

July 2021 OGC API Code Sprint Summary Engineering Report

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Chapter 1. Subject

The subject of this Engineering Report (ER) is a virtual code sprint that was held from July 21st to July 23rd, 2021 to advance the development of the OGC API - Processes draft standard, OGC API - Records draft standard, and the OGC API - Coverages draft standard. An Application Programming Interface (API) is a standard set of documented and supported functions and procedures that expose the capabilities or data of an operating system, application or service to other applications (adapted from ISO/IEC TR 13066-2:2016).

Chapter 2. Executive Summary

This Engineering Report (ER) summarizes the main achievements of the July 2021 OGC API Virtual Code Sprint, conducted from July 21st to July 23rd. The goal of the code sprint was to progress the development of the draft OGC API standards for Records, Coverages and Processes. The sprint served to accelerate development of candidate standards of the OGC APIs.

Specifically, the objectives of the code sprint were to:

- Develop prototype implementations of OGC API – Processes
- Develop prototype implementations of OGC API – Records
- Develop prototype implementations of OGC API – Coverages
- Test the prototype implementations
- Provide feedback to the Editor about what worked and what did not work
- Provide feedback about the specification document, especially what is missing from the document

Part of the motivation for holding the sprint was:

- APIs are a popular, effective method for rapid software development
- There is an increasing need for interoperability between Web APIs
- The growing uptake of location within and outside of geospatial developer communities

The draft OGC API - Processes specification defines an interface that enables the execution of geospatial computing processes and the retrieval of metadata describing their purpose and functionality. Typically, these processes execute well-defined algorithms that ingest vector and/or coverage data to produce new datasets.

The draft OGC API - Records specification defines an interface that enables discovery and access to metadata records about resources such as features, coverages, tiles / maps, models, assets, services or widgets. The draft specification enables the discovery of geospatial resources by standardizing the way collections of descriptive information about the resources (metadata) are exposed and accessed.

The draft OGC API - Coverages specification defines an interface that enables access to coverages that are modeled according to the Coverage Implementation Schema (CIS) 1.1. Coverages are represented by some binary or ASCII serialization, specified by some data (encoding) format. Arguably the most popular type of coverage is that of a gridded coverage. Gridded coverages have a grid as their domain set describing the direct positions in multi-dimensional coordinate space, depending on the type of grid. Satellite imagery is typically modeled as a gridded coverage, for example.

The code sprint facilitated the development and testing of prototype implementations of the aforementioned OGC API candidate standards. The code sprint therefore successfully met all of its objectives and achieved its goal of progressing the development of the standards.

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Chapter 3. References

The following normative documents are referenced in this document.

- OGC: OGC 18-062, OGC API - Processes - Part 1: Core candidate standard [<http://docs.ogc.org/DRAFTS/18-062.html>]
- OGC: OGC 20-004, OGC API - Records - Part 1: Core candidate standard [<http://docs.ogc.org/DRAFTS/20-004.html>]
- OGC: OGC 19-087, OGC API - Coverages - Part 1: Core candidate standard [<http://docs.ogc.org/DRAFTS/19-087.html>]
- IETF: RFC-7946 The GeoJSON Format (2016)

Chapter 4. Terms and definitions

For the purposes of this report, the definitions specified in Clause 4 of the OWS Common Implementation Standard **OGC 06-121r9** [https://portal.opengeospatial.org/files/?artifact_id=38867&version=2] shall apply. In addition, the following terms and definitions apply.

- *coordinate reference system*

coordinate system that is related to the real world by a datum term name (source: ISO 19111)

- *coverage*

feature that acts as a function to return values from its range for any direct position within its spatiotemporal domain, as defined in OGC Abstract Topic 6

- *record*

atomic unit of information of a catalogue that is used to provide information about a particular resource

- *OpenAPI Document*

A document (or set of documents) that defines or describes an API. An OpenAPI definition uses and conforms to the OpenAPI Specification (<https://www.openapis.org>)

- *Web API*

API using an architectural style that is founded on the technologies of the Web [source: OGC API - Features - Part 1: Core]

NOTE

See Best Practice 24: Use Web Standards as the foundation of APIs (W3C Data on the Web Best Practices) for more detail.

4.1. Abbreviated terms

- **API** Application Programming Interface
- **CORS** Cross-Origin Resource Sharing
- **OGC** Open Geospatial Consortium

Chapter 5. Introduction

This Engineering Report (ER) summarizes the main achievements of the July 2021 OGC API Virtual Code Sprint, conducted from July 21st to July 23rd. The sprint had been organized to advance the development of draft standards of OGC APIs for Records, Coverages and Processes. Sprint participants prototyped implementations of the draft standards, validating the requirements and providing feedback so that the draft standards could be improved.

An OGC Code Sprint is a collaborative and inclusive event driven by innovative and rapid programming with minimal process and organization constraints to support the development of new applications and open standards. OGC Code Sprints experiment with emerging ideas in the context of geospatial standards, help improve interoperability of existing standards by experimenting with new extensions or profiles, and are used as a proof of concept for other OGC Innovation Program initiatives, or to support OGC Standards Program activities.

Chapter 6. High-Level Architecture

6.1. High Level Overview

The focus of the sprint was on support of the development of the draft OGC API - Records [<https://ogcapi.ogc.org/records>], OGC API - Processes [<https://ogcapi.ogc.org/processes>] and OGC API - Coverages [<https://ogcapi.ogc.org/coverages>] standards. Implementations of these draft standards were deployed in participants' own infrastructure in order to build a solution with the architecture shown below in [Figure 1](#).

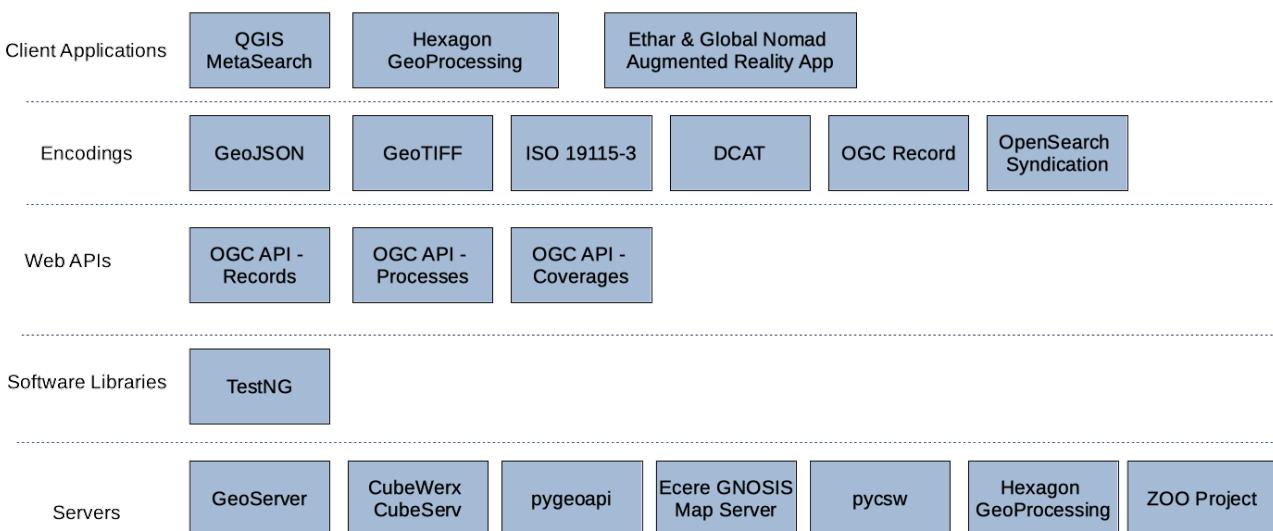


Figure 1. High level overview of the architecture implemented during the sprint

As illustrated, the sprint architecture was designed with the view of enabling client applications to connect to different servers that implement OGC APIs. The servers were provisioned with metadata, implementations of algorithms for geospatial analysis, vector feature data, and coverages such as satellite imagery.

6.2. Candidate Standards

6.2.1. OGC API - Processes

The draft OGC API - Processes specification defines an interface that enables the execution of geospatial computing processes and the retrieval of metadata describing their purpose and functionality. Typically, these processes execute implementations of well-defined algorithms that ingest vector and/or coverage data to produce new datasets or analytical products.

6.2.2. OGC API - Records

The draft OGC API - Records specification defines an interface that enables discovery and access to metadata records about resources such as features, coverages, tiles / maps, models, assets, services or widgets. The draft specification enables the discovery of geospatial resources by

standardizing the way collections of descriptive information about the resources (metadata) are exposed and accessed.

6.2.3. OGC API - Coverages

The draft OGC API - Coverages specification defines an interface that enables access to coverages that are modeled according to the Coverage Implementation Schema (CIS) 1.1. Coverages are represented by some binary or ASCII serialization, specified by some data (encoding) format. Arguably the most popular type of coverage is that of a gridded coverage. Gridded coverages have a grid as their domain set describing the direct positions in multi-dimensional coordinate space, depending on the type of grid. Satellite imagery is typically modeled as a gridded coverage, for example.

Chapter 7. Results

Multiple organizations provided servers, API implementations, and capabilities during the event. The rest of this section describes each of the implementations.

7.1. Augmented Reality Application

Developers from Ethar Inc and Global Nomad took part in the code sprint, extending an Augmented Reality (AR) application that they are building for Testbed-17. The AR application, which runs on a smartphone, allows a coverage such as one representing a Digital Elevation Model (DEM), to be visualized in a three-dimensional AR view as shown in [Figure 2](#). This facilitates 'tabletop' visualization so that a group of people could potentially stand around a table and see geographic representation superimposed onto that table, with the DEM viewed either through smart glasses or a smartphone. The AR application can ingest coverages encoded in GeoTIFF format, therefore the application could be served by an implementation of OGC API - Coverages.

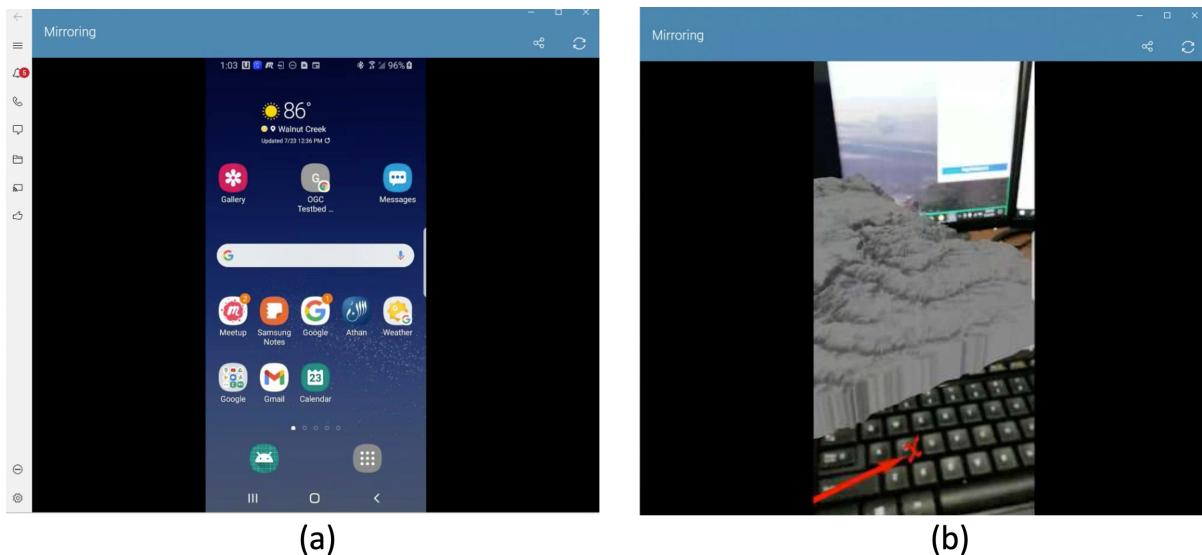


Figure 2. Screenshots of a smartphone mirrored (a) at standby (b) with the augmented reality application running

7.2. CubeWerx CubeSERV

The CubeWerx server ("CubeSERV") supports a wide variety of back ends including Oracle, MariaDB, SHAPE files, etc. It also supports a wide array of service-dependent output formats (e.g. GML, GeoJSON, Mapbox Vector Tiles, MapMP, etc.) and coordinate reference systems. During this code sprint, CubeWerx helped fine-tune and mature several aspects of the OGC API specifications in focus for the sprint, and refined CubeSERV accordingly. CubeSERV supports multiple OGC API specifications.

The CubeSERV implementation of OGC API - Processes was configured to demonstrate a Ship

Detection capability, identifying ships from RADARSAT imagery. This was achieved by executing the analytical process on multiple nodes running in different Public Cloud regions (i.e. one in North America and another in Europe). [Figure 3](#) shows a view of the different nodes, running in different Cloud regions and used to detect the ships. The different nodes communicated through interfaces that conform to OGC API - Processes.

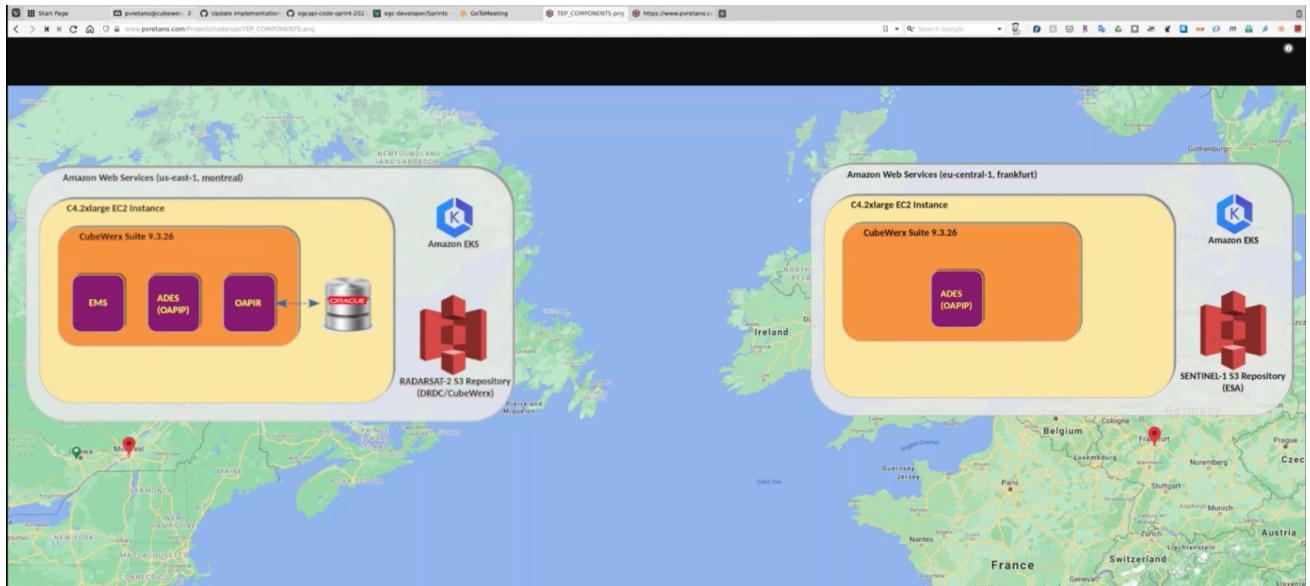


Figure 3. Screenshot from a demonstration of CubeSERV

Once a processing job running in CubeSERV has completed the outputs are made available for display on a web portal. In the case of Ship Detection, the location of ships was displayed as shown in [Figure 4](#).

