



OGC API - DISCRETE GLOBAL GRID SYSTEMS - PART 1: CORE

STANDARD
Implementation

CANDIDATE SWG DRAFT

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I

ABSTRACT

The OGC API – Discrete Global Grid Systems – Part 1: Core Standard defines requirements that can be implemented and integrated into a deployed Web API. The DGGs API allows to retrieve geospatial data for a specific area, time and resolution of interest, based on a specific Discrete Global Grid Reference System (DGGRS). Additionally, the DGGs API defines operations to query the list of DGGRS zones from which data is available and/or matching a specified query. Such queries are expressed by combining HTTP query parameters, including the possibility to express more complex filtering queries using the [OGC Common Query Language \(CQL2\)](#).

Readers are strongly encouraged to first familiarize themselves with the Discrete Global Grid Systems (DGGs) concepts defined in [OGC Abstract Specification Topic 21](#) laying the foundation for this Standard.

Please note that in the remainder of this document, the Standard will be referred to as the “OGC API – DGGs Standard”, “the DGGs API” or “this Standard”.

II

KEYWORDS

The following are keywords to be used by search engines and document catalogues.

ogcdoc, OGC document, API, openapi, html, ogcapi, DGGs, discrete global grid, ISEA, hexagonal grids



PREFACE

This document defines the *OGC API – Discrete Global Grid Systems – Part 1: Core Standard*. Suggested additions, changes and comments on this standard are welcome and encouraged. Such suggestions may be submitted as an issue on the [OGC API – DGGS GitHub repository](#).

OGC API Standards define modular API components to spatially enable Web APIs in a consistent way. OGC API Standards use the OpenAPI specification for describing the API components.

The *OGC API – Discrete Global Grid Systems* defines API components to retrieve data and query zones based on Discrete Global Grid Systems (DGGS) concepts defined in [OGC Abstract Specification Topic 21](#). Additional parts for the *OGC API – Discrete Global Grid Systems* Standard may be defined in the future to provide additional capabilities.

OGC API — DGGs — Part 1 only defines HTTP GET operations. As such the security considerations are limited to those applicable to a “read only” service. However, implementations of the OGC API — DGGs Standard will have to process resource paths and query parameters in a way that cannot be used by a client to inject malicious queries that makes available unforeseen data or even force the server to perform unwanted or dangerous actions. The following paragraphs enumerate some security considerations.

Due to the flexibility in querying DGGs zones, implementations of the OGC API — DGGs Standard that are not optimized can easily encounter requests that take some time to resolve. If several of these requests are processed simultaneously, the server can become slow or unresponsive. Servers should take advantage of the space partitioning structures of the implemented DGGs that guarantee a deterministic maximum amount of data to process, ensuring that maximum refinement level is used for regions covering a larger area, and refusing requests which would otherwise be problematic for the server. Servers should also set and apply reasonable limits (e.g., maximum number of zones to return, etc.) to prevent Denial of Service attacks.

Some deployments of the OGC API — DGGs Standard may assign different roles to different users that may result in accessing different collections or geographical areas for which data can be retrieved or zones can be queried. The access control can be described in the OpenAPI definition as discussed in the OGC API — Common Standard (https://docs.ogc.org/is/19-072/19-072.html#rc_oas30-security). Servers should take care that all resources in all representations and ways they can be requested (e.g., adding query parameters) are managed consistently.

Another security consideration is that DGGs data or DGGs zone lists returned by a DGGs API endpoint may be positionally incorrect and potentially guide users to wrong locations. One possible way this situation could happen is the manipulation by a malicious actor of a projection library installed on a server deployment.

Using HTTPS queries is preferred to using HTTP. The obvious reason is the DGGs response returned by the DGGs API endpoint should be only accessible to the requesting user. Another reason is related to the public accessibility of the request itself. Request to a DGGs API endpoint reveal geographical extents that might be associated with private or sensitive information. For instance, users commonly visit “home” or “work” or “target places” (such as holiday destinations or churches). These requests can be used to predict personal or private activities.



SUBMITTING ORGANIZATIONS

The following organizations submitted this Document to the Open Geospatial Consortium (OGC):

- Pangaea Innovations Pty. Ltd.
- Ecere Corporation
- Landcare Research New Zealand
- Peking University Collaborative Innovation Center for Geospatial Big Data
- European Commission Joint Research Centre
- Natural Resources Canada
- University of Tartu
- European Space Agency



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1

SCOPE

This OGC API – DGGs Standard specifies a Web API that enables the direct retrieval of geospatial data for a specified area, time and resolution of interest, based on a specific Discrete Global Grid Reference System (DGGRS). Additionally, the DGGs API defines operations to query the list of DGGRS Zones from which data is available and/or matching a particular query. Such queries are expressed by combining HTTP query parameters, including the possibility to express more complex filtering queries using the [OGC Common Query Language \(CQL2\)](#).

This Standard also specifies several encodings for retrieving both DGGs data and lists of zones, including JSON encodings suitable for data quantized to DGGRS zones of arbitrary geometries as well as widely adopted geospatial data formats. Compact binary representations for zone data as well as for lists of zones are proposed as well.

An informative annex presents a JSON schema for describing a Discrete Global Grid Reference System (DGGRS), as well as examples of such DGGRS definitions which can be implemented in connection with this standard.



2

CONFORMANCE

The one Standardization Target for this Standard is Web APIs.

OGC API – *Common* provides a common foundation for OGC API Standards. Some conformance classes of this standard have a dependency on, or are designed to be easily integrated with, conformance classes defined in OGC API – Common – Part 1 and/or Part 2, as well as within a Web API conforming to additional OGC API Standards.

This Standard identifies twenty-eight Conformance Classes. Each Conformance Class has an associated Requirements Class. The Requirements Classes define the functional requirements which will be tested through the associated Conformance Class. Only the Core requirements class is mandatory, all others are optional. However, a Web API with practical use needs to implement either the Data Retrieval and/or the Zone Query requirements class.

Conformance with this Standard shall be checked using all the relevant tests specified in Annex A (normative) of this document. The framework, concepts, and methodology for testing, and the criteria to be achieved to claim conformance are specified in the OGC Compliance Testing Policies and Procedures and the OGC Compliance Testing web site.

To conform to this OGC API – DGGS Standard, a software implementation shall implement at minimum the “Core” requirements class, as well as either the “Data Retrieval” and/or the “Zone Query” requirements class.

All requirements-classes and conformance-classes described in this document are owned by the standard(s) identified.

The Requirements Classes for *OGC API – Discrete Global Grid Systems* are:

2.1. Requirements classes defining resources

In addition to the Core requirements class defining the `../dggs`, `../dggs/{dggrsId}` and `../dggs/{dggrsId}/zones/{zoneId}` resources, either the Zone Data retrieval (`../dggs/{dggrsId}/zones/{zoneId}/data`) or Zone Query requirements classes (`../dggs/{dggrsId}/zones` with support for parameters such as `zone-level=`, `parent-zone=`, `compact-zones=`, `bbox=` and `datetime=`) need to be implemented for a DGGS API implementation to have practical use.

- **Core**
- **Zone Data Retrieval**
- **Zone Query**

2.2. Requirements classes defining origins

These requirements classes define DGGs resources for the API (/dgg) and collections (/collections/{collectionId}/dgg).

- **Root DGGs**
- **Collection DGGs**

2.3. Requirements classes defining parameters

Three requirements classes add support for the subset, properties, exclude-properties, zone-depth and filter parameters to zone data resources:

- **Zone data subsetting**
- **Zone data custom depths**
- **Filtering zone data with CQL2**

A requirements class adds support for the filter parameter for zone query resources:

- **Filtering Zone Queries with CQL2**

2.4. Requirements classes defining resource representations

2.4.1. Zone data encodings

The Data Encoding Requirements Classes address support for formats commonly used for encoding geospatial data, as well as encodings based on JSON and [UBJSON](#) using a schema specifically designed for zone data referenced to a particular DGGs. DGGs-(UB)JSON allows encoding one or more depths of DGGs-quantized raster data, including optional support for multiple fields (properties) and additional dimensions beyond those of the DGGs, whereas DGGs-FG-(UB)JSON encode vector features and geometry based on OGC Features Geometry JSON using sub-zone order indices as coordinates at an arbitrary relative depth / precision.

- DGGs-JSON Data
- DGGs-UBJSON Data
- DGGs-FG-JSON Data
- DGGs-FG-UBJSON Data
- GeoJSON Data
- FG-JSON Data
- GeoTIFF Data
- netCDF Data
- Zarr Data
- CoverageJSON Data
- JPEG XL Data
- PNG Data

2.4.2. Zone list encodings

The Zone List Encoding Requirements Classes address support for formats efficiently and/or intuitively encoding a list of DGGs zone identifiers.

- JSON Zone List
- HTML Zone List
- 64-bit Binary Zone List
- GeoJSON Zone List
- FG-JSON Zone List
- GeoTIFF Zone List

2.4.3. Operation IDs in API definitions

The *Operation IDs* Requirements Class defines requirements for using specific operation IDs in API definitions, which can be combined with requirements classes for specific API definition, such as the OpenAPI 3.0 requirements class of OGC API – *Common – Part 1: Core*, facilitating the identification of DGGs resources.

- **Operation IDs**

2.5. Summary of conformance URIs

Table 1 — Conformance class URIs

CORRESPONDING REQUIREMENTS CLASS	CONFORMANCE CLASS URI
Core	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/core
<i>For Data Retrieval</i>	
Zone Data Retrieval	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-retrieval
Data subsetting	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-subsetting
Data custom depths	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-custom-depths
Filtering Zone Data with CQL2	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-cql2-filter
<i>For Zone Queries</i>	
Zone Query	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-query
Filtering Zone Queries with CQL2	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-query-cql2-filter
<i>OGC API integration</i>	
Root DGGS	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/root-dggs
Collection DGGS	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/collection-dggs
Operation IDs	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/operation-ids
<i>Zone Data Encodings</i>	
DGGS-JSON Data	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-json
DGGS-UBJSON Data	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-ubjson
DGGS-FG-JSON Data	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-dggs-fgjson
DGGS-FG-UBJSON Data	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-dggs-fgubjson

CORRESPONDING REQUIREMENTS CLASS	CONFORMANCE CLASS URI
GeoJSON Data	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-geojson
FG-JSON Data	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-fgjson
GeoTIFF Data	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-geotiff
netCDF Data	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-netcdf
CoverageJSON Data	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-coveragejson
Zarr Data	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-zarr
JPEG XL Data	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-jpegxl
PNG Data	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-png
Zone List Encodings	
JSON Zone List	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-json
HTML Zone List	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-html
64-bit Binary Zone List	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-uint64
GeoJSON Zone List	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-geojson
FG-JSON Zone List	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-fgjson
GeoTIFF Zone List	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-geotiff



3

NORMATIVE REFERENCES

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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4

TERMS AND DEFINITIONS

TERMS AND DEFINITIONS

This document uses the terms defined in OGC Policy Directive 49, which is based on the ISO/IEC Directives, Part 2, Rules for the structure and drafting of International Standards. In particular, the word “shall” (not “must”) is the verb form used to indicate a requirement to be strictly followed to conform to this document and OGC documents do not use the equivalent phrases in the ISO/IEC Directives, Part 2.

This document also uses terms defined in the OGC Standard for Modular specifications (OGC 08-131r3), also known as the ‘ModSpec’. The definitions of terms such as standard, specification, requirement, and conformance test are provided in the ModSpec.

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

4.1. child zone

immediate descendant of a parent zone

Note 1 to entry: adapted from *child cell* in OGC Abstract Specification Topic 21

[SOURCE: OGC 20-040r3]

4.2. discrete global grid (DGG)

set of zones at the same refinement level, that uniquely and completely cover a globe

Note 1 to entry: Adapted to use zones rather than cells to avoid potential confusion with the similar concept of grid cells in a *coverage*. As noted in OGC Abstract Specification Topic 21, “While the terms cell and zone are often used interchangeably, strictly zone is the preferred term.”.

[SOURCE: OGC 20-040r3]

4.3. discrete global grid hierarchy (DGGH)

series of discrete global grids organized in a hierarchy of successive levels of zone refinement, using a specific set of parameters fully establishing the geometry of all zones

Note 1 to entry: Example of parameters part of the DGGH definition include the underlying Earth model spheroid, and the orientation of a base polyhedron.

Note 2 to entry: This definition corresponds to the term “hierarchy” (4.26) in OGC Abstract Specification Topic 21, and refers strictly to a mathematical structure, excluding the concept of zonal identifiers, which are introduced as part of a discrete global grid reference system, and excluding notions of software functionality or interoperability implied by a DGGs.

Note 3 to entry: In some DGGs literature, the term DGGs refers to this DGGH meaning, where the word *system* in “system of discrete global grids” is used in the sense of a “series” of grids (e.g., “*A Discrete Global Grid System (DGGs) is a series of discrete global grids*” [Sahr2003]), as opposed to a software or data integration / processing system.

Note 4 to entry: The ISEA3H (Icosahedral Snyder Equal-Area Aperture 3 Hexagonal) Discrete Global Grid Hierarchy, using the standard ISEA orientation and the WGS84 authalic sphere as the underlying Earth model, irrespective of a particular indexing scheme or sub-zone ordering, is an example of a DGGH.

[SOURCE: OGC 20-040r3]

4.4. discrete global grid reference system (DGGRS)

integrated system comprised of a specific discrete global grid hierarchy, spatiotemporal referencing by zone identifiers and deterministic sub-zone ordering

Note 1 to entry: the term DGGRS did not appear in the terms and definitions of version 2.0.0 of OGC Abstract Specification Topic 21, but is defined in Section 8 as the DGG_ReferenceSystem interface.

Note 2 to entry: Annex B provides an informative schema for defining a DGGRS with accompanying examples of specific DGGRSs.

Note 3 to entry: this standard introduces the concept of sub-zone ordering, which is not part of the DGG_ReferenceSystem interface defined in topic 21, for the purpose of compact storage and transmission of data quantized to a particular DGGRS.

[SOURCE: OGC 20-040r3]

4.5. discrete global grid system (DGGS)

integrated system comprising a hierarchy of discrete global grids, spatiotemporal referencing by zonal identifiers and functions for quantization, zonal query, and interoperability

Note 1 to entry: In some DGGS literature, the term DGGS is sometimes used with the meaning of a discrete global grid hierarchy.

Note 2 to entry: An implementation of the OGC API — DGGS Standard would be considered a DGGS.

[SOURCE: OGC 20-040r3]

4.6. globe

region of space-time enclosing a celestial body

[SOURCE: OGC 20-040r3]

4.7. parent zone

zone in a coarser refinement level of a discrete global grid with immediate descendants

Note 1 to entry: adapted from *parent cell* in OGC Abstract Specification Topic 21

Note 2 to entry: Adapted to say *coarser* rather than *higher*, where *coarser* refers to a zone covering a larger area of space-time.

[SOURCE: OGC 20-040r3]

4.8. refinement level

numerical order of a discrete global grid in the tessellation sequence

Note 1 to entry: The discrete global grid with the least number of zones has a refinement level of 0.

[SOURCE: OGC 20-040r3]

4.9. relative depth

the number of refinement levels separating a finer discrete global grid from a coarser discrete global grid in a discrete global grid hierarchy

4.10. slicing

extracting a hyperplane of data along a particular dimension, resulting in a dataset of reduced dimensionality

[SOURCE:]

4.11. sub-zone

zone at a greater refinement level than a parent zone whose geometry is at least partially contained within the geometry of the parent zone

Note 1 to entry: At a relative depth of 1, the sub-zones of the parent zone are its immediate children.

Note 2 to entry: In some DGGHs, the children of the children of a parent zone (relative depth of 2) are not all sub-zones of that parent zone.

Note 3 to entry: A discrete global grid reference system defines a deterministic order for sub-zones

4.12. trimming

extracting a subset of data between a lower and upper bound along one or more dimensions, preserving dimensionality

[SOURCE:]

4.13. Web API

An Application Programming Interface (API) using an architectural style that is founded on the technologies of the Web

Note 1 to entry: See [Best Practice 24: Use Web Standards as the foundation of APIs](#) (W3C Data on the Web Best Practices) for more detail.

[SOURCE: OGC 19-072]

4.14. zone identifier

spatiotemporal reference in the form of a label or code that uniquely identifies a zone

Note 1 to entry: synonym of “zonal identifier” and “zone ID”.

Note 2 to entry: This Standard and the DGGRS definitions described in Annex B require textual identifiers (which may or may not be comprised of only digit characters), while optionally supporting 64-bit integer identifiers for the purpose of compact transmission and internal representation.

[SOURCE: OGC 20-040r3]

4.15. zone identifier reference system (ZIRS)

reference system establishing a specific association of zone identifiers to zones for one or more discrete global grid hierarchy

Note 1 to entry: synonym of “zonal identifier reference system” and “zone indexing scheme”

4.16. zone

particular region of space-time

[SOURCE: OGC 20-040r3]



5

CONVENTIONS

This section provides details of conventions used in this document.

5.1. Identifiers

The normative provisions in this standard are denoted by the URI <https://www.opengis.net/spec/ogcapi-dggs-1/1.0>.

All requirements and conformance tests that appear in this document are denoted by partial URIs which are relative to this base.

5.2. Link relations

To express relationships between resources, [RFC 8288 \(Web Linking\)](#) is used.

Note that the CURIE based on the pattern `[ogc-rel:<relation>]` is also considered equivalent. For example, `[ogc-rel:dggrs-definition]` corresponds to <https://www.opengis.net/def/rel/ogc/1.0/dggrs-definition>.

The following [IANA link relation types](#) are used in this document:

- **alternate**: Refers to a substitute for this context.
- **self**: Conveys an identifier for the link's context.
- **service-desc**: Identifies service description for the context that is primarily intended for consumption by machines (Web API definitions are considered service descriptions).
- **service-doc**: Identifies service documentation for the context that is primarily intended for human consumption.

The following link relation types which were previously defined for other OGC API standards are applicable:

- **<https://www.opengis.net/def/rel/ogc/1.0/dataset>**: The target IRI points to a resource representing the dataset (e.g., the root of an OGC Web API).
- **<https://www.opengis.net/def/rel/ogc/1.0/geodata>**: The target IRI points to a resource representing a collection of geospatial data.

In addition, the following link relation types are used for which no applicable registered link relation type could be identified:

- <https://www.opengis.net/def/rel/ogc/1.0/dggrs>: The target IRI points to the description, which includes a link to the definition as well as deployment-specific elements, of the Discrete Global Grid Reference System related to the link's context.
- <https://www.opengis.net/def/rel/ogc/1.0/dggrs-list>: The target IRI points to the descriptive list of the Discrete Global Grid Reference Systems available for the resource of the link's context.
- <https://www.opengis.net/def/rel/ogc/1.0/dggrs-definition>: The target IRI points to the definition of the Discrete Global Grid Reference System using a well-defined schema (see Annex B), for example as available from an authoritative DGGRS registry.
- <https://www.opengis.net/def/rel/ogc/1.0/dggrs-zone-info>: The target IRI points to information about a particular zone of a Discrete Global Grid Reference System, such as its geometry, area/volume, and any relevant links (e.g., to retrieve data from the zone).
- <https://www.opengis.net/def/rel/ogc/1.0/dggrs-zone-data>: The target IRI points to data pertaining to a particular zone of a Discrete Global Grid Reference System. This link relation is typically used with a link template where a zone identifier can be substituted.
- <https://www.opengis.net/def/rel/ogc/1.0/dggrs-zone-query>: The target IRI points to a zone listing resource allowing to perform queries for a particular Discrete Global Grid Reference System.
- <https://www.opengis.net/def/rel/ogc/1.0/dggrs-zone-parent>: The target IRI points to the information resource of a zone which is a parent of the link's context zone.
- <https://www.opengis.net/def/rel/ogc/1.0/dggrs-zone-child>: The target IRI points to the information resource of a zone which is an immediate child of the link's context zone.
- <https://www.opengis.net/def/rel/ogc/1.0/dggrs-zone-neighbor>: The target IRI points to the information resource of a zone which is a neighbor of the link's context zone.

Each resource representation includes an array of links. Implementations are free to add additional links for all resources provided by the Web API implementing OGC API – DGGS requirement(s).

Used in combination OGC API – Common – Part 1: Core, other link relation types will be used, including:

- <https://www.opengis.net/def/rel/ogc/1.0/conformance>: Refers to a resource that identifies the specifications that the link's context conforms to.

Used in combination with OGC API – Common – Part 2: Geospatial Data, other link relation types will be used, including:

- <https://www.opengis.net/def/rel/ogc/1.0/data>: Refers to the list of collections available for a dataset.

5.3. Use of HTTPS

For simplicity, the OGC API – DGGs Standard only refers to the HTTP protocol. This is not meant to exclude the use of HTTPS and simply is a shorthand notation for “HTTP or HTTPS.” Following the recent push towards enhancing web security, public facing web servers are expected to use HTTPS rather than HTTP. In the context of the OGC API – DGGs Standard, use of HTTPS provides a layer of security to prevent leaking of information related to users requesting DGGs-structured data or zones list for a particular geographical area, which may be private or sensitive in nature (for example, their own location, or the location of endangered species).



6

REQUIREMENTS CLASS “CORE”

6.1. Overview

An implementation of the DGGS API “Core” Requirements Class enables a client to list available DGGRSs for a given resource, retrieve additional information about a particular DGGRS, and retrieve information about a particular DGGRS zone.

The “Core” Requirements Class is the only mandatory Requirements Class. However, an implementation with practical use is expected to additionally implement either the “Zone Data Retrieval” Requirements Class, so that a client can ask a question of the type “*What is here?*” and/or the “Zone Query” Requirements Class, so that a client can ask a question of the type “*Where is it?*”

An [example OpenAPI 3.0 definition for OGC API — DGGS](#) is provided, defined as individual components which can be assembled with the [swagger-cli tool](#) after customizing the API definition for a particular implementation or deployment. The example API definition can be visualized with [SwaggerUI](#).

REQUIREMENTS CLASS 1: REQUIREMENTS CLASS CORE

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/core
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.1: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/core
NORMATIVE STATEMENTS	Requirement 1: /req/core/dggrs-list Requirement 2: /req/core/dggrs-info Requirement 3: /req/core/zone-info

6.2. Listing available DGGRS (.../dggs)

REQUIREMENT 1

IDENTIFIER [/req/core/dggrs-list](#)

REQUIREMENT 1

INCLUDED IN

Requirements class 1: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/core>

STATEMENT For retrieving the list of available discrete global grid reference systems:

- A** The Implementation SHALL support an HTTP GET operation at a resource path ending with `.../dggs`.
- B** The Implementation SHALL support a JSON representation of this `.../dggs` resource.
- C** The `.../dggs` resource SHALL include a `dggrs` array property listing all discrete global grid reference systems supported by the Implementation.
- D** Each element of the `dggrs` array SHALL include a subset of the information available in the individual DGGRS information described below, including at minimum the `id`, `title`, `uri` (if applicable), and `links`.
- E** The `links` property SHALL include at minimum a link to the discrete global grid reference system using the `self` link relation type, as well as a link to the discrete global grid reference system definition using the `[ogc-rel:dggrs-definition]` relation type.
- F** The link relation type to use for linking from the corresponding resource to the list of available DGGRSs for that resource SHALL be `[ogc-rel:dggrs-list]`.

6.3. Discrete global grid reference system information (`.../dggs/{dggrsId}`)

REQUIREMENT 2

IDENTIFIER `/req/core/dggrs-info`

INCLUDED IN

Requirements class 1: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/core>

STATEMENT For retrieving information for a particular available discrete global grid reference system:

- A** The Implementation SHALL support an HTTP GET operation at a resource path ending with `.../dggs/{dggrsId}`.
- B** The Implementation SHALL support a JSON representation of this `.../dggs/{dggrsId}` resource.
- C** The `.../dggs/{dggrsId}` resource SHALL include an `id` property consistent with the `{dggrsId}` resource path parameter.

REQUIREMENT 2

D	The <code>.../dggs/{dggrsId}</code> resource SHALL include a link to the resource itself using the <code>self</code> link relation type.
E	The <code>.../dggs/{dggrsId}</code> resource SHALL include a link to a definition of the discrete global grid reference system (describing both the discrete global grid as well as the particular indexing scheme to identify zones by identifiers), using the link relation type <code>[ogc-rel:dggrs-definition]</code> . The schema for that definition is likely to evolve in order to support describing a growing number of classes of DGGHs. A first draft of this schema is available in Annex B — Discrete Global Grid Reference System Definitions.
F	The <code>.../dggs/{dggrsId}</code> resource SHALL include a templated link in the <code>linkTemplates</code> array to request information for a particular zone using the link relation type <code>[ogc-rel:dggrs-zone-info]</code> and the template variable <code>{zoneId}</code> .
G	If the discrete global grid reference system (the combination of the discrete global grid and indexing system) is registered with an authority, the resource SHALL include a <code>uri</code> property corresponding to that registered discrete global grid reference system.
H	If the discrete global grid reference system is based on a particular coordinate reference system, the resource SHALL specify that CRS in a <code>crs</code> property, preferably as a URI (if one is available).
I	The Implementation SHALL include a short <code>title</code> property identifying the discrete global grid reference system intended for display to a human.
J	The Implementation SHALL include a <code>description</code> property providing a summary description of the discrete global grid reference system.

RECOMMENDATION 1

IDENTIFIER `/rec/core/max-refinement`

STATEMENT For specifying a maximum refinement level and a maximum relative depth for a discrete global grid reference system associated with a particular geospatial data resource:

A For DGGs resources associated with a data source, the Implementation SHOULD include a `maxRefinementLevel` integer property in the `.../dggs/{dggrsId}` resource specifying the maximum refinement level at which the full resolution of the data can be retrieved (using a zone-depth relative depth of 0) and/or used for performing the most accurate zone queries (using that value for `zone-level`).

B For DGGs resources associated with a data source, the Implementation SHOULD include a `maxRelativeDepth` integer property in the `.../dggs/{dggrsId}` resource specifying the maximum relative depth at which data can be retrieved.

PERMISSION 1

IDENTIFIER `/per/core/beyond-max-refinement`

PERMISSION 1

STATEMENT For handling requests beyond `maxRefinementLevel`:

- A** The Implementation MAY return a 4xx error for data retrieval and/or zone query requests beyond a `maxRefinementLevel` specified in the DGGRS description associated with the request.
- B** Alternatively, the Implementation MAY process the request by properly oversampling the data values for handling refinement levels beyond the `maxRefinementLevel`.

6.4. Retrieving zone information (.../dggs/{dggrsId}/zones/{zoneId})

REQUIREMENT 3

IDENTIFIER `/req/core/zone-info`

INCLUDED IN Requirements class 1: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/core>

STATEMENT For retrieving information for a particular DGGRS zone:

- A** The Implementation SHALL support an HTTP GET operation at a resource path ending with `.../dggs/{dggrsId}/zones/{zoneId}` providing information for valid individual zones of the discrete global grid reference system.
- B** The zone information resource SHALL support a JSON representation.
- C** The zone information resource SHALL include an `id` property corresponding to the `{zoneId}` resource path parameter.
- D** The zone information resource SHALL include a link back to the corresponding DGGRS resource (`.../dggs/{dggrsId}`) using the `[ogc-rel:dggs]` link relation type.

RECOMMENDATION 2

IDENTIFIER `/rec/core/zone-info`

STATEMENT For recommending additional things that should be included in zone information resources:

- A** The zone information resource SHOULD include a `shapeType` property indicating the shape type of the zone's geometry (e.g., hexagon or pentagon).

RECOMMENDATION 2

B	The zone information resource SHOULD include a <code>level</code> property indicating the refinement level of the zone.
C	The zone information resource SHOULD include a <code>crs</code> property indicating the Coordinate Reference System (CRS) in which the geometry, centroid and <code>bbox</code> property are specified.
D	The zone information resource SHOULD include a <code>centroid</code> property indicating the centroid of the zone. In the JSON representation, this should be an array of two numbers in the CRS specified in <code>crs</code> .
E	The zone information resource SHOULD include a <code>bbox</code> property indicating the extent (envelope / bounding box) of the zone. In the JSON representation, this should be an array of four (4) coordinates for a DGGRS with two spatial dimensions or six (6) coordinates for a DGGRS with three spatial dimensions, in the CRS specified in <code>crs</code> .
F	The zone information resource SHOULD include links to its parent(s) zone(s) using link relation <code>[ogc-rel:dggrs-zone-parent]</code> .
G	The zone information resource SHOULD include links to its immediate children zone using link relation <code>[ogc-rel:dggrs-zone-child]</code> .
H	The zone information resource SHOULD include links to its neighboring zones using link relation <code>[ogc-rel:dggrs-zone-neighbor]</code> .
I	The zone information resource SHOULD include an <code>areaMetersSquare</code> property indicating the surface area of the zone in square meters.
J	For a DGGS with three spatial dimension, the zone information resource SHOULD include a <code>volumeMetersCube</code> property indicating the volume of the zone in cubic meters.
K	For a temporal DGGS, the zone information resource SHOULD include a <code>temporalDurationSeconds</code> property indicating the amount of time covered by the zone in seconds.
L	The zone information resource SHOULD include a <code>geometry</code> property indicating the 2D and/or 3D spatial geometry of the zone using GeoJSON or OGC Features Geometry JSON for the JSON encoding, and including intermediate points between the vertices of the geometry so as to accurately represent the shape of the zones for DGGRSs defined in a CRS other than the CRS used to express the coordinates of the vertices. The coordinates should be in the CRS specified in the <code>crs</code> property.
M	For a temporal DGGS, the zone information resource SHOULD include a <code>temporalInterval</code> property indicating the start and end time of the zone.
N	The implementation SHOULD support a GeoJSON and/or OGC Features Geometry JSON representation of the zone information resource where the top-level object is a feature representing the zone geometry, a <code>zoneID</code> property of that feature corresponds to the textual identifier (the <code>{zoneId}</code>), the <code>id</code> of the feature corresponds to either a sequential feature identifier starting at 1, the textual identifier of the zone, or the 64-bit unsigned integer identifier of the zone, and the other properties described in this recommendation are properties of that feature.
O	For a zone associated with a particular collection, the Implementation SHOULD provide summary statistics (minimum, maximum, average, <code>stdDev</code>) pertaining to this zone for each field (fields of the range of a coverage, or relevant numeric properties of a feature collection) of the data. In the JSON encoding, this SHOULD be implemented as a <code>statistics</code> JSON dictionary property mapping field names to an object containing each statistic.

RECOMMENDATION 2

P

For a zone associated with a particular collection, the Implementation SHOULD provide `areaMetersSquareWithData`, `volumeMetersCubeWithData`, `temporalDurationSecondsWithData` properties corresponding to the respective properties defined above for the overall zones, but considering only the portions of the zone where there is data (e.g., regions of the zone excluding NODATA values for a gridded coverage, or within geometry for a feature collection).

RECOMMENDATION 3

IDENTIFIER `/rec/core/robots-txt`

STATEMENT For discouraging automated crawling of zone information resources:

A

Implementations SHOULD include a [robots.txt](#) file at the root of their Web API discouraging robots from crawling the DGGs zone resources.

B

The content of that Robots.txt file SHOULD include `Disallow: */dggs/*/zones/*` to prevent crawling all DGGs resources under the `/zones/` resource path.

NOTE: The presence of a `robots.txt` file is not a security measure and relies on the voluntary compliance of well-intended crawlers to minimize unnecessary requests. This measure does not prevent malicious clients from overwhelming the server with numerous requests which may result in Denial of Service attacks.



7

REQUIREMENTS CLASS “DATA RETRIEVAL”

7.1. Overview

The OGC API — DGGS “Data Retrieval” requirements class allows retrieving data from a specific Discrete Global Grid Reference System (DGGRS), that is a specific hierarchy of Discrete Global Grids combined with a particular zone indexing reference system (ZIRS), for an individual zone. It describes an HTTP GET operation, as well as its response. The selected DGGRS is listed as available and described in the Core requirements class, and conforms to [OGC Topic 21](#).

The data for a particular zone is retrieved based on a URI template including a variable representing a Zone ID.

The resource from which data is retrieved could be for a particular collection of geospatial data (Collection DGGS Requirements Class) or for a dataset as a whole (Root DGGS Requirements Class).

The collection could also be virtual in nature, as described in the [OGC API — Processes — Part 3: Workflows](#) candidate Standard “Collection Output” requirements class, allowing to perform on-demand processing for a spatiotemporal region of interest associated with the zone for which data is being requested.

An implementation of this requirements class enables a client to ask a question of the type “*What is here?*”, where the “*what*” refers to data values associated with a particular dataset, collection, or processing workflow, and the *here* refers to a particular spatiotemporal region identified by the Zone ID.

