](https://ghrc.nsstc.nasa.gov/opendap/ssmi/f14/daily/data/2005/f14_ssmi_20050101v7.nc) via OPeNDAP will need the following URL surfaced to open the file for reading in [NCL](#):

https://ghrc.nsstc.nasa.gov/opendap/ssmi/f14/daily/data/2005/f14_ssmi_20050101v7.nc.

```
url =
"https://ghrc.nsstc.nasa.gov/opendap/ssmi/f14/daily/data/2005/f14_ssmi_2005
0101v7.nc"
```

```
f = addfile(url, "r")
```

R

A user wanting to use a THREDDS Data Server OPeNDAP protocol to access daily maximum temperature for North America in 2016 from a [Daymet collection](#) will need the following URL surfaced to them:

https://thredds.daac.ornl.gov/thredds/dodsC/ornl/daac/1328/2016/daymet_v3_tmax_2016_na.nc4.html.

```
library(ncdf4)
```

```
url =
```

```
"https://thredds.daac.ornl.gov/thredds/dodsC/ornl/daac/1328/1980/daymet_v3_t  
max_1980_na.nc4"
```

```
daymet_data = nc_open(url)
```

Python

A user wanting to access the July 2018 [M2IMNPASM](https://goldsmr5.gesdisc.eosdis.nasa.gov/opensap/MERRA2_MONTHLY/M2IMNPASM.5.12.4/2018/MERRA2_400.instM_3d_asm_Np.201807.nc4) MERRA-2 granule via OPeNDAP will need the following URL surfaced to open the file for reading:

https://goldsmr5.gesdisc.eosdis.nasa.gov/opensap/MERRA2_MONTHLY/M2IMNPASM.5.12.4/2018/MERRA2_400.instM_3d_asm_Np.201807.nc4.

```
import netCDF4
```

```
input_url =
```

```
"https://goldsmr5.gesdisc.eosdis.nasa.gov/opensap/MERRA2_MONTHLY/M2IMNPASM.  
5.12.4/2018/MERRA2_400.instM_3d_asm_Np.201807.nc4"
```

```
ncId = netCDF4.Dataset(input_url, "r")
```