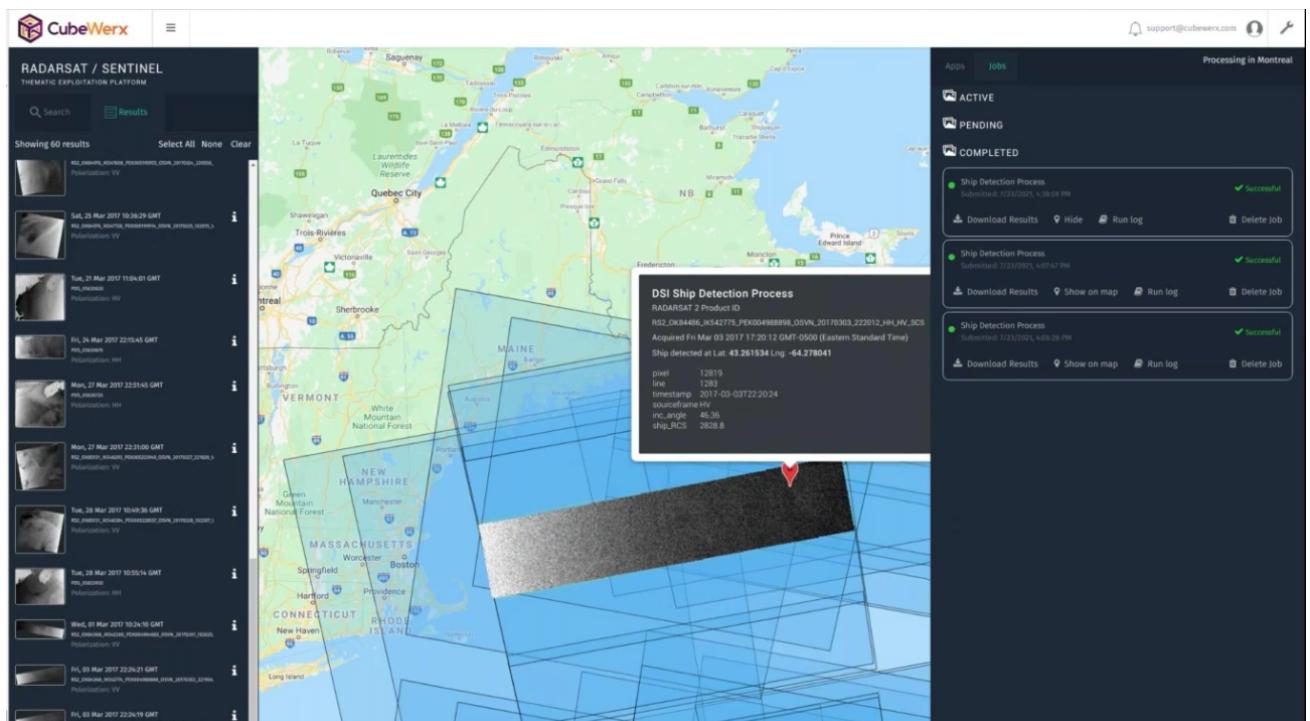


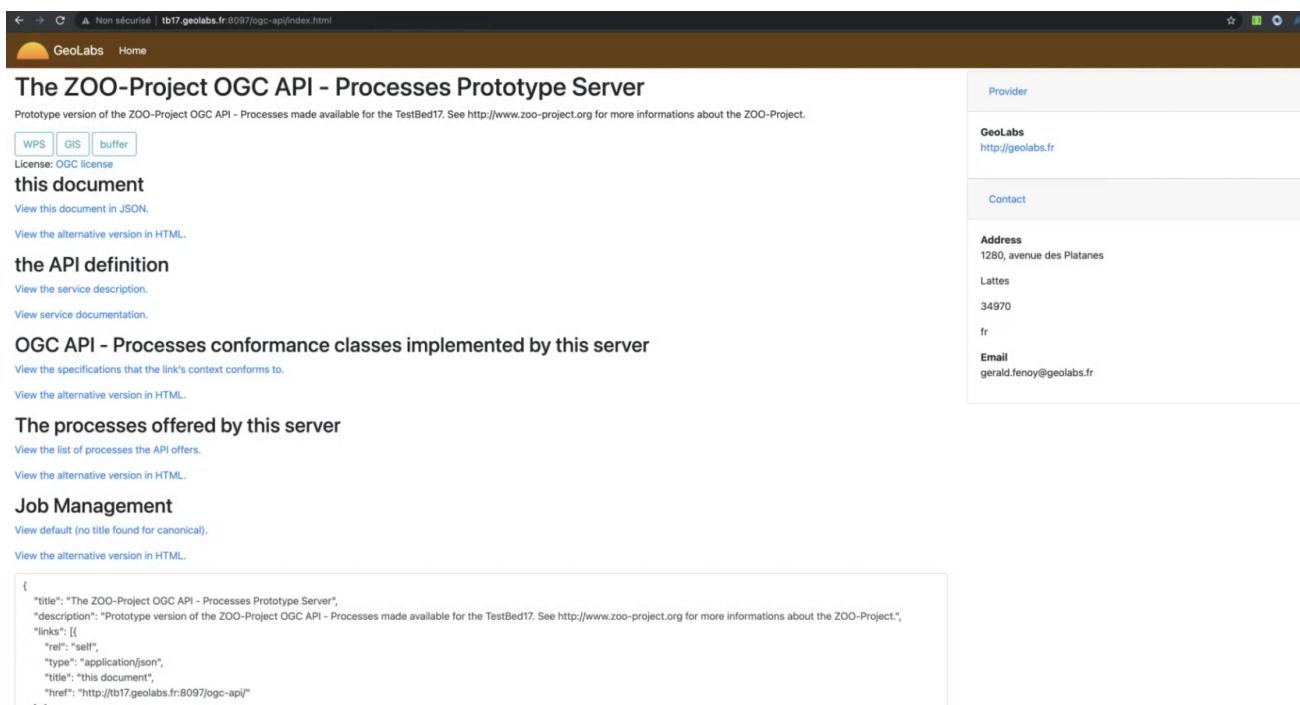
Figure 4. A second screenshot from a demonstration of CubeSERV

The CubeSERV implementation of OGC API - Records was configured to support discussion and validation of the specification, whereas the OGC API - Coverages implementation facilitated

development of compliance tests during the code sprint.

7.3. ZOO Project

Developers from Geolabs deployed an instance of ZOO Project, an open source platform written in C that implements a number of interface standards for geospatial processing, including OGC API - Processes and multiple versions of the WPS standard. The ZOO Project instance deployed for the code sprint offered wrappers around libraries such as the Orfeo Toolbox (OTB) and software such as GRASS GIS and SAGA GIS. This meant that through the OGC API - Processes interface, a client application could invoke the processing and analytical functions offered by these software packages. A screenshot of a landing page from a Geolabs ZOO Project instance is shown in [Figure 5](#).



The screenshot shows a web browser displaying the 'The ZOO-Project OGC API - Processes Prototype Server'. The page header includes the Geolabs logo and a 'Home' link. Below the header, there's a navigation bar with buttons for 'WPS', 'GIS', and 'buffer', and a 'License: OGC license' link. The main content area is titled 'this document' and contains links to view it in JSON or HTML. It also lists 'the API definition' and 'View the service description.' A section titled 'OGC API - Processes conformance classes implemented by this server' provides links to view specifications and alternative versions. Another section, 'The processes offered by this server', includes links to view the list of processes and an alternative version. A 'Job Management' section follows, with a note about default titles and an alternative version. On the right side, there are two panels: 'Provider' (listing Geolabs with its address, Lattes, 34970, fr, and email) and 'Contact' (with the same information). At the bottom left, there's a JSON snippet showing the structure of the API response for the 'this document' link.

```
{
  "title": "The ZOO-Project OGC API - Processes Prototype Server",
  "description": "Prototype version of the ZOO-Project OGC API - Processes made available for the TestBed17. See http://www.zoo-project.org for more informations about the ZOO-Project.",
  "links": [
    {
      "rel": "self",
      "type": "application/json",
      "title": "this document",
      "href": "http://tb17.geolabs.fr:8097/ogc-api/"
    }
  ]
}
```

Figure 5. A landing page from a Geolabs ZOO Project instance

A screenshot of a request and response from a completed processing job executed on ZOO Project is shown in [Figure 6](#).

The screenshot shows a web interface for a processing job titled "Pythagoras' Tree". On the left, there's a sidebar with "Execution options" like "Subscribers", "Response", and "Mode", and a "Submit" button. Below that is a section for "Execute End Point" with a "View the execution endpoint of a process" link and a "View the alternative version in HTML" link. The main content area contains a "Your request" dialog box with JSON code, a "Close" button, and a "Submit Job" button. At the bottom, there's a footer with links to "http://tb17.geolabs.fr:8097/ogc-api/processes/SAGA.garden_fractals.1.html", "Last modified: Wed Jul 21 16:36:03 CEST 2021", and "Powered by ZOO-Project 1.8.1-dev".

```

{
  "id": "SAGA.garden_fractals.1",
  "title": "Pythagoras' Tree",
  "description": "Pythagoras' Tree",
  "version": "1.0.0",
  "jobControlOptions": ["sync-execute", "async-execute", "dismiss"],
  "outputTransmission": ["value", "reference"],
  "links": [
    {
      "rel": "execute",
      "type": "application/json",
      "title": "Execute End Point",
      "href": "http://tb17.geolabs.fr:8097/ogc-api/processes/SAGA.garden_fractals.1/execution"
    }
  ]
}

```

```

{
  "request": {
    "format": "text/xml",
    "transmission": "reference"
  },
  "subscriber": {
    "successUri": "http://tb17.geolabs.fr:8097/cgi-bin/publish.py?jobid=JOBSOCKET-8b5089fe-ebf9-11eb-b313-0242c0a81006&type=success",
    "inProgressUri": "http://tb17.geolabs.fr:8097/cgi-bin/publish.py?jobid=JOBSOCKET-8b5089fe-ebf9-11eb-b313-0242c0a81006&type=inProgress",
    "failedUri": "http://tb17.geolabs.fr:8097/cgi-bin/publish.py?jobid=JOBSOCKET-8b5089fe-ebf9-11eb-b313-0242c0a81006&type=failed"
  },
  "RESULT": {
    "href": "http://tb17.geolabs.fr:8097/cgi-bin/mapserv?map=/usr/com/zoo-project/RESULT_0_a16c0ac4-ebf9-11eb-8816-0242c0a81006",
    "type": "text/xml"
  }
}

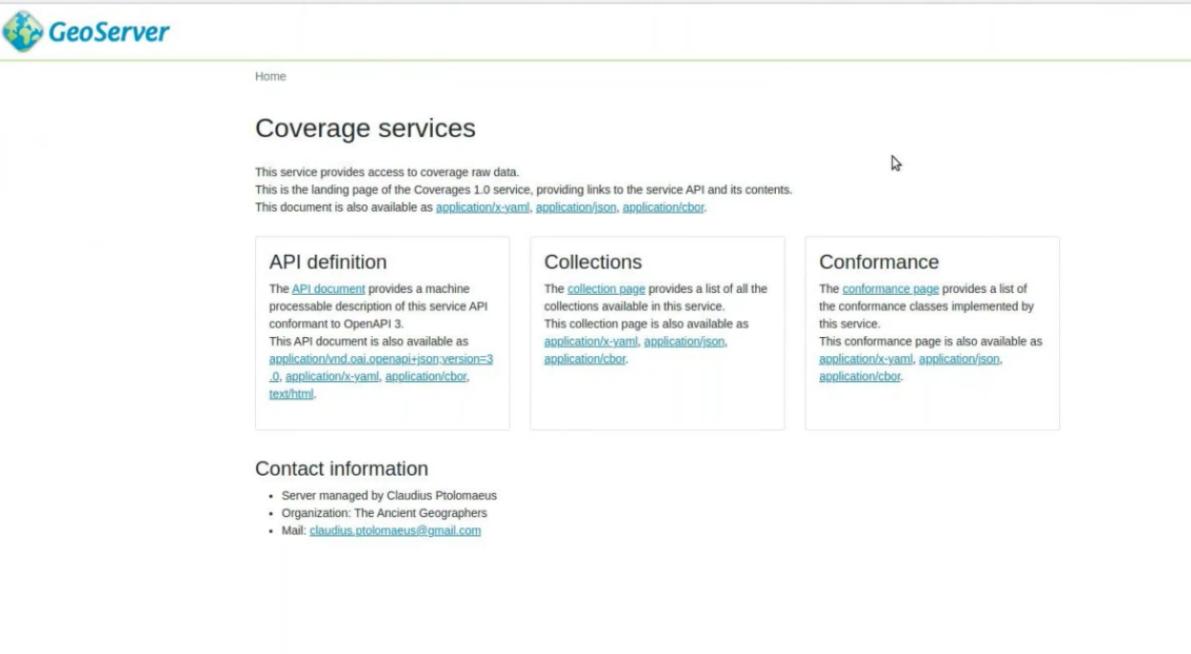
```

Figure 6. A request and response from a completed processing job executed on ZOO Project

7.4. GeoServer

GeoSolutions deployed an instance of the GeoServer product. GeoServer is a Java-based software server that allows users to view and edit geospatial data. GeoServer supports multiple OGC API specifications. For this code sprint, the server was configured to offer an endpoint supporting multiple conformance classes and recommendations from the draft OGC API - Coverages - Part 1: Core specification. The development focused on updating the OGC API - Coverages implementation to the latest evolution of the spec, building on GeoServer's existing support for the Web Coverage Service (WCS) standard.

