CEOS Working Group
on Information Systems and Services

WGISS Connected Data Assets Client Partner Guide (OpenSearch)

Publication Date: 2019-04-04

Updated : 2021-11-26

Document version: V1.2

Category: WGISS Technical Document

Editors: WGISS CDA System-Level Team

Table of Contents

1. Introduction

This document contains the comprehensive client partner's guide for OpenSearch, as adopted in the CEOS WGISS Connected Data Assets project. The document introduces the architecture background and required skills to be a client, the query interface, and an implementation outline. Several detailed use cases about how to retrieve the IDN (International Directory Network) collection ID and how to interact with the WGISS Connected Assets Granule Gateway servers are also included in this document.

2. Scope

This client partner guide applies to the CEOS WGISS Connected Data Assets. This client partner guide is applicable to the CWIC within CMR and the FedEO instances, as well as potential other data partners.

The target audience for this document is the community of software developers who are:

a) Implementers of IDN OpenSearch

b) Implementers of CEOS Best Practices-compliant OpenSearch server

c) Implementers of CEOS Best Practices OpenSearch client

3. References

The following documents provide more background and supportive information.

Document Reference & Version	Document Title / Description
CEOS-OS-BP	CEOS OpenSearch Best Practice Document, Version 1.3
CWIC-DOC-17-002r01	CWIC Client Partner Guide (OpenSearch)
	WGISS Connected Data Assets, FedEO Data Partner Guide, Version 1.1, 2021-09-14.
OGC 10-157r4	Earth Observation Metadata profile of Observations & Measurements, Version 1.1
OGC 10-032r8	OpenSearch Geo and Time Extensions
OGC 13-026r8	OpenSearch Extension for Earth Observation

4. Before You Begin

This chapter introduces the background, concepts and architecture of IDN, CWIC/CMR, and FedEO, within the scope of the WGISS Connected Assets. The related skills you will need as a client partner are also discussed.

4.1. WGISS Connected Data Assets Background

For scientists who conduct multi-disciplinary research, there may be a need to search multiple catalogs in order to find the data they need. Such work can be very time-consuming and tedious, especially when different catalogs may use different metadata models and catalog interface protocols. It would be desirable, therefore, for those catalogs to be integrated into a catalog federation which will present a well-known and documented metadata model and interface protocol to users and hide the complexity and diversity of the affiliated catalogs behind the interface. With such a federation, users only need to work with the federated catalog through the public interface or API to find the data they need instead of working with various catalogs individually.

The Committee on Earth Observation Satellites (CEOS) addresses coordination of the satellite Earth Observation (EO) programs of the world's government agencies, along with agencies that receive and process data acquired remotely from space. The Working Group on Information Systems and Services (WGISS) is a subgroup of CEOS, which aims to promote collaboration in the development of systems and services that manage and supply EO data to users world-wide.

NASA's contributions to the Committee on Earth Observation Satellites (CEOS) International Directory Network (IDN) provides access to more than 50,000 Earth science data set and service descriptions (stored in the Common Metadata Repository [CMR]) which cover subject areas within Earth and environmental sciences. The IDN's mission is to assist researchers, policy makers, and the public in the discovery of and access to data and related services relevant to Earth science research.

To aid in the search and discovery effort, Global Change Master Directory (GCMD) controlled keywords have been developed and are regularly being refined and expanded. These keywords are also used in other applications within the broader scientific community. Users may perform searches through the IDN website and OpenSearch API using the controlled keywords, free-text searches, map/date searches, or any combination of the above; and may also search or refine a search by data center, instrument, platform, project, or temporal/spatial resolution.

The IDN also supports draft Metadata Management Tool (dMMT), a web-based metadata authoring tool that allows metadata authors to add (or modify) data set descriptions that comply with the CMR Unified Metadata Model for Collections (UMM-C). The tool also allows metadata authors to validate and submit their metadata records directly for discovery in the IDN.

The CEOS WGISS Integrated Catalog (CWIC) is a collection of WGISS data partners which supports data discovery from multiple EO data centers through the NASA CMR system. CWIC was initiated and initially supported by NASA, NOAA, and USGS as a contribution to CEOS. CWIC functionality was migrated to NASA's Common Metadata Repository (CMR) in April 2021. To achieve this, CWIC data partners adopted and implemented the recommended WGISS interoperable standards and NASA evolved the architecture by allowing data partners to manage their underlying connections to CWIC with the support of the WGISS System Level Team. CMR provides inventory search to WGISS agency catalog systems for EO data by distributing search requests to the appropriate server and sending search responses back to the requesting client.

FedEO (Federated Earth Observation Gateway) provides a unique entry point to a growing number of scientific catalogues and services for, but not limited to, EO European and Canadian missions. FedEO is deployed with ESA (European Space Agency) infrastructure as a gateway to

provide brokered discovery, access and ordering capability to European/Canadian EO missions data based on HMA (Heterogeneous Missions Accessibility) interfaces.

WGISS is now coordinating efforts to connect CWIC and FedEO system with the IDN through a common registration of metadata records to seamlessly provide search results for relevant data sets regardless of which system is used to access the granule level data.
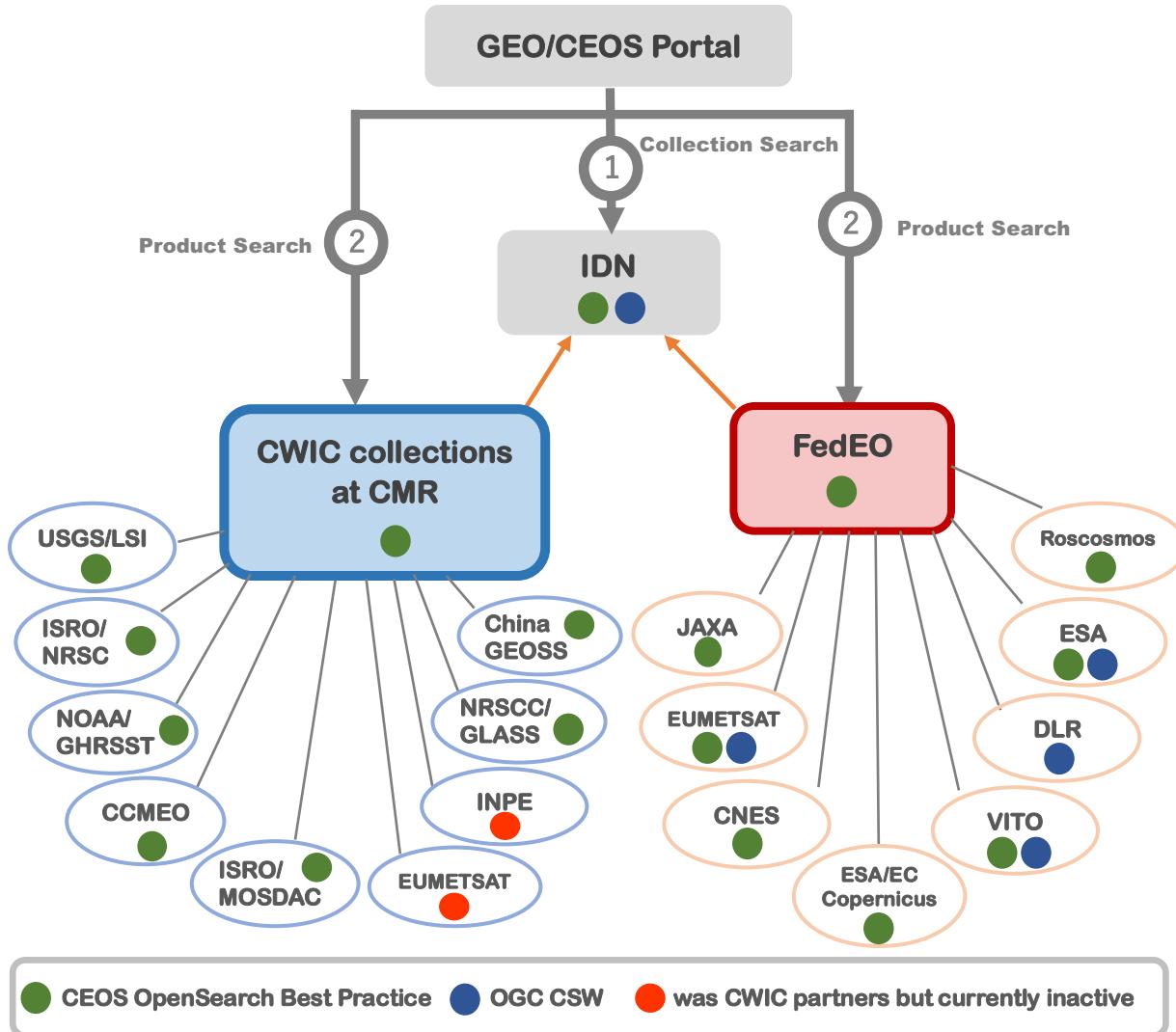

Fig. 1 CEOS WGISS Connected Data Assets

4.2.   Search Concept and Design

A two-step collection/granule search process, which separates discovery of collections from searching within relevant collections to retrieve specific data granules, has been adopted to realize the integrated access to heterogeneous, autonomous data sources.