REQUIREMENTS CLASS 2: REQUIREMENTS CLASS DATA RETRIEVAL

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.2: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-retrieval
PREREQUISITE	https://www.opengis.net/spec/ogcapi-common-1/1.0/req/core
NORMATIVE STATEMENT	Requirement 4: /req/data-retrieval/zone-data

7.2. Retrieving data from a zone (../dggs/{dggrsId}/zones/{zoneId}/data)

The following requirements describe how a client can retrieve data from a single DGGS zone at the resource path ../dggs/{dggrsId}/zones/{zoneId}/data.

REQUIREMENT 4

IDENTIFIER /req/data-retrieval/zone-data

INCLUDED IN Requirements class 2: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval>

STATEMENT For retrieving data for a single DGGS zone:

- A** The Implementation SHALL support an HTTP GET operation at a resource path ending with ../dggs/{dggrsId}/zones/{zoneId}/data.
- B** The Implementation SHALL include a templated link to this resource path in the "Core" ../dggs/{dggrsId} resource link templates, and regular link in the ../dggs/{dggrsId}/zones/{zoneId} resource links using the link relation type [ogc-rel:dggs-zone-data] for all zones for which data is available.
- C** The response of the HTTP GET operation SHALL have a status code of 200.
- D** The content of the response SHALL be a data packet corresponding precisely to the area covered by the DGGS zone.
- E** The selection of an encoding for the response SHALL be consistent with HTTP content negotiation.
- F** The ../dggs/{dggrsId} resource SHALL include a defaultDepth property indicating the Implementation's default depth for when the zone-depth parameter is omitted. This default value could be any valid value and/or form as defined in the /req/data-custom-depths/zone-depth-parameter requirement (single depth, range of depths, or list of depths, relative to the {zoneId} hierarchy level).
- G** Unless a zone-depth parameter is specified, the response SHALL return a data packet consistent with this defaultDepth property, in accordance with the capabilities of the negotiated data packet encoding.

7.3. Recommendation for a crs parameter

The following recommendation describe how a server should support a `crs` query parameter for the `.../zones/{zoneId}/data` resource if the data can be returned in multiple applicable CRSs.

RECOMMENDATION 4	
IDENTIFIER	/rec/data-retrieval/crs
STATEMENT	For retrieving data in alternate CRSs:
A	If the data is available in multiple CRSs, the Implementation SHOULD support a <code>crs</code> query parameter for the resource path ending with <code>.../dggs/{dggrsId}/zones/{zoneId}/data</code> .
B	The value of this parameter SHOULD support values for this parameter specified either as full URIs (e.g., http://www.opengis.net/def/crs/OGC/1.3/CRS84) or as CURIEs (e.g., <code>[OGC:CRS84]</code> , <code>[EPSG:4326]</code>).
C	The list of supported CRSs SHOULD be included in a <code>crs</code> property of the DGGs origin resource (such as the collection description) as an array of URIs or CURIEs.



8

REQUIREMENTS CLASS “DATA SUBSETTING”

8.1. Overview

The OGC API — DGGS “Data Subsetting” requirements class extends the zone data retrieval requirements with the ability to subset data for additional dimensions beyond those defined by the discrete global grid reference systems (DGGRS), for example along time or vertical dimension if those axes are not part the DGGRS definition, or along additional dimensions such as atmospheric pressure levels. Two parameters are defined for this purpose: `datetime` (specifically for time) and `subset` (for any dimension, including time). Additionally, this requirements class defines the `properties` parameter to select specific fields to include in the response instead of all fields which are included by defaults.

REQUIREMENTS CLASS 3: REQUIREMENTS CLASS DATA SUBSETTING

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-subsetting
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.3: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-subsetting
PREREQUISITE	Requirements class 2: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval
NORMATIVE STATEMENTS	Requirement 5: <code>/req/data-subsetting/subset</code> Requirement 6: <code>/req/data-subsetting/datetime</code> Requirement 7: <code>/req/data-subsetting/properties</code>

8.2. Parameter subset

REQUIREMENT 5

IDENTIFIER	<code>/req/data-subsetting/subset</code>
INCLUDED IN	Requirements class 3: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-subsetting

REQUIREMENT 5

STATEMENT For specifying a multi-dimensional subset for the zone data being retrieved (excluding dimensions of the discrete global grid reference system):

A	The Implementation SHALL support a subset query parameter for the zone data retrieval operation (resource path ending with .../dggs/{dggsId}/zones/{zoneId}/data) conforming to the following Augmented Backus Naur Form (ABNF) fragment: <pre> SubsetSpec: "subset"=axisName(intervalOrPoint) axisName: {text} intervalOrPoint: interval \ point interval: low : high low: point \ * high: point \ * point: {number} \ "{text}" </pre> Where: \" = double quote = ASCII code 0x42, {number} is an integer or floating-point number, and {text} is some general ASCII text (such as a time and date notation in ISO 8601).
B	The Implementation SHALL support as an axis names `time` for a temporal dataset, unless this temporal axis is an axis of the discrete global grid reference system.
C	If a third vertical spatial dimension is supported (if the resource's spatial extent bounding box is three dimensional) and that dimension is not part of the discrete global grid system definition, the Implementation SHALL also support a h dimension (elevation above the ellipsoid in EPSG:4979 or CRS84h) for geographic CRS and z for projected CRS, which are to be interpreted as the vertical axis in the CRS definition.
D	The Implementation SHALL support as axis names any additional dimension (beyond spatial and temporal) as described in the extent property of the collection or dataset description.
E	The Implementation SHALL return a 400 error status code if an axis name does not correspond to one of the axes of the Coordinate Reference System (CRS) of the data or an axis defined in the relevant extent property.
F	If a subset parameter including any of the dimensions corresponding to the axes of the discrete global grid reference system is used, the server SHALL return a 400 client error.
G	The Implementation SHALL interpret multiple subset parameters, as if all dimension subsetting values were provided in a single subset parameter (comma separated). Example: subset=time("2018-02-12T16:00:00Z": "2018-02-12T20:00:00Z")&subset=atm_pressure_hpa(500:750) is equivalent to subset=time("2018-02-12T16:00:00Z": "2018-02-12T20:00:00Z"),atm_pressure_hpa(500:750)

NOTE: When the *interval* values fall partially outside of the range of valid values defined by the CRS for the identified axis, the service is expected to return the non-empty portion of the data resulting from the subset.

8.3. Parameter datetime

REQUIREMENT 6

IDENTIFIER /req/data-subsetting/datetime

INCLUDED IN Requirements class 3: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-subsetting>

STATEMENT For specifying a time instant or interval for which to retrieve data from a zone for a non-temporal DGGS:

A	The Implementation SHALL support a datetime parameter expressed corresponding to either a date-time instant or a time interval, conforming to the following syntax (using ABNF):
	<pre>interval-bounded = instant "/" instant interval-bounded-start = [".."] "/" instant interval-bounded-end = instant "/" [".."] interval-unbounded = [".."] "/" [".."] interval = interval-bounded / interval-bounded-start / interval-bounded-end / interval-unbounded datetime = instant / interval</pre>
B	The implementation SHALL support an instant defined as specified by RFC 3339, 5.6 , with the exception that the server is only required to support the Z UTC time notation, and not required to support local time offsets.
C	Only the portions of the data within the specified interval SHALL be part of the zone data response, performing a trim operation for an interval or a slicing operation for an instant (in the case of a gridded coverage), or a filtering operation for feature data.
D	Time intervals unbounded at the start or at the end SHALL be supported using a double-dot (..) or an empty string for the start/end.
E	If a datetime parameter is specified requesting zone data where no temporal dimension applies, the Implementation SHALL either ignore the parameter or return a 4xx client error.

Note: ISO 8601-2 distinguishes unbounded start/end timestamps (double-dot) and unknown start/end timestamps (empty string). For queries, an unspecified start/end has the same effect as an unbounded start/end.

Examples:

Example 1 — A date-time: February 12, 2018, 23:20:52 GMT:

`datetime=2018-02-12T23:20:52Z`

Example 2 — Intervals: February 12, 2018, 00:00:00 GMT to March 18, 2018, 12:31:12 GMT:

`datetime=2018-02-12T00:00:00Z/2018-03-18T12:31:12Z`

February 12, 2018, 00:00:00 UTC or later:

datetime=2018-02-12T00:00:00Z/..

March 18, 2018, 12:31:12 UTC or earlier:

datetime=../2018-03-18T12:31:12Z

8.4. Parameter properties

REQUIREMENT 7

IDENTIFIER /req/data-subsetting/properties

INCLUDED IN Requirements class 3: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-subsetting>

STATEMENT For specifying fields to include when retrieving zone data

A

The zone data retrieval operation SHALL support a parameter `properties` where the value is a comma-separated list of fields to be returned.

B

The Implementation SHALL support selecting a field using the identifier corresponding to the top-level property keys of the logical schema of the resource associated with the DGGRS zone data request, and return 400 status code for an unrecognized selected field.

C

Only the selected fields SHALL be returned from the zone data request.

D

If the zone data encodings response can self-describe its list of fields (as with the `schema` property of the DGGS-JSON encoding), the field description SHALL correspond to the requested list of fields.

E

If the negotiated format of the response has a concept of field order, then the fields SHALL be in the same order as the requested list of selected fields.

8.5. Parameter exclude-properties

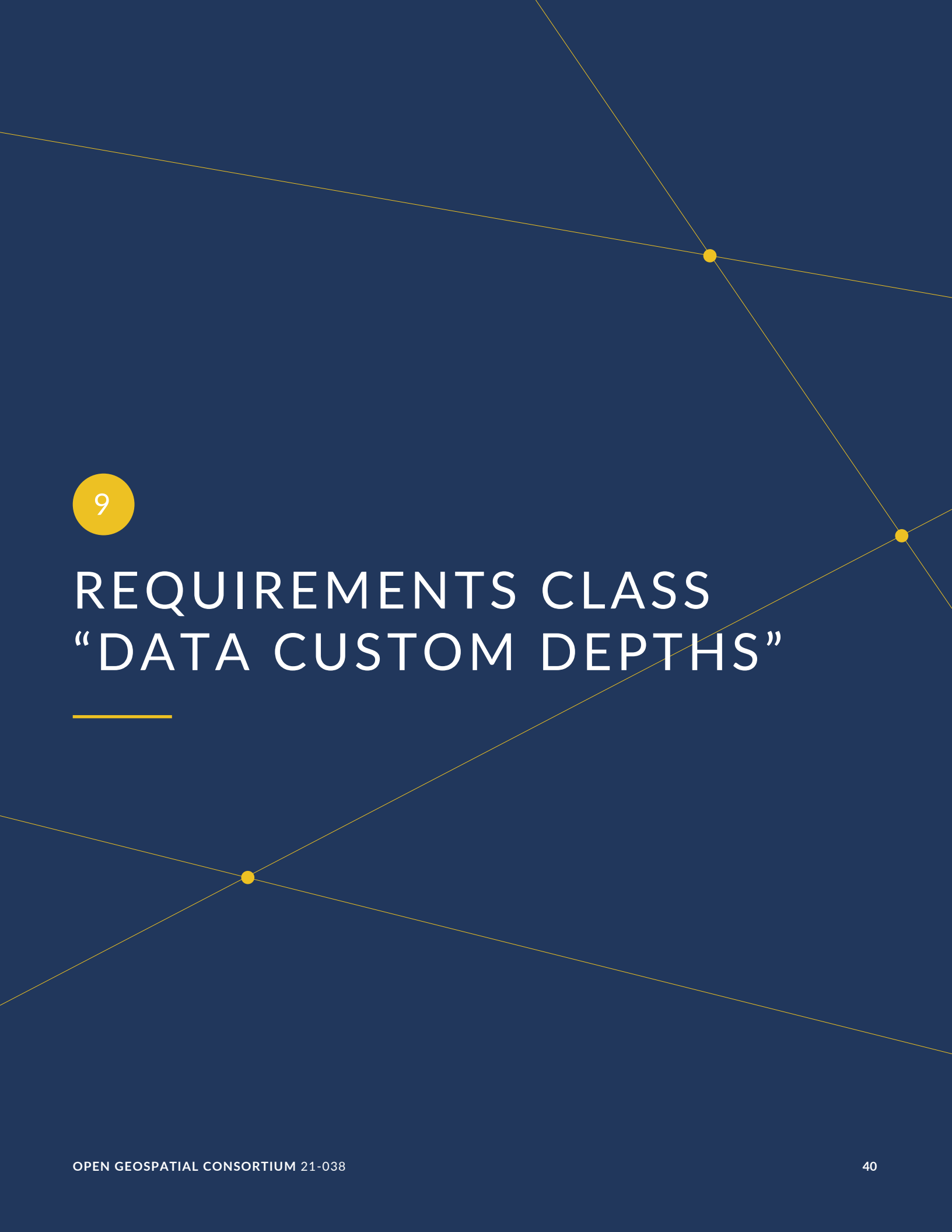
REQUIREMENT 8

IDENTIFIER /req/data-subsetting/exclude-properties

STATEMENT For including all but specific fields when retrieving zone data

REQUIREMENT 8

A	The zone data retrieval operation SHALL support a parameter <code>exclude-properties</code> where the value is a comma-separated list of fields not to be returned.
B	The Implementation SHALL support selecting fields not to return using the identifier corresponding to the top-level property keys of the logical schema of the resource associated with the DGGRS zone data request, and return 400 status code for an unrecognized selected field.
C	All but the selected fields SHALL be returned from the zone data request.
D	The Implementation SHALL return a 4xx error when using the both the <code>properties</code> and <code>exclude-properties</code> parameters in the same request.



9

REQUIREMENTS CLASS “DATA CUSTOM DEPTHS”

REQUIREMENTS CLASS “DATA CUSTOM DEPTHS”

9.1. Overview

The OGC API – DGGS “Data Custom Depths” requirements class extends the zone data retrieval requirements class allowing a client to customize which depths to include as part of a zone data response relative to the requested hierarchy level for which data is being requested. This can be either a single depth, a range of depths, or a list of depths. The depths to include in the response are specified using the zone-depth query parameter. This depth customization ability can be restricted by the capability of the particular zone data response encoding negotiated.

REQUIREMENTS CLASS 4: REQUIREMENTS CLASS DATA CUSTOM DEPTHS

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-custom-depths
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.4: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-custom-depths
PREREQUISITE	Requirements class 2: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval
NORMATIVE STATEMENT	Requirement 9: /req/data-custom-depths/zone-depth-parameter

9.2. Parameter zone-depth

REQUIREMENT 9

IDENTIFIER	/req/data-custom-depths/zone-depth-parameter
INCLUDED IN	Requirements class 4: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-custom-depths

REQUIREMENT 9

STATEMENT	Parameter to specify the DGGs refinement levels beyond the specified DGGs zone's refinement level to include in the response, when retrieving data for that zone
A	The Implementation SHALL support a zone-depth parameter for the HTTP GET operation on a resource path ending with <code>.../dgg/{dggId}/zones/{zoneId}/data</code> .
B	The Implementation SHALL accept the following types of values for the zone-depth parameter: • A single positive integer value — representing a specific zone depth to return (e.g., zone-depth=5); • A range of positive integer values in the form “{low}-{high}” — representing a continuous range of zone depths to return (e.g., zone-depth=1-8); or, • A comma separated list of at least two (2) positive integer values — representing a set of specific zone depths to return (e.g., zone-depth=1, 3, 7). Some or all of these forms of the zone-depth parameter may not be supported with particular data packet encodings (the data encoding may support a fixed depth, a range of depths, and/or an arbitrary selection of depths).
C	For each zone depth to be included in the response, the interpretation of a selected depth (whether requesting a single depth, a range of depths, or a list of depths) SHALL be: • 0 corresponding to a single set of range (properties / field) value(s) for the requested zone, • 1 corresponding to all zones of the next deeper hierarchy level associated with the requested zone by the indexing scheme, • .. • <i>n</i> corresponding to all zones for the <i>n</i>'th deeper level in the hierarchy level associated with the requested zone by the indexing scheme.
D	The association of zones of deeper hierarchy levels with the requested zone SHALL be based on the DGGs reference system, which takes into consideration both the grid definition as well as the indexing system in use for the DGGs resource.
E	If a zone-depth is specified, the operation SHALL return the data at the refinement level(s) specified.

NOTE 1: A use case for a zone-depth of 0 would be to query the single set of values for a specific DGGs zone.

NOTE 2: For use cases such as visualization and performing analysis over a certain area, a non-zero zone-depth would normally be used to avoid an overwhelming number of server round-trips. In this case, more than a single value would be returned for each zone request, with values returned for descendent zones at zone-depth levels deeper than the requested zone's level. For example, requesting data for a level 10 zone with a zone-depth of 8 would return individual values for each level 18 zones contained within that level 10 zone being requested.

RECOMMENDATION 5

IDENTIFIER `/rec/data-custom-depths/beyond-max-depth`

STATEMENT For handling requests beyond `maxRelativeDepth`:

RECOMMENDATION 5

A

The Implementation SHOULD return a 4xx error for data retrieval beyond the `maxRelativeDepth` specified in the DGGRS description associated with the request.

10

REQUIREMENTS CLASS “FILTERING ZONE DATA WITH CQL2”

REQUIREMENTS CLASS “FILTERING ZONE DATA WITH CQL2”

10.1. Overview

The OGC API – DGGS “Filtering Zone Data with CQL2” requirements class defines a filter query parameter where an OGC Common Query Language (CQL2) expression can be used to filter the data returned for a zone, for example based on the properties / fields of the data, or for performing spatial and/or temporal intersections.

REQUIREMENTS CLASS 5: REQUIREMENTS CLASS FILTERING ZONE DATA WITH CQL2

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-cql2-filter
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.5: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-cql2-filter
PREREQUISITES	Requirements class 2: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval https://www.opengis.net/spec/cql2/1.0/req/cql2-text
NORMATIVE STATEMENT	Requirement 10: /req/data-cql2-filter/filter

10.2. Parameter filter

The following requirements describe how a client can specify a filtering CQL2 expression to apply on a zone data retrieval request.

REQUIREMENT 10

IDENTIFIER	/req/data-cql2-filter/filter
INCLUDED IN	Requirements class 5: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-cql2-filter

REQUIREMENT 10

STATEMENT For specifying a CQL2 expression filtering the data returned from a zone data request:

A	The Implementation SHALL support a <code>filter</code> query parameter specified using the CQL2-Text encoding of the OGC Common Query Language for the zone data retrieval operation (resource path ending with <code>.../dggs/{dggrsId}/zones/data</code>).
B	For a rasterized representation, the data returned SHALL have null or NODATA values for sub-zones where the CQL2 expression evaluates to false when considering the geometry and the data of that sub-zone.
C	For a vector representation, the data returned SHALL only include features where the CQL2 expression evaluates to true when considering the geometry and the data of that sub-zone.
D	The CQL2 expression evaluator SHALL support the queryables declared in the JSON Schema resource linked to from the origin of the DGGRS resources using the <code>[ogc-rel:queryables]</code> link relation type.

NOTE: The available queryables would typically include the fields of the data source being returned in the response.



11

REQUIREMENTS CLASS “ZONE QUERY”

11.1. Overview

The OGC API – DGGS “Zone Query” requirements class supports requesting the list of zones from a specific Discrete Global Grid Reference System (DGGRS), that is a specific hierarchy of Discrete Global Grids combined with a particular zone indexing reference system (ZIRS), for which there is data available, or matching a particular query (e.g., using a filtering parameter). This requirements class describes an HTTP GET operation, as well as its response. The selected DGGRS is listed as available and described in the Core requirements class, and conforms to [OGC Topic 21](#). The list of zones from a Web API using this requirements class can either be for a particular collection of geospatial data, for a dataset as a whole, or in connection with [OGC API – Processes – Part 3: Workflows & Chaining](#), the output of a processing workflow.

This requirements class enables a client to ask a question of the type “*Where is it?*”. The “*where*” refers to the spatiotemporal response encoded as a list of Zone IDs. The “*it*” refers to either the availability of data associated with a particular collection, dataset, or processing workflow (where the result itself could simply be this spatiotemporal region), as well as the evaluation of any additional filtering query expressed as per the CQL2 filtering requirements class.

Implementations of this requirements class are required to support at minimum the JSON encoding of zones list, and therefore also need to implement the JSON Zone List encoding requirements class.

REQUIREMENTS CLASS 6: REQUIREMENTS CLASS ZONE QUERY

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.6: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-query
PREREQUISITE	Requirements class 1: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/core
NORMATIVE STATEMENTS	Requirement 11: /req/zone-query/zones-list Requirement 12: /req/zone-query/zone-level Requirement 13: /req/zone-query/compact-zones Requirement 14: /rec/zone-query/parent-zone Requirement 15: /req/zone-query/bbox Requirement 16: /req/zone-query/bbox-crs Requirement 17: /req/zone-query/subset Requirement 18: /req/zone-query/subset-crs

11.2. Listing zones (.../dggs/{dggrsId}/zones)

The following requirements describe how a client can retrieve the list of zones from which data is available at the resource path .../dggs/{dggrsId}/zones.

REQUIREMENT 11

IDENTIFIER /req/zone-query/zones-list

INCLUDED IN Requirements class 6: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query>

STATEMENT For retrieving a list of DGGS zones.

- A** The Implementation SHALL support an HTTP GET operation at a resource path ending with .../dggs/{dggrsId}/zones.
- B** The Implementation SHALL include a link to this resource path in the “Core” .../dggs/{dggrsId} resource links using the link relation type <https://www.opengis.net/def/rel/ogc/1.0/dggs-zone-query>.
- C** The response of the HTTP GET operation SHALL have a status code of 200.
- D** The content of the response SHALL be a list of zones fully covering where data is available (in the case where the resource is associated with a particular dataset), and matching any additional query parameters specified by the client (e.g., a filtering query parameter), without any redundancy.
- E** Unless the zones are a compact list of zones (see compact-zones parameter), the zones returned SHALL all be of the same DGGS hierarchy level.
- F** The selection of an encoding for the returned list of zones SHALL be consistent with HTTP content negotiation.
- G** The Implementation SHALL support at minimum a JSON encoding (media type application/json) where each zone ID is specified as a string within an array of zones assigned to a zones property within a JSON object (e.g., { "zones": ["1-E-14", "1-E-15", "1-F-14", "1-F-15", "1-F-16"] }).

The following recommendation describes how the response should include the total surface area of the zones returned from the query (or volume / hypervolume in the case of spatiotemporal and/or 3D DGGS), excluding overlapping regions when returning compact zones.

RECOMMENDATION 6

IDENTIFIER /rec/zone-query/zone-total-area

STATEMENT For returning the total area (or volumes) occupied by zones returned by the query.

A The Implementation SHOULD indicate the total surface area (in the case of a 2D DGGs) or total (hyper)volume occupied (in the case of a 3D or 4D DGGs) occupied by the zones being returned, adding only once any overlaps which may occur for compact zone responses where zones are non-congruent.

11.3. Parameter zone-level

The following requirements describe how a client can specify the DGGs hierarchy level at which to retrieve the list of zones.

REQUIREMENT 12

IDENTIFIER /req/zone-query/zone-level

INCLUDED IN Requirements class 6: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query>

STATEMENT For specifying a level at which to return a list of DGGs zones using a zone-level query parameter.

A The Implementation SHALL support a zone-level query parameter for the zone query operation (resource path ending with .../dggs/{dggsId}/zones).

B If a compact zones list is used (the default), the zones returned in the response SHALL be of the DGGs hierarchy level specified by the zone-level query parameter, or of a lower hierarchy level standing in for a compact representation of multiple zones at the requested hierarchy level.

C If a compact zones list is not used, the zones returned in the response SHALL be of the DGGs hierarchy level specified by the zone-level query parameter.

11.4. Parameter compact-zones

By default, implementations return a compact list of zones where children zones fully covering a parent are recursively replaced by the parent zones, allowing to express large areas in a much more compact list of zones. The following requirements describe how a client can disable returning a compact list of zones.

REQUIREMENT 13

IDENTIFIER /req/zone-query/compact-zones

INCLUDED IN Requirements class 6: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query>

STATEMENT For specifying whether to retrieve a list of DGGS zones using a compact-zones parameter.

- | | |
|----------|---|
| A | The Implementation SHALL support a Boolean compact-zones query parameter for the zone query operation (resource path ending with .../dggs/{dggsId}/zones), where a value of true corresponds to the default behavior when the parameter is not specified, and a value of false disables the use of compact-zones in the response. |
| B | When the compact-zones parameter is set to false, the zones list response SHALL NOT be a compact list, and SHALL explicitly list every individual zone at the requested or default DGGS hierarchy level. |
| C | When the compact-zones parameter is set to true (or unspecified), the zones list response SHALL be a compact list, where children zones completely covering the area of a parent zone SHALL be replaced by that parent zone, in a recursive manner all the way to the lowest DGGS hierarchy level. |

11.5. Parameter parent-zone for hierarchical exploration

The following requirement describes how a client can specify a parent zone to only return zones within this parent zone, enabling the exploration of a large list in a hierarchical manner (in combination with zone-level) as multiple requests and responses.

REQUIREMENT 14

IDENTIFIER /rec/zone-query/parent-zone

INCLUDED IN Requirements class 6: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query>

STATEMENT For specifying a parent zone within which to restrict zone listing using a parent-zone query parameter.

- | | |
|----------|--|
| A | The Implementation SHALL support a parameter parent-zone zone identifier query parameter. |
| B | When specified, the response SHALL NOT contain zones which are not this parent zone itself or a sub-zone of that zone. |

RECOMMENDATION 7

IDENTIFIER /rec/zone-query/zone-order

STATEMENT Recommendation to follow the DGGRS sub-zone ordering

A When the parent-zone parameter is used, the Implementation SHOULD return a list of zones ordered according to the canonical sub-zone ordering defined by the DGGRS (the same order used for encoding values for data retrieval in formats such as DGGS-JSON relying on a shared understanding of this order by the server/producer and client/consumer).

11.6. Parameter limit for paging (recommendation)

The following recommendation describes how a client can specify a limit to the number of zones to be returned and page through large list of zones as multiple requests and responses.

RECOMMENDATION 8

IDENTIFIER /rec/zone-query/limit

STATEMENT For specifying a paging limit for the list of zones using a limit query parameter.

- A** The Implementation SHOULD support a parameter limit integer query parameter, with a minimum value of 1.
- B** The response SHOULD not contain more zones than specified by the optional limit parameter (if specified).
- C** If the API definition specifies a maximum value for the limit parameter, the response SHOULD not contain more zones than this maximum value.
- D** If the value of the limit parameter is larger than the maximum value, this SHOULD NOT result in an error (but instead be replaced by the maximum as the parameter value).
- E** If using compact zones, the parent zones SHOULD count as a single zone, rather than the number of children zones they stand in for.
- F** If an implementation does not return the full list of zones for the request, a link with relation type next SHOULD be included in a links array property of the response, which a client can request to resume listing the zones.

11.7. Parameter bbox

REQUIREMENT 15

IDENTIFIER /req/zone-query/bbox

INCLUDED IN Requirements class 6: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query>

STATEMENT For specifying a spatial bounding box for which to return a list of DGGS zones.

The Implementation SHALL support a bbox query parameter for the zone query operation (resource path ending with `.../dggs/{dggsId}/zones`) with the characteristics defined in the OpenAPI Specification 3.0 fragment:

bbox:

name: bbox

in: query

description:

Bounding box of the rendered map. The bounding box is provided as four or six coordinates

- * Lower left corner, coordinate axis 1
- * Lower left corner, coordinate axis 2
- * Minimum value, coordinate axis 3 (optional)
- * Upper right corner, coordinate axis 1
- * Upper right corner, coordinate axis 2
- * Maximum value, coordinate axis 3 (optional)

A

The coordinate reference system and axis order of the values are indicated in the ``bbox-crs`` parameter or if the parameter is missing in <https://www.opengis.net/def/crs/OGC/1.3/CRS84>

required: false

schema:

type: array

oneOf:

- minItems: 4

maxItems: 4

- minItems: 6

maxItems: 6

items:

type: number

format: double

style: form

explode: false

B

bbox SHALL be a comma separated list of four or six floating point numbers. If the bounding box consists of six numbers, the first three numbers are the coordinates of the lower bound corner of a three-dimensional bounding box and the last three are the coordinates of the upper bound corner. The axis order is determined by the `bbox-crs` parameter value or longitude and latitude if the parameter is missing (<https://www.opengis.net/def/crs/OGC/1.3/CRS84> axis order for a 2D bounding box, <https://www.opengis.net/def/crs/OGC/1.3/CRS84h> for a 3D bounding box). For example in <https://www.opengis.net/def/crs/OGC/1.3/CRS84> the order is `left_lon`, `lower_lat`, `right_lon`, `upper_lat`.

REQUIREMENT 15

C	The returned list of zone IDs SHALL only contain zones inside or intersecting with the spatial extent of the geographical area of the bounding box.
---	---

11.8. Parameter bbox-crs

REQUIREMENT 16

IDENTIFIER	/req/zone-query/bbox-crs
INCLUDED IN	Requirements class 6: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query
STATEMENT	For specifying the CRS used for the bbox parameter using the bbox-crs parameter.
A	The list of zones resource SHALL support a bbox-crs parameter specifying the CRS used for the bbox parameter.
B	For Earth centric data, the Implementation SHALL support https://www.opengis.net/def/crs/OGC/1.3/CRS84 as a value.
C	If the bbox-crs is not indicated https://www.opengis.net/def/crs/OGC/1.3/CRS84 SHALL be assumed.
D	The native CRS (storageCRS) SHALL be supported as a value. Other conformance classes may allow additional values (see crs parameter definition).
E	The CRS expressed as URIs or as safe CURIEs SHALL be supported.
F	If the bbox parameter is not used, the bbox-crs SHALL be ignored.

11.9. Parameter subset

REQUIREMENT 17

IDENTIFIER	/req/zone-query/subset
INCLUDED IN	Requirements class 6: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query

REQUIREMENT 17

STATEMENT For specifying a multi-dimensional subset for which to return a list of DGGS zones.

A	The Implementation SHALL support a subset query parameter for the zone query operation (resource path ending with .../dggs/{dggrsId}/zones) conforming to the following Augmented Backus Naur Form (ABNF) fragment: <pre> SubsetSpec: "subset"=axisName(intervalOrPoint) axisName: {text} intervalOrPoint: interval \ point interval: low : high low: point \ * high: point \ * point: {number} \ "{text}" Where: \" = double quote = ASCII code 0x42, {number} is an integer or floating-point number, and {text} is some general ASCII text (such as a time and date notation in ISO 8601).</pre>
B	The Implementation SHALL support as axis names Lat and Lon for geographic CRS and E and N for projected CRS, which are to be interpreted as the best matching spatial axis in the CRS definition.
C	If a third spatial dimension is supported (if the resource's spatial extent bounding box is three dimensional), the Implementation SHALL also support a h dimension (elevation above the ellipsoid in EPSG:4979 or CRS84h) for geographic CRS and z for projected CRS, which are to be interpreted as the vertical axis in the CRS definition.
D	The Implementation SHALL support as axis names time for a temporal dataset.
E	The Implementation SHALL support as axis names any additional dimension (beyond spatial and temporal) as described in the extent property of the collection or dataset description.
F	The Implementation SHALL return a 400 error status code if an axis name does not correspond to one of the axes of the Coordinate Reference System (CRS) of the data or an axis defined in the relevant extent property.
G	For a CRS where an axis can wrap around, such as subsetting across the dateline (anti-meridian) in a geographic CRS, a <i>low</i> value greater than <i>high</i> SHALL be supported to indicate an extent crossing that wrapping point.
H	The Implementation SHALL interpret the coordinates as values for the named axis of the CRS specified in the subset-crs parameter value or in https://www.opengis.net/def/crs/OGC/1.3/CRS84 (https://www.opengis.net/def/crs/OGC/1.3/CRS84h for vertical dimension) if the subset-crs parameter is missing.
I	If the subset parameter including any of the dimensions corresponding to those of the map bounding box is used with a bbox, the server SHALL return a 400 client error.
J	The Implementation SHALL interpret multiple subset parameters, as if all dimension subsetting values were provided in a single subset parameter (comma separated). Example: subset=Lat(-90:90)&subset=Lon(-180:180) is equivalent to subset=Lat(-90:90),Lon(-180:180)

NOTE 1: A subset parameter for <https://www.opengis.net/def/crs/OGC/1.3/CRS84> will read as subset=Lon(left_lon:right_lon),Lat(lower_lat:upper_lat).

NOTE 2: When the *interval* values fall partially outside of the range of valid values defined by the CRS for the identified axis, the service is expected to return the non-empty portion of the resource resulting from the subset.

NOTE 3: For the operation of returning a list of zone IDs, there normally is no value in preserving dimensionality, therefore a *slicing* operation (using the *point* notation) is usually equivalent to a *trimming* operation (using the *interval* notation) when the low and high bounds of an interval are the same. Therefore, use of the point notation is encouraged in these cases.