<http://gs-main.geosolutionsgroup.com/geoserver/ogc/coverages>



The screenshot shows the GeoServer Coverage services landing page. At the top, there's a header with the GeoServer logo and a navigation bar with links like 'Home', 'Coverage services', 'Contact information', 'Help', and 'Logout'. Below the header, there's a main content area with three sections: 'API definition', 'Collections', and 'Conformance'. Each section contains a brief description and links to various document formats (e.g., application/x-yaml, application/json). Below these sections, there's a 'Contact information' block with a list of details about the server manager. At the bottom, there's a footer with links to 'OGC API - Coverages', 'OGC API - Features', 'OGC API - Catalog', and 'OGC API - Data'. The central part of the page features a large map of North America.

Figure 7. The landing page of the OGC API - Coverages implementation of GeoServer

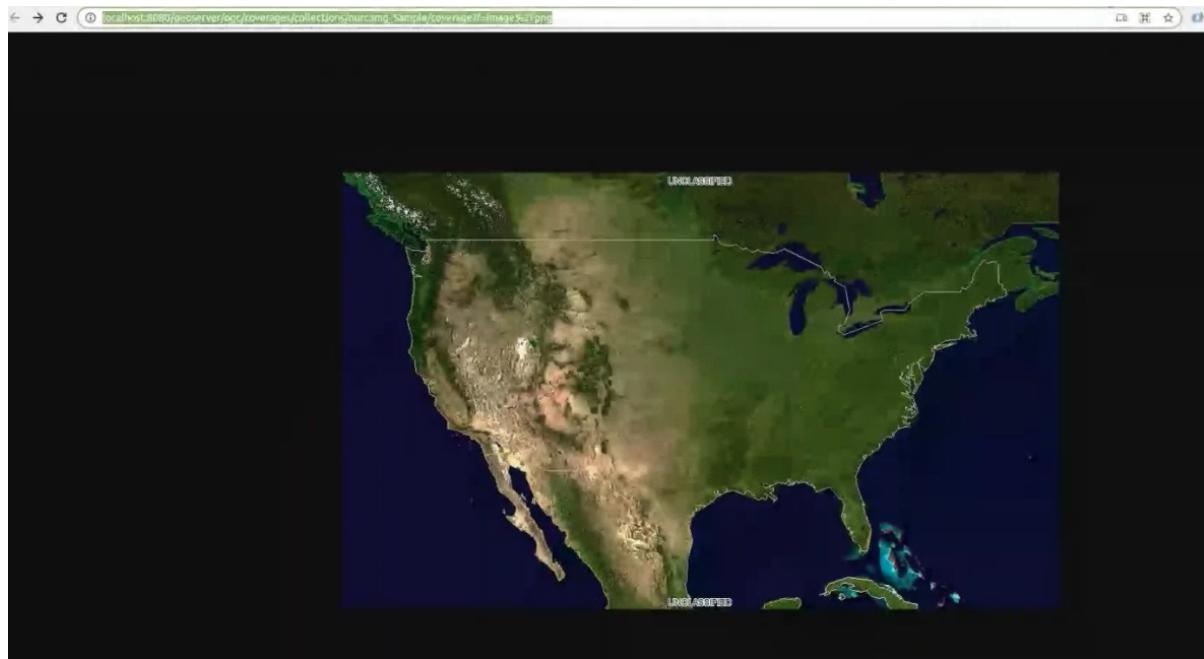


Figure 8. A coverage retrieved from the OGC API - Coverages implementation of GeoServer

7.5. Ecere GNOSIS Map Server

The GNOSIS Map Server is written in the eC programming language and supports multiple OGC API specifications. The API allows for retrieval of coverages, maps and tiles (both coverage and map tiles) of a dataset. Ecere configured the server to offer coverages through an interface conforming to OGC API - Coverages. Multiple encodings are supported including GNOSIS Map Tiles (which can contain either vector data, gridded coverages, imagery, point clouds or 3D meshes), GeoTIFF, GeoJSON, Mapbox Vector Tiles and MapML. For this code sprint, the server was used in support of the development of compliance tests.

7.6. Hexagon Geoprocessing Suite

Developers from Hexagon took part in the code sprint, focusing on the OGC API - Processes candidate standard. The developers configured the Hexagon Geoprocessing Suite, which includes a number of Hexagon products, to offer a variety of image analysis capabilities. The suite includes ERDAS APOLLO, which provides an end-to-end workflow to execute algorithms that operate on geospatial data. The algorithms were exposed as processes through an interface conforming to OGC API - Processes. The suite also includes ERDAS IMAGINE, a software product for image analysis and processing. The workflows were designed using the Spatial Model Editor from ERDAS IMAGINE product, a screenshot of which is shown in [Figure 9](#).

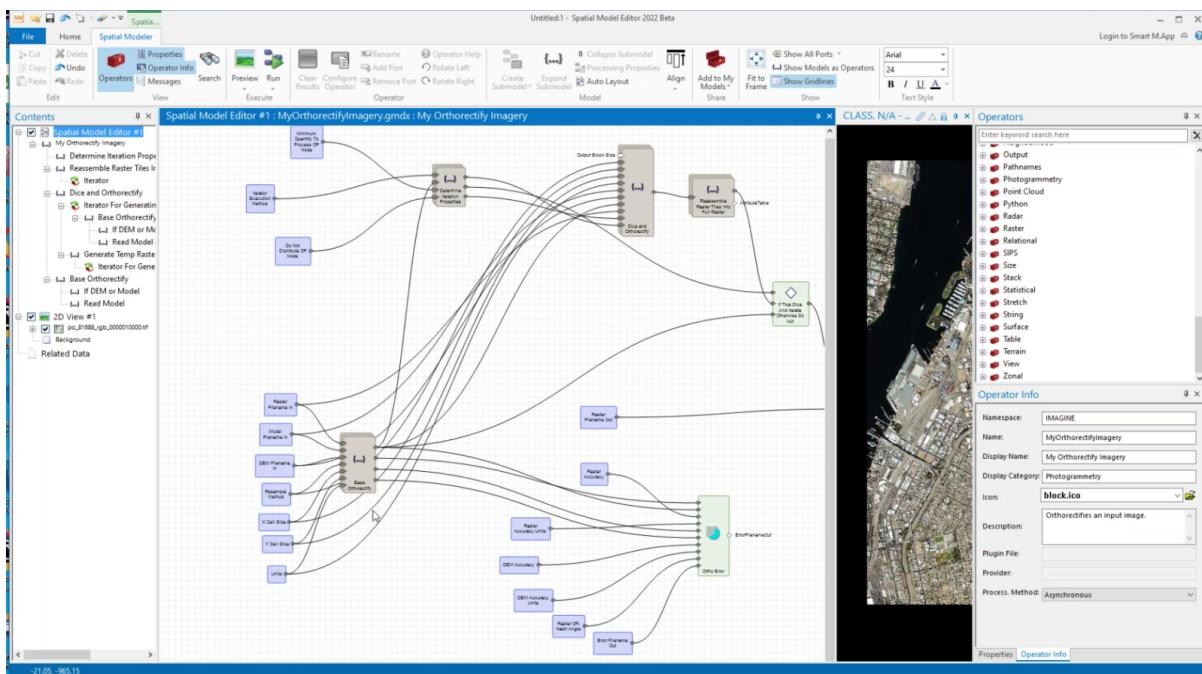


Figure 9. A screenshot of a workflow designed using Hexagon's Spatial Model Editor

ERDAS IMAGINE allows geospatial analysts to create custom models and to publish the models to the ERDAS APOLLO catalog, from where they can be executed by end-users as illustrated in [Figure 10](#). While each processing job is running, an administrator can monitor the jobs through a status view as shown in [Figure 11](#). This capability demonstrated the ability of OGC API - Processes to support both synchronous and asynchronous execution modes.

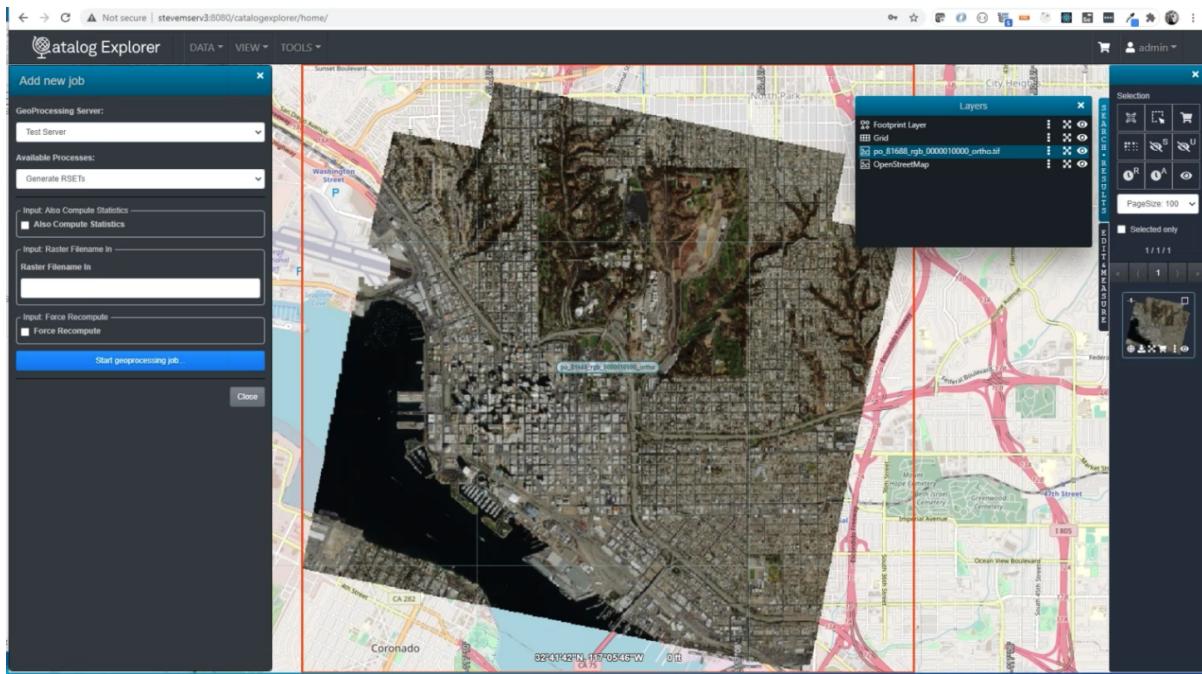


Figure 10. A screenshot of the output of a completed processing job in Hexagon Geoprocessing suite

JOBS		WORKERS		PROCESSES							
Geoprocessing Jobs				Submitted date		Completed date		Auto refresh			
Actions	Job ID	Process	Step	Step Worker Node	Progress	Submitted	Status	Duration	Processing Start	Processing End	Outcome
	eed52e51-56e8-448d-a1ca-e5a2de4cad9	MyOrthorectifyImagery		pmw5520	<div style="width: 100%;">100%</div>	7/23/2021 9:11:43 AM	successful	16 seconds	7/23/2021 9:11:43 AM	7/23/2021 9:11:59 AM	
	86666441-c3e8-4b55-97e9-590e8782f2f	MyOrthorectifyImagery		pmw5520	<div style="width: 100%;">100%</div>	7/23/2021 8:55:28 AM	successful	15 seconds	7/23/2021 8:55:28 AM	7/23/2021 8:55:43 AM	
	f4c19e5a-812d-4a41-8ceb-35cc88555267	MyOrthorectifyImagery		pmw5520	<div style="width: 0%; background-color: #ccc;">0%</div>	7/23/2021 8:52:04 AM	failed	5 seconds	7/23/2021 8:52:04 AM	7/23/2021 8:52:09 AM	
	5092848c-a251-4d27-a75f-8992c2659d74	MyOrthorectifyImagery		pmw5520	<div style="width: 100%;">100%</div>	7/23/2021 8:20:12 AM	successful	15 seconds	7/23/2021 8:20:12 AM	7/23/2021 8:20:27 AM	
	721e9c0d-18a7-4409-8d26-874752d64fb0	MyOrthorectifyImagery		pmw5520	<div style="width: 100%;">100%</div>	7/23/2021 2:40:59 PM	successful	10 seconds	7/23/2021 2:40:59 PM	7/23/2021 2:41:09 PM	
	c8945276-48bb-4e2e-ae23-6faeb2771e4	MyOrthorectifyImagery		pmw5520	<div style="width: 100%;">100%</div>	7/23/2021 2:11:56 PM	successful	10 seconds	7/23/2021 2:11:56 PM	7/23/2021 2:12:06 PM	
	bcd85744-3d56-4021-9f4a-2bcbab5f0bd0	MyOrthorectifyImagery		pmw5520	<div style="width: 100%;">100%</div>	7/23/2021 11:48:50 AM	successful	10 seconds	7/23/2021 11:48:50 AM	7/23/2021 11:49:00 AM	
	47a310f-f097-4421-95a8-560e4a1fd17f	MyOrthorectifyImagery		pmw5520	<div style="width: 100%;">100%</div>	7/23/2021 11:11:50 AM	successful	10 seconds	7/23/2021 11:11:50 AM	7/23/2021 11:12:00 AM	

Figure 11. A screenshot of an overview of the status of processing jobs in Hexagon Geoprocessing suite

7.7. QGIS MetaSearch Plugin

During the code sprint, developers from OSGeo, MSC and GeoCat BV worked on an enhancement to the QGIS MetaSearch plugin to improve support for OGC API - Records. MetaSearch is a core plugin that enables QGIS to act as a client application for interacting with metadata catalogue services. A screenshot of the search dialog window of the QGIS MetaSearch plugin is shown in Figure 12.