The WGISS Connected Data Assets system is an implementation of this two-step process. The IDN provides an OpenSearch front end to the collection search. The response from the collection search includes links to the OpenSearch Descriptor Documents (OSDD) at one of several Granule Gateways, providing search capability for granules at the relevant data providers. Current WGISS Connected Data Assets Granule Gateways include the CWIC data partners under CMR and FedEO. Each of these systems provides access to different data archive systems using the same OpenSearch protocol. Spatial and temporal metadata are the only attributes guaranteed to be supported at all data providers. The CEOS OpenSearch Best Practice supports a number of metadata attributes through the Parameter extensions, but they are not all universally supported across CWIC/CMR or FedEO.

4.2.1. Granule Search Criteria

Section 5 (below) gives complete details about the OpenSearch API for specifying search criteria.

It is important to understand how the OSDD documents search parameters both for collections and, separately, for granules.

The step 2 search, i.e. granule search, supports constraints with spatial, temporal, and pagination. Spatial constraint is specified with a bounding box. Temporal filter can be specified with begin and end time in standard ISO 8601 timestamp format. See Section 5 for specific query parameters.

4.2.2. Current Data Partners

Current data partners providing granule search access through WGISS Connected Data Assets include systems from the various agencies shown in Figure 1. WGISS maintains a current list of the data providers that comprise the WGISS Connected Data Assets on the WGISS website https://ceos.org/wgiss-connected-data-assets-status/

4.3.   WGISS Architecture for Connected Data Assets

At its core, the systems present to End Users and Clients an OpenSearch server compliant with the CEOS OpenSearch Best Practice. In this way, outside clients need to have no specific knowledge of the particular partner data systems and communicate only via OpenSearch.

4.4.   Skills You Will Need as a Client Partner

As a Client Data Partner, you need to be familiar with basic web application technology such as:

- XML and XML Schema (XSD[1])
- OpenSearch[2] related technologies
- RESTFul[3] related architecture and technologies
- Web development programming language

4.5.   WGISS Connected Data Assets Terms and Definitions

For the purposes of this document, the following terms and definitions apply:

(1) **client**

   A software component that can invoke an operation from a server

(2) **CMR**

   The Common Metadata Repository is the database system used to manage earth science metadata records for the IDN.

(3) **collection**

   A grouping of granules that all come from the same source, such as a modeling group or institution. Collections have information that is common across all the granules they "own" and a template for describing additional attributes not already part of the metadata model.

(4) **data clearinghouse**

   The collection of institutions providing digital data, which can be searched through a single interface using a common metadata standard

(5) **dataset**

   Has the same meaning as collection, see (3)

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[1] XML Schema: https://en.wikipedia.org/wiki/XML_Schema_%28W3C%29

[2] OpenSearch specification verison 1.1 (https://www.opensearch.org/doc/1.1)

[3] RESTFul: https://en.wikipedia.org/wiki/Representational_state_transfer

(6) GCMD Keywords

The Global Change Master Directory (GCMD) Keywords are a hierarchical set of controlled Earth Science vocabularies that help ensure Earth science data, services, and variables are described in a consistent and comprehensive manner and allow for the precise searching of metadata and subsequent retrieval of data, services, and variables.

(7) granule

The smallest aggregation of data that can be independently managed (described, inventoried, and retrieved). Granules have their own metadata model and support values associated with the additional attributes defined by the owning collection.

(8) Granule Gateway

A CEOS OpenSearch compliant server providing access to remote data partner inventory systems.

(9) granule ID

A character string that uniquely identifies a single granule to a granule gateway

(10) identifier

A character string that may be composed of numbers and characters that is exchanged between the client and the server with respect to a specific identity of a resource

(11) IDN

The CEOS International Directory Network (IDN) is a gateway to earth science data and services.

(12) IDN collection ID

Unique collection identifier in IDN, returned from the IDN in response to the OSDD request. This identifier is assigned by the IDN CMR database.

(13) native ID

Collection identifier used by CWIC and FedEO to retrieve granule metadata through data provider API. This identifier is assigned by the data provider but may be the same as the CMR collection ID.

(14) operation

The specification of a transformation or query that an object may be called to execute

(15) OSDD

OpenSearch Description Document

(16) profile

A set of one or more base standards and - where applicable - the identification of chosen clauses, classes, subsets, options and parameters of those base standards that are necessary for accomplishing a particular function

(17) request

The invocation of an operation by a client

(18) response

The result of an operation, returned from server to client

4.6.   Contact Information

All the documents and information about WGISS Connected Data Assets are available at WGISS

page at

https://ceos.org/ourwork/workinggroups/wgiss/access/cwic/

Any questions regarding to WCDA, please send the email to

Access-SysTeam-help@wgiss.ceos.org

5. Client Partner Implementation Outline

5.1. Client Search Scenario

All Connected Data Asset clients are, at their core, just conventional OpenSearch clients with a few extensions and conventions to make the CEOS OpenSearch protocol useful in the WGISS environment. The IDN identifier of the collection of interest is a mandatory element in CEOS OpenSearch request. Clients could retrieve the collection ID from the IDN OpenSearch Description Document (OSDD).

This chapter will give brief steps about how to retrieve an IDN collection ID and how to interact with the granule search server for inventory search. The corresponding details are elaborated in the Use Case chapters.

Data providers will have registered the metadata of their archived collections into the IDN. The client can query the IDN to retrieve the IDN collection ID for a desired collection of interest and, based on that collection ID and other spatial-temporal query conditions, build a valid CEOS OpenSearch query. The following steps describe the client search scenario starting with IDN OpenSearch.

Step 1: Obtain the IDN OpenSearch OSDD to formulate a valid IDN OpenSearch request.

```
https://cmr.earthdata.nasa.gov/opensearch/collections/descriptor_document.xml?clientId=cswOpenSearchDoc
```
Fig. 2 Example of IDN OpenSearch OSDD request

Step 2: Search collections of interest through IDN OpenSearch with proper request parameters (*e.g.* spatial footprint, temporal extent and keyword).

```
https://cmr.earthdata.nasa.gov/opensearch/collections.atom?keyword=Landsat*&numberOfResults=10&clientId=wgissOpenSearchDoc
```
Fig. 3 Example of IDN OpenSearch request (CWIC collection)

```
https://cmr.earthdata.nasa.gov/opensearch/collections.atom?keyword=CryoSat&numberOfResults=10&clientId=wgissOpenSearchDoc
```
Fig. 4 Example of IDN OpenSearch request (FedEO collection)

Step 3: With the IDN OpenSearch response, obtain the CWIC or FedEO OSDD endpoint according to CEOS-BP-001 for the collection by parsing the href attribute in <link rel="search" type="application/opensearchdescription+xml" > (CEOS-BP-001).

```
<feed xmlns="https://www.w3.org/2005/Atom" xmlns:dc="https://purl.org/dc/terms/">
    <entry>
        …
            <dc:identifier>
    https://cmr.earthdata.nasa.gov/opensearch/collections.atom?uid=C1235542031-USGS_LTA
        </dc:identifier>
        …
            <link
href="https://cmr.earthdata.nasa.gov/opensearch/granules/descriptor_document.xml?collectionConceptId=C1235542031-USGS_LTA"
    hreflang="en-US"
    type="application/opensearchdescription+xml"
    rel="search"
    title="CWIC Granule Open Search Descriptor Document"/>
        …
    </entry>
```

```
</feed>
```

<div align="center">Fig.5 Example of IDN OpenSearch response</div>

Step 4: Based on the retrieved OSDD, formulate an OpenSearch request for granules belonging to that collection, directed to the relevant server.

```
https://m2m.cr.usgs.gov/api/open-search/granules.atom?datasetName=LANDSAT_8_C1&timeStart=1972-09-
26
```

<div align="center">Fig. 6 Example of granule OpenSearch request</div>

5.2.   Obtaining the OpenSearch Description Document (OSDD)

OpenSearch Description Documents (OSDDs) provide necessary information for clients to programmatically formulate valid search requests. Specifically, clients are expected to acquire both the cardinality and the domain of request parameters based on the query template in the OSDD. Collection valids (*e.g.* spatial bounding coordinates and temporal extent) are also provided in the OSDD in both machine parsable and human readable formats. Collection valids enable clients to formulate valid requests yielding more accurate results.