RECOMMENDATION 9

IDENTIFIER /rec/zone-query/subset-crs-axis-names

A	The names of the axis SHOULD be the abbreviated names of the axis in the CRS definition (e.g. the ones defined in the EPSG database).
B	'e' (in lowercase), 'X' (lowercase/uppercase) or 'Easting' (lowercase/uppercase) SHOULD be interpreted as synonymous of 'E'.
C	'n' (in lowercase) or 'Y' (lowercase/uppercase) or 'Northing' (lowercase/uppercase) SHOULD be interpreted as synonymous of 'N'.
D	'Long' (lowercase/uppercase) or 'Longitude' SHOULD be interpreted as synonymous of 'Lon'.
E	'Latitude' SHOULD be interpreted as synonymous of 'Lat'.

11.10. Parameter subset-crs

REQUIREMENT 18

IDENTIFIER /req/zone-query/subset-crs

INCLUDED IN Requirements class 6: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query>

STATEMENT For specifying the CRS used for the subset parameter using the subset-crs parameter.

A	The zone listing operation SHALL support a parameter subset-crs with the characteristics identifying the CRS in which the subset parameter is specified with a URI or safe CURIE.
B	For Earth centric data, https://www.opengis.net/def/crs/OGC/1.3/CRS84 as a value SHALL be supported.

REQUIREMENT 18

C	If the subset-crs is not indicated, https://www.opengis.net/def/crs/OGC/1.3/CRS84 SHALL be assumed.
D	The native CRS (storageCRS) SHALL be supported as a value. Other requirements classes may allow additional values (see crs parameter definition).
E	CRSs expressed as URIs or as safe CURIEs SHALL be supported.
F	If no subset parameter referring to an axis of the CRS is used, the subset-crs SHALL be ignored.

11.11. Parameter datetime

REQUIREMENT 19

IDENTIFIER /req/zone-query/datetime

INCLUDED IN Requirements class 6: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query>

STATEMENT For specifying a multi-dimensional subset for which to return a list of DGGS zones.

A The Implementation SHALL support a datetime parameter expressed corresponding to either a date-time instant or a time interval, conforming to the following syntax (using [ABNF](#)):

interval-bounded	= instant "/" instant
interval-bounded-start	= [".."] "/" instant
interval-bounded-end	= instant "/" [".."]
interval-unbounded	= [".."] "/" [".."]
interval	= interval-bounded / interval-bounded-start / interval-bounded-end / interval-unbounded
datetime	= instant / interval

B The implementation SHALL support an instant defined as specified by [RFC 3339, 5.6](#), with the exception that the server is only required to support the Z UTC time notation, and not required to support local time offsets.

C Only the zones with data whose geometry intersect with the specified temporal interval SHALL be part of the zone list response.

D Time intervals unbounded at the start or at the end SHALL be supported using a double-dot (..) or an empty string for the start/end.

E If a datetime parameter is specified requesting zone data where no temporal dimension applies, the Implementation SHALL either ignore the parameter or return a 4xx client error.

12

REQUIREMENTS CLASS “FILTERING ZONE QUERIES WITH CQL2”

REQUIREMENTS CLASS “FILTERING ZONE QUERIES WITH CQL2”

12.1. Overview

The OGC API — DGGS “Filtering Zone Queries with CQL2” requirements class defines a filter query parameter where an OGC Common Query Language (CQL2) expression can be used to filter the list of returned zones. Such CQL2 queries enable filtering based on the properties / fields of the data, or on spatiotemporal intersections.

REQUIREMENTS CLASS 7: REQUIREMENTS CLASS FILTERING ZONE QUERIES WITH CQL2

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query-cql2-filter
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.7: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-query-cql2-filter
PREREQUISITES	Requirements class 6: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query https://www.opengis.net/spec/cql2/1.0/req/cql2-text
NORMATIVE STATEMENT	Requirement 20: /req/zone-query-cql2-filter/filter

12.2. Parameter filter

The following requirements describe how a client can specify a filtering CQL2 expression querying a list of zones.

REQUIREMENT 20

IDENTIFIER	/req/zone-query-cql2-filter/filter
INCLUDED IN	Requirements class 7: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query-cql2-filter

REQUIREMENT 20

STATEMENT For specifying a CQL2 expression filtering the zones returned from a zone query:

- | | |
|----------|---|
| A | The Implementation SHALL support a <code>filter</code> query parameter specified using the CQL2-Text encoding of the OGC Common Query Language for the zone query operation (resource path ending with <code>.../dggs/{dggrsId}/zones</code>). |
| B | The list of returned zones SHALL only be those for which the CQL2 expression evaluates to true when considering the geometry and the data of the DGGS zones resource being queried. |
| C | The CQL2 expression evaluator SHALL support the queryables declared in the JSON Schema resource linked to from the origin of the DGGRS resources using the <code>[ogc-rel:queryables]</code> link relation type. |

NOTE: The available queryables would typically include the fields of the data source, which may also be retrieved using the Data Retrieval requirements class.



13

REQUIREMENTS CLASS “ROOT DGGS”

13.1. Overview

The OGC API — DGGS “Root DGGS” Requirements Class defines the availability of DGGS resources applying to a whole dataset or API, as defined by *OGC API — Common — Part 1: Core*.

REQUIREMENTS CLASS 8: REQUIREMENTS CLASS ROOT DGGS

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/root-dggs
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.8: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/root-dggs
PREREQUISITE	https://www.opengis.net/spec/ogcapi-common-1/1.0/req/core
NORMATIVE STATEMENT	Requirement 21: /req/root-dggs/dggs

13.2. Root DGGS (/dggs)

REQUIREMENT 21

IDENTIFIER	/req/root-dggs/dggs
INCLUDED IN	Requirements class 8: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/root-dggs
STATEMENT	For API/dataset-wide DGGS resources:
A	The Implementation SHALL support the resource paths and associated HTTP methods defined in the “Core” requirements class, as well as any additional resources defined in other requirements classes to which the Implementation declares conformance, for the root of the API as an origin. If the API allows to retrieve and/or query data, this means that the data returned or queried considers all collections comprising the dataset (unless an extension is used to select specific collections e.g.

REQUIREMENT 21

, using a `collections` parameter). The root DGGRS origin can also be used in API deployment not associated with any dataset, solely for the purpose of exploring and demonstrating the DGGRS.

B

The Implementation SHALL include a link to the list of available DGGRSs for the API/dataset at `/dggs` in the links of the landing page using the link relation type `[ogc-rel:dggrs-list]`.

C

If the API deployment supports querying or retrieving data from a dataset, the `/dggs` and `/dggs/{dggrsId}` resources SHALL include a link to the landing page using the link relation type `[ogc-rel:dataset]`.



14

REQUIREMENTS CLASS “COLLECTION DGGS”

14.1. Overview

The OGC API — DGGS “Collection DGGS” Requirements Class defines the availability of DGGS resources applying to one or more collections of geospatial data, as defined by *OGC API — Common — Part 2: Geospatial data*.

REQUIREMENTS CLASS 9: REQUIREMENTS CLASS COLLECTION DGGS

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/collection-dggs
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.9: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/collection-dggs
PREREQUISITE	https://www.opengis.net/spec/ogcapi-common-2/1.0/req/collections
NORMATIVE STATEMENT	Requirement 22: /req/collection-dggs/dggs

14.2. Collection DGGS (/collections/{collectionId}/dggs)

REQUIREMENT 22

IDENTIFIER	/req/collection-dggs/dggs
INCLUDED IN	Requirements class 9: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/collection-dggs
STATEMENT	For collection DGGS resources:
A	The Implementation SHALL support the resource paths and associated HTTP methods defined in the “Core” requirements class, as well as any additional resources defined in other requirements classes to which the Implementation declares conformance, for at least one collection of the dataset offered by the API deployment.

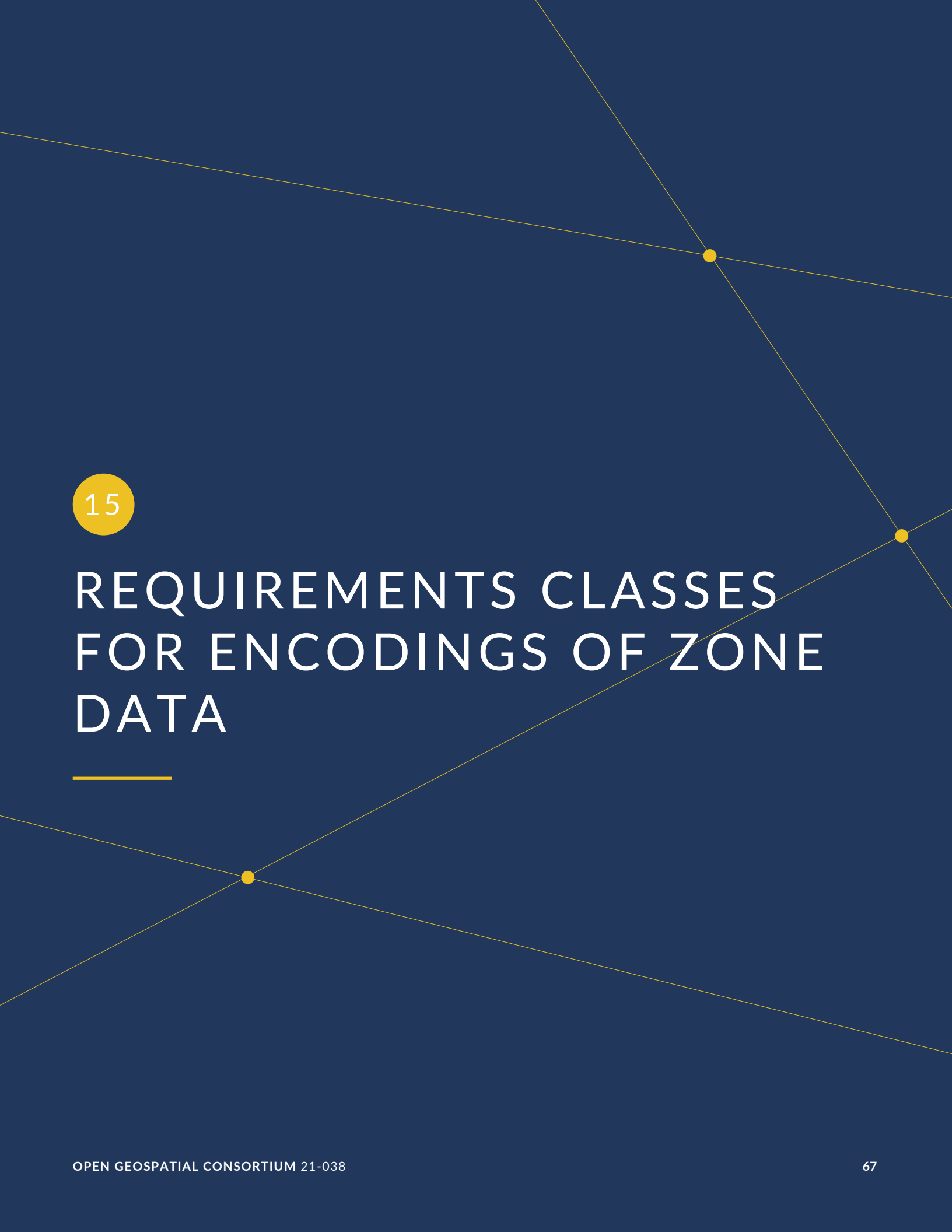
REQUIREMENT 22

B

The Implementation SHALL include a link to the list of available DGGRSs for the collection at /collections/{collectionId}/dggs in the links of the collection using the link relation type [ogc-rel:dggrs-list].

C

The /collections/{collectionId}/dggs and /collections/{collectionId}/dggs/{dggrsId} resources SHALL include a link to the collection using the link relation type [ogc-rel:geodata].



15

REQUIREMENTS CLASSES FOR ENCODINGS OF ZONE DATA

REQUIREMENTS CLASSES FOR ENCODINGS OF ZONE DATA

The OGC API – DGG Standard does not mandate any particular encoding or format in which to return the `.../dggs/{dggsId}/zones/{zoneId}/data` resources. DGG Zone Data can be encoded in any suitable data format. However, the Standard does define requirements classes for zone data encodings which are expected to be commonly supported in implementations of this standard. These requirements classes include:

For data rasterized to DGGRS sub-zones:

- DGG-JSON Data
- DGG-UBJSON Data
- Zarr Data

For vector features whose geometry coordinates are quantized to DGGRS sub-zones:

- DGG-FG-JSON Data
- DGG-FG-UBJSON Data

For rasterized data output readily usable in non-DGG systems or to facilitate interoperability with other DGGs:

- GeoTIFF Data
- netCDF Data
- CoverageJSON Data
- JPEG XL Data
- PNG Data

For vector features output readily usable in non-DGG systems or to facilitate interoperability with other DGGs:

- GeoJSON Data
- FG-JSON Data

15.1. Media Types (for zone data)

A table of the media types used in the encoding of the Zone Data requirements classes defined in this Standard follows.

Table 2 — Media Types used for zone data encoding requirements classes

Encoding	Media type
DGGS-JSON zone data	application/json
DGGS-UBJSON zone data	application/ubjson
DGGS-FG-JSON zone data	application/fg+json (with geometry=quantized or geometry=quantized-zoneids query parameter)
DGGS-FG-UBJSON zone data	application/fg+ubjson (with geometry=quantized or geometry=quantized-zoneids query parameter)
GeoJSON data	application/geo+json
JSON-FG data	application/fg+json
GeoTIFF data	image/tiff; application=geotiff
netCDF zone data	application/x-netcdf
Zarr zone data	application/zarr+zip
CoverageJSON zone data	application/prs.coverage+json
PNG zone data	image/png
JPEG XL zone data	image/jxl

15.2. Requirements Class “DGGGS-JSON Zone data encoding” (for data rasterized to sub-zones)

15.2.1. Overview

The DGGGS-JSON Zone Data encoding requirements class defines support for encoding a DGGGS Zone data response in JSON, using a schema defined below named “DGGGS-JSON”.

This encoding is intended to support one-to-one mapping of sub-zones values, for one or more zone depths, regardless of zone geometry type, in a human-readable format.

Values are encoded as a one-dimensional array following a sub-zone order defined by the DGGRS.

Example encodings follow:

```
{
  "$schema" : "https://schemas.opengis.net/ogcapi/dggs/part1/1.0/openapi/
schemas/dggs-json/schema",
  "dggrs": "https://www.opengis.net/def/dggrs/OGC/1.0/ISEA3H",
  "zoneId": "C0-2B-A",
  "depths": [ 0, 1 ],
  "schema":
  {
    "$schema" : "https://json-schema.org/draft/2020-12/schema",
    "$id" : "https://example.com/ogcapi/collections/climate/schema",
    "title" : "Temperature",
    "type": "object",
    "properties":
    {
      "t": {
        "type": "number",
        "title": "air temperature in celsius",
        "x-ogc-propertySeq" : 1,
        "x-ogc-definition": "https://qudt.org/vocab/quantitykind/
Temperature",
        "x-ogc-unit": "C"
      }
    }
  },
  "values":
  {
    "t": [
      {
        "depth": 0,
        "shape": { "count": 1, "subZones": 1 },
        "data": [ 22.8 ]
      },
      {
        "depth": 1,
        "shape": { "count": 7, "subZones": 7 },
        "data": [ 25.1, 25.8, 22.0, 23.1, 22.8, 20.0, 17.1 ]
      }
    ]
  }
}
```

```

    }
}

```

Listing 6 — Example encoding for DGGS-JSON

```

{
  "$schema" : "https://schemas.opengis.net/ogcapi/dggs/part1/1.0/openapi/
schemas/dggs-json/schema",
  "dggrs": "https://www.opengis.net/def/dggrs/OGC/1.0/ISEA3H",
  "zoneId": "C0-2B-A",
  "depths": [ 0, 1 ],
  "schema":
  {
    "$schema" : "https://json-schema.org/draft/2020-12/schema",
    "$id" : "https://example.com/ogcapi/collections/climate/schema",
    "title" : "Climate Variables",
    "type": "object",
    "properties":
    {
      "rh": {
        "type": "number",
        "title": "relative humidity",
        "x-ogc-propertySeq" : 1,
        "x-ogc-definition": "https://qudt.org/vocab/quantitykind/
RelativeHumidity"
      },
      "t": {
        "type": "number",
        "title": "air temperature in celsius",
        "x-ogc-propertySeq" : 2,
        "x-ogc-definition": "https://qudt.org/vocab/quantitykind/
Temperature",
        "x-ogc-unit": "C"
      },
      "ua": {
        "type": "number",
        "title": "Eastward wind",
        "x-ogc-propertySeq" : 3,
        "x-ogc-definition": "https://qudt.org/vocab/quantitykind/Speed",
        "x-ogc-unit": "m/s"
      },
      "va": {
        "type": "number",
        "title": "Northward wind",
        "x-ogc-propertySeq" : 4,
        "x-ogc-definition": "https://qudt.org/vocab/quantitykind/Speed",
        "x-ogc-unit": "m/s"
      }
    }
  },
  "dimensions" : [
    {
      "name": "time",
      "interval" : [ "2020-01-01", "2020-04-30" ],
      "grid" : { "cellsCount" : 4, "resolution" : "P1M" }
    },
    {
      "name": "pressure",
      "definition": "https://qudt.org/vocab/quantitykind/AtmosphericPressure",
      "unit" : "hPa",
      "interval" : [ 850.0, 50.0 ],
      "grid" : { "cellsCount" : 3, "coordinates" : [ 850.0, 250.0, 50.0 ] }
    }
  ]
}

```

```

    ],
    "values":
    {
        "rh": [
            {
                "depth": 0,
                "shape": { "count": 9, "subZones": 1, "dimensions": { "time": 4,
"pressure": 3 } } },
                "data": [
                    25.1, 25.8, 22.0,    23.1, 22.8, 20.0,    17.1, 12.8, 14.0,    24.1,
13.8, 12.0
                ]
            },
            {
                "depth": 1,
                "shape": { "count": 84, "subZones": 7, "dimensions": { "time": 4,
"pressure": 3 } } },
                "data": [
                    23.2, 25.8, 22.0,    22.8, 20.0, 22.0,    17.1, 12.8, 14.0,    23.1,
17.0, 24.0,
                    22.1, 23.8, 22.0,    28.0, 23.2, 22.8,    18.0, 22.0, 17.1,    12.8,
12.0, 17.0,
                    25.2, 25.8, 22.0,    27.0, 23.1, 22.8,    21.0, 20.0, 16.1,    12.8,
14.0, 12.0,
                    24.1, 24.8, 21.0,    23.0, 23.3, 22.8,    23.0, 22.0, 17.1,    12.8,
13.0, 17.0,
                    25.1, 25.8, 22.0,    21.0, 22.1, 22.8,    22.0, 21.0, 13.1,    12.8,
14.0, 14.0,
                    26.1, 25.8, 20.0,    22.0, 23.5, 22.8,    21.0, 22.0, 17.1,    12.8,
11.0, 17.0
                ]
            }
        ],
        "t": [ ... ], "ua": [ ... ], "va": [ ... ]
    }
}

```

Listing 7 — A more complex example encoding for DGGS-JSON with more variables and additional dimensions beyond those of the DGRS

REQUIREMENTS CLASS 10: REQUIREMENTS CLASS DGGS-JSON ZONE DATA

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-json
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.10: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-json
PREREQUISITES	JSON Requirements class 2: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval
NORMATIVE STATEMENT	Requirement 23: /req/data-json/content

REQUIREMENT 23

IDENTIFIER /req/data-json/content

INCLUDED IN	Requirements class 10: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-json
A	Every 200 response of the server for zone data with the media type application/json SHALL be a JSON document representing the data values for all selected fields of each included sub-zone.
B	The schema for the JSON document SHALL follow the JSON Schema for DGGS-JSON described below.
C	Every zone depth requested using the zone-depth parameter SHALL be included in the response.
D	At every depth, each individual value SHALL correspond exactly to the data sampled representative of that sub-zone.
E	The list of data values SHALL follow the default zone order as specified by the Discrete Global Grid Reference System (for example based on a scanline or space-filling curved defined therein) for which the request is made.
F	Null values SHALL use the null JSON value.

```
{
  "$schema" : "https://json-schema.org/draft/2020-12/schema",
  "$id" : "https://schemas.opengis.net/ogcapi/dggs/part1/1.0/openapi/schemas/
dggs-json/schema",
  "type": "object",
  "properties":
  {
    "dggrs" : { "type": "string", "format": "uri" },
    "zoneId" : { "type": "string" },
    "depths" : { "type": "array", "items": { "type": "integer", "minimum": 0 }
  },
  "schema" : { "$ref": "https://json-schema.org/draft/2020-12/schema" },
  "dimensions" :
  {
    "type": "array",
    "items":
    {
      "type": "object",
      "properties":
      {
        "name": { "type": "string" },
        "definition": { "type": "string", "format": "uri" },
        "unit": { "type": "string" },
        "unitLang": { "type": "string", "format": "uri" },
        "grid":
        {
          "type": "object",
          "properties":
          {
            "cellsCount" : { "type": "integer" },
            "resolution" : { },
            "coordinates": {
              "type": "array",
              "items": {
```

```

        "oneOf": [
            { "type": "number", "nullable": true },
            { "type": "string", "nullable": true },
        ]
    }
}
},
"interval": {
    "type": "array",
    "items": {
        "oneOf": [
            { "type": "number", "nullable": true },
            { "type": "string", "nullable": true },
        ]
    }
},
"required": [ "name", "interval", "grid" ]
}
},
"values" :
{
    "additionalProperties":
    {
        "type": "array",
        "items":
        {
            "type": "object",
            "properties":
            {
                "depth": { "type": "integer" },
                "shape":
                {
                    "type": "object",
                    "properties":
                    {
                        "count": { "type": "integer" },
                        "subZones": { "type": "integer" },
                        "dimensions":
                        {
                            "type": "object",
                            "additionalProperties": { "type": "integer" }
                        }
                    }
                },
                "required": [ "count", "subZones" ]
            },
            "data":
            {
                "type": "array",
                "items":
                {
                    "type": "number",
                    "nullable": true
                }
            }
        }
    }
}
},
"required": [ "dggrs", "zoneId", "depths", "values" ]

```

}

Listing 8 — JSON Schema for DGGS-JSON

IMPORTANT

*For DGGS-JSON containing additional dimensions, the one-dimensional array of *values* is ordered in a sub-zone order major manner. This is so all values of a particular field for a given sub-zone are regrouped together. Values for the first dimensions listed in the *dimensions* array are then regrouped together, followed by additional dimensions as they appear in order in the *dimensions* array.*

15.3. Requirements Class “DGGS-UBJSON Zone data encoding” (for data rasterized to sub-zones)

15.3.1. Overview

The DGGS-UBJSON Zone Data encoding requirements class defines support for encoding a DGGS Zone data response using the same JSON structure as the above JSON data requirements class but using the binary UBJSON encoding.

REQUIREMENTS CLASS 11: REQUIREMENTS CLASS UBJSON

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-ubjson
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.11: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-ubjson
PREREQUISITES	https://ubjson.org/ Requirements class 2: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval
NORMATIVE STATEMENT	Requirement 24: /req/data-ubjson/content

REQUIREMENT 24

IDENTIFIER	/req/data-ubjson/content
------------	---

REQUIREMENT 24

INCLUDED IN	Requirements class 11: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-ubjson
A	Every 200 response of the server for zone data with the media type <code>application/ubjson</code> SHALL be a <u>Universal Binary JSON</u> document representing the data values for all selected fields for a single zone.
B	The schema for the UBJSON document SHALL follow the same JSON Schema as for DGGS-JSON described above.
C	Every zone depth requested using the <code>zone-depth</code> parameter SHALL be included in the response.
D	At every depth, each individual value SHALL correspond exactly to the data sampled representative of that zone geometry.
E	The list of data values SHALL follow the default zone order as specified by the Discrete Global Grid Reference System (for example based on a scanline or space-filling curve defined therein) for which the request is made.
F	Null values SHALL use the <code>null</code> JSON value.

The `py-ubjson` tool can be used to easily convert between JSON and UBJSON. After installing with `pip3 install py-ubjson`, a DGGS-JSON file can be converted to DGGS-(UB)JSON with `ubjson fromjson zoneData.dggs.json`, and a DGGS-(UB)JSON file can be converted to DGGS-JSON with `ubjson tojson zoneData.dggs.ubj`.

15.4. Requirements Class “DGGS-FG-JSON Zone data encoding” (for geometry coordinates quantized to sub-zones)

15.4.1. Overview

The DGGS-FG-JSON Zone Data encoding requirements class defines support for encoding a DGGS Zone data response for vector features in JSON. This is accomplished by extending OGC Features & Geometry JSON with the concepts of DGGRS, reference parent zone, relative depth and deterministic sub-zone order, allowing to encode coordinates pairs as local sub-zone indices. Alternatively, coordinates can be encoded using global zone IDs.

DGGS-FG-JSON Zone Data is intended to support efficient encoding of vector geometry at arbitrary precision using finer grids to locally address the inside of the reference parent zones.

This is done in a manner agnostic of the DGGRS (which needs to define a deterministic sub-zone order), in a human-readable format sharing as much as possible with existing practice for exchanging geospatial vector data in JSON.

Example encodings follow:

```
{
  "conformsTo": [
    "https://www.opengis.net/spec/json-fg-1/0.2/conf/core",
    "https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-dggs-fgjson"
  ],
  "dggrs": "[ogc-dggrs:ISEA3H]",
  "zoneId": "I0-1EFA652-D",
  "depth": "15",
  "type": "FeatureCollection",
  "features": [ {
    "type": "Feature",
    "id": 2305843009218664049,
    "geometry": null,
    "place": null,
    "time": null,
    "dggsPlace": {
      "type": "LineString",
      "coordinates": [ 13866054, 13899376, 13953688 ]
    },
    "properties": {
      "highway": "service",
      "name": "Parliament Road",
      "name:fr": "chemin Parliament",
      "access": "no"
    }
  }, {
    "type": "Feature",
    "id": 2305843009218664071,
    "geometry": null,
    "place": null,
    "time": null,
    "dggsPlace": {
      "type": "LineString",
      "coordinates":
    ...
  }
```

Listing 9 — Example encoding of DGGS-FG-JSON for OpenStreetMap data

```
{
  "conformsTo": [
    "https://www.opengis.net/spec/json-fg-1/0.2/conf/core",
    "https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-dggs-fgjson"
  ],
  "dggrs": "[ogc-dggrs:ISEA3H]",
  "zoneId": "B0-5-A",
  "depth": "15",
  "geometryDimension": 2,
  "type": "FeatureCollection",
  "features": [
    {
      "type": "Feature",
      "id": 1,
      "properties": {
        "scalerank": 0,
        "featurecla": "Bathymetry"
      }
    },
  ],
}
```



```

    "geometry" : null,
    "place": null,
    "time" : null,
    "dggsPlace": {
      "type": "MultiPolygon",
      "coordinates": [
        [ 14355360, 14355250, 14355141, 14355032, 14354922, 14354813, .
..

```

Listing 10 — Example encoding of DGGS-FG-JSON for Natural Earth bathymetry in the arctic

REQUIREMENTS CLASS 12: REQUIREMENTS CLASS DGGS-FG-JSON ZONE DATA	
IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-dggs-fgjson
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.12: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-dggs-fgjson
PREREQUISITES	JSON Requirements class 2: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval https://www.opengis.net/spec/json-fg-1/0.3/req/core
NORMATIVE STATEMENT	Requirement 25: /req/data-dggs-fgjson/content

REQUIREMENT 25	
IDENTIFIER	/req/data-dggs-fgjson/content
INCLUDED IN	Requirements class 12: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-dggs-fgjson
A	The Implementation SHALL support a geometry query parameter with a value of either quantized or quantized-zoneids allowing a client to request a DGGS-FG-JSON response.
B	Every 200 response of the server for zone data with the media type <code>application/fg+json</code> and a <code>geometry=quantized</code> (or <code>geometry=quantized-zoneids</code>) query parameter SHALL be an extended <u>Features & Geometry JSON</u> (FG-JSON) document representing the vector features within the requested zone.
C	The JSON document SHALL follow the JSON Schema for FG-JSON, with geometry stored in a <code>dggsPlace</code> property mirroring the FG-JSON <code>place</code> schema and supporting all of the same feature types, but where <code>coordinates</code> use sub-zone indices (for <code>geometry=quantized</code>) or global textual zone identifiers (for <code>geometry=quantized-zoneids</code>) as described in later parts of this requirement.
D	The JSON document SHALL additionally contain a <code>dggrs</code> property set to the URI or CURIEs of the DGGRS of the response, which replaces the <code>coordRefSys</code> property and concept.

REQUIREMENT 25

E	The JSON document SHALL additionally contain a <code>zoneId</code> property indicating the requested reference zone.
F	The JSON document SHALL additionally contain a <code>depth</code> property corresponding to the relative zone depth (as specified in the single depth format of the OGC API — DGGs <code>zone-depth</code> parameter for zone data retrieval), determining how coordinates are resolved from sub-zone indices (in the case of <code>geometry=quantized</code>), and as a result, their precision.
G	For <code>geometry=quantized</code> , the JSON document SHALL contain a <code>dggsPlace</code> property specifying geometry using local sub-zone indices ranging from 1 to the number of sub-zones within the reference parent zone at the declared depth, based on the deterministic sub-zone order of the DGGRS.
H	For <code>geometry=quantized-zoneids</code> , the JSON document SHALL contain a <code>dggsPlace</code> property specifying geometry using global textual zone identifiers (as defined in the DGGRS zone indexing reference system) at the declared depth.
I	When all spatial coordinates are dimensions of the DGGRS, the array of coordinates including the square brackets SHALL be replaced by the local index or global identifier of the sub-zone within which the coordinates are located.
J	When additional spatial coordinates that are not part of the DGGRS, such as elevation above ground for a 2D DGGRS, are needed to define the geometry coordinates, only the coordinates corresponding to DGGRS dimensions SHALL be replaced by the local index or global identifier of the sub-zone.
K	Only features fully or partly located within the reference zone SHALL be included.
L	For feature geometry intersecting the boundaries of the reference zone, the sub-zone within which the intersection is located SHALL be included, with a separate single <code>0</code> special sub-zone index (in the case of <code>geometry=quantized</code>) or a null value (in the case of <code>geometry=quantized-zoneids</code>) representing all outside points before a point inside, after a point inside, or in between two inside points.
M	For geometry in two or more dimensions with an outside point (identified by a <code>0</code> sub-zone index for <code>geometry=quantized</code> or null for <code>geometry=quantized-zoneids</code>) and which is necessarily between two contour points, the portion of the zone edge(s) between the exit and entry point SHALL be considered inside of that contour.

15.5. Requirements Class “DGGS-FG-UBJSON Zone data encoding” (for geometry coordinates quantized to sub-zones)

15.5.1. Overview

The DGGS-UB-FGJSON Zone Data encoding requirements class defines support for encoding a DGGS Zone data response for vector features using the same JSON structure as the above DGGS-FG-JSON data requirements class, but using the binary UBJSON encoding.

REQUIREMENTS CLASS 13: REQUIREMENTS CLASS DGGS-FG-UBJSON

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-dggs-fgubjson
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.13: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-dggs-fgubjson
PREREQUISITES	https://ubjson.org/ Requirements class 2: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval https://www.opengis.net/spec/json-fg-1/0.3/req/core
NORMATIVE STATEMENT	Requirement 26: /req/data-dggs-fgubjson/content

REQUIREMENT 26

IDENTIFIER	/req/data-dggs-fgubjson/content
INCLUDED IN	Requirements class 13: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-dggs-fgubjson
A	The Implementation SHALL support a geometry query parameter with a value of either quantized or quantized-zoneids allowing a client to request a DGGS-FG-UBJSON response.
B	Every 200 response of the server for zone data with the media type <code>application/fg+ubjson</code> and a <code>geometry=quantized</code> (or <code>geometry=quantized-zoneids</code>) query parameter SHALL be a <u>Universal Binary JSON</u> document representing the vector features within the requested zone.
C	The content of the UBJSON document SHALL follow all the of same requirements as for DGGS-FG-JSON described above.

The `py-ubjson` tool can be used to easily convert between JSON and UBJSON. After installing with `pip3 install py-ubjson`, a DGGs-FG-JSON file can be converted to DGGs-FG-UBJSON with `ubjson fromjson zoneData.dggsfg.json`, and a DGGs-FG-UBJSON file can be converted to DGGs-FG-JSON with `ubjson tojson zoneData.dggsfg.ubj`.

15.6. Requirements Class “GeoTIFF Zone data encoding”

15.6.1. Overview

The GeoTIFF Zone Data encoding requirements class defines support for encoding a DGGs Zone data response according to the [OGC GeoTIFF standard](#).

GeoTIFF is a commonly used format for representing 2-dimensional gridded coverages.

For a DGGs with non-rectangular zones (e.g., hexagonal zones), a GeoTIFF representation can be the minimal bounding rectangle of the zone shape, with NODATA values used outside the bounds of the zone.