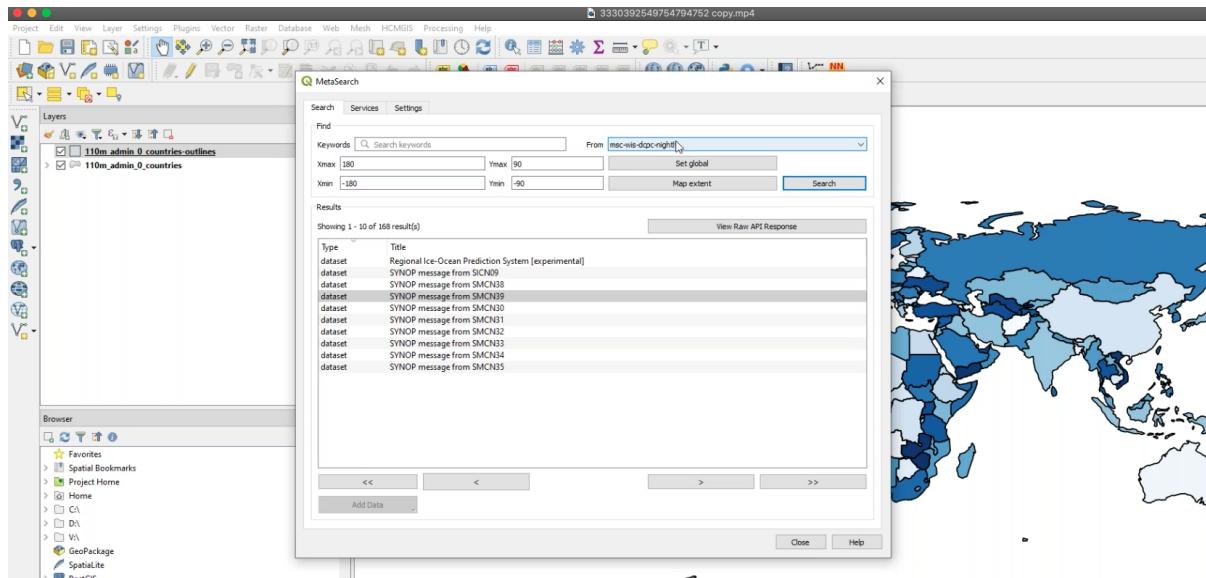


Figure 12. The search dialog window of the QGIS MetaSearch plugin

A screenshot of the metadata view window of the QGIS MetaSearch plugin is shown in Figure 13.

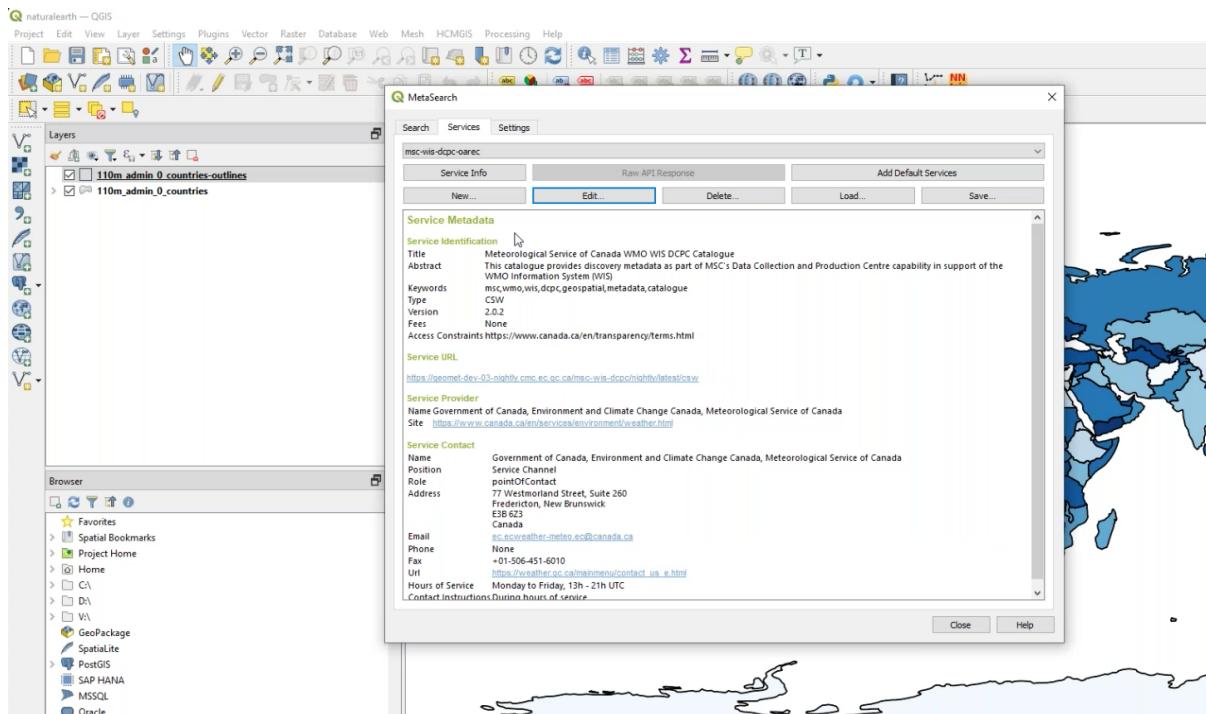


Figure 13. The metadata view window of the QGIS MetaSearch plugin

Another screenshot of the QGIS MetaSearch plugin windows is shown in Figure 14.

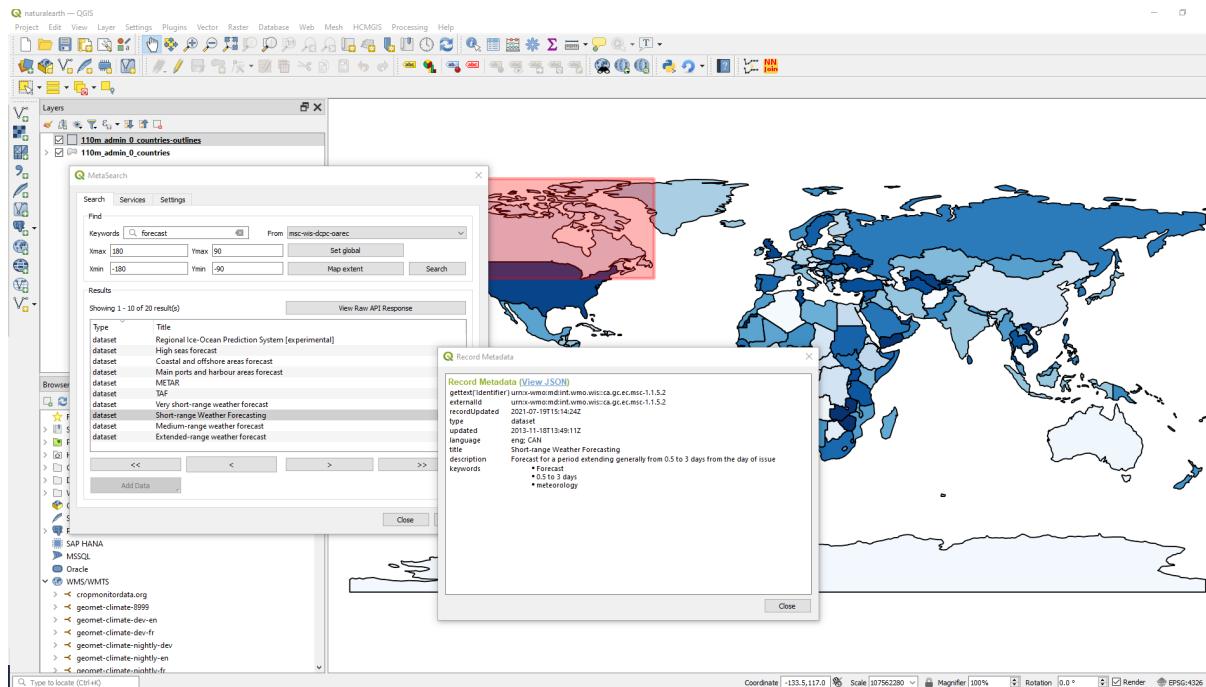


Figure 14. Another screenshot of the QGIS MetaSearch plugin windows

As a result, QGIS Metasearch supports both OGC CSW and OGC API - Records. The functionality is currently in a development branch and will be added to QGIS master branch in fall 2021.

7.8. Mappings between ISO 19115-3 and OGC API - Records Queryables

Developers from OpenWork took part in the code sprint, with focus on metadata and OpenSearch Syndication. The work on metadata involved designing mappings between the 'queryables' model implemented by OGC API - Records and ISO 19115-3, the XML Schema of ISO 19115-1 the international geospatial metadata standard. The mappings have been archived on the sprint's [GitHub repository](#) [https://github.com/opengeospatial/ogcapi-code-sprint-2021-07/blob/main/mappings/ISO19115-3_Mappings.md] and are presented in [Appendix B](#).

7.9. OpenSearch Syndication Protocol

Some of the prototyping by developers from OpenWork involved implementation of an OpenSearch description document. The OpenSearch description document is used to describe a search engine so that it can be used by search client applications. Once configured on an OpenSearch client (ideally a web browser), the search engine becomes accessible as illustrated on [Figure 15](#).

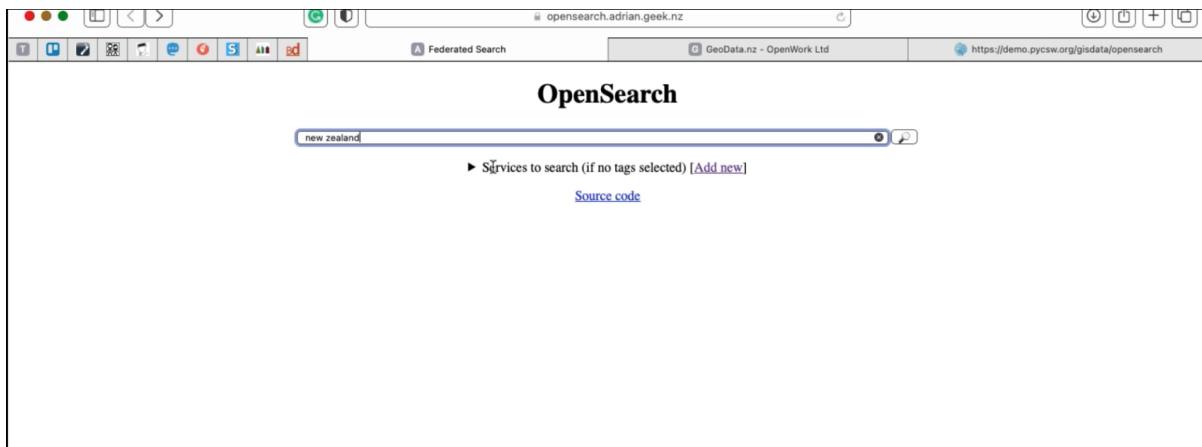


Figure 15. The landing page of a search engine's user interface

A screenshot of search results retrieved through OpenSearch Syndication is shown in Figure 16.

Rough count per page: 10

- [**NZ Orthophotos 1995-1996**](#)
 <p>LINZ publishes 1:25,000 scale orthophotos of New Zealand from its archive. The New Zealand orthophotos shown are historical and no further orthophotos of New Zealand will be published. Coverage of 1 pixel is 2.5m x 2.5m
</p><br clear="all"/>
 From:
- [**NZ Orthophotos 1995-1996**](#)
 <p>LINZ publishes 1:25,000 scale orthophotos of New Zealand from its archive. The New Zealand orthophotos shown are historical and no further orthophotos of New Zealand will be published. Coverage of 1 pixel is 2.5m x 2.5m
</p><br clear="all"/>
 From:
- [**NZ Orthophotos 1997-1998**](#)
 <p>LINZ publishes 1:25,000 scale orthophotos of New Zealand from its archive. The New Zealand orthophotos shown are historical and no further orthophotos of New Zealand will be published. Coverage of 1 pixel is 2.5m x 2.5m
</p><br clear="all"/>
 From:
- [**NZ Orthophotos 1997-1998**](#)
 <p>LINZ publishes 1:25,000 scale orthophotos of New Zealand from its archive. The New Zealand orthophotos shown are historical and no further orthophotos of New Zealand will be published. Coverage of 1 pixel is 2.5m x 2.5m
</p><br clear="all"/>

Figure 16. A screenshot of search results retrieved through OpenSearch Syndication.

7.10. pycsw

During the code sprint, developers from the Open Source Geospatial Foundation (OSGeo) deployed an instance of [pycsw](https://pycsw.org) [https://pycsw.org], an open source server-side Python implementation of the OGC Catalogue Services for the Web (CSW) standard. The pycsw software product allows for the publishing and discovery of geospatial metadata via numerous APIs (CSW 2.0.2, CSW 3.0.0, OpenSearch Syndication Protocol, and others), providing a standards-based metadata and catalogue component of spatial data infrastructures. The OSGeo developers extended the pycsw code base to include support for OGC API - Records, as well as the [SpatioTemporal Asset Catalog \(STAC\)](https://stacspec.org) [https://stacspec.org]. A screenshot of the landing page of one of the pycsw instances is shown in Figure 17.

The screenshot shows the landing page of a pycsw instance. At the top, there's a header bar with the title "pycsw Geospatial Catalogue". Below the header, a sidebar on the left lists various links: "Collections", "OpenAPI" (with "Swagger" and "JSON" sub-links), "Conformance" (with "CSW 3.0.0" and "CSW 2.0.2" sub-links), "OpenSearch", "QAI-PMH", and "SRU". The main content area contains the text "pycsw is an OGC CSW server implementation written in Python". At the bottom, it says "Powered by pycsw 3.0.dev0".

Figure 17. The landing page of one of the pycsw instances

A screenshot of a series of metadata records from a collection accessed on an instance of pycsw is shown in Figure 18.

The screenshot shows a list of metadata records from a collection. On the left, there's a map of the world with a blue rectangle highlighting a specific region. To the right of the map, there are "Prev" and "Next" navigation buttons. Below the map, a table lists ten metadata records. Each record has two columns: "Title" and "Type". The titles are hyperlinks, and the types are "dataset".