The federated system provides both generic and collection specific OSDDs.   IDN provides the generic OSDD to be used for collection search.   Alternatively, clients are also able to fetch a generic OSDD through the CWIC or FedEO OSDD endpoint.   The OSDD request should also include a client identifier string, as recommended by the CEOS OpenSearch Best Practices.

Collection-specific OSDD are returned by IDN as part of collection search results. In a collection specific OSDD, the domain is provided for some parameters (*e.g.,* timeStart and timeEnd) in addition to the request parameter syntax.

Generic OSDD request URL example (CMR):

https://cmr.earthdata.nasa.gov/opensearch/collections/descriptor_document.xml?clientId=foo

Generic OSDD request URL example (FedEO):

https://fedeo.ceos.org/opensearch/description.xml

Collection specific OSDD request URL example (CWIC/CMR):

https://cmr.earthdata.nasa.gov/opensearch/granules/descriptor_document.xml?collectionConceptId=C1235542
031-USGS_LTA&clientId=testingClient

Collection specific OSDD request URL example (FedEO):

https://fedeo.ceos.org/opensearch/description.xml?parentIdentifier=CryoSat.products

<div align="center">Fig. 7 Examples of OSDD requests</div>

5.3.   Search request

CEOS OpenSearch supports both searching for collections through the IDN (See chapter 6) and for granules in a specific collection at one of the data partners (See chapter 7 "CWIC" and chapter 8 "FedEO"). It executes a collection or inventory search, as appropriate, and returns the matching results.

In order to initialize a valid request, clients will fill request parameters with proper values. The template of the OpenSearch request is available under the <Url> element in OSDD.

5.4.   Search response

OpenSearch does not define or require any specific encoding format for the search response.

Instead, it defines a set of search-related metadata elements which can be inserted into existing encoding formats. Typically, list-based XML syndication formats - such as RSS 2.0 and Atom 1.0 - are used.

The OpenSearch response elements include:

totalResults: number of total results

startIndex: index number corresponding to the first entry item returned

itemsPerPage: number of results returned

Query: search query to get the same search response

Below is an example of a search response from the IDN in Atom, to the free keyword search "water".

Request:

```
https://cmr.earthdata.nasa.gov/opensearch/collections.html?keyword=water&cursor=1&numberOfResults=1&
offset=1&clientId=wcdadoc
```

Fig. 8 Example of IDN search request

Response:

```
<?xml version="1.0" encoding="UTF-8"?>
<feed xmlns:relevance="https://a9.com/-/opensearch/extensions/relevance/1.0/" xmlns:os="https://a9.com/-
/spec/opensearch/1.1/" xmlns:georss="https://www.georss.org/georss"
xmlns="https://www.w3.org/2005/Atom" xmlns:dc="https://purl.org/dc/terms/"
xmlns:echo="https://cmr.earthdata.nasa.gov/search/site/docs/search/api.html#atom"
xmlns:esipdiscovery="https://commons.esipfed.org/ns/discovery/1.2/"
xmlns:gml="https://www.opengis.net/gml" xmlns:time="https://a9.com/-/opensearch/extensions/time/1.0/"
xmlns:eo="https://a9.com/-/opensearch/extensions/eo/1.0/" esipdiscovery:version="1.2">
    <updated>2019-03-17T19:35:10.918Z</updated>
    <id>https://cmr.earthdata.nasa.gov/opensearch/collections.atom</id>
    <author>
        <name>CMR</name>
        <email>echodev@echo.nasa.gov</email>
    </author>
    <title type="text">ECHO dataset metadata</title>
    <subtitle type="text">Search parameters: keyword =&gt; water</subtitle>
    <link href="https://cmr.earthdata.nasa.gov/opensearch/granules/descriptor_document.xml" hreflang="en-
US" type="application/opensearchdescription+xml" rel="search"/>
    <link
href="https://cmr.earthdata.nasa.gov/opensearch/collections.atom?keyword=water&amp;cursor=1&amp;numb
erOfResults=1&amp;offset=1&amp;clientId=wcdadoc" hreflang="en-US" type="application/atom+xml"
rel="self"/>
    <link
href="https://cmr.earthdata.nasa.gov/opensearch/collections.atom?keyword=water&amp;cursor=1&amp;numb
erOfResults=1&amp;clientId=wcdadoc&amp;offset=13143" hreflang="en-US" type="application/atom+xml"
rel="last"/>
    <link
href="https://cmr.earthdata.nasa.gov/opensearch/collections.atom?keyword=water&amp;cursor=1&amp;numb
erOfResults=1&amp;clientId=wcdadoc&amp;offset=0" hreflang="en-US" type="application/atom+xml"
rel="previous"/>
    <link
href="https://cmr.earthdata.nasa.gov/opensearch/collections.atom?keyword=water&amp;cursor=1&amp;numb
erOfResults=1&amp;clientId=wcdadoc&amp;offset=2" hreflang="en-US" type="application/atom+xml"
rel="next"/>
    <link
```

```
href="https://cmr.earthdata.nasa.gov/opensearch/collections.atom?keyword=water&amp;cursor=1&amp;numb
erOfResults=1&amp;clientId=wcdadoc&amp;offset=0" hreflang="en-US" type="application/atom+xml"
rel="first"/>
    <link href="https://wiki.earthdata.nasa.gov/display/echo/Open+Search+API+release+information"
hreflang="en-US" type="text/html" rel="describedBy" title="Release Notes"/>
    <os:Query xmlns:geo="https://a9.com/-/opensearch/extensions/geo/1.0/" role="request"
os:searchTerms="water"/>
    <os:totalResults>13143</os:totalResults>
    <os:itemsPerPage>1</os:itemsPerPage>
    <os:startIndex>2</os:startIndex>
    <entry>
        <id>https://cmr.earthdata.nasa.gov/opensearch/collections.atom?uid=C1214561069-JAXA</id>
        <author>
            <name>CMR</name>
            <email>echodev@echo.nasa.gov</email>
        </author>
        <title type="text">Level 3 Cloud liquid water (AMSR2) product</title>
        <summary type="text">The Advanced Microwave Scanning Radiometer 2 (AMSR2) onboard the
GCOM-W1 satellite is a remote sensing instrument for measuring weak microwave emission from the surface
and the atmosphere of the Earth. From about 700 km above the Earth, AMSR2 will provide us highly accurate
measurements of the intensity of microwave emission and scattering.
The antenna of AMSR2 rotates once per 1.5 seconds and obtains data over a 1450 km swath. This conical scan
mechanism enables AMSR2 to acquire a set of daytime and nighttime data with more than 99% coverage of
the Earth every 2 days.

Definition of Level3 data processing
* Grid data with 0.1/0.25 degrees (10/25km) resolution
* Brightness temperatures and geophysical parameters
* Daily and monthly temporal average
* Equidistant Cylindrical and Polar Stereo Projection

Following is the detail of product.
Procut: Integrated cloud liquid water
Area    : Global, over ocean
Grid      : 15(Km)
Accuracy
            Data relase threshhold:    0.10 kg/m2
            Standard:       0.05 kg/m2
            Goal:    0.02 kg/m2
Range : 0-1.0 kg/m2
Other : Vertically integrated (columnar) cloud liquid water. Except sea ice and precipitating areas.</summary>
        <updated>1970-01-01T00:00:00.000Z</updated>
        <link rel="describedBy" hreflang="en-US" href="https://gcom-w1.jaxa.jp/auth.html" type="text/html"/>
        <link rel="describedBy" hreflang="en-US" href="https://suzaku.eorc.jaxa.jp/GCOM/index.html"
type="text/html"/>
        <link href="https://gcmd.nasa.gov/getdif.htm?GCOM-W1_Level3_AMSR2_CLW_GCOM-
W1_Level3_AMSR2_CLW" hreflang="en-US" type="text/html" rel="enclosure" title="GCOM-
W1_Level3_AMSR2_CLW"/>
        <link href="https://cmr.earthdata.nasa.gov/search/concepts/C1214561069-JAXA.xml" hreflang="en-US"
type="application/xml" rel="via" title="Product metadata"/>
        <dc:identifier>C1214561069-JAXA</dc:identifier>
        <dc:date>2012-07-02T00:00:00.000Z/</dc:date>
        <echo:datasetId>Level 3 Cloud liquid water (AMSR2) product</echo:datasetId>
        <echo:shortName>GCOM-W1_Level3_AMSR2_CLW</echo:shortName>
        <echo:versionId>GCOM-W1_Level3_AMSR2_CLW</echo:versionId>
```

```
        <echo:dataCenter>JAXA</echo:dataCenter>
        <echo:archiveCenter>JP/JAXA/SAOC</echo:archiveCenter>
        <echo:organization>JP/JAXA/SAOC</echo:organization>
        <echo:processingLevelId>3</echo:processingLevelId>
        <echo:coordinateSystem>CARTESIAN</echo:coordinateSystem>
        <echo:orbitParameters/>
        <georss:box>-90 -180 90 180</georss:box>
        <echo:hasVariables>false</echo:hasVariables>
        <echo:hasFormats>false</echo:hasFormats>
        <echo:hasTransforms>false</echo:hasTransforms>
        <echo:hasSpatialSubsetting>false</echo:hasSpatialSubsetting>
        <relevance:score>1.43</relevance:score>
    </entry>
</feed>
```