REQUIREMENTS CLASS 14: REQUIREMENTS CLASS GEOTIFF DATA

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-geotiff
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.14: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-geotiff
PREREQUISITES	TIFF V6.0 GeoTIFF Requirements class 2: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval
NORMATIVE STATEMENT	Requirement 27: /req/data-geotiff/content

REQUIREMENT 27

IDENTIFIER	/req/data-geotiff/content
INCLUDED IN	Requirements class 14: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-geotiff

REQUIREMENT 27

A	Every 200 response of the server for zone data with the media type image/tiff SHALL be a TIFF image representing the data values for all selected fields for a single zone.
B	If the TIFF encoding incorporates a GeoTIFF georeference, this information SHALL be consistent with the DGGRS Zone ID.
C	If the zone geometry is not rectangular, the closest bounding rectangle SHALL be used for referencing the image.
D	A distinct value for each sub-zone implied from the requested zone-depth SHALL correspond to at least one distinct cell value in the response.
E	For Implementations supporting Data Custom Depths, each depth of the requested zone depth pyramid SHALL be a separate image (overview) in the response.

RECOMMENDATION 10

IDENTIFIER /rec/data-geotiff/null-values

A	Null values SHOULD be used for cells lying outside the zone geometry.
---	---

RECOMMENDATION 11

IDENTIFIER /rec/data-geotiff/crs

A	The CRS of the response SHOULD be consistent with either the DGGRS or the underlying geographic CRS (e.g., CRS84).
---	--

15.7. Requirements Class “GeoJSON Zone data encoding”

15.7.1. Overview

The GeoJSON Zone Data encoding requirements class defines support for encoding a DGGS Zone data response according to the [GeoJSON specification](#).

GeoJSON is a commonly used format for representing features with simple geometries and related properties. GeoJSON is simple to understand and is well supported by tools and software libraries. Since most Web developers are comfortable with using JSON-based formats, supporting GeoJSON is recommended for a vector representation of DGGS Zone data.

REQUIREMENTS CLASS 15: REQUIREMENTS CLASS GEOJSON

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-geojson
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.15: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-geojson
PREREQUISITES	GeoJSON Requirements class 2: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval
NORMATIVE STATEMENT	Requirement 28: /req/data-geojson/content

REQUIREMENT 28

IDENTIFIER	/req/data-geojson/content
INCLUDED IN	Requirements class 15: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-geojson
A	Every 200 response of the server for zone data with the media type <code>application/geo+json</code> SHALL be a <u>GeoJSON</u> document representing the features, including their geometry and associated properties, for a single zone.
B	Unless otherwise specified by a prior arrangement (for example, a <code>crs</code> output parameter), the coordinate reference system SHALL be CRS84(h) in longitude and latitude (and optional height above the WGS84 ellipsoid).
C	Features whose geometry lie wholly outside of the zone geometry SHALL NOT be included in the response.

RECOMMENDATION 12

IDENTIFIER	/rec/data-geojson/clipping
A	For features partially inside of the zone geometry, the geometry included in the response SHOULD be clipped to the boundaries of the zone geometry.

RECOMMENDATION 13

IDENTIFIER	/rec/data-geojson/generalization
------------	----------------------------------

RECOMMENDATION 13

- A** The geometry of the features in the response **SHOULD** be generalized to the scale associated with the hierarchy level implied from the zone-depth relative to the requested zone.

RECOMMENDATION 14

IDENTIFIER /rec/data-geojson/omission

- A** For datasets whose features have either a size (such as areal or linear feature) or other properties making some features irrelevant at lower hierarchy levels, such irrelevant features **SHOULD** be omitted from the response based on the hierarchy level implied from the zone-depth relative to the requested zone.

RECOMMENDATION 15

IDENTIFIER /rec/data-geojson/geometry

- A** The implementation **SHOULD** support a geometry query parameter allowing a client to choose how to return feature geometry.
- B** The implementation **SHOULD** support a value of geometry=zone-centroid to request a representation where each feature is a zone intersecting the data, with the feature geometry of each feature being a Point geometry for the centroid of that zone.
- C** The implementation **SHOULD** support a value of geometry=zone-region to request a representation where each feature is a zone intersecting the data, with the feature geometry of each feature being a (Multi)Polygon geometry.
- D** The implementation **SHOULD** support a value of geometry=vectorized to request a representation where each feature corresponds to a feature of the data (sharing identical property values).
- E** If a geometry value is not specified, the Implementation **SHOULD** return the representation closest to the native data.
- F** If a requested geometry representation is not supported, the Implementation **SHOULD** return a 4xx or 501 "Not Implemented" HTTP error.

15.8. Requirements Class “FG-JSON Zone data encoding”

15.8.1. Overview

The FG-JSON Zone Data encoding requirements class defines support for encoding a DGGS Zone data response according to the [OGC FG JSON candidate Standard](#).

FG JSON is an OGC format for representing features with simple geometries and related properties extending GeoJSON for greater flexibility. FG JSON is simple to understand and well supported by tools and software libraries. Since most Web developers are comfortable with using JSON-based formats, supporting FG JSON is recommended for a vector representation of DGGS Zone data.

REQUIREMENTS CLASS 16: REQUIREMENTS CLASS FG-JSON DATA

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-fgjson
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.16: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-fgjson
PREREQUISITES	OGC 21-045r1 Requirements class 2: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval
NORMATIVE STATEMENT	Requirement 29: /req/data-fgjson/content

REQUIREMENT 29

IDENTIFIER	/req/data-fgjson/content
INCLUDED IN	Requirements class 16: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-fgjson
A	Every 200 response of the server for zone data with the media type application/fg+json SHALL be a Feature & Geometries JSON document representing the features, including their geometry and associated properties, for a single zone.
B	Features whose geometry lie wholly outside of the zone geometry SHALL NOT be included in the response.

RECOMMENDATION 16

IDENTIFIER /rec/data-fgjson/clipping

- A** For features partially inside of the zone geometry, the geometry included in the response SHOULD be clipped to the boundaries of the zone geometry.

RECOMMENDATION 17

IDENTIFIER /rec/data-fgjson/generalization

- A** The geometry of the features in the response SHOULD be generalized to the scale associated with the hierarchy level implied from the zone-depth relative to the requested zone.

RECOMMENDATION 18

IDENTIFIER /rec/data-fgjson/omission

- A** For datasets whose features have either a size (such as areal or linear feature) or other properties making some features irrelevant at lower hierarchy levels, such irrelevant features SHOULD be omitted from the response based on the hierarchy level implied from the zone-depth relative to the requested zone.

RECOMMENDATION 19

IDENTIFIER /rec/data-fgjson/crs

- A** The CRS of the response SHOULD be consistent with either the DGGRS or the underlying geographic CRS (e.g., CRS84).

RECOMMENDATION 20

IDENTIFIER /rec/data-fgjson/geometry

- A** The implementation SHOULD support a geometry query parameter allowing a client to choose how to return feature geometry.
- B** The implementation SHOULD support a value of geometry=zone-centroid to request a representation where each feature is a zone intersecting the data, with the feature geometry of each feature being a Point geometry for the centroid of that zone.

RECOMMENDATION 20

C	The implementation SHOULD support a value of <code>geometry=zone-region</code> to request a representation where each feature is a zone intersecting the data, with the feature geometry of each feature being a (Multi)Polygon or Polyhedron geometry.
D	The implementation SHOULD support a value of <code>geometry=vectorized</code> to request a representation where each feature corresponds to a feature of the data (sharing identical property values).
E	If a <code>geometry</code> value is not specified, the Implementation SHOULD return the representation closest to the native data.
F	If a requested geometry representation is not supported, the Implementation SHOULD return a 4xx or 501 “Not Implemented” HTTP error.

15.9. Requirements Class “netCDF zone data encoding”

15.9.1. Overview

The netCDF Zone Data encoding requirements class defines support for encoding a DGGS Zone data response according to the [OGC netCDF standard](#) and to any encoding extension such as the [NetCDF classic and 64-bit offset format](#), or netCDF version 4 based on [OGC HDF5](#). NetCDF (network Common Data Form) is a data model for array-oriented scientific data, a freely distributed collection of access libraries implementing support for that data model, and machine-independent formats.

REQUIREMENTS CLASS 17: REQUIREMENTS CLASS NETCDF

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-netcdf
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.17: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-netcdf
PREREQUISITES	OGC Network Common Data Form (NetCDF) Core Encoding Standard version 1.0 Requirements class 2: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval
NORMATIVE STATEMENT	Requirement 30: /req/data-netcdf/content

REQUIREMENT 30

IDENTIFIER /req/data-netcdf/content

INCLUDED IN Requirements class 17: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-netcdf>

- A** Every 200 response of the server for zone data with the media type application/netcdf SHALL be a netCDF file representing the data values for all selected fields for a single zone.
- B** The response SHALL be encoded using a netCDF encoding extension, such as the NetCDF classic and 64-bit offset format, or netCDF version 4 based on OGC HDF5 (the selection of a particular netCDF format / version could be negotiated through media type parameters or some other mechanism).
- C** If the netCDF data incorporates georeferencing information, this information SHALL be consistent with the DGGRS Zone ID.
- D** If the zone geometry is not rectilinear, the closest bounding rectangle (or volume) SHALL be used for referencing the data.
- E** A distinct value for each sub-zone implied from the requested zone-depth SHALL correspond to at least one distinct cell value in the response.

RECOMMENDATION 21

IDENTIFIER /rec/data-netcdf/null-values

- A** Null values SHOULD be used for cells lying outside the zone geometry.

RECOMMENDATION 22

IDENTIFIER /rec/data-netcdf/crs

- A** The spatial reference of the response, determined by the units of the coordinate variables and whether or not the grid_mapping attribute exists, as well as any applicable extension in use such as CF-netCDF, SHOULD be consistent with either the DGGRS or the underlying geographic CRS (e.g., CRS84).

15.10. Requirements Class “Zarr zone data encoding”

15.10.1. Overview

The Zarr Zone Data encoding requirements class defines support for encoding a DGGS Zone data response according to the OGC Zarr Storage Specification 2.0 Community Standard, packed into a Zip archive.

REQUIREMENTS CLASS 18: REQUIREMENTS CLASS ZARR

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-zarr
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.18: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-zarr
PREREQUISITES	OGC Zarr Storage Specification 2.0 Community Standard ISO/IEC 21320-1:2015 Information technology — Document Container File (Zip) Requirements class 2: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval
NORMATIVE STATEMENT	Requirement 31: /req/data-zarr/content

REQUIREMENT 31

IDENTIFIER	/req/data-zarr/content
INCLUDED IN	Requirements class 18: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-zarr
A	Every 200 response of the server for zone data with the media type <code>application/zarr+zip</code> SHALL be a Zip file containing the data values for all selected fields for a single zone data encoded following the Zarr Storage Specification Version 2 file.
B	A dimension of the Zarr data SHALL correspond to the sub-zones for which values are being returned following the DGGRS deterministic sub-zone ordering.
C	If multiple relative zone depths are being returned, each depth SHALL be encoded as a separate Zarr dataset within the data packet.
D	Every zone depth requested using the <code>zone-depth</code> parameter SHALL be included in the response.

REQUIREMENT 31

E	At every depth, each individual value SHALL correspond exactly to the data sampled representative of that sub-zone.
F	The list of data values SHALL follow the default zone order as specified by the Discrete Global Grid Reference System (for example based on a scanline or space-filling curved defined therein) for which the request is made.

RECOMMENDATION 23

IDENTIFIER /rec/data-zarr/no-extra-chunking

A	Since the zone data packet are for a limited set of sub-zones within a single parent zone, the zone data response SHOULD be encoded as a single chunk.
---	--

15.11. Requirements Class “CoverageJSON zone data encoding”

15.11.1. Overview

The CoverageJSON requirements class defines support for encoding a DGGS Zone data response according to the OGC CoverageJSON Community Standard.

REQUIREMENTS CLASS 19: REQUIREMENTS CLASS COVERAGEJSON DATA

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-coveragejson
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.19: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-coveragejson
PREREQUISITES	OGC 21-069r2 Requirements class 2: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval
NORMATIVE STATEMENT	Requirement 32: /req/data-coveragejson/content

REQUIREMENT 32

IDENTIFIER /req/data-coveragejson/content

INCLUDED IN Requirements class 19: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-coveragejson>

- A** Every 200 response of the server for zone data with the media type `application/prs.coverage+json` SHALL be a CoverageJSON file representing the data values for all selected fields for a single zone.
- B** If the CoverageJSON encoding incorporates georeferencing information, this information SHALL be consistent with the DGGRS Zone ID.
- C** If the zone geometry is not rectilinear, the closest bounding rectangle (or volume) SHALL be used for referencing the data.
- D** A distinct value for each sub-zone implied from the requested zone-depth SHALL correspond to at least one distinct cell value in the response.

RECOMMENDATION 24

IDENTIFIER /rec/data-coveragejson/null-values

- A** Null values SHOULD be used for cells lying outside the zone geometry.

RECOMMENDATION 25

IDENTIFIER /rec/data-coveragejson/crs

- A** The CRS of the response SHOULD be consistent with either the DGGRS or the underlying geographic CRS (e.g., CRS84).

15.12. Requirements Class “JPEG-XL Zone data encoding”

15.12.1. Overview

The JPEG XL Zone Data encoding requirements class defines support for encoding a DGGS Zone data response according to the JPEG XL ISO/IEC 18181 Standard.

JPEG XL supports a large number of bands, image dimensions, and floating point values.

REQUIREMENTS CLASS 20: REQUIREMENTS CLASS JPEG XL DATA

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-jpegxl
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.20: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-jpegxl
PREREQUISITES	ISO/IEC 18181-1 ISO/IEC 18181-2 Requirements class 2: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval
NORMATIVE STATEMENT	Requirement 33: /req/data-jpegxl/content

REQUIREMENT 33

IDENTIFIER	/req/data-jpegxl/content
INCLUDED IN	Requirements class 20: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-jpegxl
A	Every 200 response of the server for zone data with the media type image/jxl SHALL be a <u>JPEG XL</u> image representing the data values for all selected fields for a single zone.
B	If the zone geometry is not rectangular, the closest bounding rectangle SHALL be used for referencing the image.
C	A distinct value for each sub-zone implied from the requested zone-depth SHALL correspond to at least one distinct cell value in the response.
D	For Implementations supporting Data Custom Depths, each depth of the requested zone depth pyramid SHALL be a separate image (overview) in the response.

RECOMMENDATION 26

IDENTIFIER	/rec/data-jpegxl/null-values
A	Null values SHOULD be used for cells lying outside the zone geometry.

RECOMMENDATION 27

IDENTIFIER /rec/data-jpegxl/crs

A

The CRS of the response **SHOULD** be consistent with either the DGGRS or the underlying geographic CRS (e.g., CRS84).

15.13. Requirements Class “PNG Zone data encoding”

15.13.1. Overview

The PNG Zone Data encoding requirements class defines support for encoding a DGGS Zone data response according to the W3C Portable Network Graphics (PNG) Specification (ISO/IEC 15948:2003).

Because PNG encoding is limited to an integer data values, this requirements class defines additional parameters and response headers allowing a client to request a specific scale factor and offset to be used to quantize data values, and allowing the implementation to inform the client of the scale factor and offset used for that quantization.

REQUIREMENTS CLASS 21: REQUIREMENTS CLASS PNG DATA

IDENTIFIER <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-png>

TARGET TYPE Web API

CONFORMANCE CLASS Conformance class A.21: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-png>

PREREQUISITES ISO/IEC 15948
Requirements class 2: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval>

NORMATIVE STATEMENT Requirement 34: /req/data-png/content

REQUIREMENT 34

IDENTIFIER /req/data-png/content

INCLUDED IN Requirements class 21: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-png>

REQUIREMENT 34

A	Every 200 response of the server for zone data with the media type image/png SHALL be a PNG image representing the data values for all selected fields for a single zone.
B	If the zone geometry is not rectangular, the closest bounding rectangle SHALL be used for referencing the image.
C	A distinct value for each sub-zone implied from the requested zone-depth SHALL correspond to at least one distinct cell value in the response.
D	For Implementations supporting Data Custom Depths, each depth of the requested zone depth pyramid SHALL be a separate image (overview) in the response.
E	A Values-Scale: response header with a numeric real value SHALL be returned indicating the factor by which values were multiplied before an offset was added to result in the encoded 8-bit or 16-bit PNG unsigned integer values.
F	A Values-Offset: response header with a numeric real value SHALL be returned indicating the offset which was added after multiplying values by the scale factor to result in the encoded 8-bit or 16-bit PNG unsigned integer values.

RECOMMENDATION 28

IDENTIFIER /rec/data-png/null-values

A	Null values SHOULD be used for cells lying outside the zone geometry.
---	---

RECOMMENDATION 29

IDENTIFIER /rec/data-png/crs

A	The CRS of the response SHOULD be consistent with either the DGGRS or the underlying geographic CRS (e.g., CRS84).
---	--

RECOMMENDATION 30

IDENTIFIER /rec/data-png/scale-offset

A	The Implementation SHOULD support a values-scale query parameter on Zone data resources when requesting a PNG output to indicate the value scale factor, as described in the Values-Scale response header part of the content requirement.
B	The Implementation SHOULD support a values-offset query parameter on Zone data resources when requesting a PNG output to indicate the value offset, as described in the Values-Offset response header part of the content requirement.



16

REQUIREMENTS CLASSES FOR ENCODINGS OF ZONE LIST

REQUIREMENTS CLASSES FOR ENCODINGS OF ZONE LIST

The OGC API – DGGs Standard does not mandate any particular encoding or format in which to return the `../dggs/{dggsId}/zones` resources. DGGs Zone Lists can be encoded in any suitable data format. However, it does define requirements classes for zone list encodings which are expected to be commonly supported in implementations of this Standard. These requirements classes include:

- JSON Zone List
- HTML Zone List
- 64-bit Binary Zone List
- GeoJSON Zone List
- FG-JSON Zone List
- GeoTIFF Zone List

16.1. Media Types (for zone list)

A table of the media types used in the zone list encoding requirements classes defined in this standard follows.

Table 3 – Media Types used for zone list encoding requirements classes

Encoding	Media type
JSON zone list	application/json
HTML zone list	text/html
Binary 64-bit zone list	application/x-binary
GeoJSON zone list	application/geo+json
JSON-FG zone list	application/fg+json
GeoTIFF zone list	image/tiff; application=geotiff

16.2. Requirements Class “JSON zone list encoding”

16.2.1. Overview

The JSON zone list encoding requirements class defines the ability to retrieve a JSON response for the DGGRS zone list resource.

The response consists of a simple JSON object with a "zones" array property listing the zone identifiers as strings. The object can also include a "links" objects linking back to other resources of the DGGRS.

This requirements class provides an easy to implement, reasonably efficient and interoperable mechanism to exchange lists of zone identifiers.

REQUIREMENTS CLASS 22: REQUIREMENTS CLASS JSON ZONE LIST

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-json
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.22: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-json
PREREQUISITES	JSON Requirements class 6: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query
NORMATIVE STATEMENT	Requirement 35: /req/zone-json/content

REQUIREMENT 35

IDENTIFIER	/req/zone-json/content
INCLUDED IN	Requirements class 22: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-json
A	Every 200 response of the server for zone query with the media type application/json SHALL be a JSON document listing the textual identifiers for all zones matching the query.
B	The schema for the JSON document SHALL follow the JSON Schema for DGGS Zone Query described below, where the zone identifiers are strings within a zones array property.
C	The links property SHALL include an [ogc-rel:dggrs] link to the Discrete Global Grid Reference System description resource.

REQUIREMENT 35

- D** The links property SHALL include an [ogc-rel:dggrs-definition] link to the DGGRS definition, using the schema defined in Annex B – DGGRS Definitions or a later version.

```
{
  "$schema" : "https://json-schema.org/draft/2020-12/schema",
  "$id" : "https://schemas.opengis.net/ogcapi/dggs/part1/1.0/openapi/schemas/
dggs-core/dggs-zones.json",
  "type": "object",
  "required": [ "zones" ],
  "properties":
  {
    "zones" : { "type": "array", "items": { "type": "string" } },
    "returnedAreaMetersSquare" : { "type": "number" },
    "returnedVolumeMetersCube" : { "type": "number" },
    "returnedVolumeMetersSquareSeconds" : { "type": "number" },
    "returnedHyperVolumeMetersCubeSeconds" : { "type": "number" },
    "links" :
    {
      "description": "Links to related resources."
      "items": { "$ref" : "https://schemas.opengis.net/ogcapi/dggs/part1/1.0/
openapi/schemas/common-core/link.yaml"
    }
  }
}
```

Listing 11 – JSON Schema for a DGGS Zone Query response

RECOMMENDATION 31

IDENTIFIER /rec/zone-json/additional-links

- A** If *DGGS Zone Data Retrieval* is supported, the linkTemplates property SHOULD include an [ogc-rel:dggrs-zone-data] link with a {zoneId} variable to retrieve data from each of these DGGRS zones.
- B** The links property SHOULD include an [ogc-rel:geodata] link for zone listing pertaining to a particular collection (for Collection DGGS requirements class).

RECOMMENDATION 32

IDENTIFIER /rec/zone-json/zone-order

- A** For responses where zones of multiple hierarchy levels are returned when compact-zones is true, the zones SHOULD be listed with coarser refinement levels first (larger zones).

RECOMMENDATION 33

IDENTIFIER /rec/zone-json/zone-total-area

STATEMENT For returning the total area (or volumes) occupied by zones returned by the query

- | | |
|----------|--|
| A | For a 2D DGGS, the Implementation SHOULD include in the response a returnedAreaMetersSquare property indicating the total surface area occupied by the zones being returned, adding the overlaps which may occur for compact zone responses where zones are non-congruent only once. |
| B | For a 3D DGGS, the Implementation SHOULD include in the response a returnedVolumeMetersCube property indicating the total volume occupied by the zones being returned, still counting overlapping regions only once. |
| C | For a 2D + Time DGGS, the Implementation SHOULD include in the response a returnedVolumeMetersSquareSeconds property indicating the total volume occupied by the zones being returned, still counting overlapping regions only once. |
| D | For a 3D + Time DGGS, the Implementation SHOULD include in the response a returnedHyperVolumeMetersCubeSeconds property indicating the total hypervolume occupied by the zones being returned, still counting overlapping regions only once. |

16.3. Requirements Class “HTML zone list encoding”

16.3.1. Overview

The HTML zone list encoding requirements class defines at a high level the ability to retrieve an HTML response for the DGGRS zone list resource intended primarily for users accessing the API from a Web browser.

The exact content of the HTML response is not prescribed, leaving the flexibility for implementations to choose a preferred approach.

HTML is the core language of the World Wide Web. An API that supports HTML will support browsing the spatial resources with a web browser and will also enable search engines to crawl and index those resources.

REQUIREMENTS CLASS 23: REQUIREMENTS CLASS HTML ZONE LIST

IDENTIFIER <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-html>

TARGET TYPE Web API

REQUIREMENTS CLASS 23: REQUIREMENTS CLASS HTML ZONE LIST

CONFORMANCE CLASS	Conformance class A.23: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-html
PREREQUISITES	https://html.spec.whatwg.org/ : Requirements class 6: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query
NORMATIVE STATEMENT	Requirement 36: /req/zone-html/content

REQUIREMENT 36

IDENTIFIER	/req/zone-html/content
INCLUDED IN	Requirements class 23: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-html
A	Every 200 response of the server for zone query with the media type text/html SHALL be an HTML document listing the textual identifiers for all zones matching the query.

RECOMMENDATION 34

IDENTIFIER	/rec/zone-html/zone-information
A	The implementation SHOULD include additional information for each zone ID, such as the area, bounding box and/or a preview of the data available for this zone.

RECOMMENDATION 35

IDENTIFIER	/rec/zone-html/zone-data
A	If the Implementation also supports Zone Data Retrieval, the Implementation SHOULD include a link for each zone to download the associated data .

16.4. Requirements Class “Binary 64-bit integer zone list encoding”

16.4.1. Overview

The binary 64-bit integer zone list encoding requirements class defines the ability to retrieve a binary response for the DGGRS zone list resource for DGGRS whose zone identifiers can be expressed as a single 64-bit integer.

The response consists of a 64-bit integer count of zones, followed by that count of zones, also 64-bit integers. With compact zones and additional HTTP content encoding compression, this provides an optimal way to exchange DGGRS zone lists.

REQUIREMENTS CLASS 24: REQUIREMENTS CLASS 64-BIT BINARY ZONE LIST

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-uint64
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.24: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-uint64
PREREQUISITE	Requirements class 6: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query
NORMATIVE STATEMENT	Requirement 37: /req/zone-uint64/content

REQUIREMENT 37

IDENTIFIER /req/zone-uint64/content

INCLUDED IN Requirements class 24: <https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-uint64>

A Every 200 response of the server for zone query with the media type application/x-binary SHALL be a binary response consisting of a first 64-bit integer count defining the number of zones returned, followed by one 64-bit integer for each zone matching the query.

B The 64-bit integer identifiers SHALL be the one defined by the DGGRS.

C The endianness of the returned count and zones integers SHALL be little endian.

REQUIREMENT 37

D	If the DGGRS does not define a 64-bit integer identifier, a 406 “Not Acceptable” response SHALL be returned.
---	--

16.5. Requirements Class “GeoJSON zone list encoding”

16.5.1. Overview

The GeoJSON zone list encoding requirements class defines support for encoding a DGGRS Zone list response according to the GeoJSON specification.

The response is a feature collection where each feature represents a zone in the list. The geometry of the zone should be polygons or multipolygons (e.g., in the case of zone geometry which must be split on the anti-meridian or pole). The zone identifier is represented in the `id` field of each feature.

While not intended to efficiently exchange zone list, as the response carries the geometry of the zones which could easily be computed client-side which takes considerable bandwidth and is not necessary for a 3 client working natively with the same DGGRS, this requirements class provides an easy way to readily visualize the response in a variety of tools. This requirements class is therefore intended for convenience, demonstration and educational purposes.

REQUIREMENTS CLASS 25: REQUIREMENTS CLASS GEOJSON ZONE LIST

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-geojson
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.25: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-geojson
PREREQUISITES	GeoJSON Requirements class 6: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query
NORMATIVE STATEMENT	Requirement 38: <code>/req/zone-geojson/content</code>

REQUIREMENT 38

IDENTIFIER	<code>/req/zone-geojson/content</code>
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REQUIREMENT 38

INCLUDED IN	Requirements class 25: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-geojson
A	Every 200 response of the server for zone query with the media type <code>application/geo+json</code> SHALL be a GeoJSON document consisting of a FeatureCollection, where every Feature represents a single zone.
B	Every feature SHALL have a <code>zoneID</code> property corresponding to the textual identifier of the zone.
C	The geometry of each feature SHALL be the geometry of the zone.

RECOMMENDATION 36

IDENTIFIER `/rec/zone-geojson/id`

A	The Feature <code>id</code> SHOULD be a sequential identifier starting at 1, have the same text value as the <code>zoneID</code> property, or correspond to the 64-bit integer identifier for the zone.
----------	---

RECOMMENDATION 37

IDENTIFIER `/rec/zone-geojson/mid-points`

A	For DGGRSs not in CRS84, the geometry SHOULD include intermediate points between the vertices of the zone geometry so as to accurately represent the shape of the zones.
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RECOMMENDATION 38

IDENTIFIER `/rec/zone-geojson/geometry`

A	The implementation SHOULD support a <code>geometry</code> query parameter allowing a client to choose how to return the geometry of each zone.
B	The implementation SHOULD support a value of <code>geometry=zone-centroid</code> to request a representation where the geometry of each a zone is a Point geometry for the centroid of that zone.
C	The implementation SHOULD support a value of <code>geometry=zone-region</code> to request a representation where the geometry of each zone is a (Multi)Polygon geometry.
D	The implementation SHOULD support a value of <code>geometry=none</code> to request a representation with a null geometry.
E	If a requested geometry representation is not supported, the Implementation SHOULD return a 4xx or 501 "Not Implemented" HTTP error.

16.6. Requirements Class “FG-JSON zone list encoding”

16.6.1. Overview

The FG-JSON zone list encoding requirements class defines support for encoding a DGGRS Zone list response according to the [FG-JSON specification](#).

The response is a feature collection where each feature represents a zone in the list. The geometry of the zone should be polygons or multipolygons (e.g., in the case of zone geometry which must be split on the anti-meridian or pole). The zone identifier is represented in the `id` field of each feature.

While not intended to efficiently exchange zone list, as the response carries the geometry of the zones which could easily be computed client-side which takes considerable bandwidth and is not necessary for a DGGS client working natively with the same DGGRS, this requirements class provides an easy way to readily visualize the response in a variety of tools. This requirements class is therefore intended for convenience, demonstration and educational purposes.

REQUIREMENTS CLASS 26: REQUIREMENTS CLASS FG-JSON ZONE LIST

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-fgjson
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.26: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-fgjson
PREREQUISITES	OGC 21-045r1 Requirements class 6: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query
NORMATIVE STATEMENT	Requirement 39: <code>/req/zone-fgjson/content</code>

REQUIREMENT 39

IDENTIFIER	<code>/req/zone-fgjson/content</code>
INCLUDED IN	Requirements class 26: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-fgjson
A	Every 200 response of the server for zone query with the media type <code>application/fg+json</code> SHALL be a Features & Geometry JSON document consisting of a <code>FeatureCollection</code> , where every <code>Feature</code> represents a single zone.

REQUIREMENT 39

- B** Every feature SHALL have a zoneID property corresponding to the textual identifier of the zone.
- C** The geometry of each feature SHALL be the geometry of the zone.

RECOMMENDATION 39

IDENTIFIER /rec/zone-fgjson/id

- A** The Feature id SHOULD have the same value as the zoneID property or use the 64-bit integer identifier.

RECOMMENDATION 40

IDENTIFIER /rec/zone-fgjson/mid-points

- A** For DGGRSs not in CRS84, the geometry SHOULD include intermediate points between the vertices of the zone geometry so as to accurately represent the shape of the zones.

RECOMMENDATION 41

IDENTIFIER /rec/zone-fgjson/geometry

- A** The implementation SHOULD support a geometry query parameter allowing a client to choose how to return the geometry of each zone.
- B** The implementation SHOULD support a value of geometry=zone-centroid to request a representation where the geometry of each a zone is a Point geometry for the centroid of that zone.
- C** The implementation SHOULD support a value of geometry=zone-region to request a representation where the geometry of each zone is a (Multi)Polygon or Polyhedron geometry.
- D** The implementation SHOULD support a value of geometry=None to request a representation with a null geometry.
- E** If a requested geometry representation is not supported, the Implementation SHOULD return a 4xx or 501 "Not Implemented" HTTP error.

16.7. Requirements Class “GeoTIFF zone list encoding”

16.7.1. Overview

The GeoTIFF zone list encoding requirements class defines support for encoding a DGGRS Zone list response according to the [OGC GeoTIFF standard](#), intended primarily for DGGRSs with rectangular zones.

The response is a 2D gridded coverage where each cell is a zone in the list, in the coordinate reference system of that DGGRS.

For DGGRSs with non-rectangular zones, the resolution would need to be higher than a single pixel per the most detailed zone to be returned in order to be able to recognize the zone geometry, and would therefore be very sub-optimal. While for rectangular zones it would be easy to identify zones with a one-to-one correspondence, recognizing non-rectangular zones would be significantly more difficult.

While not intended to efficiently exchange zone list, this requirements class provides an easy way to readily visualize the response in a variety of tools. This requirements class is therefore intended for convenience, demonstration and educational purposes.

REQUIREMENTS CLASS 27: REQUIREMENTS CLASS GEOTIFF ZONE LIST

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-geotiff
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.27: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-geotiff
PREREQUISITES	TIFF V6.0 GeoTIFF Requirements class 6: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query
NORMATIVE STATEMENT	Requirement 40: /req/zone-geotiff/content

REQUIREMENT 40

IDENTIFIER	/req/zone-geotiff/content
INCLUDED IN	Requirements class 27: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-geotiff

REQUIREMENT 40

- A** Every 200 response of the server for zone query with the media type image/tiff SHALL be a Geo TIFF document representing the zones matching the query in a geo-referenced image where each zone corresponds to at least one pixel.
- B** The GeoTIFF SHALL be encoded as Pixel-Is-Area.

RECOMMENDATION 42

IDENTIFIER /rec/zone-geotiff/crs

- A** The CRS of the response SHOULD be consistent with either the DGGRS or the underlying geographic CRS (e.g., CRS84).

RECOMMENDATION 43

IDENTIFIER /rec/zone-geotiff/values

- A** The value of the pixel SHOULD be a 64-bit integer identifier representing the zone, if the DGGRS provides for such an identifier.

RECOMMENDATION 44

IDENTIFIER /rec/zone-geotiff/non-rectilinear

- A** For DGGRS where the zones do not correspond to a rectilinear structure, the resolution of the response image SHOULD be high enough so that the shape of the zone geometry is recognizable.