Title	Type
S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE	dataset
S2A_MSIL1C_20200930T092031_N0209_R093_T34SDJ_20200930T105731.SAFE	dataset
S2A_MSIL1C_20200930T092031_N0209_R093_T34SDH_20200930T105731.SAFE	dataset
Sentinel-2 MSI	dataset
S2A_MSIL1C_20200930T092031_N0209_R093_T34SEJ_20200930T105731.SAFE	dataset
S2A_MSIL1C_20200930T092031_N0209_R093_T35SKC_20200930T105731.SAFE	dataset
S2A_MSIL1C_20200930T092031_N0209_R093_T34TDK_20200930T105731.SAFE	dataset
S2A_MSIL1C_20200930T092031_N0209_R093_T34TFL_20200930T105731.SAFE	dataset
S2A_MSIL1C_20200930T092031_N0209_R093_T34TEK_20200930T105731.SAFE	dataset
S2A_MSIL1C_20200930T092031_N0209_R093_T35TKF_20200930T105731.SAFE	dataset

Powered by pycsw 3.0.dev0

Figure 18. A series of metadata records from a collection accessed on an instance of pycsw

A screenshot of a single metadata record from an instance of pycsw is shown in Figure 19.

resource-catalogue.demo.eopca.org/collections/metadata/main/items/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE

Property	Value
externalId	S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE
recordUpdated	2021-04-19T13:34:16Z
type	dataset
created	2020-09-30T10:57:31.000000Z
updated	2020-09-30T10:57:31.000000Z
title	S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE
description	S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE
keywords	['Orthoimagery', 'Land cover', 'Geographical names', 'data set series', 'processing', 'eo:productType:/', 'eo:orbitNumber:/', 'eo:orbitDirection:/', 'eo:processingLevel:Level-1C']
extents	{'spatial': {'bbox': [[19.88, 36.06, 21.11, 37.04]], 'crs': 'http://www.opengis.net/def/crs/OGC/1.3/CRS84'}}}

Powered by pycsw 3.0.dev0

Figure 19. A single metadata record from an instance of pycsw

7.11. pygeoapi

A number of sprint participants deployed instances of [pygeoapi](https://pygeoapi.io) [<https://pygeoapi.io>] and worked collaboratively to enhance the software's support for various OGC APIs. Participants working on pygeoapi included developers from OSGeo, Meteorological Service of Canada (MSC), 52 North, GeoCat BV and Geobeyond Srl. pygeoapi is an open source Python server implementation of the OGC API suite of standards. The product supports the microservices approach and allows for scalability and cloud friendly deployment.

7.11.1. Accessing metadata records

Developers from MSC, OSGeo, GeoCat BV and Geobeyond Srl configured an instance of pygeoapi to enable access to metadata records. A screenshot of the landing page of one of the pygeoapi instances is shown in Figure 20.

The screenshot shows the landing page of a pygeoapi instance. At the top, there's a header with a logo, a search bar, and a 'Contact' link. Below the header, the title 'pygeoapi Demo instance - running latest GitHub version' is displayed. A sub-header states 'pygeoapi provides an API to geospatial data'. There are three tabs: 'geospatial', 'data', and 'api'. Under the 'data' tab, links to 'Terms of service' and 'License' are shown, both pointing to Creative Commons BY 4.0 license information. The main content area is divided into several sections: 'Collections', 'SpatioTemporal Assets', 'Processes', 'API Definition', 'Conformance', and 'Contact point'. The 'Contact point' section contains detailed information about the provider, address, email, telephone, fax, contact URL, and hours of service.

Figure 20. The landing page of one of the pygeoapi instances

A screenshot of an overview of one of the collections of metadata records offered by one of the pygeoapi instances is shown in [Figure 21](#).

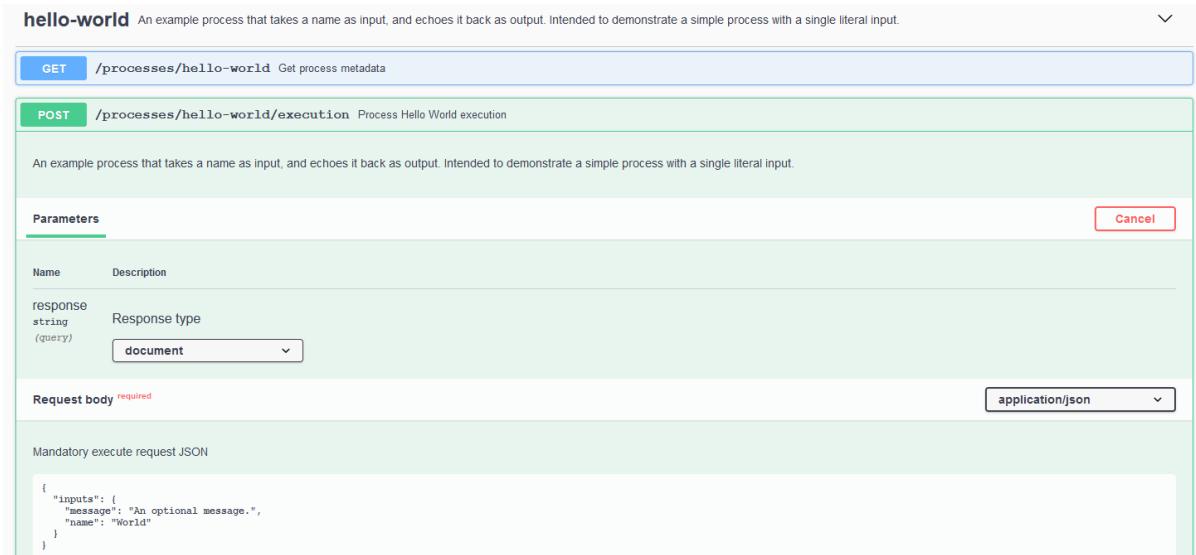
The screenshot shows the collection overview page for 'dutch-metadata'. It features a large map of the Netherlands and surrounding regions. A blue box highlights a specific area on the map. Below the map, there are sections for 'Browse', 'Queryables', and 'Links'. The 'Browse' section lists items from the 'Dutch Nationala georegister'. The 'Queryables' section lists queryables from the same source. The 'Links' section provides various links to the document in different formats. A footer at the bottom indicates the page is powered by pygeoapi 0.11.dev0.

Figure 21. An overview of one of the collections of metadata records offered by one of the pygeoapi instances

7.11.2. Accessing processes

Developers from MSC, OSGeo, GeoCat BV and Geobeyond Srl configured an instance of pygeoapi to enable access to processes through an interface conforming to OGC API - Processes. A screenshot of a rendering of the API definition of one of the processes is shown in [Figure 22](#).

pygeoapi was updated to support the latest changes in the OGC API - Processes specification.



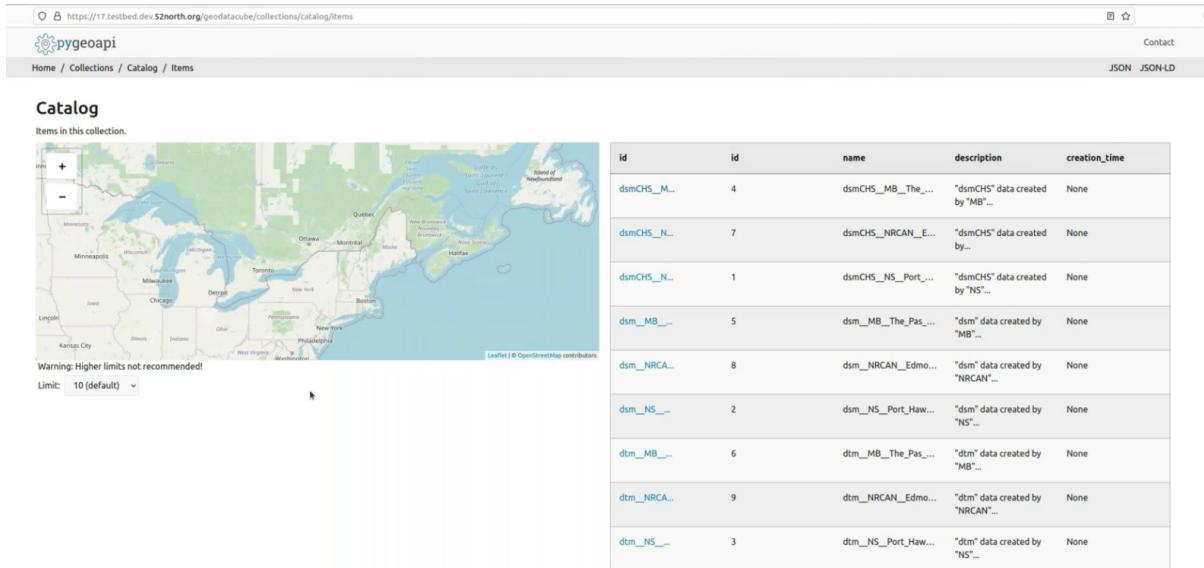
A screenshot of a web-based API documentation interface. At the top, there's a header for a process named "hello-world". Below it, there are two main sections: "GET /processes/hello-world" and "POST /processes/hello-world/execution". The "POST" section is highlighted in green. A detailed description follows, stating: "An example process that takes a name as input, and echoes it back as output. Intended to demonstrate a simple process with a single literal input." Under the heading "Parameters", there's a table with one row. The first column is "Name" and the second is "Description". There's one entry: "response_string (query)" with "Response type" set to "document". Below this is a "Request body" field with the note "required" and a dropdown menu showing "application/json". The "Request body" field contains a JSON object:

```
{ "inputs": { "message": "An optional message.", "name": "World" } }
```

Figure 22. A screenshot of a rendering of the API definition of one of the processes

7.11.3. Accessing coverages

Developers from 52°North configured an instance of pygeoapi to enable access to Data Cubes, initially deployed for Testbed-17. A screenshot of the pygeoapi interface from the 52°North Data Cube demonstration is shown in Figure 23.



A screenshot of a web-based interface for a data cube. At the top, there's a header with the URL "https://17.testbed.dev.52north.org/geodatacube/collections/catalog/items". Below the header, there's a "pygeoapi" logo and navigation links for "Home", "Collections", "Catalog", and "Items". On the right side, there are links for "Contact", "JSON", and "JSON-LD". The main area is titled "Catalog" and shows a map of North America with various data coverage areas. Below the map, there's a warning: "Warning: Higher limits not recommended!" and a dropdown for "Limit: 10 (default)". To the right of the map, there's a table listing data items:

id	id	name	description	creation_time
dsmCHS_M...	4	dsmCHS_MB_The...	"dsmCHS" data created by "MB" ...	None
dsmCHS_N...	7	dsmCHS_NRCAN_E...	"dsmCHS" data created by ...	None
dsmCHS_N...	1	dsmCHS_NS_Port_...	"dsmCHS" data created by "NS" ...	None
dsm_MB_...	5	dsm_MB_The_Pas...	"dsm" data created by "MB" ...	None
dsm_NRCA...	8	dsm_NRCAN_Edm...	"dsm" data created by "NRCA" ...	None
dsm_NS_...	2	dsm_NS_Port_Haw...	"dsm" data created by "NS" ...	None
dtm_MB_...	6	dtm_MB_The_Pas...	"dtm" data created by "MB" ...	None
dtm_NRCA...	9	dtm_NRCAN_Edm...	"dtm" data created by "NRCA" ...	None
dtm_NS_...	3	dtm_NS_Port_Haw...	"dtm" data created by "NS" ...	None

Figure 23. Screenshot of pygeoapi interface from the 52°North Data Cube demonstration

Once coverages from the data cube are published through the pygeoapi, they can be accessed through the OGC API - Coverages interface and displayed on a client application such as QGIS. A coverage displayed using QGIS after download from a data cube is shown in Figure 24.

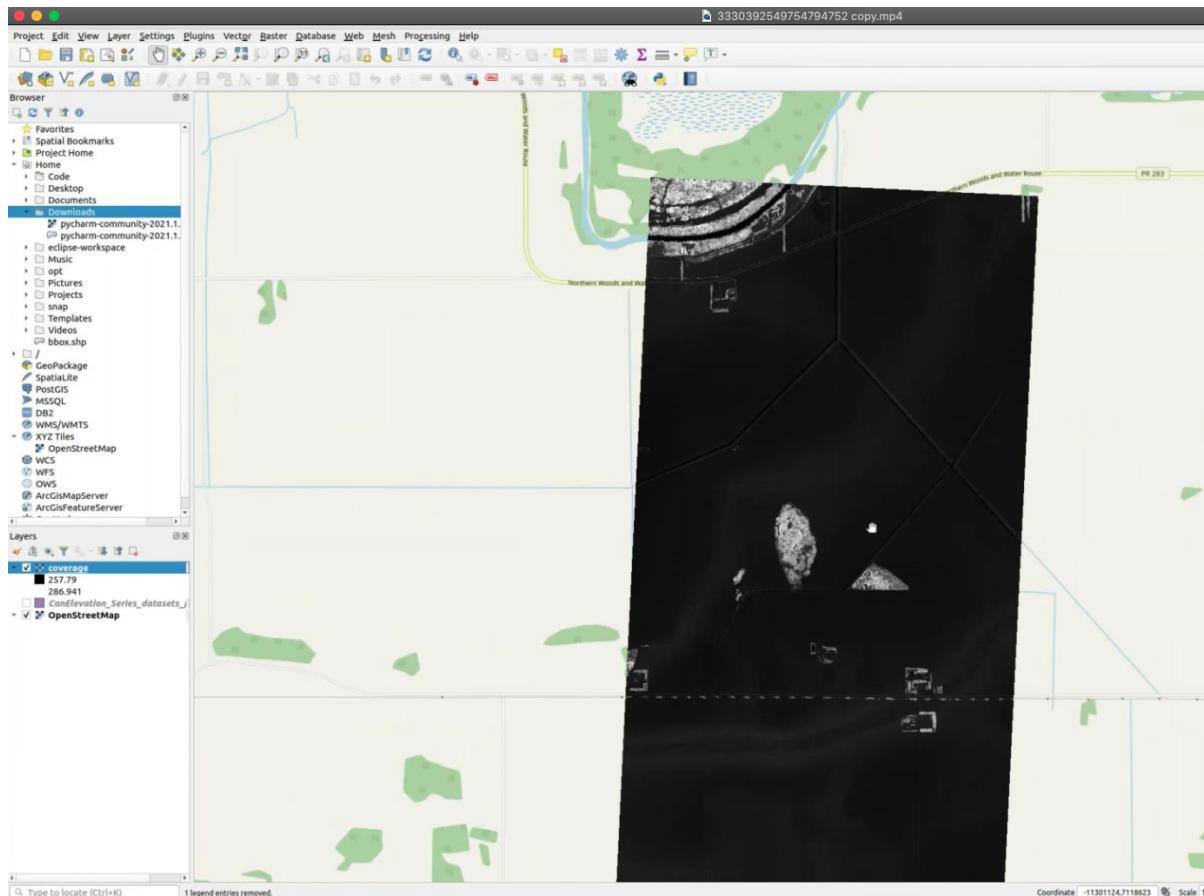


Figure 24. Coverage displayed using QGIS after download from the 52°North Data Cube supplied using pygeoapi

7.12. Other Outputs

Other developments and software deployments during the code sprint are described in the following sections.