Fig. 9 Example of IDN search response

Notice the OpenSearch elements which appear inside the feed element. Namespaces referred in the OpenSearch response are listed as follows:

Namespace	URL
xmlns:atom	https://www.w3.org/2005/Atom
xmlns:os	https://a9.com/-/spec/opensearch/1.1/
xmlns:relevance	https://a9.com/-/opensearch/extensions/relevance/1.0
xmlns:dc	https://purl.org/dc/terms/
xmlns:echo	https://cmr.earthdata.nasa.gov/search/site/docs/search/api.html#atom
xmlns:georss	https://www.georss.org/georss/10
xmlns:geo	https://a9.com/-/opensearch/extensions/geo/1.0/
xmlns:time	https://a9.com/-/opensearch/extensions/time/1.0/
xmlns:cwic	https://cwic.wgiss.ceos.org/opensearch/extensions/1.0/
esipdiscover	https://commons.esipfed.org/ns/discovery/1.2/
eo	https://a9.com/-/opensearch/extensions/eo/1.0/
media	https://search.yahoo.com/mrss/
sru	https://a9.com/-/opensearch/extensions/sru/2.0/

Table 1 Table of OpenSearch namespaces

ATOM <feed> element, Granule (Step 2) Search

Element	Value
atom: title	Atom feed title element
atom: updated	Date tag indicating when granule metadata is returned from data provider
atom: author	Fixed value, which is the contact information of supporting team, *e.g.* <author> <name>…</name> <email>…</email> </author>
atom: id	Fixed value for search identifier
opensearch: totalResults	Number of records matched
opensearch: startIndex	Number of start record desired by client
opensearch: itemsPerPage	Actual number of returned items per page
opensearch: Query	Query element recording actual request parameter values from client
atom: link	Traversal link. Supported 'rel' attribute values include: first: link to the first matching result last: link to the last matching result previous: link to previous granule, where applicable next: link to next granule, where applicable

	profile: link to specified profile(s)
	up: link to parent identifier
	search: link to OSDD endpoint
	self: link of submitted OpenSearch request

Table 2 Table of Atom <feed> element

ATOM <entry> element

Element	Value
atom: title	Descriptive title for the entry
atom: id	Unique identifier of the entry within the local catalog system
atom: updated	Date tag indicating when entry metadata is last updated by data provider
atom: author	Fixed value, which is the contact information of data provider
spatial extent elements	For each granule, at least one <georss:box> will be provided to represent the minimum bounding rectangle of spatial extent of entry, if applicable. <georss:box> is formatted with coordinate order of WestBoundingLongitude, SouthBoundingLatitude, EastBoundingLongitude, NorthBoundingLatitude. All coordinates are in EPSG:4326 <georss:polygon>　and other geometries may also be provided if it is available in data provider's metadata.
temporal element	For each entry, a single <dc:date> element will be provided to represent the temporal extent of the entry, if applicable. *e.g.* 1989-10-19T00:00:00.000Z/1989-10-21T23:59:59.000Z
atom: link	Supported values under 'rel' attribute: via/enclosure/alternate/icon Detailed information refers to Table 4
atom: summary	Summary descriptive text for the entry

Table 3 Table of Atom <entry> element

'rel' attributes under ATOM <link> element

'rel' attribute	Artifact
via	Metadata
icon	Browse
alternate	Documentation
enclosure	Product
up	Collection Metadata

Table 4 Table of 'rel' attributes

5.5. Error Handling

The CEOS OpenSearch Best Practices (CEOS-BP-017) recommends the use of HTTP status codes as following, 4xx for client errors, and 5xx for server errors.

- 400 Bad Request: The request has an invalid syntax (i.e. badly formatted geometry)
- 413 Request Entity Too Large: The request originates too many returnable hits
- 415 Unsupported media type: Media type in the request is not available or valid.
- 500 Internal Server Error: Default code for the server side for an execution error.
- 501 Not Implemented: When requesting an unimplemented feature (e.g. relation operator not supported).
- 503 Service Unavailable: When the search service is temporarily not available (due to overload or other reasons).
- 504 Gateway Timeout: When the search engine is a broker or aggregator to other services that fail to produce an answer within a giving time frame.

CEOS OpenSearch implementations are recommended to support these codes.

6. Use Case – Collection Search (IDN)

This chapter provides a comprehensive and detailed process about how to implement a WGISS OpenSearch client, which includes how to retrieve the OSDD for the collection of interest, and how to build an OpenSearch request.

6.1.   IDN Systems

The IDN, CMR OpenSearch (for IDN), and the GCMD's Keyword Management Service (KMS) only have operational systems which end-users can access.

- ▪ IDN site is available to all users.
    - Location: https://idn.ceos.org/
- ▪ OpenSearch API for IDN (via CMR) - production instance is available to all users.
    - Location: https://cmr.earthdata.nasa.gov/opensearch/
- ▪ KMS - production instance is available to all users.
    - Location: https://gcmd.earthdata.nasa.gov/kms/capabilities?format=html

The IDN site search interface and the CMR OpenSearch production instances will provide access to all collections which have been registered in the IDN. The KMS production instance will provide access to all approved GCMD keywords registered by IDN providers.

6.2. Retrieve Collections via IDN OpenSearch

CEOS OpenSearch supports searching for collections through the IDN.   Searching for granules in a specific collection is supported at the data partners via the Granule Gateways (see chapter 7 "CWIC" and chapter 8 "FedEO").   It executes a collection or inventory search, as appropriate, and returns the matching results.

In order to create a valid request, clients have to obtain the IDN OpenSearch OSDD and fill request parameters with proper values.

Step 1: Obtain IDN OpenSearch OSDD to formulate a valid IDN OpenSearch request.

https://cmr.earthdata.nasa.gov/opensearch/collections/descriptor_document.xml?clientId=cswOpenSearchDoc