17

REQUIREMENTS CLASS “API DEFINITION OPERATION IDS”

REQUIREMENTS CLASS “API DEFINITION OPERATION IDS”

The OGC API – DGGs Standard does not mandate any particular API definition language. However, if the API is described using a definition language supporting operation identifiers, such as OpenAPI 3.0, being able to associate the functionality described in these requirements with an operation defined in the language is useful. This requirements class defines how this is achieved.

17.1. Overview

REQUIREMENTS CLASS 28: REQUIREMENTS CLASS API DEFINITION OPERATION IDS	
IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/operation-ids
TARGET TYPE	Web API
CONFORMANCE CLASS	Conformance class A.28: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/operation-ids
PREREQUISITE	https://www.opengis.net/spec/ogcapi-common-1/1.0/req/landing-page
NORMATIVE STATEMENT	Requirement 41: /req/operation-ids/operation-ids

17.2. Operation IDs

REQUIREMENT 41	
IDENTIFIER	/req/operation-ids/operation-ids
INCLUDED IN	Requirements class 28: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/operation-ids
STATEMENT	For specifying the operation identifiers associated with the capabilities defined in OGC API – DGGs

REQUIREMENT 41

A

The API definition SHALL identify the supported operations defined in this Standard using the identifier suffixes defined in table Table 4.

Table 4 — API operation identifier suffixes

ORIGIN	RESOURCE	OPERATION ID SUFFIXES
<i>With the origins described in this document</i>		
DataSet ⁴	DGGRS List ¹	.dataset.getDGRSList
DataSet ⁴	DGGRS Description ¹	.dataset.getDGRS
DataSet ⁴	DGGRS Zones ²	.dataset.getDGRSZones
DataSet ⁴	DGGRS Zone Information ¹	.dataset.getDGRSZoneInfo
DataSet ⁴	DGGRS Zone Data ³	.dataset.getDGRSZoneData
Collection ⁵	DGGRS List ¹	.collection.getDGRSList
Collection ⁵	DGGRS Description ¹	.collection.getDGRS
Collection ⁵	DGGRS Zones ²	.collection.getDGRSZones
Collection ⁵	DGGRS Zone Information ¹	.collection.getDGRSZoneInfo
Collection ⁵	DGGRS Zone Data ³	.collection.getDGRSZoneData
<i>With other potential origins⁶</i>		
other	DGGRS List ¹	#.getDGRSList
other	DGGRS Description ¹	#.getDGRS
other	DGGRS Zones ²	#.getDGRSZones
other	DGGRS Zone Information ¹	#.getDGRSZoneInfo
other	DGGRS Zone Data ³	#.getDGRSZoneData
¹ The <i>DGGRS List</i> (.../dggs), <i>DGGRS Description</i> (.../dggs/{dggsId}) and <i>DGGRS Zone Information</i> (.../dggs/{dggsId}/zones/{zoneId}) resources are defined in requirements class "Core".		

ORIGIN	RESOURCE	OPERATION ID SUFFIXES
² The <i>DGGRS Zones</i> resource (<code>.../dggs/{dggrsId}/zones</code>) is defined in the “Zone Query” requirements class.		
³ The <i>DGGRS Zone Data</i> resource (<code>.../dggs/{dggrsId}/zones/{zoneId}/data</code>) is defined in the “Data Retrieval” requirements class.		
⁴ The <i>DataSet</i> origin is defined in requirements class “Root DGGS” and depends on <i>OGC API – Common – Part 1: Core</i> .		
⁵ The <i>Collection</i> origin is defined in requirements class “Collection DGGS” and depends on the <i>Collections</i> requirements class defined in <i>OGC API – Common – Part 2: Geospatial data</i> .		
⁶ ‘#’ represents an optional <i>origin</i> that could be defined in another relevant standard.		



ANNEX A (NORMATIVE) CONFORMANCE CLASS ABSTRACT TEST SUITE

A

ANNEX A

(NORMATIVE)

CONFORMANCE CLASS ABSTRACT TEST SUITE

A.1. Conformance Class “Core”

CONFORMANCE CLASS A.1	
IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/core
REQUIREMENTS CLASS	Requirements class 1: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/core
TARGET TYPE	Web API
CONFORMANCE TESTS	Abstract test A.1: /conf/core/dggrs-list Abstract test A.2: /conf/core/dggrs-info Abstract test A.3: /conf/core/zone-info

A.1.1. Abstract Test for Requirement Listing available DGGRS

ABSTRACT TEST A.1	
IDENTIFIER	/conf/core/dggrs-list
REQUIREMENT	Requirement 1: /req/core/dggrs-list
TEST PURPOSE	Verify that the Implementation supports listing the available DGGRSs
TEST METHOD	Given: a geospatial data resource conforming to the DGGS API Standard, with an API path including .../dggs or discovered following a link with relation type [ogc-rel:dggrs-list] When: performing a GET operation on the .../dggs resource with an application/json media type specified in the Accept: header (e.g., Accept: application/json)

ABSTRACT TEST A.1

Then: (assert that all parts of the requirement are fully satisfied)

A.1.2. Abstract Test for Discrete global grid reference system information

ABSTRACT TEST A.2

IDENTIFIER /conf/core/dggrs-info

REQUIREMENT Requirement 2: /req/core/dggrs-info

TEST PURPOSE Verify that the Implementation supports retrieving information for a particular DGGRS

TEST METHOD **Given:** a DGGRS resource identified from listing available DGGRS or discovered by following a link with relation type [ogc-rel:dggrs]
When: performing a GET operation on the .../dggs/{dggrsId} resource with an application/json media type specified in the Accept: header (e.g., Accept: application/json)
Then: (assert that all parts of the requirement are fully satisfied)

A.1.3. Abstract Test for Retrieving zone information

ABSTRACT TEST A.3

IDENTIFIER /conf/core/zone-info

REQUIREMENT Requirement 3: /req/core/zone-info

TEST PURPOSE Verify that the Implementation supports retrieving information for a particular DGGRS zone

TEST METHOD **Given:** a DGGRS zone information resource identified from a [ogc-rel:dggrs-zone-info] link template within a DGGRS description resource, replacing the {zoneId} variable with a known valid identifier for the DGGRS, not beyond the maxRefinementLevel if one is specified
When: performing a GET operation on the .../dggs/{dggrsId}/zones/{zoneID} resource with an application/json media type specified in the Accept: header (e.g., Accept: application/json)
Then: (assert that all parts of the requirement are fully satisfied)

A.2. Conformance Class “Data Retrieval”

CONFORMANCE CLASS A.2

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-retrieval
REQUIREMENTS CLASS	Requirements class 2: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-retrieval
TARGET TYPE	Web API
CONFORMANCE TEST	Abstract test A.4: /conf/data-retrieval/zone-data

A.2.1. Abstract Test for Retrieving data from a zone

ABSTRACT TEST A.4

IDENTIFIER	/conf/data-retrieval/zone-data
REQUIREMENT	Requirement 4: /req/data-retrieval/zone-data
TEST PURPOSE	Verify that the Implementation supports retrieving data for a particular DGGRS zone
TEST METHOD	Given: a DGGRS zone data resource identified from a <code>[ogc-rel:dggrs-zone-data]</code> link template within a DGGRS description resource, replacing the <code>{zoneId}</code> variable with a known valid identifier for the DGGRS, not beyond the <code>maxRefinementLevel</code> if one is specified When: performing a GET operation on the <code>.../dggs/{dggrsId}/zones/{zoneID}/</code> data resource with supported media type specified in the <code>Accept:</code> header (e.g., <code>Accept: application/json</code> for DGGS-JSON) Then: (assert that all parts of the requirement are fully satisfied)

A.3. Conformance Class “Data Subsetting”

CONFORMANCE CLASS A.3

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-subsetting
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CONFORMANCE CLASS A.3

REQUIREMENTS CLASS	Requirements class 3: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-subsetting
TARGET TYPE	Web API

A.4. Conformance Class “Data Custom Depths”

CONFORMANCE CLASS A.4

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-custom-depths
REQUIREMENTS CLASS	Requirements class 4: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-custom-depths
TARGET TYPE	Web API

A.5. Conformance Class “Filtering Zone Data with CQL2”

CONFORMANCE CLASS A.5

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-cql2-filter
REQUIREMENTS CLASS	Requirements class 5: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-cql2-filter
TARGET TYPE	Web API

A.6. Conformance Class “Zone Query”

CONFORMANCE CLASS A.6

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-query
REQUIREMENTS CLASS	Requirements class 6: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query
TARGET TYPE	Web API
CONFORMANCE TEST	Abstract test A.5: /conf/zone-query/zones-list

A.6.1. Abstract Test for Listing zones

ABSTRACT TEST A.5

IDENTIFIER	/conf/zone-query/zones-list
REQUIREMENT	Requirement 11: /req/zone-query/zones-list
TEST PURPOSE	Verify that the Implementation supports querying DGGRS zones
TEST METHOD	Given: a DGGRS zones query resource identified from a <code>[ogc-rel:dggrs-zone-query]</code> link When: performing a GET operation on the <code>.../dggs/{dggrsId}/zones</code> resource with supported media type specified in the <code>Accept:</code> header (e.g., <code>Accept: application/json</code> for a JSON zone list) Then: (assert that all parts of the requirement are fully satisfied)

A.7. Conformance Class “Filtering Zone Queries with CQL2”

CONFORMANCE CLASS A.7

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-query-cql2-filter
REQUIREMENTS CLASS	Requirements class 7: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-query-cql2-filter
TARGET TYPE	Web API

A.8. Conformance Class “Root DGGS”

CONFORMANCE CLASS A.8

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/root-dggs
REQUIREMENTS CLASS	Requirements class 8: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/root-dggs
TARGET TYPE	Web API

A.9. Conformance Class “Collection DGGS”

CONFORMANCE CLASS A.9

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/collection-dggs
REQUIREMENTS CLASS	Requirements class 9: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/collection-dggs
TARGET TYPE	Web API

A.10. Conformance Class “DGGS-JSON encoding for Zone Data”

CONFORMANCE CLASS A.10

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-json
REQUIREMENTS CLASS	Requirements class 10: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-json
TARGET TYPE	Web API

A.11. Conformance Class “DGGS-UBJSON encoding for Zone Data”

CONFORMANCE CLASS A.11

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-ubjson
REQUIREMENTS CLASS	Requirements class 11: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-ubjson
TARGET TYPE	Web API

A.12. Conformance Class “DGGS-FG-JSON encoding for Zone Data”

CONFORMANCE CLASS A.12

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-dggs-fgjson
REQUIREMENTS CLASS	Requirements class 12: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-dggs-fgjson
TARGET TYPE	Web API

A.13. Conformance Class “DGGS-FG-UBJSON encoding for Zone Data”

CONFORMANCE CLASS A.13

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-dggs-fgubjson
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CONFORMANCE CLASS A.13

REQUIREMENTS CLASS	Requirements class 13: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-dggs-fgubjson
TARGET TYPE	Web API

A.14. Conformance Class “GeoTIFF encoding for Zone Data”

CONFORMANCE CLASS A.14

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-geotiff
REQUIREMENTS CLASS	Requirements class 14: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-geotiff
TARGET TYPE	Web API

A.15. Conformance Class “GeoJSON encoding for Zone Data”

CONFORMANCE CLASS A.15

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-geojson
REQUIREMENTS CLASS	Requirements class 15: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-geojson
TARGET TYPE	Web API

A.16. Conformance Class “FG-JSON encoding for Zone Data”

CONFORMANCE CLASS A.16

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-fgjson
REQUIREMENTS CLASS	Requirements class 16: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-fgjson
TARGET TYPE	Web API

A.17. Conformance Class “netCDF encoding for Zone Data”

CONFORMANCE CLASS A.17

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-netcdf
REQUIREMENTS CLASS	Requirements class 17: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-netcdf
TARGET TYPE	Web API

A.18. Conformance Class “Zarr encoding for Zone Data”

CONFORMANCE CLASS A.18

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-zarr
REQUIREMENTS CLASS	Requirements class 18: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-zarr

CONFORMANCE CLASS A.18

TARGET TYPE	Web API
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A.19. Conformance Class “CoverageJSON encoding for Zone Data”

CONFORMANCE CLASS A.19

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-coveragejson
REQUIREMENTS CLASS	Requirements class 19: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-coveragejson
TARGET TYPE	Web API

A.20. Conformance Class “JPEG XL Encoding for Zone Data”

[[conf_data-jpegxl<https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-jpegxl>]]

CONFORMANCE CLASS A.20

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-jpegxl
REQUIREMENTS CLASS	Requirements class 20: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-jpegxl
TARGET TYPE	Web API

A.21. Conformance Class “PNG encoding for Zone Data”

CONFORMANCE CLASS A.21

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-png
REQUIREMENTS CLASS	Requirements class 21: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/data-png
TARGET TYPE	Web API

A.22. Conformance Class “JSON encoding for Zone Listing”

CONFORMANCE CLASS A.22

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-json
REQUIREMENTS CLASS	Requirements class 22: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-json
TARGET TYPE	Web API

A.23. Conformance Class “HTML encoding for Zone Listing”

CONFORMANCE CLASS A.23

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-html
REQUIREMENTS CLASS	Requirements class 23: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-html
TARGET TYPE	Web API

A.24. Conformance Class “Binary 64-bit integer encoding for Zone Listing”

CONFORMANCE CLASS A.24

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-uint64
REQUIREMENTS CLASS	Requirements class 24: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-uint64
TARGET TYPE	Web API

A.25. Conformance Class “GeoJSON encoding for Zone Listing”

CONFORMANCE CLASS A.25

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-geojson
REQUIREMENTS CLASS	Requirements class 25: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-geojson
TARGET TYPE	Web API

A.26. Conformance Class “FG-JSON encoding for Zone Listing”

CONFORMANCE CLASS A.26

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-fgjson
------------	---

CONFORMANCE CLASS A.26

REQUIREMENTS CLASS	Requirements class 26: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-fgjson
TARGET TYPE	Web API

A.27. Conformance Class “GeoTIFF encoding for Zone Listing”

CONFORMANCE CLASS A.27

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/zone-geotiff
REQUIREMENTS CLASS	Requirements class 27: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/zone-geotiff
TARGET TYPE	Web API

A.28. Conformance Class “Operation IDs”

CONFORMANCE CLASS A.28

IDENTIFIER	https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/operation-ids
REQUIREMENTS CLASS	Requirements class 28: https://www.opengis.net/spec/ogcapi-dggs-1/1.0/req/operation-ids
TARGET TYPE	Web API
CONFORMANCE TEST	Abstract test A.6: /conf/operation-ids/operation-ids

A.28.1. Abstract Test for Operation IDs

ABSTRACT TEST A.6

IDENTIFIER /conf/operation-ids/operation-ids

REQUIREMENT Requirement 41: /req/operation-ids/operation-ids

TEST PURPOSE Verify that the correct operation IDs suffixed are used in the API definition to identify DGGS resources

TEST METHOD **Given:** an DGGS API implementation providing an API definition with a concept of operation IDs (such as OpenAPI 3.0)

When: inspecting the operations in the API definition for DGGS resources

Then:

- assert that the operation IDs for DGGS resources correspond to those specified in Table 4



B

ANNEX B (INFORMATIVE) DISCRETE GLOBAL GRID REFERENCE SYSTEM DEFINITIONS



B

ANNEX B

(INFORMATIVE)

DISCRETE GLOBAL GRID REFERENCE SYSTEM DEFINITIONS

The following informative schema describes the expected response of the resource linked to by using the `[ogc-rel:dggrs-definition]` link relation from the DGGRS description. This behavior is specified by the Core requirements class. An important objective for this schema is to support establishing authoritative registries of DGGRSs providing a URI for a DGGRS corresponding to a specific definition.

Note that this schema is preliminary, and a normative version may be defined in a later version of the OGC API — DGGS Standard or by a future part of OGC Abstract Specification Topic 21. The schema may change to support a better description of existing and new classes of DGGH.

The DGGRS definition consists of three main components:

- The definition of the hierarchy of discrete global grids (dggh), including any parameterization such as the spheroid or orientation, establishing both the topology as well as the geometry of every zone,
- The Zonal Identifier Reference System (zirs), with textual identifiers being mandatory while 64-bit integer identifiers (which support the 64-bit integer zone list encoding requirements class) are optional,
- The sub-zone ordering (subZoneOrder), which allows for retrieving zone data using e.g., DGGS-JSON at a zone-depth other than 0 (the values of sub-zones can be provided as a 1D array of values with a pre-established association to sub-zones).

Whereas the ZIRS provides a mechanism to globally identify a single zone using a textual identifier (and alternatively using a 64-bit integer), the deterministic sub-zone order provides a local indexing mechanism to address smaller regions within a particular zone. This local indexing mechanism enables the DGGS-optimized data encodings defined by the DGGS-JSON and DGGS-FG-JSON requirements classes. The two mechanisms may potentially be related to each other, for example using the same space filling curve such as a [Morton code \(Z-order curve\)](#), but do not need to be. If defining a more optimal sub-zone order for a particular DGGRS is not practical, the ascending sort order of the sub-zone identifiers can be specified as a fallback, based on either the ASCII character strings of the textual identifiers, or the 64-bit integer identifiers.

B.1. JSON Schema for defining a DGGRS

```
{
  "$schema": "https://json-schema.org/draft/2019-09/schema",
  "description": "Discrete Global Grid System Reference System (DGGRS)",
  "Definition.",
  "type": "object",
  "required": [
    "dggh",
    "zirs",
    "subZoneOrder"
  ],
  "properties": {
    "title": {
      "type": "string"
    },
    "description": {
      "type": "string"
    },
    "uri": {
      "type": "string",
      "format": "uri",
      "description": "The authoritative URI associated with this DGGRS",
      "definition"
    },
    "dggh": {
      "type": "object",
      "description": "The hierarchical series of Discrete Global Grid upon which",
      "this DGGRS is based, including any parameters.",
      "properties": {
        "definition": {
          "description": "The base definition of the hierarchical series of",
          "Discrete Global Grid, which may be parameterized.",
          "type": "object",
          "required": [
            "spatialDimensions",
            "temporalDimensions"
          ],
          "properties": {
            "crs": {
              "allOf": [
                {
                  "description": "The native Coordinate Reference System (CRS)",
                  "in which the geometry of the zones for this DGG hierarchy is defined."
                },
                {
                  "anyOf": [
                    {
                      "type": "string",
                      "format": "uri",
                      "example": "EPSG:7789"
                    }
                  ]
                }
              ]
            }
          }
        },
        "basePolyhedron": {
          "type": "string",

```

```

        "description": "The Type/Class of Polyhedron used to construct the
Discrete Global Grid System - if it is constructed using a Base Polyhedron.",
        "example": "icosahedron"
    },
    "refinementRatio": {
        "description": "The ratio of the area of zones between two
consecutive hierarchy level (the ratio of child zones to parent zones, also
called the aperture).",
        "example": 9,
        "type": "integer"
    },
    "constraints": {
        "type": "object",
        "properties": {
            "cellAxisAligned": {
                "description": "Set to true if all edges of the geometry of
all zones are aligned with one of the axis of the `crs`.",
                "type": "boolean",
                "default": false
            },
            "cellConformal": {
                "type": "boolean",
                "default": false
            },
            "cellEquiAngular": {
                "type": "boolean",
                "default": false
            },
            "cellEquiDistant": {
                "type": "boolean",
                "default": false
            },
            "cellEqualSized": {
                "description": "Set to true if the area of all zones is the
same for a particular zone geometry type of any specific discrete global grid of
the DGG hierarchy.",
                "type": "boolean",
                "default": false
            }
        }
    },
    "spatialDimensions": {
        "description": "Number of Spatial Dimensions defined by the
Discrete Global Grid System.",
        "example": 2,
        "type": "integer"
    },
    "temporalDimensions": {
        "description": "Number of Temporal Dimensions defined by the
Discrete Global Grid System.",
        "example": 0,
        "type": "integer"
    },
    "zoneTypes": {
        "type": "array",
        "items": {
            "type": "string",
            "enum": [
                "triangle",
                "square",
                "hexagon",
                "pentagon",
                "rhombus"
            ]
        }
    }
}

```

```

    ],
    },
    "example": [
        "hexagon",
        "pentagon"
    ]
},
"refinementStrategy": {
    "description": "The refinement strategy used by the Discrete
Global Grid System",
    "type": "array",
    "items": {
        "type": "string",
        "enum": [
            "centredChildCell",
            "nestedChildCell",
            "nodeCentredChildCell",
            "edgeCentredChildCell",
            "faceCentredChildCell",
            "solidCentredChildCell"
        ]
    },
    "example": [ "nestedChildCell" ]
}
},
"parameters": {
    "description": "The optional parameters establishing a very specific
Discrete Global Grid System, where each zone has a well-defined geometry.",
    "type": "object",
    "properties": {
        "ellipsoid": {
            "type": "string",
            "format": "uri",
            "description": "Globe Reference System Identifier/Specification",
            "example": [
                "EPSG:7019"
            ]
        },
        "orientation": {
            "type": "object",
            "properties": {
                "latitude": {
                    "description": "Reference Latitude in decimal degrees to fix
the orientation of the polyhedron.",
                    "example": 58.28252559,
                    "type": "number"
                },
                "longitude": {
                    "description": "Reference Longitude in decimal degrees to fix
the orientation of the polyhedron.",
                    "example": 11.20,
                    "type": "number"
                },
                "azimuth": {
                    "description": "Azimuth in decimal degrees of second vertex
relative to the first vertex.",
                    "example": 0.0,
                    "type": "number",
                    "default": 0.0
                },
                "description": {
                    "type": "string"
                }
            }
        }
    }
}

```

```

    },
    "required": [
        "longitude",
        "latitude"
    ]
}
}
}
},
"zirs": {
    "description": "The Zone Identifier Reference System used for this
Discrete Global Grid System Reference System.",
    "type": "object",
    "required": [
        "textZIRS"
    ],
    "properties": {
        "textZIRS": {
            "description": "textual zone identifier indexing scheme",
            "type": "object",
            "required": [
                "description"
            ],
            "properties": {
                "description": {
                    "type": "string",
                    "examples": [
                        "Topological Morton Code (Space Filling Curve) Identifier.
With a Level 0 alphabetical identifier from 'A' to 'S' followed by a numeric
reference from 1 to 9 for all subsequent levels representing the arrangement
of child zones following a Morton (Z-code) subdivision of the parent zone. The
length of the identifier represents the level of refinement.",
                        "Universal Morton Code (Space Filling Curve) Identifier. An
ellipsoidal bitwise concatenation of longitude and latitude direct position to
form a direct Morton code. This can be used across multiple DGGs infrastructures
to provide a common index structure that is fixed in nature regardless of the
topological zone index used by each DGGs.",
                        "An identifier comprised of three separate level, row and column
components corresponding to an OGC 2D Tile Matrix Set tile identifier, where the
individual component are represented by uppercase hexadecimal numbers separated
by a hyphen.",
                        "An identifier comprised of an uppercase letter representing
a level (A for level 0, B for level 1...), followed by a number from 0 to 9
representing the root rhombus corresponding to the faces of an icosahedron,
in a staircase order from the top-left to the bottom right of an ISEA planar
projection after a 60 degrees clockwise rotation, followed by a hyphen, then by
an uppercase hexadecimal number identifying a sub-zone starting to count from 0
in row-major order.",
                        "An identifier comprised of an uppercase letter representing
the ISEA9R level corresponding to the current even or immediate lower odd
ISEA3H level (A for level 0, B for level 1...), followed by a number from 0
to 9 representing the root rhombus corresponding to the faces of an icosahedron,
in a staircase order from the top-left to the bottom right of an ISEA planar
projection after a 60 degrees clockwise rotation, followed by a hyphen, then by
an uppercase hexadecimal number identifying a sub-zone starting to count from 0
in row-major order, followed by a second hyphen, then by a letter identifying a
hexagonal or pentagonal zone intersecting the sub-rhombus: A: even level regular
zone B: even level North pole zone C: even level South pole zone D: odd level
zone centered on rhombus vertex E: odd level zone top-right of rhombus vertex
F: odd level zone bottom-right of rhombus vertex G: odd level North pole zone H:
odd level South pole zone\n"
                    ]
                }
            }
        }
    }
}

```

```

    ],
    "type": {
      "anyOf": [
        {
          "type": "string"
        },
        {
          "type": "string",
          "enum": [
            "hierarchicalConcatenation",
            "ogc2DTMSHexLevelRowCol",
            "levelRootFaceHexRowMajorSubZone"
          ]
        }
      ]
    }
  },
  "uint64ZIRS": {
    "description": "64-bit unsigned integer zone indexing scheme",
    "type": "object",
    "required": [
      "description"
    ],
    "properties": {
      "description": {
        "type": "string",
        "examples": [
          "A 64-bit integer with the 30 least significant bits corresponds
to a column, the next 29 bits corresponding to a row, and the 5 most significant
bits correspond to a level of an OGC 2D Tile Matrix Set identifier, with
individual components using little endian.",
          "A 64-bit integer with the 3 least significant bits
corresponding to a hexagonal or pentagonal zone intersecting a sub-rhombus: 0:
even level regular zone 1: even level North pole zone 2: even level South pole
zone 3: odd level zone centered on rhombus vertex 4: odd level zone top-right
of rhombus vertex 5: odd level zone bottom-right of rhombus vertex 6: odd level
North pole zone 7: odd level South pole zone, the next 51 bits corresponding to
a sub-rhombus index, the next 4 bits corresponding to a root rhombus, the next 5
bits corresponding to an associated ISEA9R level, and the last most significant
bit always 0 for a valid zone identifier.\n"
        ]
      },
      "type": {
        "anyOf": [
          {
            "type": "string"
          },
          {
            "type": "string",
            "enum": [
              "ogc2DTMSHexLevelRowCol"
            ]
          }
        ]
      }
    }
  },
  "subZoneOrder": {

```



```

    "description": "The ordering used for this Discrete Global Grid System
Reference System when encoding the values associated with sub-zones at any given
depth relative to a parent zone.",
    "type": "object",
    "required": [
        "description"
    ],
    "properties": {
        "description": {
            "type": "string",
            "examples": [
                "The zones are ordered in tightly packed scanlines. For an odd
relative depth, scanlines start along a hexagon edge, whereas for even relative
depths, scanlines start on a hexagon vertex. Scanlines run in a clockwise
direction. For sub-zones at an even refinement level, zones are ordered left to
right along a scanline and scanlines are ordered from top to bottom (considering
the ISEA planar projection). For sub-zones at an odd refinement level, zones are
ordered top to bottom along a scanline and scanlines are ordered from left to
right. Sub-zones are at an even refinement level when the parity (even/odd) of
the parent zone level corresponds to the parity of the relative depth, and at an
odd refinement level when the parity of the parent zone level and relative depth
do not match. For polar pentagons, the orientation of the scanlines varies in
the ISEA planar projection but is always clockwise, the vertex/edge of the first
sub-zone is on the left side of the planar ISEA projection for the north pole
(in root rhombus 0), and on the right side for the south pole (in root rhombus
9)."
```

Listing B.1 — JSON Schema for the DGGRS Definition

The following example JSON DGGRS definitions conform to this schema.

B.2. ISEA9R DGGRS definition

The following DGGRS is for an axis-aligned and equal-area DGGH based on the [Icosahedral Snyder Equal-Area \(ISEA\)](#) planar projection (see [PROJ](#) and [geogrid](#) for open-source

implementations) using rhombuses with a refinement ratio of 9. When the ISEA projection is rotated clockwise 60 degrees, sheared horizontally by a -60 degrees angle, and units are mapped to a 5×6 space, the zones become square and their edges are aligned with the CRS axes, while remaining equal area. A [2D Tile Matrix Set](#) can also be defined in this transformed CRS, allowing for compatibility with [OGC API – Tiles](#), [WMTS](#) and traditional client and visualization software with no built-in DGGS functionality. This transformed CRS distorts angles and distances more than the planar ISEA projection, but the topology, indexing, and surface geometry on the Earth model remains the same as in that planar ISEA projection.

While the ISEA projection is defined for an authalic sphere, this DGGRS assumes that when importing or exporting data referenced to the WGS84 ellipsoid a conversion between geodetic and authalic latitude is performed. This guarantees that all zones are exactly the same area on the surface of the ellipsoid.