7.12.1. Documentation

- A [draft user guide](https://github.com/opengeospatial/ogcapi-code-sprint-2021-07/tree/main/Draft_Spring_Guide_for_OGC_API_Proceses) [https://github.com/opengeospatial/ogcapi-code-sprint-2021-07/tree/main/Draft_Spring_Guide_for_OGC_API_Proceses] was developed for software developers that use the [Spring Framework](https://spring.io/projects/spring-framework) [<https://spring.io/projects/spring-framework>] to build implementation of OGC API - Processes. The Spring Framework is an open source application framework and inversion of control container for the Java Platform. The user guide developed during the code sprint made use of Spring along with OpenAPI Tools Generator.

Chapter 8. Discussion

This sections provides a summary of the discussion.

8.1. Potential relationship between STAC and OGC API - Records

The sprint participants discussed the potential relationship between STAC and OGC API - Records, in order to identify opportunities for alignment. This subsection summarises that discussion.

The sprint participants noted that there had been previous discussions between OGC staff and the STAC community about the possibility of bringing the STAC API into the OGC's standardization process. This was partly because the STAC API is an extension of OGC API - Features - Part 1: Core. The current thinking is to submit STAC into the standardization process as a candidate OGC Community Standard. That would require STAC to be stable, at version 1.0 at least.

Some of the opportunities for alignment between STAC and OGC API - Records are static equivalents for Collections and Records. The sprint participants noted that, in a previous discussion, there was an observation that there is a need for a 'Dataset Record'. A 'Record' would be a flexible and generic concept, whereas a Dataset Record would represent dataset metadata such as in the context of ISO 19115. The grouping would be the Collection. With these concepts in place, it would potentially be possible to have STAC as a Record or an extension of OGC API - Records.

The sprint participants noted that in OGC API - Records, in contrast to STAC, the actual Record description is distinct from the API. The Record description is loosely bound to the API in OGC API - Records, for example, there is no requirement for the record to be encoded in GeoJSON as other encodings (e.g. ATOM) are allowed. The Record is also not bound to a particular dataset or asset. There is an expectation that developers would take the Record and enrich the content to suit specific needs. There was an observation made that it would benefit developers to extract the description of the Record content model and make it more standard-alone on either the specification document as a building block or in an accompanying document such as user guide.

What is the distinction between the STAC Catalog and the STAC Collections specifications? The STAC Catalog is a JSON file of links that provides a structure to organize and browse STAC Items. The STAC Collection is an extension of the STAC Catalog with additional information that describes STAC Items that fall within the Collection. The STAC Catalog specification is therefore less tied to the API. It is just a structured concept that says "this links to more items". If you have millions of records, instead of placing them in a single collection, the catalog lets you break them up in arbitrary ways. The approach is based on OGC API - Features, and so a STAC Collection can be served as a Collection from an OGC API - Features implementation.

The Records API does not do anything different to what the Features API does. That is, the two APIs are consistent. This suggests that the biggest need is for the Dataset Collection, with the

fields in the collection clearly defined. This is necessary because Collection is non-GeoJSON, whereas Record is GeoJSON. They should translate between each other easily. This could, for instance, lead to a static Features API involving a series of files in a Cloud Storage resource. The sprint participants observed that, from a Meteorological perspective, it would be useful to have a static API that provides access to a series of files.

STAC inherits from an OGC API - Features collection, but ideally the preference would be to inherit from a Dataset Collection. So potentially there could be two separate representations of the collection, at different levels of the API hierarchy, using an 'alternate' relation type to provide links to the two different representations. The sprint participants suggested that Part 1 should be more generic and then consider the Dataset Collection for Part 2. Support for datasets should be optional and could be based on ISO 19115-1 metadata. This could then lead to a Part 3 that focuses on STAC. The work on STAC should not start until the Part 1 is stable.

There was also discussion about the structure of the Part 1 document, including whether some conformance classes (e.g. sort by) should be moved to OGC API - Features. This also included consideration of where a section describing the Collection could be placed in OGC API - Records - Part 1: Core. This capability would facilitate the creation of static catalogs. A static catalog would offer value to some user needs. Such a capability could have more utility and wider uptake if included in OGC API - Features, and possibly in the long term it could be part of OGC API - Common. The capability could also be specified in OGC API - Records and still have utility in OGC API - Features. In OGC API - Features, by default, every API implementing the standard will provide access to a single dataset.

8.2. Should OGC API - Records support the OpenSearch Syndication Protocol?

The sprint participants discussed whether OpenSearch Syndication Protocol is still being used and whether it is still relevant. The discussion was in part triggered by the migration of the OpenSearch Syndication Protocol from its previous home of opensearch.org to a personal GitHub repository. OpenSearch is now a registered trademark of Amazon Web Services and [refers](<https://opensearch.org>) to a community-driven, open source search and analytics suite derived from Apache 2.0 licensed Elasticsearch 7.10.2 and Kibana 7.10.2. To disambiguate between the two OpenSearch initiatives, an [explanatory web page](<https://opensearch.org/disambiguation.html>) has been created. The sprint participants also observed that, after supporting the OpenSearch Syndication Protocol for a number of years, the protocol was **no longer supported** [<https://blog.mozilla.org/addons/2019/10/15/search-engine-add-ons-to-be-removed-from-addons-mozilla-org/>] in add-ons of the Mozilla Firefox web browser.

The OpenSearch Syndication Protocol is referenced by a number of OGC Standards, namely **OGC® OpenSearch Geo and Time Extensions (OGC 10-032)** [https://portal.ogc.org/files/?artifact_id=56866], **OGC OpenSearch Extension for Earth Observation (OGC 13-026r9)** [<http://docs.opengeospatial.org/is/13-026r9/13-026r9.html>], **OGC OpenSearch-EO GeoJSON(-LD) Response Encoding Standard (OGC 17-047r1)** [<http://docs.opengeospatial.org/is/17-047r1/17-047r1.html>], and **OGC EO Dataset Metadata GeoJSON(-LD) Encoding Standard (17-003r2)** [<https://docs.ogc.org/is/17-003r2/17-003r2.html>]. The OpenSearch Syndication Protocol works by allowing a client application to be configured

according to an OpenSearch description document which is an XML document that contains standard substitution variables that can be used to create a template. The protocol is actively used in the Earth Observation community, for example, at the European Space Agency (ESA) and the US National Aeronautics and Space Administration (NASA).

The draft OGC API - Records - Part 1: Core standard currently includes a conformance class for the OpenSearch Syndication Protocol. The sprint participants recommended that the conformance class be removed out of the draft OGC API - Records - Part 1: Core standard and be considered for a future extension. Specifying the conformance class in a separate extension would allow the conformance class to be easily deprecated in the future without affecting the rest of OGC API - Records.

8.3. Coverage Processing in OGC API - Processes

There was a discussion to explore whether a new language could be developed to support the analysis of coverages in implementations of OGC API - Processes. Such a language would address similar needs to those addressed by the Web Coverage Processing Service (WCPS). There was concern that WCPS could be too complex to use, hence the need for a simpler alternative. Having a simpler alternative would allow client applications to specify the language that they are using in a request. The sprint participants noted that currently several products use raster algebra to support analysis and filtering, however, the products do not appear to share a common language for expressing the raster algebra.

The sprint participants expressed an interest in having a consistent syntax for expressions. The new language or syntax for describing coverage analysis would need to be able to access information about the coverage at multiple levels e.g. at coverage level, band level and at pixel level. The expressivity of the language was therefore identified as a key consideration, on a simplicity spectrum, a single link expression would be the easiest to implement but would be limited in its ability to express analysis. In contrast, a procedural language would be more expressive and allow the description of more complex analysis.

8.4. Supporting ISO 19115-1:2014 and ISO 19115:2003 in OGC API - Records

There are also several organizations that have established infrastructure that relies on ISO 19115-1:2014, [ISO 19115:2003](https://www.iso.org/standard/26020.html) [<https://www.iso.org/standard/26020.html>] and their profiles. Examples of profiles of ISO 19115-1:2014 include [NSG Metadata Foundation \(NMF\)](https://gwg.nga.mil/documents/NMF_v1_final.doc) [https://gwg.nga.mil/documents/NMF_v1_final.doc] and [DGIWG Metadata Foundation \(DMF\)](https://portal.dgiwg.org/files/67565) [<https://portal.dgiwg.org/files/67565>]. Examples of profiles of ISO 19115:2003 include the [INSPIRE Metadata Implementing Rules](https://inspire.ec.europa.eu/documents/inspire-metadata-implementing-rules-technical-guidelines-based-en-iso-19115-and-en-iso-1) [<https://inspire.ec.europa.eu/documents/inspire-metadata-implementing-rules-technical-guidelines-based-en-iso-19115-and-en-iso-1>] and [ANZLIC Metadata Profile](https://www.anzlic.gov.au/sites/default/files/files/anzlic_metadata_profile_v1_1.pdf) [https://www.anzlic.gov.au/sites/default/files/files/anzlic_metadata_profile_v1_1.pdf]. The sprint participants noted that one of the challenges of the OGC API - Records SWG will be to design the API in such a way that allows for the publication of metadata encoded according to ISO 19115-1 or its profiles.

The sprint participants confirmed that OGC API - Records can return records representing

metadata fields from ISO 19115-1:2014, which are encoded according to the schemas specified in [ISO/TS 19115-3:2016](https://www.iso.org/standard/32579.html) [<https://www.iso.org/standard/32579.html>]. Similarly, OGC API - Records can return records representing metadata fields from ISO 19115:2003, which are encoded according to the schemas specified in [ISO/TS 19139:2007](https://www.iso.org/standard/32557.html) [<https://www.iso.org/standard/32557.html>]. This is achieved through Content Negotiation. For example, the following GET request retrieves a JSON encoded metadata record from a pycsw instance deployed for the EO Exploitation Platform Common Architecture (EOEPCA). The response is as shown in [Example Support of JSON encoded Metadata in OGC API - Records](#).

https://resource-catalogue.demo.eoepca.org/collections/metadata:main/items/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE?f=json

The same metadata record can be retrieved encoded in XML conforming to ISO 19115-3 through the request below. The response is as shown in [Example Support of ISO 19115-3 encoded Metadata in OGC API - Records](#).

https://resource-catalogue.demo.eoepca.org/collections/metadata:main/items/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE?f=xml

The examples above highlight that one of the reasons why the Records API has a Record model is to allow an implementation of OGC API - Records to query across any metadata standard that can be mapped to the Record model. If a data publisher has a catalogue that is based on ISO 19115-3, then all they need to do is to map their schema to the model in OGC API - Records. Another option is to make a mapping between ISO to the Record model in OGC API - Records. An example of such a mapping was developed during the code sprint and is available on the sprint's [GitHub repository](#) [https://github.com/opengeospatial/ogcapi-code-sprint-2021-07/blob/main/mappings/ISO19115-3_Mappings.md] and is also presented in [Appendix B](#). As the example listings shown above indicate, there is a need to specify which XML profile to retrieve the metadata in. This is something that could be proposed as a new conformance class in a new OGC API - Records extension or profile standard. The Content Negotiation mechanism would be designed to allow the use of the [profile](#) mechanism in media types or a [schema](#) query parameter to identify the schema to use.

8.5. Lessons Learnt

Towards the end of the sprint, participants held a discussion on the lessons learnt from the initiative. A summary of the lessons identified by the sprint participants is presented below:

- RecordsAPI: The relationship with STAC was clarified in this sprint. The direction of the RecordsAPI is aligning more with STAC.
- RecordsAPI: Crosswalk aligned ISO 19115-3 with the OGC Record.
- There may be a little bit of work to do in aligning satellite imagery support between RecordsAPI and STAC.
- Clarity on what it means to have an ISO 19115 conformance class in OGC API - Records.

- The change with OpenSearch.org introduces challenges in terms of usage/licence. Will mean change requests for existing OGC OpenSearch standards.
- OpenSearch is still an active thing in OGC. It will be placed in an extension of OGC API - Records and not the Core.
- OGC Member Meeting in September 2021 (Metadata Adhoc) will have a session on tackling metadata issues. It's linked to the Singapore Geo Festival.
- Lots of implementations of OGC API - Processes provides confidence that it works.
- The Spring work will help develop Guides.
- OGC API - Processes is sufficiently different from WPS
- The use of JSON Schema to describe inputs and outputs is going to be great for uptake.
- There is an increasing need for Best Practices and Profiles. e.g. Routing, Maps, NDVI, ...
- OGC API - Processes weather toolbox (we're starting to think about this in MetOceanDWG)

Chapter 9. Conclusions

The code sprint successfully met all of its objectives and achieved its goal of progressing the development of the OGC API - Processes draft standard, OGC API - Records draft standard, and the OGC API – Coverages draft standard. There were no issues found on the Processes API, which helped to validate the maturity and stability of the API. Discussion about the Records API helped to improve understanding of the potential relationship to other related specifications (e.g. STAC and ISO 19115). Issues raised relating to the Coverages API, were focused around clarification, thereby identifying areas where the documentation could be improved. The sprint participants demonstrated that the OGC API pattern can effectively address the needs of communities that use, process and analyze geospatial data.

9.1. Future work

The following general recommendations for future work items were made during the sprint.

9.1.1. Ideas for the Innovation Program

Future work in Innovation Program could include:

- Development of Developer Guides (e.g. Spring, Python, Node.js etc), including around toolchains
- Some experimentation on Workflows (OGC API - Processes - Part 3), covering chaining
- The filtering and coverage processing. Filtering at the metadata level and at the coverage cell value level
- GeoDataClass (aka StylistableLayerSet) concept in relation to discovering Processes & Data that can be used together, including in the context of Workflows
- Some along the workflow of a search process (e.g. ISO 19115, STAC, etc).