Fig. 10 Example of IDN OpenSearch OSDD request

The template of the OpenSearch request is available under the <Url> element in OSDD and is included below.

```
<?xml version="1.0"?>
<os:OpenSearchDescription xmlns:os="https://a9.com/-/spec/opensearch/1.1/"
    xmlns:echo="https://cmr.earthdata.nasa.gov/search/site/docs/search/api.html#atom"
    xmlns:geo="https://a9.com/-/opensearch/extensions/geo/1.0/"
    xmlns:time="https://a9.com/-/opensearch/extensions/time/1.0/"
    xmlns:esipdiscovery="https://commons.esipfed.org/ns/discovery/1.2/" esipdiscovery:version="1.2"
    xmlns:params="https://a9.com/-/spec/opensearch/extensions/parameters/1.0/"
    xmlns:referrer="https://www.opensearch.org/Specifications/OpenSearch/Extensions/Referrer/1.0"
    xmlns:eo="https://a9.com/-/opensearch/extensions/eo/1.0/"
    xmlns:atom="https://www.w3.org/2005/Atom" >
    <os:ShortName>CMR Collections</os:ShortName>
    <os:Description>NASA CMR Collection search using geo, time and parameter
extensions</os:Description>
    <os:Tags>CMR NASA CWIC CEOS-OS-BP-V1.1/L3 ESIP OGC collection pageOffset=1
indexOffset=0</os:Tags>
```

```
        <os:Contact>echodev@echo.nasa.gov</os:Contact>
        <os:Url type="application/atom+xml" rel="collection"
            params:method="GET"
template="https://cmr.earthdata.nasa.gov/opensearch/collections.atom?keyword={os:searchTerms?}&amp;inst
rument={echo:instrument?}&amp;satellite={eo:platform?}&amp;boundingBox={geo:box?}&amp;geometry=
{geo:geometry?}&amp;placeName={geo:name?}&amp;startTime={time:start?}&amp;endTime={time:end?}
&amp;cursor={os:startPage?}&amp;numberOfResults={os:count?}&amp;offset={os:startIndex?}&amp;uid={
geo:uid?}&amp;hasGranules={echo:hasGranules?}&amp;isCwic={echo:isCwic?}&amp;isGeoss={echo:isGe
oss?}&amp;isCeos={echo:isCeos?}&amp;isEosdis={echo:isEosdis?}&amp;provider={echo:provider?}&amp;
clientId=cswOpenSearchDoc">
            <params:Parameter name="keyword" uiDisplay="Search terms" value="{os:searchTerms}"
title="Inventory with terms expressed by these search terms" minimum="0">
                <atom:link rel="profile"
href="https://www.elasticsearch.org/guide/en/elasticsearch/reference/current/query-dsl-query-string-
query.html" title="This parameter follows the elastic search free text search implementations" />
            </params:Parameter>
            <params:Parameter name="instrument" uiDisplay="Instrument" value="{echo:instrument}"
title="Inventory associated with a satellite instrument expressed by this short name" minimum="0"/>
            <params:Parameter name="satellite" uiDisplay="Satellite" value="{eo:platform}" title="Inventory
associated with a Satellite/platform expressed by this short name" minimum="0"/>
            <params:Parameter name="boundingBox" uiDisplay="Bounding box" value="{geo:box}"
title="Inventory with a spatial extent overlapping this bounding box" minimum="0"/>
            <params:Parameter name="geometry" uiDisplay="Geometry" value="{geo:geometry}"
title="Inventory with a spatial extent overlapping this geometry" minimum="0">
                <atom:link rel="profile" href="https://www.opengis.net/wkt/LINESTRING" title="This service
accepts WKT LineStrings"/>
                <atom:link rel="profile" href="https://www.opengis.net/wkt/POINT" title="This service accepts
WKT Points"/>
                <atom:link rel="profile" href="https://www.opengis.net/wkt/POLYGON" title="This service
accepts WKT Polygons"/>
            </params:Parameter>
            <params:Parameter name="placeName" uiDisplay="Place name" value="{geo:name}"
title="Inventory with a spatial location described by this name" minimum="0"/>
            <params:Parameter name="startTime" uiDisplay="Start time" value="{time:start}" title="Inventory
with a temporal extent containing this start time" minimum="0"/>
            <params:Parameter name="endTime" uiDisplay="End time" value="{time:end}" title="Inventory
with a temporal extent containing this end time" minimum="0"/>
            <params:Parameter name="cursor" uiDisplay="Start page" value="{os:startPage}" title="Start page
for the search result" minimum="0" />
            <params:Parameter name="numberOfResults" uiDisplay="Number of results" value="{os:count}"
title="Maximum number of records in the search result" minimum="0" maxInclusive="2000"/>
            <params:Parameter name="offset" uiDisplay="Start index" value="{os:startIndex}" title="0-based
offset used to skip the specified number of results in the search result set" minimum="0"/>
            <params:Parameter name="uid" uiDisplay="Unique identifier" value="{geo:uid}" title="Inventory
associated with this unique ID" minimum="0"/>
            <params:Parameter name="hasGranules" uiDisplay="Has granules" value="{echo:hasGranules}"
title="Inventory with granules">
                <params:Option value="true" label="Yes"/>
                <params:Option value="false" label="No"/>
            </params:Parameter>
            <params:Parameter name="isCwic" uiDisplay="CWIC collection" value="{echo:isCwic}"
title="Inventory related to CWIC">
                <params:Option value="true" label="Yes"/>
            </params:Parameter>
            <params:Parameter name="isGeoss" uiDisplay="GEOSS collection" value="{echo:isGeoss}"
```

```
title="Inventory related to GEOSS">
                <params:Option value="true" label="Yes"/>
            </params:Parameter>
                    <params:Parameter name="isCeos" uiDisplay="CEOS collection" value="{echo:isCeos}"
title="Inventory related to CEOS">
                <params:Option value="true" label="Yes"/>
            </params:Parameter>
            <params:Parameter name="isEosdis" uiDisplay="EOSDIS collection" value="{echo:isEosdis}"
title="Inventory related to EOSDIS">
                <params:Option value="true" label="Yes"/>
            </params:Parameter>
            <params:Parameter name="provider" uiDisplay="Provider" value="{echo:provider}"
title="Inventory associated with a provider" minimum="0"/>
            <params:Parameter name="clientId" uiDisplay="Client identifier" value="{referrer:source}"
title="Client identifier to be used for metrics" minimum="0"/>
        </os:Url>
        <os:Url type="text/html" rel="collection"
            params:method="GET"
template="https://cmr.earthdata.nasa.gov/opensearch/collections.html?keyword={os:searchTerms?}&amp;instr
ument={echo:instrument?}&amp;satellite={eo:platform?}&amp;boundingBox={geo:box?}&amp;geometry={
geo:geometry?}&amp;placeName={geo:name?}&amp;startTime={time:start?}&amp;endTime={time:end?}&
amp;cursor={os:startPage?}&amp;numberOfResults={os:count?}&amp;offset={os:startIndex?}&amp;uid={g
eo:uid?}&amp;hasGranules={echo:hasGranules?}&amp;isCwic={echo:isCwic?}&amp;isGeoss={echo:isGeos
s?}&amp;isCeos={echo:isCeos?}&amp;isEosdis={echo:isEosdis?}&amp;provider={echo:provider?}&amp;cl
ientId=cswOpenSearchDoc">
            <params:Parameter name="keyword" uiDisplay="Search terms" value="{os:searchTerms}"
title="Inventory with terms expressed by these search terms" minimum="0">
                <atom:link rel="profile"
href="https://www.elasticsearch.org/guide/en/elasticsearch/reference/current/query-dsl-query-string-
query.html" title="This parameter follows the elastic search free text search implementations" />
            </params:Parameter>
            <params:Parameter name="instrument" uiDisplay="Instrument" value="{echo:instrument}"
title="Inventory associated with a satellite instrument expressed by this short name" minimum="0"/>
            <params:Parameter name="satellite" uiDisplay="Satellite" value="{eo:platform}" title="Inventory
associated with a Satellite/platform expressed by this short name" minimum="0"/>
            <params:Parameter name="boundingBox" uiDisplay="Bounding box" value="{geo:box}"
title="Inventory with a spatial extent overlapping this bounding box" minimum="0"/>
            <params:Parameter name="geometry" uiDisplay="Geometry" value="{geo:geometry}"
title="Inventory with a spatial extent overlapping this geometry" minimum="0">
                <atom:link rel="profile" href="https://www.opengis.net/wkt/LINESTRING" title="This service
accepts WKT LineStrings"/>
                <atom:link rel="profile" href="https://www.opengis.net/wkt/POINT" title="This service accepts
WKT Points"/>
                <atom:link rel="profile" href="https://www.opengis.net/wkt/POLYGON" title="This service
accepts WKT Polygons"/>
            </params:Parameter>
            <params:Parameter name="placeName" uiDisplay="Place name" value="{geo:name}"
title="Inventory with a spatial location described by this name" minimum="0"/>
            <params:Parameter name="startTime" uiDisplay="Start time" value="{time:start}" title="Inventory
with a temporal extent containing this start time" minimum="0"/>
            <params:Parameter name="endTime" uiDisplay="End time" value="{time:end}" title="Inventory
with a temporal extent containing this end time" minimum="0"/>
            <params:Parameter name="cursor" uiDisplay="Start page" value="{os:startPage}" title="Start page
for the search result" minimum="0" />
            <params:Parameter name="numberOfResults" uiDisplay="Number of results" value="{os:count}"
```

```
title="Maximum number of records in the search result" minimum="0" maxInclusive="2000"/>
        <params:Parameter name="offset" uiDisplay="Start index" value="{os:startIndex}" title="0-based
offset used to skip the specified number of results in the search result set" minimum="0"/>
        <params:Parameter name="uid" uiDisplay="Unique identifier" value="{geo:uid}" title="Inventory
associated with this unique ID" minimum="0"/>
        <params:Parameter name="hasGranules" uiDisplay="Has granules" value="{echo:hasGranules}"
title="Inventory with granules">
            <params:Option value="true" label="Yes"/>
          <params:Option value="false" label="No"/>
        </params:Parameter>
        <params:Parameter name="isCwic" uiDisplay="CWIC collection" value="{echo:isCwic}"
title="Inventory related to CWIC">
            <params:Option value="true" label="Yes"/>
        </params:Parameter>
        <params:Parameter name="isGeoss" uiDisplay="GEOSS collection" value="{echo:isGeoss}"
title="Inventory related to GEOSS">
            <params:Option value="true" label="Yes"/>
        </params:Parameter>
        <params:Parameter name="isCeos" uiDisplay="CEOS collection" value="{echo:isCeos}"
title="Inventory related to CEOS">
            <params:Option value="true" label="Yes"/>
        </params:Parameter>
        <params:Parameter name="isEosdis" uiDisplay="EOSDIS collection" value="{echo:isEosdis}"
title="Inventory related to EOSDIS">
            <params:Option value="true" label="Yes"/>
        </params:Parameter>
        <params:Parameter name="provider" uiDisplay="Provider" value="{echo:provider}"
title="Inventory associated with a provider" minimum="0"/>
        <params:Parameter name="clientId" uiDisplay="Client identifier" value="{referrer:source}"
title="Client identifier to be used for metrics" minimum="0"/>
    </os:Url>
    <os:Query role="example" searchTerms="Amazon River Basin Precipitation, 1972-1992" title="Sample
search"/>
    <os:Attribution>NASA CMR</os:Attribution>
    <os:SyndicationRight>open</os:SyndicationRight>
</os:OpenSearchDescription>
```

Fig. 11 Extract of IDN OpenSearch OSDD

The available request parameters and their cardinality are presented in section 6.3.