NOTE: The authalic (meaning “area preserving”) sphere is a sphere that has the same surface area as the oblate ellipsoid being used.

```
{
  "title": "ISEA9R",
  "description": "An ISEA9R Discrete Global Grid Reference System using an
ISEA orientation symmetric about the equator with a single vertex on land, and
WGS84 authalic sphere (a WGS84 geodetic latitude is mapped to the sphere by
converting it to an authalic latitude), a {level}{rootRhombus}-{hexSubZone}
indexing system, and scanline-based sub-zone ordering. The ten root rhombuses
are formed by combining two icosahedron triangles at their base. Depending
on whether the ISEA planar CRS is rotated, sheared and scaled or not, the
geometries of the zones are either squares or rhombuses, and the zone edges
are either axis-aligned, or the angles and distances are preserved. In either
case, the topology, indexing and surface geometry on the Earth model remains the
same. The ISEA9R DGGRS is a dual of the ISEA3H DGGRS even levels (a vertex/node in
ISEA9R is the centroid of an ISEA3H zone).",
  "uri": "https://www.opengis.net/def/dggrs/OGC/1.0/ISEA9R",
  "links": [ { "rel": "describedby", "href": "https://portal.ogc.org/files/?
artifact_id=107432" } ],
  "dggrs": {
    "definition": {
      "spatialDimensions": 2,
      "temporalDimensions": 0,
      "crs": "https://www.opengis.net/def/crs/OGC/0/153456",
      "projString": "+proj=pipeline +step +proj=isea +R=6371007.18091847
+x_0=19186144.8709340879 +y_0=-3323137.7717834860 +step +proj=affine +inv
+s11=3837228.974186818 +s12=3837228.974186818 +s21=6646275.543566972 +s22=-
6646275.543566972",
      "links": [
        { "rel": "related", "href": "https://doi.org/10.3138/27H7-8K88-4882-
1752" },
        { "rel": "related", "href": "https://proj.org/en/9.3/operations/
projections/isea.html" },
      ],
      "basePolyhedron": "icosahedron",
      "refinementRatio": 9,
      "refinementStrategy": [ "nestedChildCell" ],
      "constraints": {
        "cellAxisAligned": true,
        "cellEqualSized": true
      },
      "zoneTypes": [ "square" ],
    },
    "parameters": {
```

```

        "ellipsoid": "Authalic sphere based on [EPSG:7030] (WGS84) -- NOTE: No
identifier defined yet? [ESPG:7048] exists for Authalic sphere based on GRS80
[EPSG:7019]",
        "orientation":
        {
            "description": "ISEA orientation symmetric about the equator with
a single icosahedron vertex falling on land, with first icosahedron vertex at
authalic latitude equal to the arctangent of the golden ratio (58.397145907431°
N), 11.20°E longitude, and second vertex due North from that first vertex.",
            "latitude": 58.28252559,
            "longitude": 11.20,
            "azimuth": 0
        }
    },
    "zirs": {
        "textZIRS": {
            "description": "An identifier comprised of an uppercase letter
representing a level (A for level 0, B for level 1...), followed by a number
from 0 to 9 representing the root rhombus corresponding to the faces of an
icosahedron, in a staircase order from the top-left to the bottom right of an
ISEA planar projection after a 60 degrees clockwise rotation, followed by a
hyphen, then by an uppercase hexadecimal number identifying a sub-zone starting
to count from 0 in row-major order.",
            "type": "levelRootFaceHexRowMajorSubZone"
        },
        "uint64ZIRS": {
            "description": "A 64-bit integer with the 30 least significant bits
corresponds to a column, the next 29 bits corresponding to a row, and the 5 most
significant bits correspond to a level of an OGC 2D Tile Matrix Set identifier,
with individual components using little endian.",
            "type": "ogc2DTMSHexLevelRowCol"
        }
    },
    "subZoneOrder": {
        "description": "The zones are ordered as scanlines in row-major order,
left to right, then top to bottom, based on a CRS derived from the planar ISEA
projection after rotating it 60° clockwise (-60° rotation) and applying a -60°
degrees horizontal shear.",
        "type": "scanline"
    }
}

```

Listing B.2 – DGGRS Definition for ISEA9R

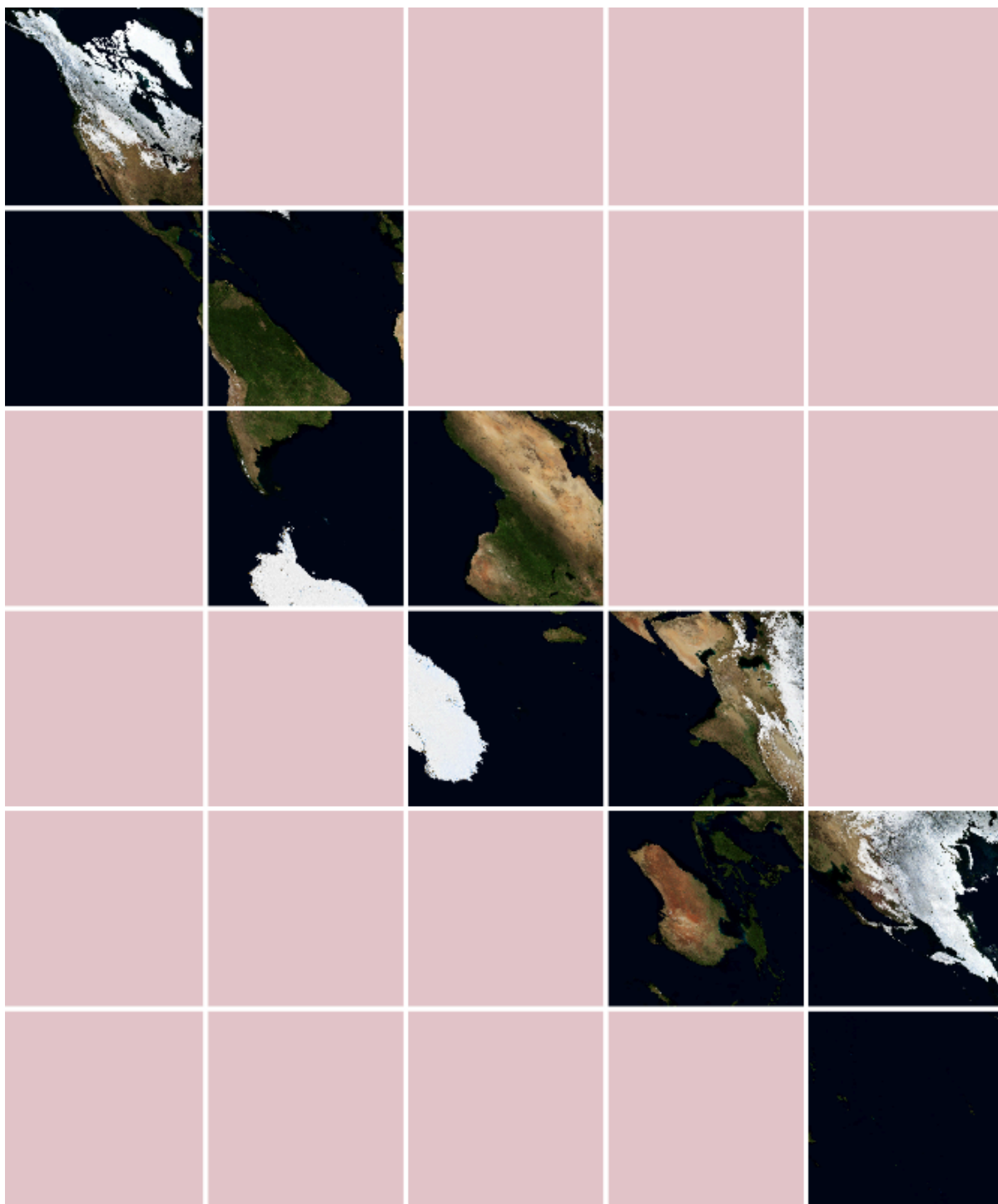


Figure B.1 — The ISEA9R squared root rhombuses (level 0) in the rotated and sheared ISEA planar CRS mapped to a 5x6 space whose axes are aligned with the zone edges, compatible with a 2DTMS definition (imagery from NASA Earth Observatory's [Blue Marble: Next Generation](#))

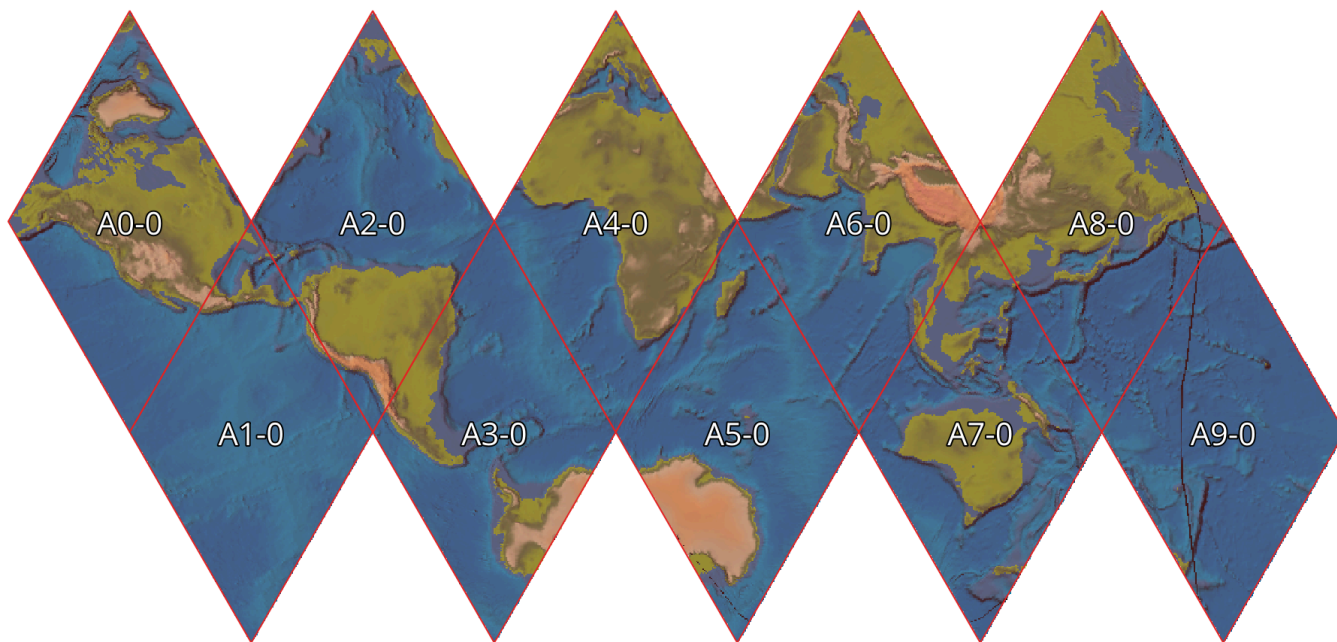


Figure B.2 — The ISEA9R level 0 zone identifiers, shown in the original ISEA planar CRS ([GEBCO 2014 bathymetry](#))

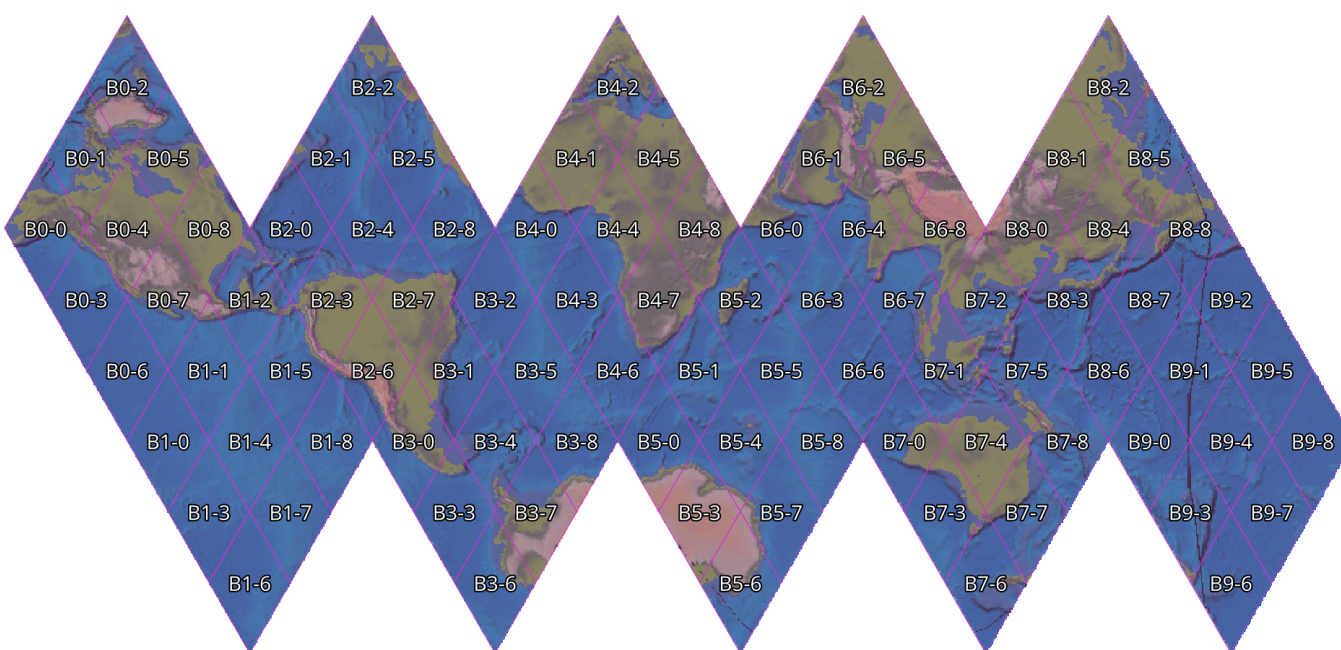


Figure B.3 — The ISEA9R level 1 zone identifiers, shown in the original ISEA planar CRS ([GEBCO 2014 bathymetry](#))

B.3. ISEA3H DGGRS definition

The following DGGRS is for an ISEA3H DGGH, also based on the ISEA planar projection, with hexagonal and pentagonal zones, and a refinement ratio of 3, using a zone reference system based in part on its dual relationship with the ISEA9R DGGH. The DGGH is considered equal area, although each of the 12 pentagonal zones at any level occupies 5/6th of the area of a hexagonal zone at the same level.

```
{
  "title": "ISEA3H",
  "description": "An ISEA3H Discrete Global Grid Reference System using an ISEA
orientation symmetric about the equator with a single vertex on land, and WGS84
authalic sphere (a WGS84 geodetic latitude is mapped to the sphere by converting
it to an authalic latitude), a zone indexing system based on an ISEA9R, and a
scanline-based sub-zone ordering",
  "uri": "https://www.opengis.net/def/dggrs/OGC/1.0/ISEA3H",
  "links": [ { "rel": "describedby", "href": "https://portal.ogc.org/files/?
artifact_id=107432" } ],
  "dggh": {
    "definition": {
      "spatialDimensions": 2,
      "temporalDimensions": 0,
      "crs": "https://www.opengis.net/def/crs/OGC/0/1534",
      "projString": "+proj=pipeline +step +proj=isea +R=6371007.18091847 +x_0=
19186144.8709340879 +y_0=-3323137.7717834860",
      "links": [
        { "rel": "related", "href": "https://doi.org/10.3138/27H7-8K88-4882-
1752" },
        { "rel": "related", "href": "https://proj.org/en/9.3/operations/
projections/isea.html" },
      ],
      "basePolyhedron": "icosahedron",
      "refinementRatio": 3,
      "refinementStrategy": [ "nestedChildCell", "nodeCentredChildCell" ],
      "constraints": {
        "cellEqualSized": true
      },
      "zoneTypes": [ "hexagon", "pentagon" ],
    },
    "parameters": {
      "ellipsoid": "Authalic sphere based on [EPSG:7030] (WGS84) -- NOTE: No
identifier defined yet? [ESPG:7048] exists for Authalic sphere based on GRS80
[EPSG:7019]",
      "orientation": {
        "description": "ISEA orientation symmetric about the equator with
a single icosahedron vertex falling on land, with first icosahedron vertex at
authalic latitude equal to the arctangent of the golden ratio (58.397145907431°
N geodetic latitude), 11.20°E longitude, and second vertex due North from that
first vertex.",
        "latitude": 58.28252559,
        "longitude": 11.20,
        "azimuth": 0
      }
    }
  },
  "zirs": {
    "textZIRS": {
```



```

        "description": "An identifier comprised of an uppercase letter
representing the ISEA9R level corresponding to the current even or immediate
lower odd ISEA3H level (A for level 0, B for level 1...), followed by a number
from 0 to 9 representing the root rhombus corresponding to the faces of an
icosahedron, in a staircase order from the top-left to the bottom right of an
ISEA planar projection after a 60 degrees clockwise rotation, followed by a
hyphen, then by an uppercase hexadecimal number identifying a sub-zone starting
to count from 0 in row-major order, followed by a second hyphen, then by a
letter identifying a hexagonal or pentagonal zone intersecting the sub-rhombus:
A: even level regular zone B: even level North pole zone C: even level South
pole zone D: odd level zone centered on rhombus vertex E: odd level zone top-
right of rhombus vertex F: odd level zone bottom-right of rhombus vertex G: odd
level North pole zone H: odd level South pole zone\n",
        "type": "levelRootFaceHexRowMajorSubZone"
    },
    "uint64ZIRS": {
        "description": "A 64-bit integer with the 3 least significant bits
corresponding to a hexagonal or pentagonal zone intersecting a sub-rhombus: 0:
even level regular zone 1: even level North pole zone 2: even level South pole
zone 3: odd level zone centered on rhombus vertex 4: odd level zone top-right
of rhombus vertex 5: odd level zone bottom-right of rhombus vertex 6: odd level
North pole zone 7: odd level South pole zone, the next 51 bits corresponding to
a sub-rhombus index, the next 4 bits corresponding to a root rhombus, the next 5
bits corresponding to an associated ISEA9R level, and the last most significant
bit always 0 for a valid zone identifier."
    },
    "subZoneOrder": {
        "description": "The zones are ordered in tightly packed scanlines.
For an odd relative depth, scanlines start along a hexagon edge, whereas for
even relative depths, scanlines start on a hexagon vertex. Scanlines run in
a clockwise direction. For sub-zones at an even refinement level, zones are
ordered left to right along a scanline and scanlines are ordered from top
to bottom (considering the ISEA planar projection). For sub-zones at an odd
refinement level, zones are ordered top to bottom along a scanline and scanlines
are ordered from left to right. Sub-zones are at an even refinement level when
the parity (even/odd) of the parent zone level corresponds to the parity of the
relative depth, and at an odd refinement level when the parity of the parent
zone level and relative depth do not match. For polar pentagons, the orientation
of the scanlines varies in the ISEA planar projection but is always clockwise,
the vertex/edge of the first sub-zone is on the left side of the planar ISEA
projection for the north pole (in root rhombus 0), and on the right side for the
south pole (in root rhombus 9).",
        "type": "scanline"
    }
}

```

Listing B.3 – DGGRS Definition for ISEA3H using indexing based on ISEA9R

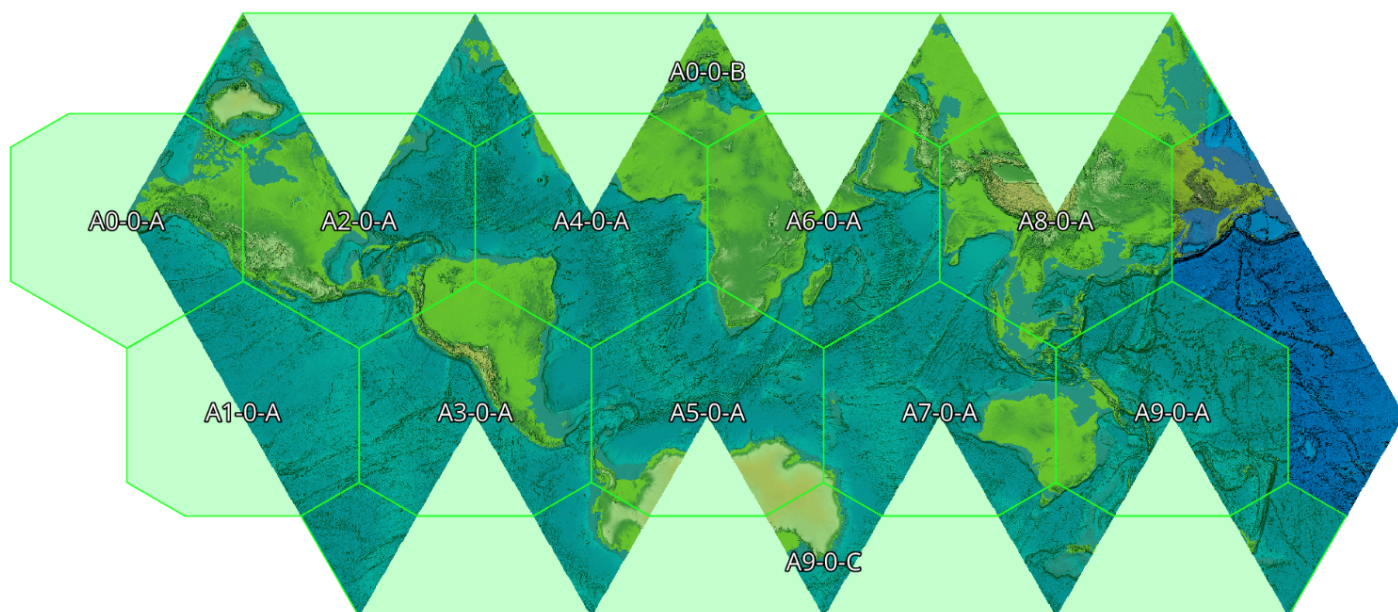


Figure B.4 — The ISEA3H level 0 zones and associated identifiers (derived from ISEA9R level 0), shown on an ISEA planar projection (GEBCO 2014 bathymetry)

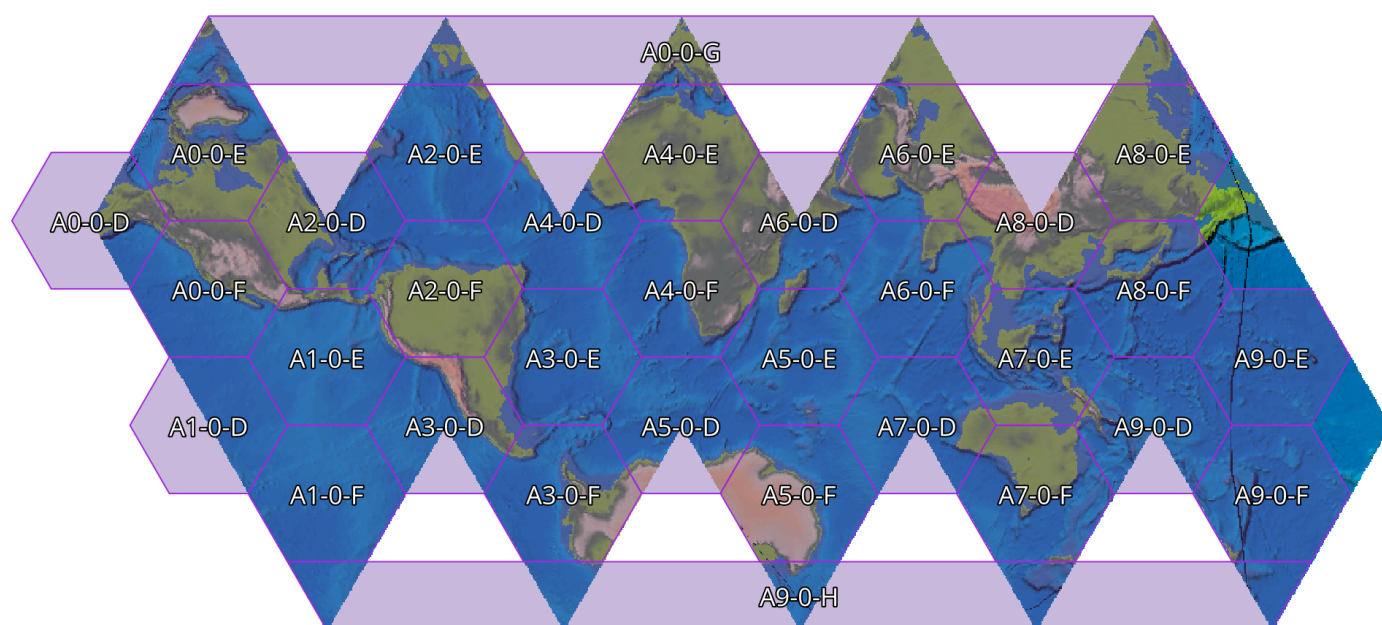


Figure B.5 — The ISEA3H level 1 zones and associated identifiers (derived from ISEA9R level 0), shown on an ISEA planar projection (GEBCO 2014 bathymetry)

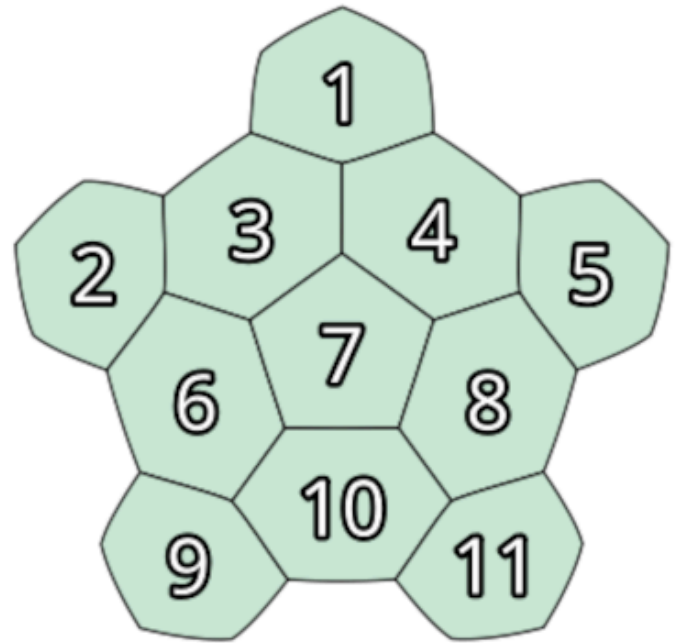
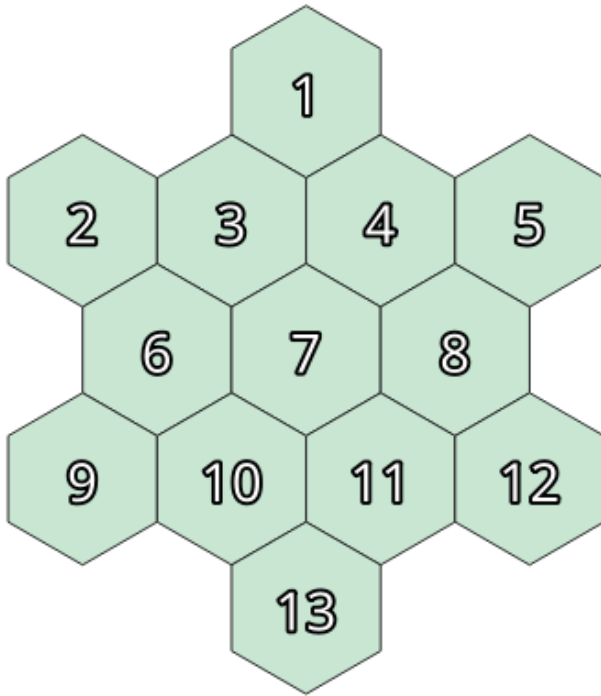


Figure B.7 – Sub-zone order for even relative depth starting on a vertex (hexagonal and pentagonal parents, depth 2)

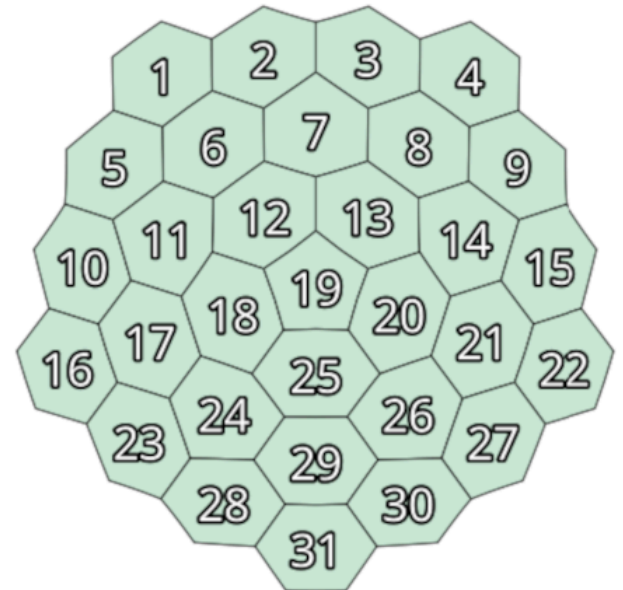
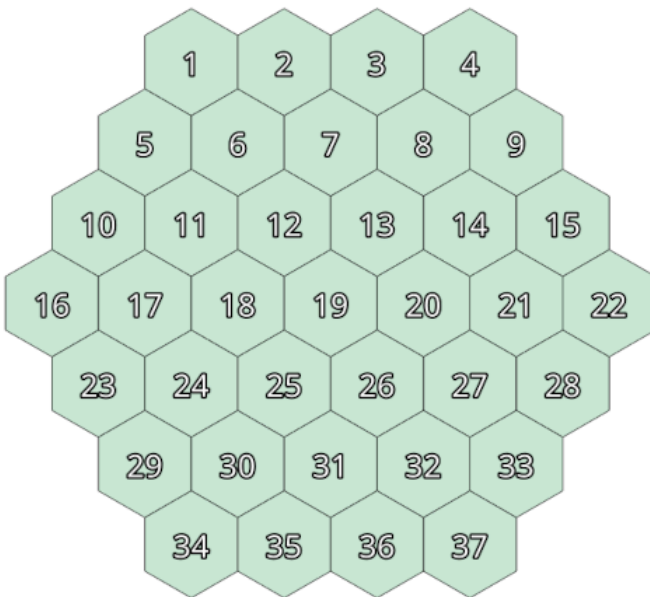


Figure B.8 – Sub-zone order for odd relative depth starting on an edge (hexagonal and pentagonal parents, depth 3)

B.4. GNOSIS Global Grid DGGRS definition

The following DGGRS is based on the variable width 2D Tile Matrix Set of the same name. The GNOSIS Global Grid is also axis-aligned, with the axes being the geographic latitude and longitude, and already corresponds to a registered 2DTMS. Through the variable width capability of the tile matrices, this DGGH approximates equal area. For example, at any refinement level, only 4 zones touch each pole. Since the error budget still exceeds the 1%, it cannot be considered equal area per the OGC Topic 21 DGGS Equal Area Earth Reference System Package. However, this divergence from the mean zone area is the same along a particular row of zones following latitude lines, and can easily be calculated and taken into consideration. Since its native axes are latitude and longitude, no additional reprojection is required to import data to or export data from this DGGH.

```
{
  "title": "GNOSISGlobalGrid",
  "description": "A Discrete Global Grid Reference System based on the GNOSIS Global Grid 2D Tile Matrix Set, a {hexLevel}-{hexRow}-{hexCol} indexing system, and scanline-based sub-zone ordering. Making use of variable matrix widths, zones are divided by 4, unless they touch the pole, in which case the half touching the pole is not split longitude-wise. The error budget is ~-25.8/+66.0% from mean zone size (+/- 45.9% from median) up to level 25 (~849 cm² mean zones).",
  "uri": "https://www.opengis.net/def/dggrs/OGC/1.0/GNOSISGlobalGrid",
  "links": [ { "rel": "describedby", "href": "https://docs.ogc.org/is/17-083r4/17-083r4.html#toc58" } ],
  "dggh": {
    "definition": {
      "spatialDimensions": 2,
      "temporalDimensions": 0,
      "crs": "https://www.opengis.net/def/crs/EPSG/0/4326",
      "links": [
        { "rel": "related", "href": "https://www.opengis.net/def/tilematrixset/OGC/1.0/GNOSISGlobalGrid" }
      ],
      "basePolyhedron": "octahedron",
      "refinementRatio": 4,
      "refinementStrategy": [ "nestedChildCell" ],
      "constraints": {
        "cellAxisAligned": true
      },
      "zoneTypes": [ "rectangle" ],
    },
    "parameters": {
      "ellipsoid": "[EPSG:7030]"
      "orientation": {
        "latitude": 0,
        "longitude": 0
      }
    }
  },
  "zirs": {
    "textZIRS": {
      "description": "An identifier comprised of three uppercase hexadecimal numbers separated by hyphens representing the level, row and column of the GNOSIS Global Grid 2D Tile Matrix Set.",
      "type": "ogc2DTMSHexLevelRowCol"
    }
  }
}
```

```

    },
    "uint64ZIRS": {
      "description": "A 64-bit integer with the 30 least significant bits
corresponds to a column, the next 29 bits corresponding to a row, and the 5 most
significant bits correspond to a level of an OGC 2D Tile Matrix Set identifier,
with individual components using little endian.",
      "type": "ogc2DTMSHexLevelRowCol"
    }
  },
  "subZoneOrder": {
    "description": "The zones are ordered as scanlines in row-major order,
left to right, then top to bottom, based on the EPSG:4326 CRS.",
    "type": "scanline"
  }
}

```

Listing B.4 – DGGRS Definition for the GNOSIS Global Grid

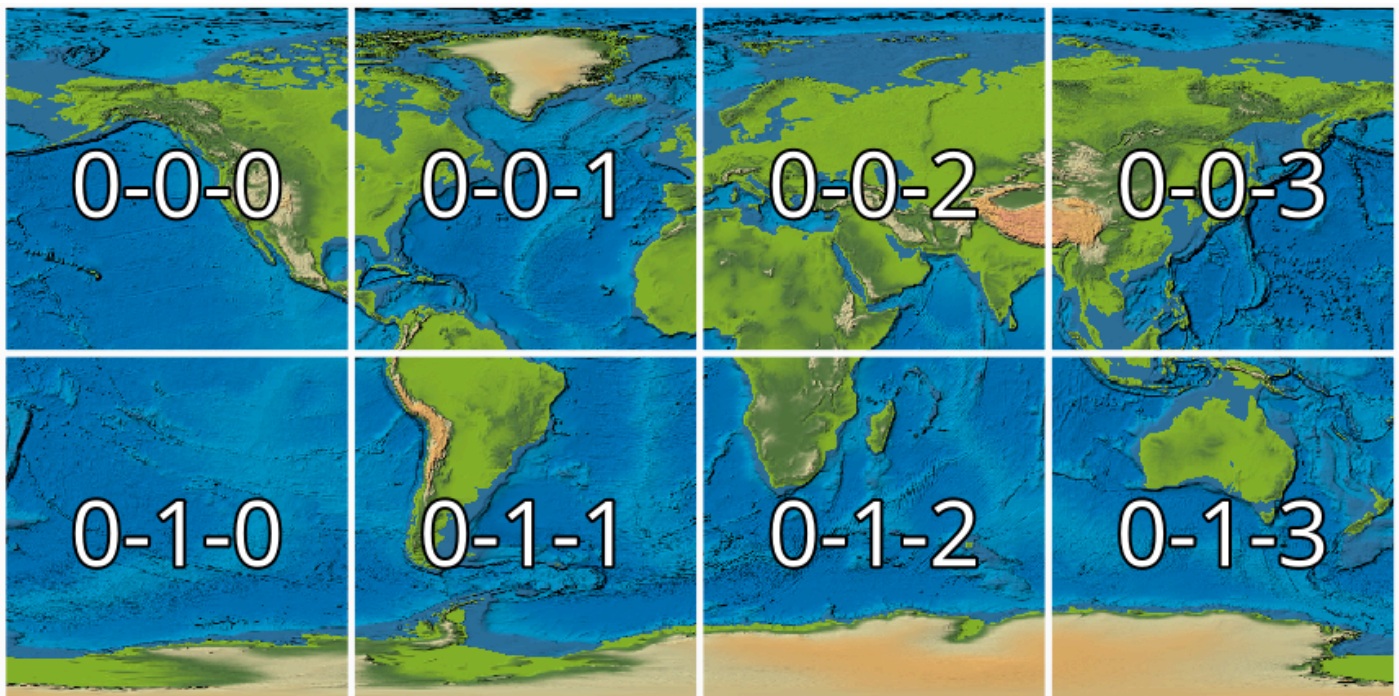


Figure B.9 – The GNOSIS Global Grid level 0 zones and associated identifiers ([GEBCO 2014 bathymetry](#))