9.1.2. Ideas for the Standards Program

Future work in the Standards Program could include:

- ETS of OGC API - Coverages, Records
- Merge the work done on the openapi schema for the Coverages API
- Transactions on OGC API - Processes (Part 2)
- OGC API - Processes - Part 3: Workflows & Chaining

Appendix A: Supporting Different Metadata Encodings in OGC API - Records

A.1. Example Support of JSON encoded Metadata in OGC API - Records

The following GET request retrieves a JSON encoded metadata record from a pycsw instance deployed for the EOEPKA.

https://resource-catalogue.demo.eoepca.org/collections/metadata:main/items/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE?f=json

The response is as shown below.

```
{  
  "id": "S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE",  
  "type": "Feature",  
  "geometry": {  
    "type": "Polygon",  
    "coordinates": [  
      [  
        [  
          [19.88,  
           36.06  
         ],  
         [  
           [19.88,  
            37.04  
         ],  
         [  
           [21.11,  
            37.04  
         ],  
         [  
           [21.11,  
            36.06  
         ],  
         [  
           [19.88,  
            36.06  
         ]  
       ]  
     ]  
   ]  
 },  
 }},
```

```

"properties": {
    "externalId": "S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE",
    "recordUpdated": "2021-04-19T13:34:16Z",
    "type": "dataset",
    "created": "2020-09-30T10:57:31.000000Z",
    "updated": "2020-09-30T10:57:31.000000Z",
    "title": "S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE",
    "description": "S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE",
    "keywords": [
        "Orthoimagery",
        "Land cover",
        "Geographical names",
        "data set series",
        "processing",
        "eo:productType:/",
        "eo:orbitNumber:/",
        "eo:orbitDirection:/",
        "eo:processingLevel:Level-1C"
    ],
    "extents": {
        "spatial": {
            "bbox": [
                [
                    19.88,
                    36.06,
                    21.11,
                    37.04
                ]
            ],
            "crs": "http://www.opengis.net/def/crs/OGC/1.3/CRS84"
        }
    }
},
"associations": [
{
    "href": "s3://EODATA/Sentinel-2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE/",
    "name": "product",
    "description": "product",
    "type": "enclosure"
},
{
    "href": "s3://EODATA/Sentinel-2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE/"
}
]
}

```

```
2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
T092031_B01.jp2",
    "name": "granule",
    "description": "granule",
    "type": "image/jp2"
},
{
    "href": "s3://EODATA/Sentinel-
2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
T092031_B02.jp2",
    "name": "granule",
    "description": "granule",
    "type": "image/jp2"
},
{
    "href": "s3://EODATA/Sentinel-
2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
T092031_B03.jp2",
    "name": "granule",
    "description": "granule",
    "type": "image/jp2"
},
{
    "href": "s3://EODATA/Sentinel-
2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
T092031_B04.jp2",
    "name": "granule",
    "description": "granule",
    "type": "image/jp2"
},
{
    "href": "s3://EODATA/Sentinel-
2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
T092031_B05.jp2",
    "name": "granule",
    "description": "granule",
    "type": "image/jp2"
},
{
    "href": "s3://EODATA/Sentinel-
2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
```

```
T092031_B06.jp2",
  "name": "granule",
  "description": "granule",
  "type": "image/jp2"
},
{
  "href": "s3://EODATA/Sentinel-
2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
T092031_B07.jp2",
  "name": "granule",
  "description": "granule",
  "type": "image/jp2"
},
{
  "href": "s3://EODATA/Sentinel-
2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
T092031_B08.jp2",
  "name": "granule",
  "description": "granule",
  "type": "image/jp2"
},
{
  "href": "s3://EODATA/Sentinel-
2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
T092031_B08A.jp2",
  "name": "granule",
  "description": "granule",
  "type": "image/jp2"
},
{
  "href": "s3://EODATA/Sentinel-
2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
T092031_B09.jp2",
  "name": "granule",
  "description": "granule",
  "type": "image/jp2"
},
{
  "href": "s3://EODATA/Sentinel-
2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
T092031_B10.jp2",
  "name": "granule",

```

```

    "description": "granule",
    "type": "image/jp2"
},
{
    "href": "s3://EODATA/Sentinel-
2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
T092031_B11.jp2",
    "name": "granule",
    "description": "granule",
    "type": "image/jp2"
},
{
    "href": "s3://EODATA/Sentinel-
2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
T092031_B12.jp2",
    "name": "granule",
    "description": "granule",
    "type": "image/jp2"
},
{
    "href": "s3://EODATA/Sentinel-
2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
T092031_TCI.jp2",
    "name": "granule",
    "description": "granule",
    "type": "image/jp2"
},
{
    "href": "https://data-
access.demo.eoepca.org/ows?service=WMS&version=1.3.0&request=GetCapabilities&
cql=identifier%3D%22S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105
731.SAFE%22",
    "name":
"S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE",
    "description": "WMS URL for
S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE",
    "type": "OGC:WMS"
},
{
    "href": "https://data-
access.demo.eoepca.org/ows?service=WCS&version=2.0.1&request=DescribeEOCovera
geSet&eoid=S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE"
,
    "name":

```

```

    "S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE",
      "description": "WCS URL for
    S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE",
      "type": "OGC:WCS"
    }
  ]
}

```

A.2. Example Support of ISO 19115-3 encoded Metadata in OGC API - Records

The same metadata record can be retrieved encoded in XML conforming to ISO 19115-3 through the request below:

https://resource-catalogue.demo.eoepca.org/collections/metadata:main/items/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T105731.SAFE?f=xml

The response is as shown below.

```

<gmi:MI_Metadata xmlns:gco="http://www.isotc211.org/2005/gco" xmlns:gmd=
"http://www.isotc211.org/2005/gmd" xmlns:gmi=
"http://www.isotc211.org/2005/gmi" xmlns:gml="http://www.opengis.net/gml"
xmlns:gmx="http://www.isotc211.org/2005/gmx" xmlns:xlink=
"http://www.w3.org/1999/xlink" xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xsi:schemaLocation="http://www.isotc211.org/2005/gmd
http://www.isotc211.org/2005/gmd/gmd.xsd http://www.isotc211.org/2005/gmx
http://www.isotc211.org/2005/gmx/gmx.xsd http://www.isotc211.org/2005/gmi
http://www.isotc211.org/2005/gmx/gmi.xsd">
  <gmd:fileIdentifier>

<gco:CharacterString>S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE</gco:CharacterString>
  </gmd:fileIdentifier>
  <gmd:language>
    <gmd:LanguageCode codeList="http://www.loc.gov/standards/iso639-2/"
codeSpace="ISO 639-2" codeListValue="eng">eng</gmd:LanguageCode>
  </gmd:language>
  <gmd:characterSet>
    <gmd:MD_CharacterSetCode codeList=
"http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_Characte
rSetCode" codeSpace="ISOTC211/19115" codeListValue="utf8">
    utf8</gmd:MD_CharacterSetCode>
  </gmd:characterSet>
  <gmd:parentIdentifier>

```

```

<gco:CharacterString>S2MSI1C</gco:CharacterString>
</gmd:parentIdentifier>
<gmd:hierarchyLevel>
  <gmd:MD_ScopeCode codeList=
"http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_ScopeCod
e" codeSpace="ISOTC211/19115" codeListValue="dataset">
dataset</gmd:MD_ScopeCode>
  </gmd:hierarchyLevel>
<gmd:contact>
  <gmd:CI_ResponsibleParty id="contact-pointOfContact">
    <gmd:contactInfo>
      <gmd:CI_Contact>
        <gmd:phone>
          <gmd:CI_Telephone>
            <gmd:voice gco:nilReason="missing"/>
            <gmd:facsimile gco:nilReason="missing"/>
          </gmd:CI_Telephone>
        </gmd:phone>
        <gmd:address>
          <gmd:CI_Address>
            <gmd:postalCode>
              <gco:CharacterString/>
            </gmd:postalCode>
          </gmd:CI_Address>
        </gmd:address>
        <gmd:onlineResource>
          <gmd:CI_OnlineResource>
            <gmd:linkage>
              <gmd:URL/>
            </gmd:linkage>
            <gmd:protocol>
              <gco:CharacterString>WWW:LINK</gco:CharacterString>
            </gmd:protocol>
            <gmd:function>
              <gmd:CI_OnLineFunctionCode codeList=
"http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_OnLineFu
nctionCode" codeListValue="information" codeSpace="ISOTC211/19115">
information</gmd:CI_OnLineFunctionCode>
              </gmd:function>
            </gmd:CI_OnlineResource>
          </gmd:onlineResource>
        </gmd:CI_Contact>
      </gmd:contactInfo>
      <gmd:role>
        <gmd:CI_RoleCode codeList=
"http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_RoleCode
" codeSpace="ISOTC211/19115" codeListValue="pointOfContact">

```

```

pointOfContact</gmd:CI_RoleCode>
    </gmd:role>
    </gmd:CI_ResponsibleParty>
</gmd:contact>
<gmd:dateStamp>
    <gco:DateTime>2020-09-30T10:57:31.00000Z</gco:DateTime>
</gmd:dateStamp>
<gmd:metadataStandardName>
    <gco:CharacterString>ISO 19115:2003 - Geographic information -
Metadata</gco:CharacterString>
    </gmd:metadataStandardName>
<gmd:metadataStandardVersion>
    <gco:CharacterString>ISO 19115:2003</gco:CharacterString>
</gmd:metadataStandardVersion>
<gmd:dataSetURI>
    <gco:CharacterString/>
</gmd:dataSetURI>
<gmd:spatialRepresentationInfo>
</gmd:spatialRepresentationInfo>
<gmd:referenceSystemInfo>
    <gmd:MD_ReferenceSystem>
        <gmd:referenceSystemIdentifier>
            <gmd:RS_Identifier>
                <gmd:authority>
                    <gmd:CI_Citation>
                        <gmd:title>
                            <gco:CharacterString>European Petroleum Survey Group (EPSG)
Geodetic Parameter Registry</gco:CharacterString>
                        </gmd:title>
                        <gmd:date>
                            <gmd:CI_Date>
                                <gmd:date>
                                    <gco:Date>2008-11-12</gco:Date>
                                </gmd:date>
                                <gmd:dateType>
                                    <gmd:CI_DateTypeCode codeList=
"mailto://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateType
Code" codeSpace="ISOTC211/19115" codeListValue="publication">
publication</gmd:CI_DateTypeCode>
                                    </gmd:dateType>
                                    <gmd:CI_Date>
                                </gmd:date>
                                <gmd:citedResponsibleParty>
                                    <gmd:CI_ResponsibleParty>
                                        <gmd:organisationName>
                                            <gco:CharacterString>European Petroleum Survey
Group</gco:CharacterString>

```

```
</gmd:organisationName>
<gmd:contactInfo>
  <gmd:CI_Contact>
    <gmd:onlineResource>
      <gmd:CI_OnlineResource>
        <gmd:linkage>
          <gmd:URL>http://www.epsg-registry.org</gmd:URL>
        </gmd:linkage>
      </gmd:CI_OnlineResource>
    </gmd:onlineResource>
  </gmd:CI_Contact>
</gmd:contactInfo>
<gmd:role>
  <gmd:CI_RoleCode codeList=
"urn:ogc:def:crs:EPSG:4326"
  "codeSpace="ISOTC211/19115" codeListValue="originator">
originator</gmd:CI_RoleCode>
  </gmd:role>
  </gmd:CI_Responsibility>
  </gmd:citedResponsibleParty>
  </gmd:CI_Citation>
</gmd:authority>
<gmd:code>
  <gco:CharacterString>
urn:ogc:def:crs:EPSG:4326</gco:CharacterString>
  </gmd:code>
<gmd:version>
  <gco:CharacterString>6.18.3</gco:CharacterString>
</gmd:version>
</gmd:RS_Identifier>
</gmd:referenceSystemIdentifier>
</gmd:MD_ReferenceSystem>
</gmd:referenceSystemInfo>
<gmd:identificationInfo>
  <gmd:MD_DataIdentification>
    <gmd:citation>
      <gmd:CI_Citation>
        <gmd:title>
<gco:CharacterString>S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE</gco:CharacterString>
        </gmd:title>
        <gmd:date>
          <gmd:CI_Date>
            <gmd:date>
              <gco:DateTime>2020-09-30T10:57:31.000000Z</gco:DateTime>
            </gmd:date>
```

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<gmd:dateType>
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"http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateType
Code" codeSpace="ISOTC211/19115" codeListValue="creation">
creation</gmd:CI_DateTypeCode>
    </gmd:dateType>
    </gmd:CI_Date>
</gmd:date>
<gmd:date>
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        <gmd:date>
            <gco:DateTime>2020-09-30T10:57:31.000000Z</gco:DateTime>
        </gmd:date>
    <gmd:dateType>
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"http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateType
Code" codeSpace="ISOTC211/19115" codeListValue="publication">
publication</gmd:CI_DateTypeCode>
        </gmd:dateType>
        </gmd:CI_Date>
    </gmd:date>
    </gmd:CI_Citation>
</gmd:citation>
<gmd:abstract>

<gco:CharacterString>S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE</gco:CharacterString>
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<gmd:status>
    <gmd:MD_ProgressCode codeList=
"http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_Progress
Code" codeSpace="ISOTC211/19115" codeListValue="onGoing">
onGoing</gmd:MD_ProgressCode>
    </gmd:status>
<gmd:resourceMaintenance>
    <gmd:MD_MaintenanceInformation>
        <gmd:maintenanceAndUpdateFrequency>
            <gmd:MD_MaintenanceFrequencyCode codeList=
"http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_Maintena
nceFrequencyCode" codeSpace="ISOTC211/19115" codeListValue="continual">
continual</gmd:MD_MaintenanceFrequencyCode>
            </gmd:maintenanceAndUpdateFrequency>
        </gmd:MD_MaintenanceInformation>
    </gmd:resourceMaintenance>
<gmd:descriptiveKeywords>
    <gmd:MD_Keywords>
        <gmd:keyword>

```