Step 2: Search collections of interest through IDN OpenSearch with proper request parameters

An example request can be formed as follows.

```
https://cmr.earthdata.nasa.gov/opensearch/collections.atom?keyword=Landsat_8&numberOfResults=10&clientId=wgissOpenSearchDoc
```

Fig. 12 Extract of IDN OpenSearch OSDD

Step 3: From the IDN OpenSearch response obtain the OSDD endpoint for the collection by parsing the href attribute under <link rel="search" type="application/opensearchdescription+xml" /> element. Note that the OSDD endpoint may refer to CWIC or FedEO.

```
<feed xmlns="https://www.w3.org/2005/Atom" xmlns:dc="https://purl.org/dc/terms/" >
    <entry>
        …
        <link
    href="https://cmr.earthdata.nasa.gov/opensearch/granules/descriptor_document.xml?collectionConceptId
=C1235542031-USGS_LTA"
```

```
        hreflang="en-US"
        type="application/opensearchdescription+xml"
        rel="search"
        title="CWIC Granule Open Search Descriptor Document"/>
            …
        </entry>
</feed>
```

Fig. 13 Example of IDN OpenSearch Response

Step 4: From the collection OSDD found in the IDN OpenSearch response, formulate a valid granule search request.　How to do this is explained in sections 7.1 ("CWIC") and 8.3 ("FedEO").

In principle, CEOS OpenSearch clients compliant with CEOS OpenSearch Best Practices should not care whether the second step (i.e. Granule search) redirects to CWIC or FedEO as both endpoints provide the same interface which clients should discover by obtaining the OSDD. Search parameters in the URL template which are specific to one of both endpoints (i.e. not defined in the CEOS Best Practice for OpenSearch or belonging to a foreign namespace) can be left empty when preparing the granule search request.

6.3. Available Collection Search Criteria

CEOS OpenSearch is used as the IDN's collections search implementation based on the OpenSearch 1.1 (Draft 5) specification and is compliant with the CEOS OpenSearch Best Practices. The IDN OpenSearch API allows clients to formulate OpenSearch compliant queries against the IDN collections and specify the desired search results format as OpenSearch compliant ATOM or HTML. The IDN OpenSearch API implements the following search fields for users' queries:

Request Parameter [a]	Description [b]	Value & Cardinality (M) = mandatory (O) = optional	Type [c]
boundingBox	Inventory with a spatial extent overlapping this bounding box	(O)	geo:box
keyword	Inventory with terms expressed by these search terms	(O)	os:searchTerms
instrument	Inventory associated with a satellite instrument expressed by this short name	(O)	echo:instrument
satellite	Inventory associated with a Satellite/platform expressed by this short name	(O)	eo:platform
geometry	Inventory with a spatial extent overlapping this geometry	(O)	geo:geometry
placeName	Inventory with a spatial location described by this name	(O)	geo:name
startTime	Inventory with a temporal extent containing this start time	(O)	time:start
endTime	Inventory with a temporal extent containing this end time	(O)	time:end
cursor	Start page for the search result	(O)	os:startPage
numberOfResults	Maximum number of records in the search result	(O)	os:count
offset	0-based offset used to skip the specified number of results in the search result set	(O)	os:startIndex

uid	Inventory associated with this unique ID	(O)	geo:uid
hasGranules	Inventory with granules	(O)	echo:hasGranules
isCwic	Inventory related to CWIC	(O)	echo:isCwic
isGeoss	Inventory related to GEOSS	(O)	echo:isGeoss
isCeos	Inventory related to CEOS	(O)	
isEosdis	Inventory related to EOSDIS	(O)	echo:isEosdis
provider	Inventory associated with a provider	(O)	echo:provider
clientId	Client identifier to be used for metrics	(O)	cswOpenSearchDoc

Table 5 Table of collection search criteria

Also, client developers are able to query with specific tags: isCeos, isCwic, isGeoss, and isFedEO. Tagging allows arbitrary sets of collections to be grouped under a single namespace value. The sets of collections can be recalled later when searching by tag fields.

IDN query examples:

- GET the first 10 IDN collections with results in the ATOM format:
  https://cmr.earthdata.nasa.gov/opensearch/collections.atom?numberOfResults=10&clientId=cswOpenSearchDoc
- GET the first 10 IDN collections containing the GCMD instrument keyword MODIS with results in the ATOM output format:
  https://cmr.earthdata.nasa.gov/opensearch/collections.atom?instrument=MODIS&numberOfResults=10&clientId=cswOpenSearchDoc
- GET the first 10 CWIC IDN collections containing the GCMD instrument keyword MODIS with results in the HTML format:
  https://cmr.earthdata.nasa.gov/opensearch/collections?instrument=MODIS&isCwic=true&numberOfResults=10&clientId=cswOpenSearchDoc

7. Use Case – Granule Search (CWIC/CMR)

This chapter provides a comprehensive and detailed process about how to implement a WGISS OpenSearch client, which includes how to retrieve the IDN collection ID for the collection of interest, and how to build an OpenSearch request for a CWIC data partner. Within CMR, CWIC partners are available directly from CMR. The IDN response records contain direct links to the OSDD from the CWIC partner server, where possible. This can be used to construct a granule search directly from the partner.

7.1. Retrieve the Collection OSDD via IDN OpenSearch

The steps in this section are identical to the steps explained in section 6.2.   To fit the end-to-end CWIC use case, the parameter values for the collection search has been selected in such a way that the granule search is eventually performed through CWIC.

Use Case Overview	
Title	Clients start from the IDN OpenSearch
Description	This use case describes steps for retrieving a collection ID from the IDN OpenSearch.
Actors	OpenSearch client
	IDN OpenSearch Server
Initial Status and Preconditions	OpenSearch clients have the IDN OpenSearch access URL.

Table 6 Use Case: Retrieve Collection OSDD from IDN OpenSearch

The following steps describe this use case.

Step 1: Obtain IDN OpenSearch OSDD to formulate a valid IDN OpenSearch request.

> https://cmr.earthdata.nasa.gov/opensearch/collections/descriptor_document.xml?clientId=wgissOpenSearchDoc

Fig. 14 Example of IDN OpenSearch OSDD request

Step 2: Search collections of interest through IDN OpenSearch with proper request parameters (e.g. spatial footprint, temporal extent and keyword). A complete list of supported request parameters, extracted from the IDN OpenSearch OSDD, was included in section 6.3.

An example request can be formed as follows.

> https://cmr.earthdata.nasa.gov/opensearch/collections.atom?keyword=Landsat_8&numberOfResults=1&clientId=wgissOpenSearchDoc

Fig. 15 Example of IDN OpenSearch Keyword Search Request

Step 3: From the IDN OpenSearch response obtain the OSDD endpoint for the collection by parsing the href attribute under <link rel="search" type="application/opensearchdescription+xml" /> element.