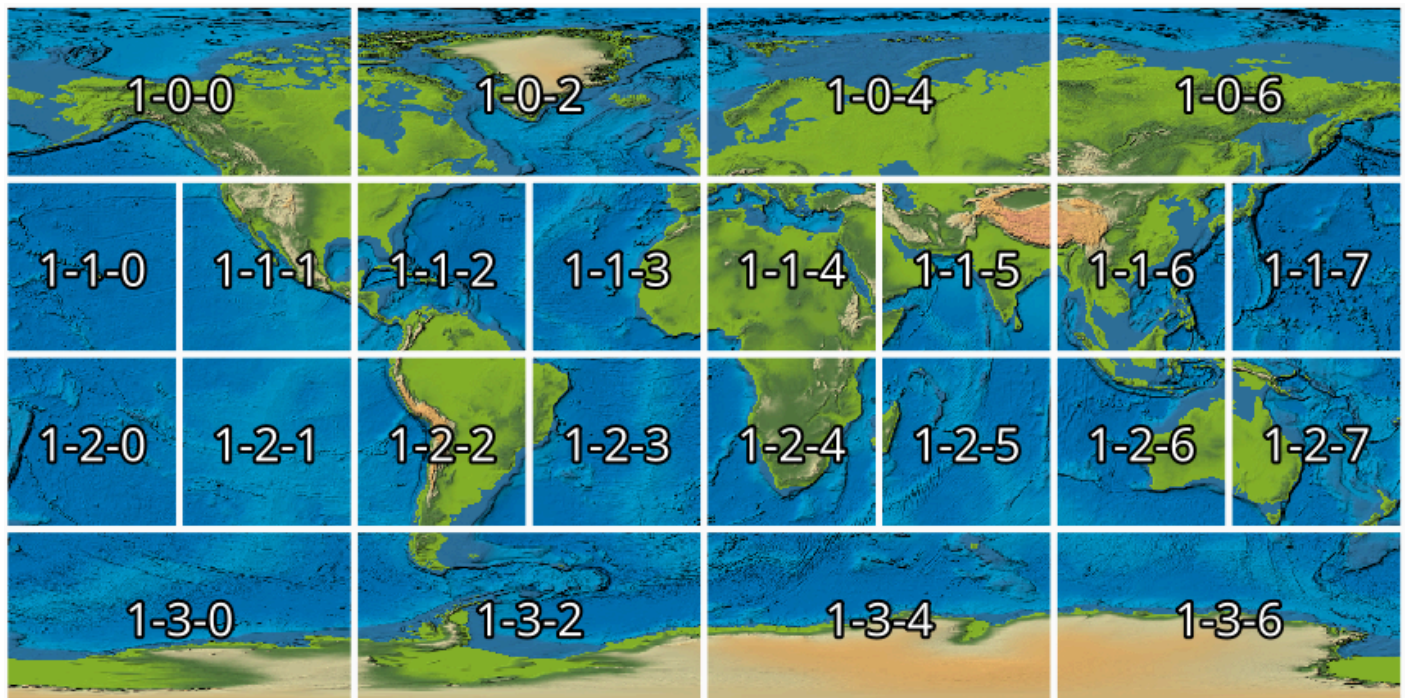


Figure B.10 – The GNOSIS Global Grid level 1 zones and associated identifiers (GEBCO 2014 bathymetry)

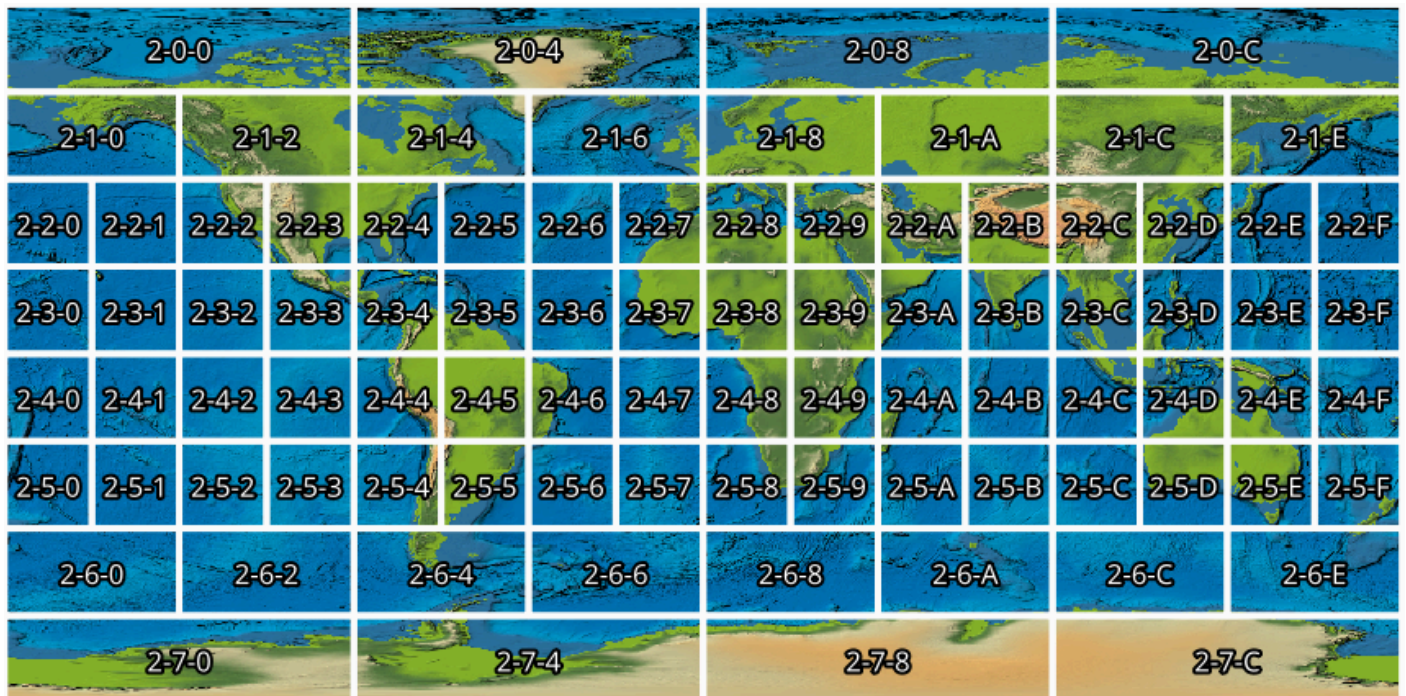


Figure B.11 – The GNOSIS Global Grid level 2 zones and associated identifiers (GEBCO 2014 bathymetry)



ANNEX C (INFORMATIVE) EXAMPLES



ANNEX C (INFORMATIVE) EXAMPLES

This annex provides a set of examples illustrating requests and responses for retrieving DGGS zone data and performing zone queries using capabilities defined by this DGGS API.

C.1. Collection description

DGGS resources can be attached to an *OGC API – Common – Part 2* collection origin resource path. The following global GEBCO 2014 bathymetry collection will be used as an example:

<https://maps.gnosis.earth/ogcapi/collections/gebco>

An example JSON response for this collection description resource, as defined by Common – Part 2 and the Collection DGGS Requirements Class, is presented below, including a link to the list of available DGGRSs:

```
{
  "id" : "gebco",
  "title" : "GEBCO 2014",
  "description" : "General Bathymetric Chart of the Oceans (2014)",
  "attribution" : "General Bathymetric Chart of the Oceans (<a href='https://www.gebco.net/news_and_media/gebco_2014_grid.html'>GEBCO_2014</a>)",
  "extent" : {
    "spatial" : {
      "bbox" : [ [ -180, -90, 180, 90 ] ],
      "grid" : [
        { "cellsCount" : 65537, "resolution" : 0.0054931640625 },
        { "cellsCount" : 32769, "resolution" : 0.0054931640625 }
      ]
    },
    "temporal" : {}
  },
  "minScaleDenominator" : 2183915.0938621787354,
  "minCellSize" : 0.0054931640625,
  "links" : [
    { "rel" : "self", "title" : "Information about this GEBCO data collection",
      "href" : "/ogcapi/collections/gebco" },
    { "rel" : "[ogc-rel:schema]", "title" : "Schema",
      "href" : "/ogcapi/collections/gebco/schema" },
    { "rel" : "[ogc-rel:queryables]", "title" : "Queryables",
      "href" : "/ogcapi/collections/gebco/queryables" },
    { "rel" : "[ogc-rel:dggrs-list]", "title" : "Available DGGRSs for this
    GEBCO data collection",
```

```

    "href" : "/ogcapi/collections/gebco/dggs"
  }
]
}

```

C.2. Listing available DGGRSs

Whether accessing DGGS resources for the root of the API (which may correspond to a dataset, as stated in [OGC API — Features](#)) or for a particular collection, the first DGGS-specific request made by a client would be to list the available DGGRSs. Following the link obtained from the previous example response, a client can determine which DGGRSs are supported by the API at that endpoint:

<https://maps.gnosis.earth/ogcapi/collections/gebco/dggs>

An example JSON response for this DGGRS list, as defined by the Core requirements class, is presented below:

```

{
  "links" : [
    { "rel" : "[ogc-rel:geodata]", "href" : "/ogcapi/collections/gebco" }
  ],
  "dggrs" : [
    {
      "id" : "GNOSISGlobalGrid",
      "title" : "GNOSIS Global Grid",
      "uri" : "[ogc-dggrs:GNOSISGlobalGrid]",
      "links" : [
        { "rel" : "self", "title" : "GNOSISGlobalGrid DGGRS for GEBCO",
          "href" : "/ogcapi/collections/gebco/dggs/GNOSISGlobalGrid" },
        { "rel" : "[ogc-rel:dggrs-definition]", "title" : "GNOSISGlobalGrid
DGGRS definition",
          "href" : "/ogcapi/dggrs/GNOSISGlobalGrid"
        }
      ]
    },
    {
      "id" : "ISEA9R",
      "title" : "ISEA Aperture 9 Rhombic",
      "uri" : "[ogc-dggrs:ISEA9R]",
      "links" : [
        { "rel" : "self", "title" : "ISEA9R DGGRS for GEBCO",
          "href" : "/ogcapi/collections/gebco/dggs/ISEA9R"
        },
        { "rel" : "[ogc-rel:dggrs-definition]", "title" : "ISEA9R DGGRS
definition",
          "href" : "/ogcapi/dggrs/ISEA9R"
        }
      ]
    },
    {
      "id" : "ISEA3H",
      "title" : "ISEA Aperture 3 Hexagonal",
      "uri" : "[ogc-dggrs:ISEA3H]",
      "links" : [
        { "rel" : "self", "title" : "ISEA3H DGGRS for GEBCO",

```



```

        "href" : "/ogcapi/collections/gebco/dggs/ISEA3H"
      },
      { "rel" : "[ogc-rel:dggrs-definition]", "title" : "ISEA3H DGGRS
definition",
        "href" : "/ogcapi/dggrs/ISEA3H"
      }
    ]
  }
}

```

C.3. Retrieving the description of a specific DGGRS

A client would then select a particular DGGRS of which it already has built-in knowledge, possibly using a software library implementing support for one or more DGGRS available from the server.

IMPORTANT

This DGGS API is intended primarily for client / server exchanges where both parties are familiar and can efficiently deal with the same DGGRS. Use cases where the client itself also acts as a server as part of data integration workflows are particularly relevant, where the combination of advanced spatial queries with the ability to request data for specific zones of interest can potentially greatly accelerate analytic processing through parallel distributed processing and lazy evaluation.

As a fallback, a client without native support for a particular DGGRS can still retrieve and interpret data from a server implementing support for both zone queries and data retrieval by performing a two-steps operation. First, the client can perform a zone query for an area of interest using the bbox query parameter. Then, the client can request data for the zones returned by this query in a georeferenced encoding which it understands and which is not tightly coupled with the DGGRS (excluding e.g., the DGGS-JSON encoding), such as GeoJSON or GeoTIFF. However, for such use cases, OGC API — DGGS does not present significant advantages over other OGC API data access mechanisms such as [OGC API — Coverages](#), [OGC API — Features](#) or [OGC API — Tiles](#).

In this example, the client selects the ISEA3H DGGRS (because it has built-in support for it) and follows the link to obtain a complete description of the DGGRS:

<https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/ISEA3H>

An example JSON response for this DGGRS description, as defined by the Core requirements class, is presented below. Note how the description is more comprehensive than the summary description included for each item in the previous DGGRS list response, including a description, a default (relative) depth as well as additional links and link templates.

```

{
  "id" : "ISEA3H",
  "title" : "ISEA Aperture 3 Hexagonal",

```

```

    "description" : "A Discrete Global Grid Reference System based on the
Icosahedral Snyder Equal Area projection, with aperture 3 hexagonal zones, using
an indexing scheme based on ISEA9R.",
    "uri" : "[ogc-dggrs:ISEA3H]",
    "defaultDepth": 10,
    "maxRefinementLevel": 18,
    "maxRelativeDepth": 13,
    "links" : [
      { "rel" : "self", "title" : "ISEA3H DGGRS for GEBCO",
        "href" : "/ogcapi/collections/gebco/dggs/ISEA3H"
      },
      { "rel" : "[ogc-rel:dggrs-definition]", "title" : "ISEA3H DGGRS
definition",
        "href" : "/ogcapi/dggrs/ISEA3H"
      },
      { "rel" : "[ogc-rel:dggrs-zone-query]", "title" : "ISEA3H DGGRS Zone
Query",
        "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones"
      },
      { "rel" : "[ogc-rel:geodata]", "href" : "/ogcapi/collections/gebco" }
    ],
    "linkTemplates" : [
      {
        "rel" : "[ogc-rel:dggrs-zone-info]",
        "title" : "DGGRS zone information for a particular ISEA3H zone",
        "uriTemplate" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/{zoneId}"
      },
      {
        "rel" : "[ogc-rel:dggrs-zone-data]",
        "title" : "Data retrieval for a particular ISEA3H zone",
        "uriTemplate" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/{zoneId}/
data"
      }
    ]
  }
}

```

ISEA3H is an equal area discrete global grid hierarchy based on the Icosahedral Snyder Equal Area projection, using hexagonal grids with a refinement ratio (aperture) of 3. All hexagonal zones of a given refinement level have exactly the same area, while each of the twelve (12) pentagonal zones occupies 5/6th the area of a hexagonal zone of the same level.

See the informative annex B for examples of DGGRS definition responses which the client could obtain by following the `[ogc-rel:dggrs-definition]` links. The annex includes provisional definitions for the ISEA3H, ISEA9R and GNOSIS Global Grid used in these examples which will likely be used to initially populate an authoritative registry. Additional DGGRS entries would be submitted, reviewed and registered based on the needs of the community.

C.4. Retrieving information for a specific DGGRS zone

Later examples will demonstrate how to list available zones by performing zone queries, but for now these examples will skip directly to retrieving information about a particular zone. This capability is also defined in the Core requirements class and exists primarily for completeness of the API resource tree, making the `../dggs/zones/{zoneId}` resource between `../dggs/zones` and `../dggs/zones/{zoneId}/data` also retrievable. The zone information is useful for enabling exploration of datasets using a browser interface, as well as for educational, demonstration

and debugging purposes. An actual DGGs API client for visualization or performing analytics would normally not access this resource at all, since URL templates allow to directly access the data for a particular zone. While the Core requirements class makes several recommendations about statistical information and topological relationships that should be included in the zone information resource, clients may not rely on any of this information being present. Clients can instead rely on their own local software libraries to establish topological relationships, can use zone queries to pose questions that can be answered by a list of zone IDs, or can retrieve zone data packets containing values from multiple sub-zones to perform their own analytics. A future extension could also introduce mandatory requirements making some of the recommended content such as summary statistics or additional useful information mandatory, which clients could then rely on for conforming implementations.

This example assumes a client does for some reason request information in a JSON representation about a particular ISEA3H DGGs zone, say E6-317-A, based on its built-in support for that DGGs. Perhaps this client is an Executable Test Suite — a set of code providing runtime tests for the assertions defined by the Abstract Test Suite. Implementing this resource is still required to conform to the Core conformance class, including at minimum an id and links to the DGGs and data retrieval, if applicable. The GET request URL and response for this zone information resource associated with the GEBCO collection would then look like the following:

<https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/ISEA3H/zones/E6-317-A>

```
{
  "id" : "E6-317-A",
  "links" : [
    { "rel" : "[ogc-rel:geodata]", "href" : "/ogcapi/collections/gebco" },
    { "rel" : "[ogc-rel:dggs]", "title" : "ISEA3H DGGs for GEBCO",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H"
    },
    { "rel" : "[ogc-rel:dggs-definition]", "title" : "ISEA3H DGGs
definition",
      "href" : "/ogcapi/dggs/ISEA3H"
    },
    { "rel" : "[ogc-rel:dggs-zone-data]", "title" : "ISEA3H Zone E6-317-A
data for GEBCO",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/E6-317-A/data"
    },
    { "rel" : "[ogc-rel:dggs-zone-parent]", "title": "Parent zone D6-65-E",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/D6-65-E" },
    { "rel" : "[ogc-rel:dggs-zone-parent]", "title": "Parent zone D6-4A-F",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/D6-4A-F" },
    { "rel" : "[ogc-rel:dggs-zone-parent]", "title": "Parent zone D6-66-D
(centroid child)",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/D6-66-D" },
    { "rel" : "[ogc-rel:dggs-zone-child]", "title": "Child zone E6-317-D
(centroid child)",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/E6-317-D" },
    { "rel" : "[ogc-rel:dggs-zone-child]", "title": "Child zone E6-317-E
(vertex child)",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/E6-317-E" },
    { "rel" : "[ogc-rel:dggs-zone-child]", "title": "Child zone E6-317-F
(vertex child)",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/E6-317-F" },
    { "rel" : "[ogc-rel:dggs-zone-child]", "title": "Child zone E6-316-E
(vertex child)",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/E6-316-E" },
  ],
}
```

```

    { "rel" : "[ogc-rel:dggrs-zone-child]", "title": "Child zone E6-2C5-F
(vertex child)",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/E6-2C5-F" },
    { "rel" : "[ogc-rel:dggrs-zone-child]", "title": "Child zone E6-2C5-E
(vertex child)",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/E6-2C5-E" },
    { "rel" : "[ogc-rel:dggrs-zone-child]", "title": "Child zone E6-2C6-F
(vertex child)",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/E6-2C6-F" },

    { "rel" : "[ogc-rel:dggrs-zone-neighbor]", "title": "Neighboring zone E6-
2C5-A (left)",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/E6-2C5-A" },
    { "rel" : "[ogc-rel:dggrs-zone-neighbor]", "title": "Neighboring zone E6-
369-A (right)",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/E6-369-A" },
    { "rel" : "[ogc-rel:dggrs-zone-neighbor]", "title": "Neighboring zone E6-
2C6-A (top-left)",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/E6-2C6-A" },
    { "rel" : "[ogc-rel:dggrs-zone-neighbor]", "title": "Neighboring zone E6-
318-A (top-right)",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/E6-318-A" },
    { "rel" : "[ogc-rel:dggrs-zone-neighbor]", "title": "Neighboring zone E6-
316-A (bottom-left)",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/E6-316-A" },
    { "rel" : "[ogc-rel:dggrs-zone-neighbor]", "title": "Neighboring zone E6-
368-A (bottom-right)",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/E6-368-A" }
  ],
  "shapeType" : "hexagon",
  "areaMetersSquare" : 7765218521.3124237060547,
  "level": 8,
  "crs": "[OGC:CRS84]",
  "centroid": [ 34.8301691522937, 45.493496839407 ],
  "bbox": [ 34.1122890215028, 45.0307065899164, 35.5548602543606,
45.9545736562164 ],
  "statistics" : {
    "Elevation" : {
      "minimum": -56.415161132812,
      "maximum": 499.67742919922,
      "average": 34.243211554643,
      "stdDev": 58.802922870029
    }
  },
  "geometry" : {
    "type" : "Polygon",
    "coordinates" : [
      [ [35.0325792437483, 45.9545736562164], [35.0675730384768,
45.9355692576877],
        [35.1025417108968, 45.9165538942826], [35.1374852871664,
45.8975275789752],
        [35.1724037934654, 45.8784903247104], [35.2072972559966,
45.859442144404],
        [35.2421657009844, 45.8403830509428], [35.2770091546753,
45.8213130571846],
        [35.3118276433383, 45.8022321759581], [35.3466211932639,
45.7831404200626],
        [35.3813898307646, 45.7640378022689], [35.4161335821748,
45.7449243353179],
        [35.4508524738509, 45.725800031922], [35.4855465321706,
45.7066649047642],
        [35.5202157835335, 45.6875189664983], [35.5548602543606,
45.6683622297491],

```

[35.5409621444686, 45.6377043376462], [35.527097993237,
 45.6070377035762],
 [35.5132676379054, 45.576362404245], [35.4994709165275,
 45.5456785157748],
 [35.4857076679667, 45.5149861137079], [35.4719777318922,
 45.4842852730117],
 [35.4582809487756, 45.4535760680823], [35.4446171598862,
 45.4228585727495],
 [35.4309862072879, 45.3921328602809], [35.4173879338344,
 45.3613990033857],
 [35.4038221831664, 45.3306570742198], [35.390288799707,
 45.2999071443891],
 [35.376787628658, 45.2691492849539], [35.3633185159963,
 45.2383835664335],
 [35.3498813084697, 45.2076100588098], [35.3020092883842,
 45.1959626800988],
 [35.2541667920171, 45.1842941045825], [35.2063537245807,
 45.1726044068217],
 [35.1585699921521, 45.1608936605836], [35.1108155016624,
 45.1491619388553],
 [35.0630901608873, 45.1374093138529], [35.0153938784362,
 45.1256358570339],
 [34.9677265637424, 45.1138416391074], [34.9200881270535,
 45.1020267300452],
 [34.8724784794212, 45.0901911990919], [34.8248975326921,
 45.0783351147756],
 [34.7773451994982, 45.0664585449175], [34.7298213932474,
 45.0545615566424],
 [34.6823260281141, 45.0426442163884], [34.6348590190306,
 45.0307065899164],
 [34.6001893100315, 45.0496582358553], [34.565495668238,
 45.0685988693406],
 [34.5307780684752, 45.0875284779916], [34.4960364855943,
 45.1064470494011],
 [34.4612708944723, 45.1253545711343], [34.4264812700118,
 45.1442510307293],
 [34.3916675871419, 45.163136415697], [34.3568298208172,
 45.1820107135215],
 [34.3219679460187, 45.2008739116594], [34.2870819377534,
 45.2197259975403],
 [34.2521717710543, 45.2385669585668], [34.2172374209808,
 45.2573967821143],
 [34.1822788626187, 45.2762154555309], [34.1472960710798,
 45.2950229661379],
 [34.1122890215028, 45.3138193012292], [34.1249230545728,
 45.34474018811],
 [34.1375863824436, 45.3756544566371], [34.1502791448219,
 45.4065620478253],
 [34.1630014821059, 45.4374629022505], [34.1757535353903,
 45.4683569600458],
 [34.1885354464684, 45.4992441608991], [34.2013473578361,
 45.5301244440496],
 [34.2141894126955, 45.5609977482844], [34.2270617549581,
 45.5918640119347],
 [34.2399645292484, 45.6227231728739], [34.2528978809076,
 45.6535751685123],
 [34.2658619559968, 45.6844199357953], [34.2788569013007,
 45.7152574111995],
 [34.2918828643314, 45.7460875307289], [34.3049399933312,
 45.7769102299116],
 [34.3532293127776, 45.7889076311011], [34.4015496229923,
 45.8008834941054],

```

        [34.4499010211884, 45.8128377421031], [34.4982836054328,
45.8247702974718],
        [34.5466974746559, 45.8366810817765], [34.5951427286622,
45.8485700157587],
        [34.64361946814, 45.8604370193242], [34.6921277946726,
45.8722820115316],
        [34.7406678107482, 45.8841049105797], [34.7892396197712,
45.8959056337956],
        [34.8378433260726, 45.9076840976223], [34.8864790349218,
45.919440217605],
        [34.9351468525365, 45.9311739083794], [34.9838468860951,
45.9428850836581],
        [35.0325792437483, 45.9545736562164] ]
    ]
}
}

```

An HTML representation of that zone information resource, allowing a user to browse through parent, children and neighboring zones, could look like the following:

Zone *E6-317-A*

for ISEA3H DGRS (General Bathymetric Chart of the Oceans)

Hierarchy Level: 8

Associated ISEA9R Zone: [E6-317](#)

Zone Surface Area: 7774.21 kilometers square (0% **more** than reference mean zone for level 8)

Centroid: { lat: 45.4293774177926, lon: 34.8301691522938 }

Extent: { { lat: 44.9665795462011, lon: 34.1122890215028 }, { lat: 45.8904784696147, lon: 35.5548602543606 } }

[Download data as GeoTIFF](#)

[Download data as DGRS-JSON](#)

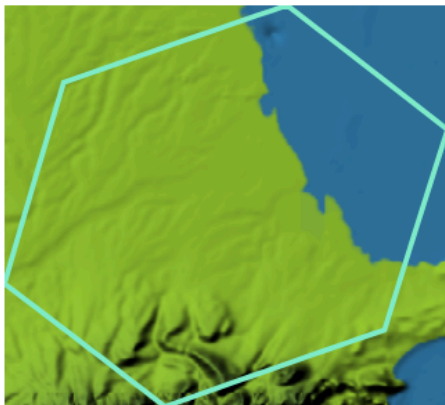
Parent: [D6-65-E](#)



Parent: [D6-4A-F](#)



Parent: [D6-66-D](#)
(centroid child)



Child	Zone ID	Map	Neighbor	Zone ID	Map
Centroid	E6-317-D		Left	E6-2C5-A	
Vertex	E6-317-E		Right	E6-369-A	
Vertex	E6-317-F		Top-Left	E6-2C6-A	
Vertex	E6-316-E		Top-Right	E6-318-A	
Vertex	E6-2C5-F		Bottom-Left	E6-316-A	
Vertex	E6-2C5-E		Bottom-Right	E6-368-A	
Vertex	E6-2C6-F				

Figure C.1 — Sample HTML response of an ISEA3H DGRS zone information resource for GEBCO data

C.5. Simple zone queries

Having selected a particular DGRS, one use case for the API is for a client to perform spatial queries by requesting a list of zones. The simplest case is to simply request a list of all available

zones for a discrete global grid of a given refinement level (`zone-level`), which in the case of a particular collection implies zones for which the collection has data.

C.5.1. Querying a particular refinement level

If no `zone-level` parameter is provided, the server is free to pick a default zone level for such queries. This would result in a reasonable number of zones returned, based on the area and resolution of the data collection. In this example, the client will explicitly request a list of zones at refinement level 1.

By default, if `compact-zones=false` is not specified by the client, zone queries are compacted. This means that if all sub-zones of a parent zone would be included in the response, they get replaced by that parent zone so that fewer zones need to be enumerated. This can result in zones being returned of a lower refinement level than the requested `zone-level`, and therefore a mix of zones of different levels. A full globe response would therefore always result in the list of all zones of refinement level 0. In these examples, the client will explicitly set `compact-zones=false`.

Following the `[ogc-rel:dggrs-zone-query]` link, specifying these parameters, and negotiating a JSON zone list response using an `Accept: application/json` header, the client requests from the endpoint:

<https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/ISEA3H/zones?zone-level=1&compact-zones=false>

An example JSON response for this Zone Query JSON, as defined by the Zone Query requirements class, is presented below:

```
{
  "zones" : [
    "A0-0-D", "A0-0-E", "A0-0-F", "A0-0-G", "A1-0-D", "A1-0-E",
    "A1-0-F", "A2-0-D", "A2-0-E", "A2-0-F", "A3-0-D", "A3-0-E",
    "A3-0-F", "A4-0-D", "A4-0-E", "A4-0-F", "A5-0-D", "A5-0-E",
    "A5-0-F", "A6-0-D", "A6-0-E", "A6-0-F", "A7-0-D", "A7-0-E",
    "A7-0-F", "A8-0-D", "A8-0-E", "A8-0-F", "A9-0-D", "A9-0-E",
    "A9-0-F", "A9-0-H"
  ],
  "returnedAreaMetersSquare" : 510065621724088.75,
  "links" : [
    { "rel" : "[ogc-rel:dggrs]", "title" : "ISEA3H DGGS for GEBCO",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H"
    },
    { "rel" : "[ogc-rel:dggrs-definition]", "title" : "ISEA3H DGGRS
definition",
      "href" : "/ogcapi/dggrs/ISEA3H"
    },
    { "rel" : "[ogc-rel:geodata]", "href" : "/ogcapi/collections/gebco" }
  ],
  "linkTemplates" : [
    { "rel" : "[ogc-rel:dggrs-zone-data]", "title" : "ISEA3H data for GEBCO",
      "uriTemplate" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/{zoneId}/
data",
    }
  ]
}
```


The server returned all 32 zones of ISEA3H level 1 (which corresponds to a truncated icosahedron — the traditional soccer ball pattern), because the collection has global coverage.

Servers may support additional representations of zone lists beyond JSON, such as a more compact binary 64-bit integers encoding, a GeoJSON representation including zone geometry or an HTML representation for exploring datasets in a browser through the DGGs API. Note that regardless of encoding, zone query responses can also be compressed for additional bandwidth efficiency if the client and server negotiate a content encoding e.g., using Content-Encoding: gzip.

CAUTION

The transfer of zone geometry in zone queries is not an efficient implementation use of the DGGs API for practical analytics purposes. This is because clients should already have built-in knowledge of the selected DGGs in their local software libraries and can efficiently infer the geometry of a zone from its zone ID alone as needed. In many use cases, the geometry may not be needed at all.

The ability to retrieve zone lists in a geospatial data format such as GeoJSON or GeoTIFF which can readily be visualized in GIS tools is useful for **educational**, **demonstration** and **debugging** purposes. For example, this functionality can be used to generate grids, such as those seen in annex B (a crs parameter to request an ISEA planar projection was used in that case to override the default GeoJSON CRS84), as well as the zone visualizations seen in the examples in this section.

A visualization of the response from negotiating application/geo+json for the above request is seen below.

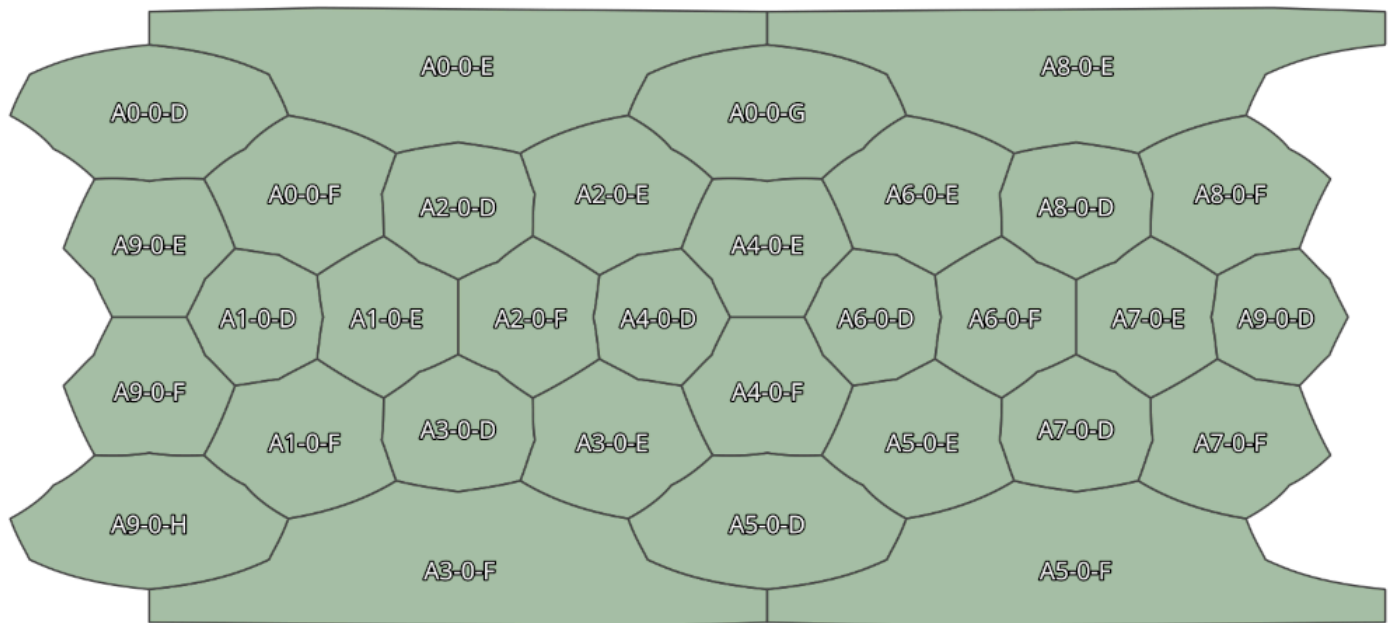


Figure C.2 — GeoJSON response for zone query for ISEA3H DGGs at level 1 visualized in QGIS

C.5.2. Querying for a spatio-temporal subset

To request a list of zones for an area of interest, the `bbox` or `subset` query parameter can be used. For temporal datasets, the `datetime` can be used as well as `subset=time(...)` to constrain the query to a time of interest. For restricting the same zone query to a bounding box area from (40°N, 30°E) to (60°N, 50°E), the client could make either of the following requests:

<https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/ISEA3H/zones?bbox=30,40,50,60&zone-level=1&compact-zones=false>

[https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/ISEA3H/zones?subset=Lat\(40:60\),Lon\(30:50\)&zone-level=1&compact-zones=false](https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/ISEA3H/zones?subset=Lat(40:60),Lon(30:50)&zone-level=1&compact-zones=false)

and obtain the following response (negotiating a JSON zone list again):

```
{
  "zones" : [ "A0-0-G", "A6-0-E" ],
  "returnedAreaMetersSquare" : 31137344609299.56640625,
  "links" : [
    { "rel" : "[ogc-rel:dggrs]", "title" : "ISEA3H DGGS for GEBCO",
      "href" : "/ogcapi/collections/gebco/dggs/ISEA3H"
    },
    { "rel" : "[ogc-rel:dggrs-definition]", "title" : "ISEA3H DGGRS
definition",
      "href" : "/ogcapi/dggrs/ISEA3H"
    },
    { "rel" : "[ogc-rel:geodata]", "href" : "/ogcapi/collections/gebco" }
  ],
  "linkTemplates" : [
    { "rel" : "[ogc-rel:dggrs-zone-data]", "title" : "ISEA3H data for GEBCO",
      "uriTemplate" : "/ogcapi/collections/gebco/dggs/ISEA3H/zones/{zoneId}/
data",
    }
  ]
}
```

This time, the server returned only two zones of ISEA3H level 1.