```

<gco:CharacterString>Orthoimagery</gco:CharacterString>
</gmd:keyword>
<gmd:keyword>
    <gco:CharacterString>Land cover</gco:CharacterString>
</gmd:keyword>
<gmd:keyword>
    <gco:CharacterString>Geographical names</gco:CharacterString>
</gmd:keyword>
<gmd:type>
    <gmd:MD_KeywordTypeCode codeList=
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ypeCode" codeSpace="ISOTC211/19115" codeListValue="theme">
theme</gmd:MD_KeywordTypeCode>
    </gmd:type>
    </gmd:MD_Keywords>
</gmd:descriptiveKeywords>
<gmd:descriptiveKeywords>
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        </gmd:keyword>
        <gmd:type>
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ypeCode" codeSpace="ISOTC211/19115" codeListValue="theme">
theme</gmd:MD_KeywordTypeCode>
            </gmd:type>
            </gmd:MD_Keywords>
</gmd:descriptiveKeywords>
<gmd:descriptiveKeywords>
    <gmd:MD_Keywords>
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        </gmd:keyword>
        <gmd:type>
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ypeCode" codeSpace="ISOTC211/19115" codeListValue="theme">
theme</gmd:MD_KeywordTypeCode>
            </gmd:type>
            </gmd:MD_Keywords>
</gmd:descriptiveKeywords>
<gmd:descriptiveKeywords>
    <gmd:MD_Keywords>
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        </gmd:keyword>

```

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</gmd:keyword>
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    <gco:CharacterString>eo:orbitDirection:/</gco:CharacterString>
</gmd:keyword>
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ypeCode" codeSpace="ISOTC211/19115" codeListValue="theme">
theme</gmd:MD_KeywordTypeCode>
    </gmd:type>
    </gmd:MD_Keywords>
</gmd:descriptiveKeywords>
<gmd:resourceConstraints>
    <gmd:MD_LegalConstraints>
        <gmd:accessConstraints>
            <gmd:MD_RestrictionCode codeList=
"http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_Restrict
ionCode" codeSpace="ISOTC211/19115" codeListValue="otherRestrictions">
otherRestrictions</gmd:MD_RestrictionCode>
            </gmd:accessConstraints>
            </gmd:MD_LegalConstraints>
        </gmd:resourceConstraints>
        <gmd:spatialRepresentationType>
            <gmd:MD_SpatialRepresentationTypeCode codeList=
"http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_SpatialR
epresentationTypeCode" codeSpace="ISOTC211/19115" codeListValue="grid">
grid</gmd:MD_SpatialRepresentationTypeCode>
            </gmd:spatialRepresentationType>
            <gmd:language gco:nilReason="missing"/>
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rSetCode" codeSpace="ISOTC211/19115" codeListValue="utf8">
utf8</gmd:MD_CharacterSetCode>
                </gmd:characterSet>
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                    <gmd:MD_TopicCategoryCode>
imageryBaseMapsEarthCover</gmd:MD_TopicCategoryCode>
                    </gmd:topicCategory>
                    <gmd:extent>
                        <gmd:EX_Extent>
                            <gmd:geographicElement>
                                <gmd:EX_GeographicBoundingBox>
                                    <gmd:extentTypeCode>
                                        <gco:Boolean>1</gco:Boolean>

```

```

        </gmd:extentTypeCode>
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        <gmd:eastBoundLongitude>
            <gco:Decimal>21.108368457453107</gco:Decimal>
        </gmd:eastBoundLongitude>
        <gmd:southBoundLatitude>
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        </gmd:southBoundLatitude>
        <gmd:northBoundLatitude>
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        </gmd:northBoundLatitude>
    </gmd:EX_GeographicBoundingBox>
</gmd:geographicElement>
<gmd:temporalElement>
    <gmd:EX_TemporalExtent>
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30T09:20:31.024Z</gml:beginPosition>
                    <gml:endPosition>2020-09-30T09:20:31.024Z</gml:endPosition>
                </gml:TimePeriod>
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        </gmd:attributeDescription>
        <gmd:contentType>
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e" codeSpace="ISOTC211/19115" codeListValue="image">
image</gmd:MD_CoverageContentTypeCode>
        </gmd:contentType>
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                </gmd:maxValue>
                <gmd:minValue>

```

```

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    </gmd:minValue>
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        </gml:UnitDefinition>
    </gmd:units>
    </gmd:MD_Band>
</gmd:dimension>
<gmd:dimension>
    <gmd:MD_Band id="B2">
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            <gco:Real>456</gco:Real>
        </gmd:maxValue>
        <gmd:minValue>
            <gco:Real>412</gco:Real>
        </gmd:minValue>
        <gmd:units>
            <gml:UnitDefinition gml:id="units-2">
                <gml:identifier codeSpace="none">nm</gml:identifier>
            </gml:UnitDefinition>
        </gmd:units>
        </gmd:MD_Band>
    </gmd:dimension>
<gmd:dimension>
    <gmd:MD_Band id="B3">
        <gmd:maxValue>
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        </gmd:maxValue>
        <gmd:minValue>
            <gco:Real>412</gco:Real>
        </gmd:minValue>
        <gmd:units>
            <gml:UnitDefinition gml:id="units-3">
                <gml:identifier codeSpace="none">nm</gml:identifier>
            </gml:UnitDefinition>
        </gmd:units>
        </gmd:MD_Band>
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<gmd:dimension>
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        </gmd:minValue>

```

```

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<gmd:dimension>
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    </gmd:minValue>
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      </gml:UnitDefinition>
    </gmd:units>
  </gmd:MD_Band>
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<gmd:dimension>
  <gmd:MD_Band id="B6">
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      <gco:Real>412</gco:Real>
    </gmd:minValue>
    <gmd:units>
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      </gml:UnitDefinition>
    </gmd:units>
  </gmd:MD_Band>
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<gmd:dimension>
  <gmd:MD_Band id="B7">
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    <gmd:minValue>
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    </gmd:minValue>
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```

```

        <gml:identifier codeSpace="none">nm</gml:identifier>
    </gml:UnitDefinition>
</gmd:units>
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<gmd:minValue>
<gco:Real>412</gco:Real>
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</gmd:units>
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<gmd:minValue>
<gco:Real>412</gco:Real>
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<gmd:units>
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</gml:UnitDefinition>

```

```

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        </gmd:minValue>
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            </gml:UnitDefinition>
        </gmd:units>
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</gmd:dimension>
<gmd:dimension>
    <gmd:MD_Band id="B11">
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        </gmd:minValue>
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            </gml:UnitDefinition>
        </gmd:units>
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</gmd:dimension>
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        </gmd:maxValue>
        <gmd:minValue>
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        </gmd:minValue>
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            </gml:UnitDefinition>
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    </gmd:MD_Band>

```

```

</gmd:dimension>
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    <gmd:code>
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    </gmd:code>
  </gmd:RS_Identifier>
</gmd:processingLevelCode>
</gmd:MD_ImageDescription>
</gmd:contentInfo>
<gmd:distributionInfo>
  <gmd:MD_Distribution>
    <gmd:distributor>
      <gmd:MD_Distributor>
        <gmd:distributorContact>
          <gmd:CI_ResponsibleParty id="contact-distributor">
            <gmd:contactInfo>
              <gmd:CI_Contact>
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                  <gmd:CI_Telephone>
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                    <gmd:facsimile gco:nilReason="missing"/>
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                </gmd:phone>
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                    <gmd:postalCode>
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                    <gmd:linkage>
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                      >information</gmd:CI_OnLineFunctionCode>

```

```

        </gmd:function>
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        </gmd:onlineResource>
        </gmd:CI_Contact>
        </gmd:contactInfo>
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            <gmd:CI_RoleCode codeList=
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" codeSpace="ISOTC211/19115" codeListValue="distributor">
distributor</gmd:CI_RoleCode>
            </gmd:role>
            <gmd:CI_ResponsibleParty>
                </gmd:distributorContact>
            </gmd:MD_Distributor>
        </gmd:distributor>
        <gmd:transferOptions>
            <gmd:MD_DigitalTransferOptions>
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                            <gmd:URL>s3://EODATA/Sentinel-
2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/</gmd:URL>
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                    </gmd:description>
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download</gmd:CI_OnLineFunctionCode>
                        </gmd:function>
                    </gmd:CI_OnlineResource>
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                        <gmd:linkage>
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2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930

```

```

T092031_B01.jp2</gmd:URL>
    </gmd:linkage>
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download</gmd:CI_OnLineFunctionCode>
        </gmd:function>
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    </gmd:onLine>
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        <gmd:CI_OnlineResource>
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2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
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                </gmd:description>
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download</gmd:CI_OnLineFunctionCode>
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                    <gmd:CI_OnlineResource>
                        <gmd:linkage>

```

```

<gmd:URL>s3://EODATA/Sentinel-
2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
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            download</gmd:CI_OnLineFunctionCode>
        </gmd:function>
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2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
T092031_B04.jp2</gmd:URL>
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            </gmd:description>
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                </gmd:function>
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        </gmd:onLine>
    </gmd:CI_OnlineResource>
</gmd:CI_OnlineResource>

```

```

<gmd:onLine>
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2/MSI/L1C/2020/09/30/S2A_MSIL1C_20200930T092031_N0209_R093_T34SDF_20200930T10
5731.SAFE/GRANULE/L1C_T34SDF_A027546_20200930T092345/IMG_DATA/T34SDF_20200930
T092031_B05.jp2</gmd:URL>
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Appendix B: Mappings from OGC API - Records Queryables to ISO 19115-3

Queryables	Obligation	Description	ISO 19115-1 (for dataset metadata)	ISO Obligation	ISO Definition	Notes
recordId	M	A unique record identifier assigned by the server.	//mdb:MD_Metadata /mcc:MD_Id entifier	M	Unique identifier for the metadata record	
recordCreated	O	The date this record was created in the server.	//mdb:MD_Metadata /mdb:dateIn fo /cit:CI_Date /cit:date --With-- /cit:dateType /cit:CI_Date TypeCode @codeListValue="creation"	M	date(s) associated with the metadata NOTE Creation date must be provided, others can also be provided	
recordUpdated	O	The most recent date on which the record was changed.	//mdb:MD_Metadata /mdb:dateIn fo /cit:CI_Date /cit:date --With-- /cit:dateType /cit:CI_Date TypeCode @codeListValue="lastUpdate"	O	date(s) associated with the metadata NOTE Creation date must be provided, others can also be provided	

Queryables	Obligation	Description	ISO 19115-1 (for dataset metadata)	ISO Obligation	ISO Definition	Notes
links	O	A list of links for navigating the API.	For link to self For link to alternate source - For link to parent -	type	M	The nature or genre of the resource.
//mdb:MD_Metadata /mdb:metadataScope /mdb:MD_MetadataScope /mdb:resourceScope	M	the scope/type of resource for which metadata is provided. From codelist - MD_ScopeCode		title	M	A human-readable name given to the resource.
//mdb:MD_Metadata /mdb:identificationInfo /mri:citation /cit:CI_Citation /cit:title	M	name by which the cited resource is known		description	O	A free-text description of the resource.
//mdb:MD_Metadata /mdb:identificationInfo /mri:MD_DatalIdentification /mri:citation /cit:CI_Citation /cit:abstract	M	brief narrative summary of the resource		keywords	O	A list of keywords or tag associated with the resource.

Queryables	Obligation	Description	ISO 19115-1 (for dataset metadata)	ISO Obligation	ISO Definition	Notes
//mdb:MD_Metadata /mdb:identificationInfo /mri:MD_Datalidentification on /mri:descriptiveKeywords /mri:MD_Ke ywords /mri:keywor d	O	commonly used word(s) or formalised word(s) or phrase(s) used to describe the subject		keywordsCo despace	O	A reference to a controlled vocabulary used for the keywords property.
//mdb:MD_Metadata /mdb:identificationInfo /mri:MD_Datalidentification on /mri:descriptiveKeywords /mri:MD_Ke ywords /mri:thesaur usName	O	name of the formally registered thesaurus or a similar authoritative source of keywords		language	O	This refers to the natural language used for textual values.
For the record- /mdb:defaultLocale For the resource- /mdb:identificationInfo /mri:MD_Datalidentification on /mdb:defaultLocale	O	language and character set used for documenting metadata Or language and character set used within the resource	Is this for the record or the resource?	externalId	O	An identifier for the resource assigned by an external entity.

Queryables	Obligation	Description	ISO 19115-1 (for dataset metadata)	ISO Obligation	ISO Definition	Notes
//mdb:MD_Metadata /mdb:identificationInfo /mri:MD_Datalocation /mri:citation /cit:CI_Citation /cit:identifier	O	value uniquely identifying an object within a namespace	Part of the CI_Citation class. Used in multiple locations	updated	O	The more recent date on which the resource was changed.
//mdb:MD_Metadata /mdb:identificationInfo /mri:MD_Datalocation /mri:citation /cit:CI_Citation /cit:date --With-- /cit:dateType /cit:CI_Date TypeCode @codeListValue="lastUpdate"	O	reference date for the cited resource		publisher	O	The entity making the resource available.

Queryables	Obligation	Description	ISO 19115-1 (for dataset metadata)	ISO Obligation	ISO Definition	Notes
//mdb:MD_Metadata /mdb:identificationInfo /mri:MD_Datalocation /mri:pointOfContact --With-- /cit:role /CI_RoleCode @codeListValue="publisher" —And/Or— /mdb:distributionInfo /mrd:MD_Disribution /mrd:disributor /mrd:MD_Disributor /mrd:disributorContact	O		At least 3 possible locations. Could also be captured under dataset citation citedResponsibleParty	themes	O	A knowledge orgnaization system used to classify the resource.
//mdb:MD_Metadata /mdb:identificationInfo /mri:MD_Datalocation /mri:topicCategory	O	main theme(s) of the resource from enumeration “MD_TopicCategoryCode”		formats	O	A list of available distributions for the resource.

Queryables	Obligation	Description	ISO 19115-1 (for dataset metadata)	ISO Obligation	ISO Definition	Notes
//mdb:MD_Metadata /mdb:distributionInfo /mrd:MD_Distribution /mrd:MD_Format	O	description of the computer language construct that specifies the representation of data objects in a record, file, message, storage device or transmission channel		contactPoint	O	An entity to contact about the resource.
//mdb:MD_Metadata /mdb:identificationInfo /mri:MD_DataIdentification /mri:pointOfContact --With-- /cit:role /CI_RoleCode @codeListValue="pointOfContact"	O	identification of, and means of communication with, person(s) and organisation(s) associated with the resource		license	O	A legal document under which the resource is made available.

Queryables	Obligation	Description	ISO 19115-1 (for dataset metadata)	ISO Obligation	ISO Definition	Notes
//mdb:MD_Metadata /mdb:identificationInfo /mri:MD_Datalocation /mri:resourceConstraints /mco:MD_LegalConstraints With either /mco:accessConstraints or /mco:useConstraints /mco:MD_RestrictionCode @codeListValue="license"	O	restrictions and legal prerequisites for accessing and using the resource or metadata	both license and copyright are captured as legal constraints	rights	O	A statement that concerns all rights not addressed by the license such as a copyright statement.

Queryables	Obligation	Description	ISO 19115-1 (for dataset metadata)	ISO Obligation	ISO Definition	Notes
//mdb:MD_Metadata /mdb:identificationInfo /mri:MD_Datadescription /mri:resourceConstraints /mco:MD_LegalConstraints With either /mco:accessConstraints or /mco:useConstraints /mco:MD_RestrictionCode @codeListValue="copyright"	O		both license and copyright are captured as legal constraints	extent	O	The spatio-temporal coverage of the resource.
//mdb:MD_Metadata /mdb:identificationInfo /mri:MD_Datadescription /mri:extent /gex:EX_Extent	O	spatial and temporal extent of the resource		associations	O	A list of links for accessing the resource, links to other resources associated with this resource, etc.

Appendix C: Revision History

Date	Editor	Release	Primary clauses modified	Descriptions
2020-11-12	G. Hobona	.1	all	initial version

Table 1. Revision History

Appendix D: Bibliography