> <feed xmlns:relevance="https://a9.com/-/opensearch/extensions/relevance/1.0/" xmlns:os="https://a9.com/-/spec/opensearch/1.1/" xmlns:georss="https://www.georss.org/georss"
> xmlns="https://www.w3.org/2005/Atom" xmlns:dc="https://purl.org/dc/elements/1.1/"
> xmlns:echo="https://cmr.earthdata.nasa.gov/search/site/docs/search/api.html#atom"
> xmlns:esipdiscovery="https://commons.esipfed.org/ns/discovery/1.2/"
> xmlns:gml="https://www.opengis.net/gml" xmlns:time="https://a9.com/-/opensearch/extensions/time/1.0/"
> xmlns:eo="https://a9.com/-/opensearch/extensions/eo/1.0/" esipdiscovery:version="1.2">
>   <entry>
>   …
>   <id>https://cmr.earthdata.nasa.gov/opensearch/collections.atom?uid=C1235542031-USGS_LTA

```
</id>
    …
            <link
href="https://cmr.earthdata.nasa.gov/opensearch/granules/descriptor_document.xml?collectionConceptId=C12
35542031-USGS_LTA"
      hreflang="en-US"
      type="application/opensearchdescription+xml"
      rel="search"
      title="Non-CMR OpenSearch Provider Granule Open Search Descriptor Document"/>


        <link href="https://cmr.earthdata.nasa.gov/search/concepts/C1235542031-USGS_LTA.xml"
      hreflang="en-US"
      type="application/xml"
      rel="via"
      title="Product metadata"/>
          …
    </entry>
</feed>
```

Fig. 16 Example of IDN OpenSearch Keyword Search Response

This response will provide the key component of searching CMR for the desired collection using the CMR conceptID. For Landsat 8, this will be C1235542031-USGS_LTA. Now obtain from CMR the URL for the local OSDD (in this case, at USGS), with the request

```
https://cmr.earthdata.nasa.gov/opensearch/granules/descriptor_document.xml?collectionConceptId=C1235542
031-USGS_LTA
```

Fig. 17 Example of IDN OpenSearch Collection OSDD Request

In the response:

```
?xml version="1.0" encoding="UTF-8" ?>
<OpenSearchDescription
   xmlns="https://a9.com/-/spec/opensearch/1.1/"
   xmlns:params ="https://a9.com/-/spec/opensearch/extensions/parameters/1.0/"
   xmlns:geo="https://a9.com/-/opensearch/extensions/geo/1.0/"
   xmlns:time="https://a9.com/-/opensearch/extensions/time/1.0/"
   xmlns:lta="/opensearch/extensions/1.0/"
   xmlns:esipdiscover="https://commons.esipfed.org/ns/discovery/1.2/">
   <ShortName>USGS&#47;EROS OpenSearch</ShortName>
   <Description>USGS&#47;EROS OpenSearch</Description>
   <Contact>custserv@usgs.gov</Contact>
   <Url type="application/atom+xml" template="https://m2m.cr.usgs.gov/api/open-
search/granules.atom?uid={uid}&amp;datasetName=LANDSAT_8_C1&amp;entryId={lta:entryId}&amp;star
tIndex={startIndex?}&amp;count={count?}&amp;timeStart={time:start?}&amp;timeEnd={time:end?}&amp;
geoBox={geo:box?}">
     <params:Parameter name="datasetName" value="{lta:datasetName}" title="Dataset Name desired by the
search client" minimum="0" maximum="1"></params:Parameter>
     <params:Parameter name="entryId" value="{lta:entryId}" title="IDN Entry ID - Can be used in place of
lta:datasetName" minimum="0" maximum="1"></params:Parameter>
     <params:Parameter name="geoBox" value="{geo:box}" title="inventory which has a spatial extent
overlapping this bounding box" minimum="0" />
     <params:Parameter name="timeStart" value="{time:start}"   minInclusive="2013-02-11T00:00:00Z"
maxInclusive="2030-01-01T00:00:00Z"    title="inventory which has a temporal extent containing this start
time" minimum="0" />
     <params:Parameter name="timeEnd" value="{time:end}" minInclusive="2013-02-11T00:00:00Z"
```

maxInclusive="2030-01-01T00:00:00Z" title="inventory which has a temporal extent containing this end time" minimum="0" />
    <params:Parameter name="startIndex" value="{startIndex}" title="First result in the set returned by the search" minimum="0" minInclusive="1" />
    <params:Parameter name="count" value="{count}" title="Number of search results per page desired by the search client" minimum="0" minInclusive="1" maxInclusive="200" />
    <params:Parameter name="uid" value="{uid}" title="Defines a specific scene for retrieval" minimum="0" maximum="1" />
  </Url>
  <Query role="example" lta:datasetName="CALVAL_PIS_MAURITANIA_1" startIndex="1" count="10" geo:box="-180.0,-90,180.0,90" time:start="1972-09-26" time:end="2020-04-07" esipdiscover:clientId="cwicClient" />
  <Query role="example" uid="CALVAL_PIS_MAURITANIA_1:entityId" esipdiscover:clientId="cwicClient" />
  <Attribution>USGS/EROS</Attribution>
  <Developer>USGS/EROS Long Term Archive</Developer>
  <InputEncoding>UTF-8</InputEncoding>
  <Language>en-us</Language>
  <OutputEncoding>UTF-8</OutputEncoding>
  <SyndicationRight>open</SyndicationRight>
  <Tags>USGS,EROS,EarthExplorer,OpenSearch</Tags>
</OpenSearchDescription>

Fig. 18 Example of IDN OpenSearch Collection OSDD Response

7.2. Retrieve Granules via OpenSearch

After retrieving the OSDD endpoint by querying through the IDN OpenSearch, OpenSearch clients will sequentially interact with the host remote server for inventory search. The following table shows the basic information about the use case of interacting with WGISS Connected Data Assets via OpenSearch.

Use Case Overview	
Title	Interact with CWIC OpenSearch APIs for inventory search
Description	This use case describes steps for executing inventory search based on the IDN collection OSDD of interest.
Actors	OpenSearch client Collection-specific granule OpenSearch API
Initial Status and Preconditions	Clients have the CWIC OpenSearch OSDD URL from IDN.

Table 7 Use Case: Interact with CWIC OpenSearch APIs

Step 4: Obtain the collection specific OSDD from the IDN response.

https://cmr.earthdata.nasa.gov/opensearch/granules/descriptor_document.xml?collectionConceptId=C1235542031-USGS_LTA

Fig. 19 Example of CWIC collection-specific OSDD request

Step 5: Based on the OSDD, formulate an OpenSearch request for granules belonging to that collection.

https://m2m.cr.usgs.gov/api/open-search/granules.atom?datasetName=LANDSAT_8_C1

Fig. 20 Example of CWIC OpenSearch request

Step 6: Parse the CWIC OpenSearch response and extract the identifier for the granule of interest from <id> element.

<feed xmlns="https://www.w3.org/2005/Atom">

```
    <entry>
        …
    <id>https://m2m.cr.usgs.gov/api/open-search/datasets.atom?datasetName=event741</id>
    </entry>
</feed>
```

Fig. 21 Example of CWIC OpenSearch response

7.3.   Available Granule Search Parameters

Request Parameter [a]	Description [b]	Value & Cardinality (M) = mandatory (O) = optional	Type [c]
datasetId	Collection identifier	(M) Allowed value is IDN collection ID	cwic[d]:datasetId
geoBox	Returned granules will have a spatial extent overlapping this bounding box	(O) Supported formats are in W,S,E,N coordinate order: W: WestBoundingLongitude S: SouthBoundingLatitude E: EastBoundingLongitude N: NorthBoundingLatitude All coordinates are in EPSG:4326	geo[e]:box
timeStart	Returned granules will have a temporal extent containing this start time	(O) Supported formats are: 'yyyy-MM-dd', 'yyyy-MM-ddTHH:mm:ssZ' or 'yyyy-MM-dd HH:mm:ss'	time[f]:start
timeEnd	Returned granules will have a temporal extent containing this end time	(O) Supported formats are: 'yyyy-MM-dd', 'yyyy-MM-ddTHH:mm:ssZ' or 'yyyy-MM-dd HH:mm:ss'	time[f]:end
startIndex	Starting record number of the set of search results desired by the search client	(O) Allowed value is any integer equal and greater than '0'.	os[g]:startIndex
count	Number of search results per page desired by the search client	(O) Allowed value is any integer within the interval of [0,200].	os[g]:count

a: All request parameters are case sensitive

b: "Definition" represents the semantic meaning of request parameter.

c: "Type" represents request parameter type restricted by namespace.

d: https://cwic.wgiss.ceos.org/opensearch/extensions/1.0/

e: https://a9.com/-/opensearch/extensions/geo/1.0/

f: https://a9.com/-/opensearch/extensions/time/1.0/

g: https://a9.com/-/spec/opensearch/1.1/

h: https://commons.esipfed.org/ns/discovery/1.2/

Table 8 Table of CWIC OpenSearch request parameters

8. Use Case – Granule Search (FedEO)

This chapter provides a comprehensive and detailed process about how to implement a CEOS OpenSearch client, which includes how to retrieve the IDN collection ID for the collection of interest, and how to build an OpenSearch request.

8.1.   FedEO Systems

There are two operational FedEO systems to which end-users have access.

- FedEO PROD – this is FedEO production instance and is available to all users.

    Location: https://fedeo.ceos.org/opensearch/description.xml

- FedEO TEST – this is FedEO testing instance used by data partners and external clients to perform testing before changes are made to the FedEO production instance.

    Location: https://geo.spacebel.be/opensearch/description.xml

The production instance will provide access to collections registered in the IDN and verified to be at least minimally compliant. The TEST instance may provide access to additional collections (*e.g.*, new collections undergoing testing and not yet registered in the IDN), and capabilities which have not yet been tested sufficiently to move to the production system.

8.2. Retrieve the Collection OSDD via IDN OpenSearch

The steps in this section are identical to the steps explained in section 6.2. To fit the end-to-end FedEO use case, the parameter values for the collection search has been selected in such a way that the granule search is eventually performed through FedEO.

Use Case Overview	
Title	Clients start from the IDN OpenSearch
Description	This use case describes steps for retrieving a collection ID from the IDN OpenSearch.
Actors	OpenSearch client
	IDN OpenSearch Server
Initial Status and Preconditions	OpenSearch clients have the IDN OpenSearch access URL.

Table 9 Use Case: Retrieve Collection OSDD from IDN OpenSearch

The following steps describe this use case.

Step 1: Obtain IDN OpenSearch OSDD to formulate a valid IDN OpenSearch request.

```
https://cmr.earthdata.nasa.gov/opensearch/collections/descriptor_document.xml?clientId=wgissOpenSearchDoc
```

Fig. 22 Example of IDN OpenSearch OSDD request

Step 2: Search collections of interest through IDN OpenSearch with proper request parameters (e.g. spatial footprint, temporal extent and keyword). A complete list of supported request parameters, extracted from the IDN OpenSearch OSDD was included in section 6.3.

An example request can be formed as follows.

```
https://cmr.earthdata.nasa.gov/opensearch/collections.atom?keyword= C1532648141-ESA
&numberOfResults=10&clientId=wgissOpenSearchDoc
```

Fig. 23 Example of IDN OpenSearch collection search request

Step 3: From the IDN OpenSearch response, obtain the OSDD endpoint for the collection by

parsing the href attribute under <link rel="search" type="application/opensearchdescription+xml"/> element. Note that this collection happens to be accessed via FedEO.

```
<feed xmlns="https://www.w3.org/2005/Atom" xmlns:dc="https://purl.org/dc/terms/" >
    <entry>
            …
            <dc:identifier>C1532648141-ESA</dc:identifier>
    …
            <link
    href="https://fedeo.ceos.org/opensearch/description.xml?parentIdentifier=CryoSat.products"
    hreflang="en-US" type="application/opensearchdescription+xml"
    rel="search"
    title="Non-CMR OpenSearch Provider Granule Open Search Descriptor Document"/>


    …
    </entry>
</feed>
```

Fig. 24 Example of IDN OpenSearch Response

8.3. Retrieve Granules via OpenSearch

After retrieving the OSDD endpoint from the IDN by querying through the CEOS OpenSearch API, OpenSearch clients will sequentially interact with the host remote server for inventory search. The following table shows the basic information about the use case of interacting with FedEO via OpenSearch.

Use Case Overview	
Title	Interact with FedEO server for inventory search
Description	This use case describes steps for executing inventory search based on the IDN collection OSDD of interest.
Actors	OpenSearch client FedEO Server
Initial Status and Preconditions	Clients have the FedEO OpenSearch URL from IDN.

Table 10 Use Case: Interact with FedEO Server

Step 4: Obtain the collection specific OSDD from the IDN response

```
https://fedeo.ceos.org/opensearch/description.xml?parentIdentifier=CryoSat.products
```

Fig. 25 Example of FedEO collection specific OSDD request

Step 5: Based on the (FedEO) OSDD, formulate a CEOS OpenSearch request for granules belonging to that collection.

```
https://fedeo.ceos.org/opensearch/request?httpAccept=application%2Fatom%2Bxml&parentIdentifier=CryoSat.products&startRecord=1&maximumRecords=5&startDate=2017-01-01&endDate=2017-12-31&bbox=-180,-90,180,90
```

Fig. 26 Example of FedEO OpenSearch request

Step 6: Parse the (FedEO) OpenSearch response and extract the identifier for the granule of interest from <id> element.

```
<feed xmlns="https://www.w3.org/2005/Atom" xmlns:alt11="https://www.opengis.net/alt/2.1"
xmlns:atom="https://www.w3.org/2005/Atom" xmlns:dc="https://purl.org/dc/elements/1.1/"
    …
xmlns:time="https://a9.com/-/opensearch/extensions/time/1.0/">
<author>
```

```
   <name>FEDEO Clearinghouse</name>
   <email>eohelp@eo.esa.int</email>
</author>
<generator>FEDEO Clearinghouse</generator>
<id>https://fedeo.ceos.org/opensearch/request</id>
<rights>Copyright 2016-2018, European Space Agency</rights>
<title>FEDEO Clearinghouse - Search Response</title>
<updated>2018-07-28T17:52:27Z</updated>
        …
   <entry>

<id>https://fedeo.ceos.org/opensearch/request/?httpAccept=application/atom%2Bxml&amp;parentIdentifier=
CryoSat.products&amp;uid=CS_OFFL_SIR_SAR_2__20151106T015949_20151106T020006_C001</id>
    …
  </entry>
    …
</feed>
```

Fig. 27 Example of FedEO OpenSearch response

8.4. Available Granule Search Parameters

The set of available granule search parameters depends on the actual collection and is not fixed. Please refer to [WGISS Connected Data Assets, FedEO Data Partner Guide] for the complete list of search parameters that may be advertised by a granule search OSDD. The meaning of these parameters is defined in [CEOS-OS-BP], [OGC 13-026r8] and [OGC 10-032r8].

The table below lists the parameters (subset of the above list) which are advertised in the FedEO top-level OSDD for granule search with their obligation.

Request Parameter [a]	Description [b]	Value & Cardinality (M) = mandatory (O) = optional	Type [c]
bbox	Returned granules will have a spatial extent overlapping this bounding box	(O)	geo:box
endDate	Returned granules will have a temporal extent containing this end time	(O)	time:end
lat	Latitude of center of area of interest used in combination with geo:lon and geo:radius.	(O)	geo:lat
lon	Longitude of center of area of interest used in combination with geo:lat and geo:radius.	(O)	geo:lon
maximumRecords	Number of search results per page desired by the search client	(O)	os:count
name	A string describing the location (place name) to perform the search. Center	(O)	geo:name

	will be used as lat/lon coordinates in combination with geo:radius.		
parentIdentifier	Collection identifier. Prefilled when obtaining OSDD from IDN.	(M)	eo:parentIdentifier
radius	A search radius from a lat-lon point. Used in combination with geo:name or geo:lat/geo:lon to determine area of interest.	(O)	geo:radius
recordSchema	Metadata model in which additional metadata should be provided inline	(O) Allowed values: • om • om10 • https://www.opengis.net/eop/2.1 • https://www.opengis.net/eop/2.0	sru:recordSchema
startDate	Returned granules will have a temporal extent containing this start time	(O)	time:start
startRecord	Starting record number of the set of search results desired by the search client	(O)	os:startIndex
startPage		(O)	os:startPage
uid	Granule returned will have this local granule identifier.	(O)	geo:uid
a: All request parameters are case sensitive b: "Definition" represents the semantic meaning of request parameter. c: "Type" represents request parameter type restricted by namespace.			

Table 51 Table of FedEO OpenSearch request parameters (Granules)

9.   Abbreviations and Glossary

Term	Meaning
AOE	Academy of Optic-Electronic (AOE) of Chinese Academy of Science
CCRS	Canada Centre for Remote Sensing (now CCMEO)
CEOS	Committee on Earth Observation Satellites
CLASS	Comprehensive Large Array-data Stewardship System
CSW	OpenGIS Catalog Service for Web
CCMEO	Canada Center for Mapping and Earth Observation
CWIC	CEOS WGISS Integrated Catalog
CMR	NASA Common Metadata Repository
ESA	European Space Agency
FedEO	Federated Earth Observation
GHRSST	Group for High Resolution Sea Surface Temperature
IDN	International Directory Network
INPE	Instituto Nacional de Pesquisas Espaciais (National Institute For Space Research, Brazil)
ISRO	Indian Space Research Organisation
JAXA	Japan Aerospace Exploration Agency
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NODC	National Oceanographic Data Center

NRSCC	National Remote Sensing Center of China
OGC	Open Geospatial Consortium
USGS	U.S. Geological Survey
WGISS	Working Group on Information Systems and Services

Document Status Sheet

Issue	Date	Comments	Editors
1.0	2019-04-04	Original	
1.0.1			
1.1	2021-09-20	Updated FedEO endpoint information.	Yves Coene
1.2	2021-09-21	Fix broken CWIC links, update version	Archie Warnock, Doug Newman, Minnie Wong