A visualization of the response from negotiating `application/geo+json` for the above request, together with the bounding box used, is seen below.

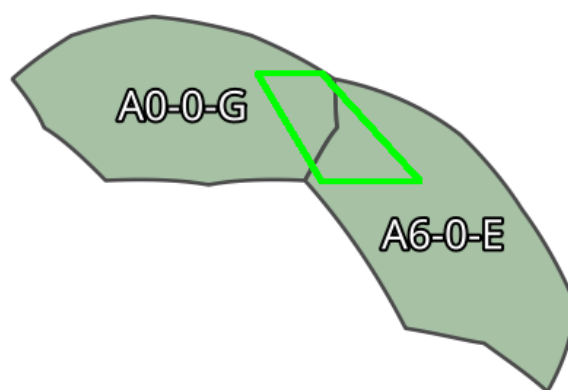


Figure C.3 – GeoJSON response for zone query for ISEA3H DGGRS at level 1 for a (40°N, 30°E) to (60°N,50°E) bounding box visualized in QGIS

As seen below, an HTML representation could include rendered previews of the data for the zone area, summary information, as well as links to retrieve the data and access the zone information resource for each zone. Note that the significant variance in area (-11.31% and +6.66% from the reference mean zone (whose area is calculated by dividing the Earth surface area by the total number of zones) is due to the fact that A0-0-G is a pentagon (in the ISEA projection – on the Earth surface it looks more like a decagon) which occupies 5/6th the area of hexagons such as A6-0-E (which on the Earth surface is one of the hexagons appearing as a nonagon), as well as the fact that at level 1, the number of pentagons (12) is significant compared to the total number of zones (32).

Zone ID	Map	Data	Zone Geometry	Area	Variance	Min Lat	Min Lon	Max Lat	Max Lon
Level 1 (variance relative to 15,939,550.68 km ² reference mean zone surface area)									
A0-0-G		data	geojson.io/download	14,136,336.1 km ²	-11.31 %	39.532480763194	-29.2549078771889164	79.2606559771152	51.7549078778955
A6-0-E		data	geojson.io/download	17,001,008.51 km ²	+6.66 %	12.1872690128254	27.142896755173	58.6687287802954	83.1792006259808

Total surface area: 31,137,344.61 km²

(~15,939,550.68 km² level 1 zone precision)

Figure C.4 – Sample HTML response for a zone query for ISEA3H DGGRS at level 1 for a (40°N, 30°E) to (60°N,50°E) bounding box

Of course with a higher zone level, many more zones can be returned:

<https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/ISEA3H/zones?bbox=30,40,50,60&zone-level=8&compact-zones=false>

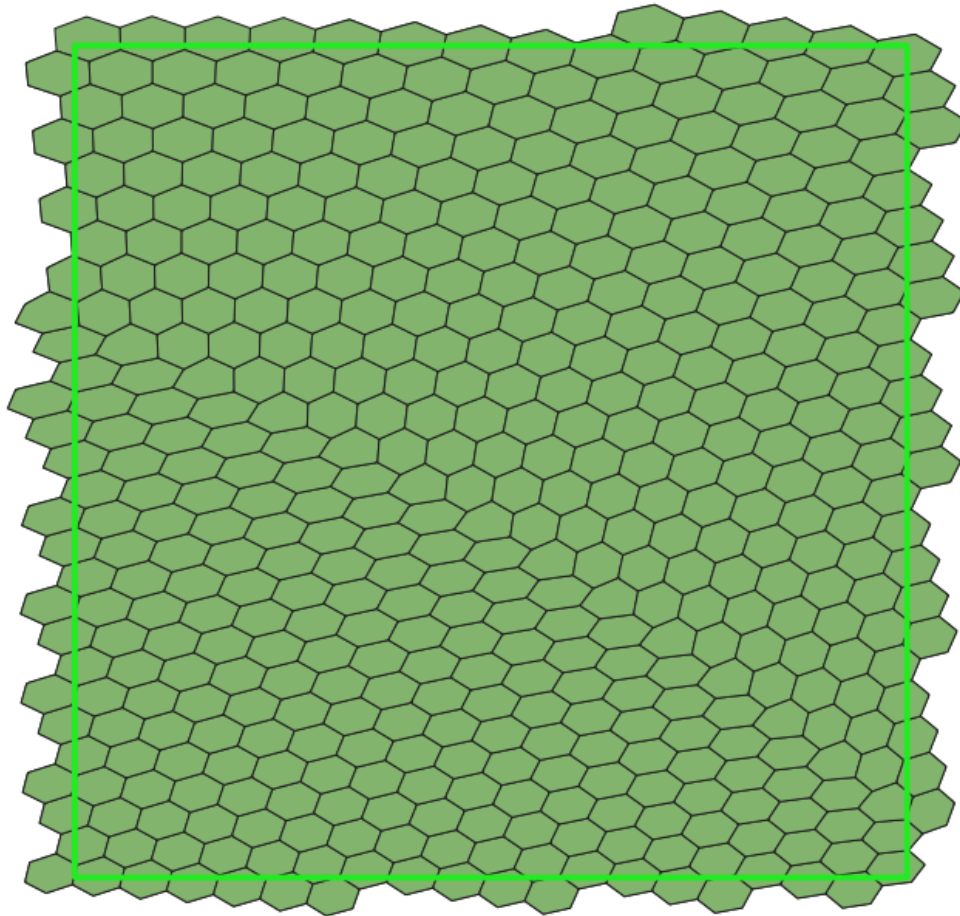


Figure C.5 — Sample HTML response for a zone query for ISEA3H DGGRS at level 8 for a (40°N, 30°E) to (60°N,50°E) bounding box

C.5.3. Zones representing data availability

The primary purpose of the Zone Query requirements class is to ask questions of the type “Where is it?”. The answer is a region of spacetime represented by a list of zones. This region might correspond to where data is available for a particular collection of data, whether that data is static or the result of a processing workflow. Later examples will demonstrate more complex queries using CQL2 expressions. These resulting spatiotemporal regions could otherwise have been communicated as a multi-polygon vector mask or as a rasterized 1-bit image or opacity channel.

The following example illustrates the case of a collection (elevation data from [Viewfinder Panoramas](#)) which does not have data for everywhere on the globe (only over land), using a higher zone level of 6 for the query.

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/ISEA3H/zones?zone-level=6&compact-zones=false

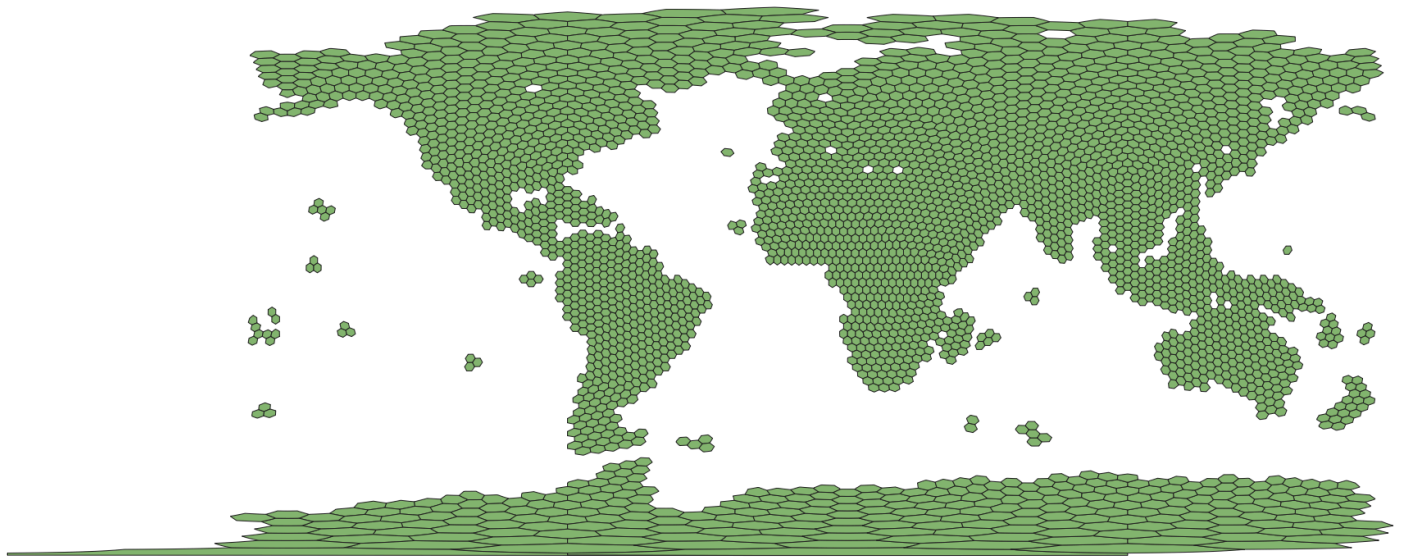


Figure C.6 — GeoJSON response for zone query for ISEA3H DGGRS at level 6 for a Viewfinder Panoramas land elevation collection, visualized in QGIS

Using a bounding box to restrict the query to an area of interest, a higher zone level of 10 could be used:

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/ISEA3H/zones?zone-level=10&bbox=30,40,50,50&compact-zones=false

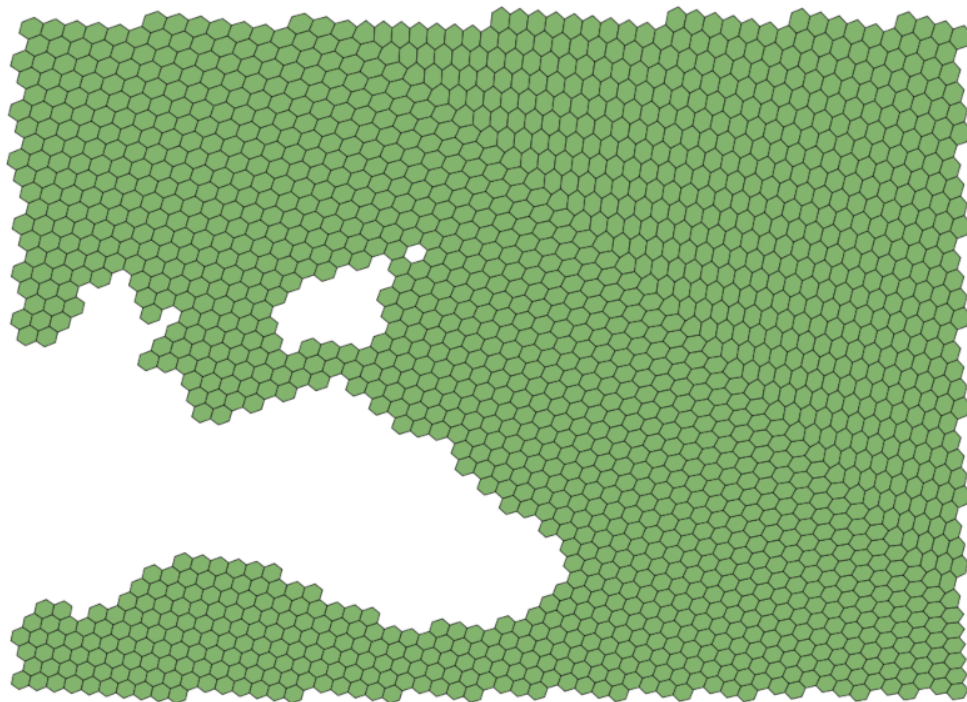


Figure C.7 — GeoJSON response for zone query for ISEA3H DGGRS at level 10, using a (40°N, 30°E) to (40°N,50°E) bounding box, for a Viewfinder Panoramas land elevation collection, visualized in QGIS

An implementation of the DGGS API works independently of the nature of the data, whether dealing with gridded coverage or vector features. This allows easily performing complex analytics involving heterogeneous data sources. The previous examples all used gridded coverage data sources. The following example illustrates the same capabilities using the Natural Earth states and provinces collection:

https://maps.gnosis.earth/ogcapi/collections/NaturalEarth:cultural:ne_10m_admin_1_states_provinces/dggs/ISEA3H/zones?zone-level=6&compact-zones=false

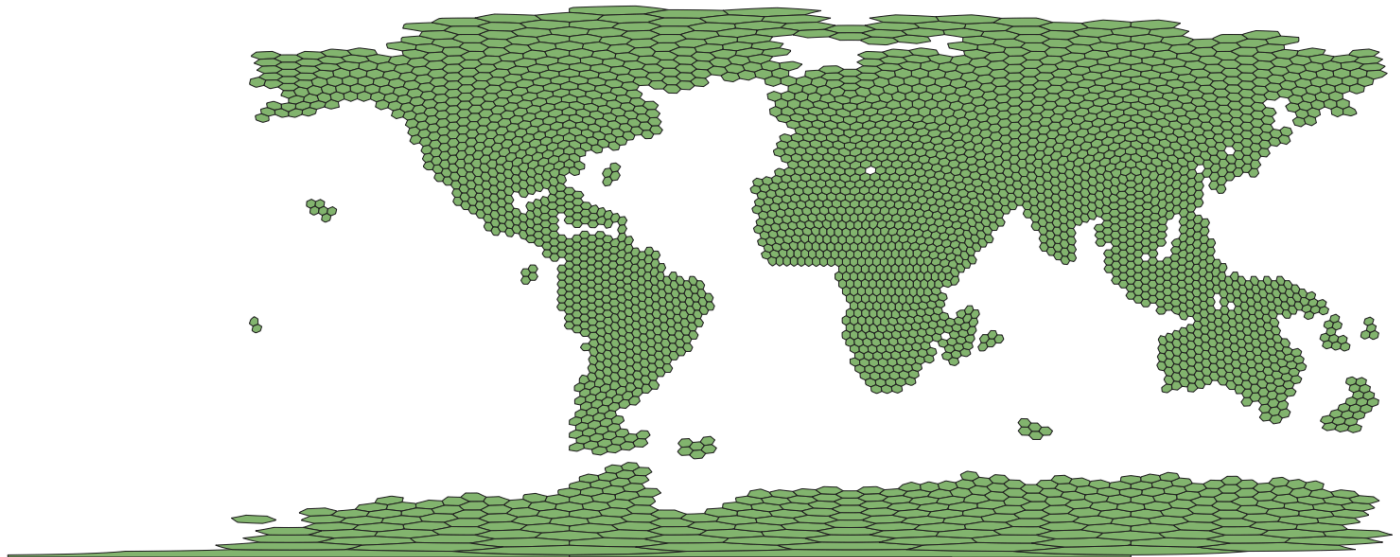


Figure C.8 — GeoJSON response for zone query for ISEA3H DGGRS at level 6, for a [Natural Earth](#) states and provinces collection, visualized in QGIS

The similarity between the response for this collection of states and provinces features compared to the same request earlier for a gridded elevation coverages showcases the potential for DGGS zone queries to facilitate data integration.

C.5.4. Querying sub-zones of a parent zone

The Zone Query requirements class defines the parent-zone query parameter as one more way to restrict the query spatially (and temporally in the case of a temporal DGGRS), which is particularly useful for hierarchical exploration. For example, to restrict the query to sub-zones of A6-0-E rather than using a bounding box, the client could perform the following request (at level 8):

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/ISEA3H/zones?zone-level=8&parent-zone=A6-0-E&compact-zones=false

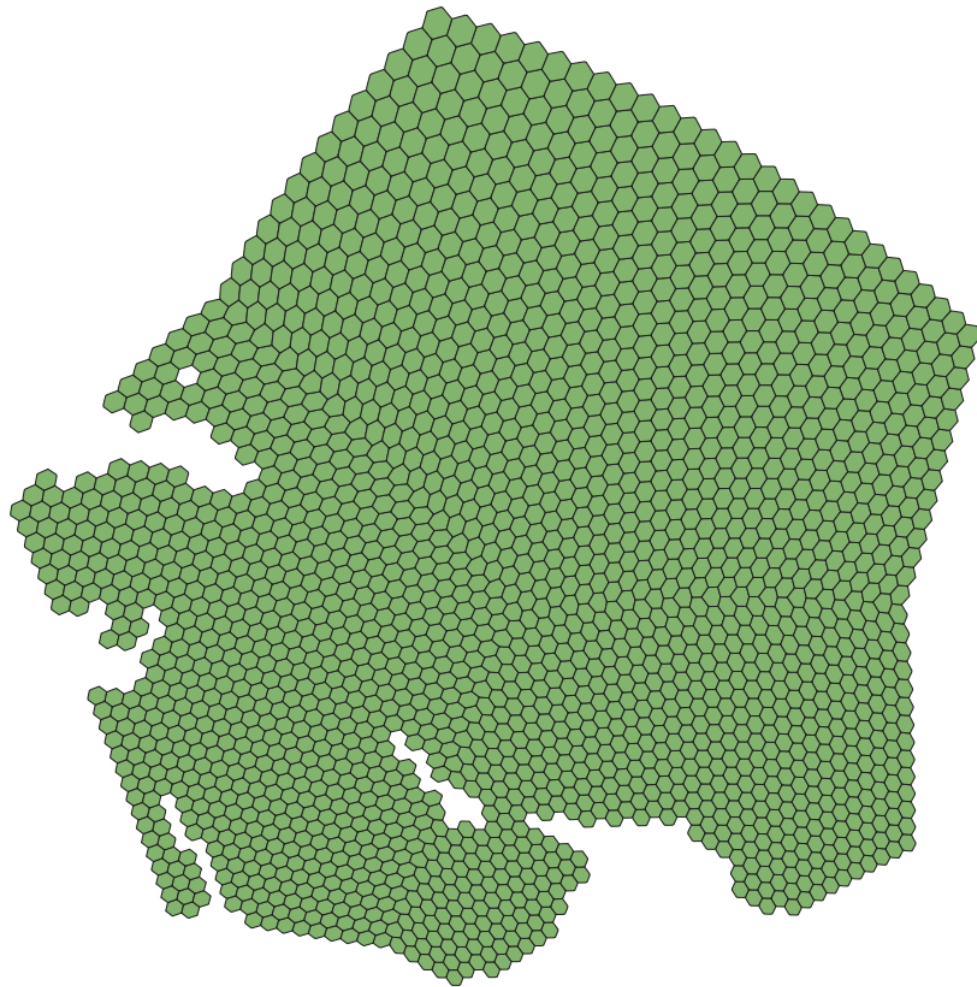


Figure C.9 — GeoJSON response for zone query for ISEA3H DGGRS at level 8, for parent zone A6-0-E, for a Viewfinder Panoramas land elevation collection, visualized in QGIS

The client could then pick one of the returned zones, say E6-317-A, for deeper exploration at level 16:

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/ISEA3H/zones?zone-level=16&parent-zone=E6-317-A&compact-zones=false

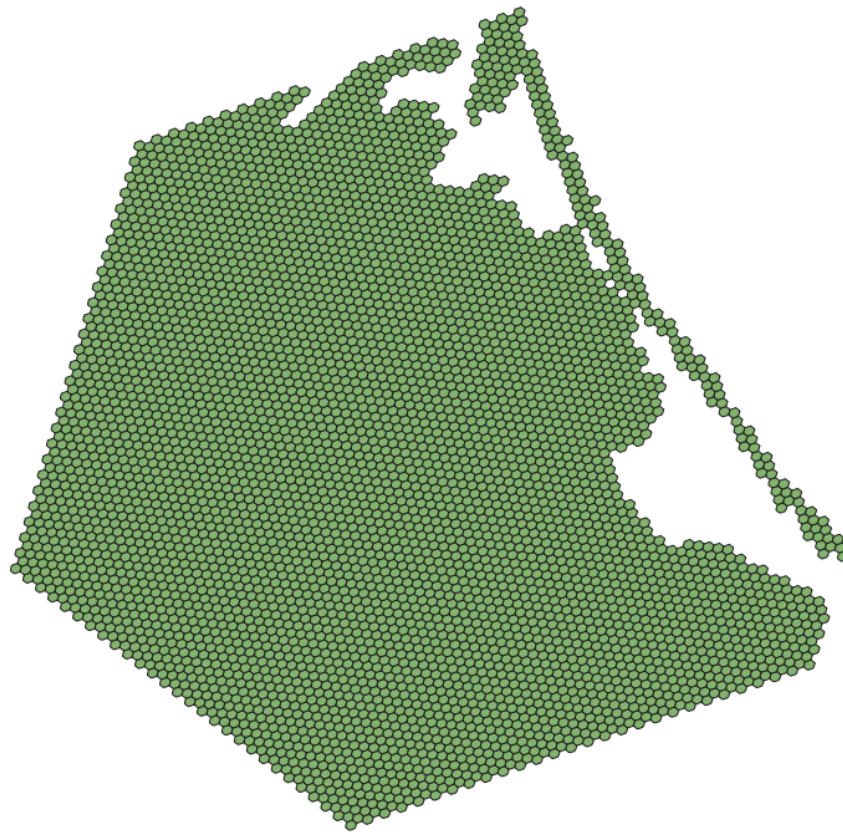


Figure C.10 — GeoJSON response for zone query for ISEA3H DGGRS at level 16, for parent zone E6-317-A, for a Viewfinder Panoramas land elevation collection, visualized in QGIS

Going back to A6-0-E (a level 1 zone), this could also be used to retrieve the immediate children by requesting the next level (2), to step down the hierarchy a single refinement level at a time:

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/ISEA3H/zones?zone-level=2&parent-zone=A6-0-E&compact-zones=false

Since they all contain data, the seven children zones (one centroid child and six vertex children) are returned.

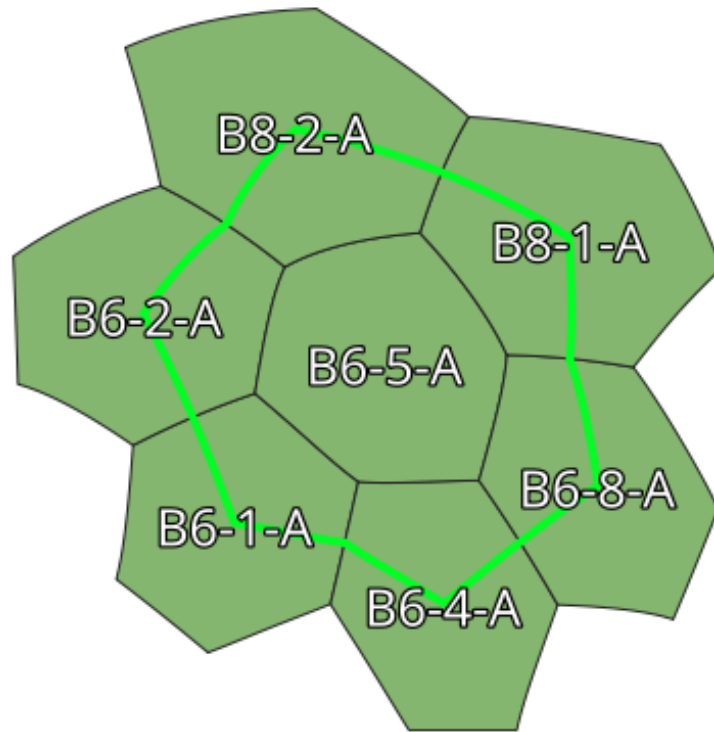


Figure C.11 — GeoJSON response for zone query for ISEA3H DGGRS at level 2, for parent zone A6-0-E (outline shown), for a [Viewfinder Panoramas](#) land elevation collection, visualized in QGIS

C.5.5. ISEA9R (rhombus) Zone Queries

Although the examples so far have used the ISEA3H DGGRS, the DGGS API Standard is completely agnostic of the DGGRS. Future planned parts for OGC Abstract Topic 21 will standardize new categories of DGGH, including volumetric (Part 2), temporal (Part 3) and axis-aligned (Part 4). The DGGS API Standard, as demonstrated in this examples section, is ready to handle any DGGRS, including DGGRSs based on these new DGGH types.

The following examples demonstrates equivalent zone queries using the ISEA9R DGGS, a dual DGGS of ISEA3H even refinement levels, which can be considered axis-aligned in a CRS derived from rotating and shearing the ISEA planar projection. In the ISEA planar projection, the ISEA9R zones are shaped as rhombuses.

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/ISEA9R/zones?zone-level=3&compact-zones=false

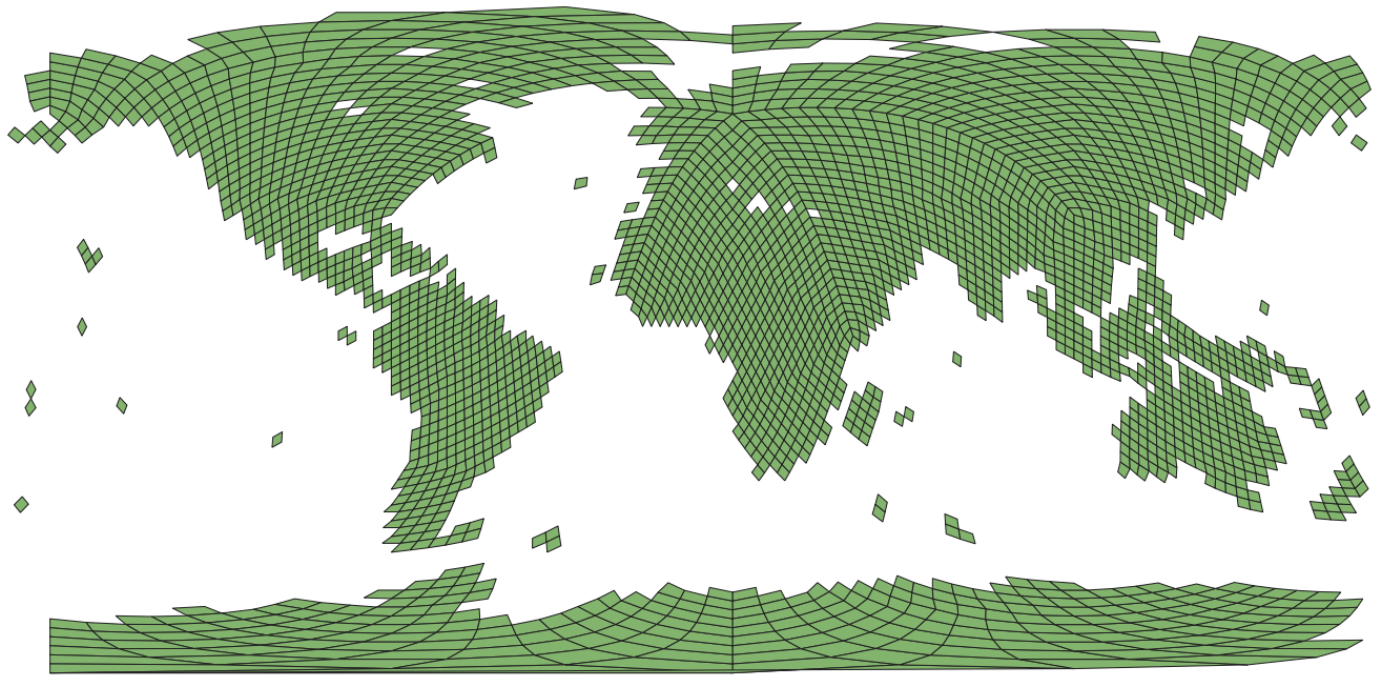


Figure C.12 — GeoJSON response for zone query for ISEA9R DGGRS at level 3 for a [Viewfinder Panoramas](#) land elevation collection visualized in QGIS

<https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/ISEA9R/zones?bbox=30,40,50,60&zone-level=4&compact-zones=false>

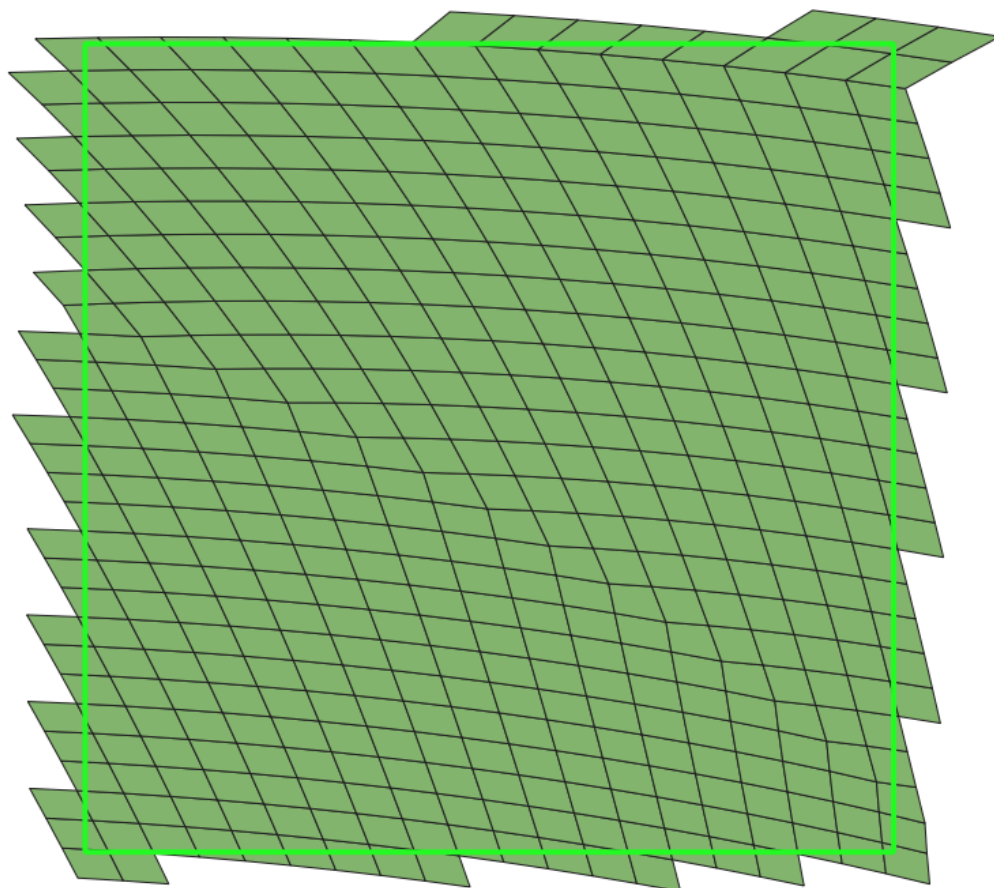


Figure C.13 – GeoJSON response for zone query for ISEA9R DGGRS at level 4 for a (40°N, 30°E) to (60°N,50°E) bounding box visualized in QGIS

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/ISEA9R/zones?zone-level=4&parent-zone=B6-2&compact-zones=false

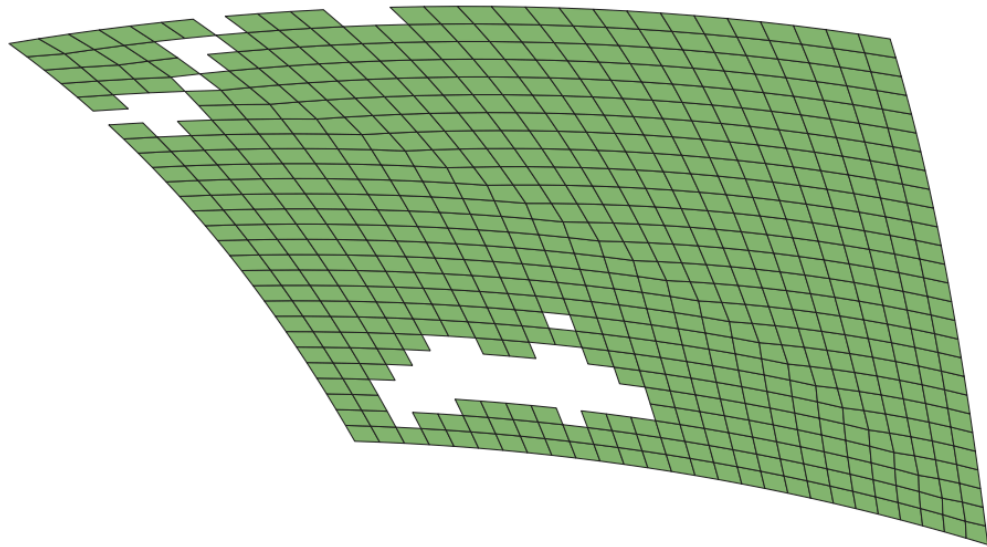


Figure C.14 – GeoJSON response for zone query for ISEA9R DGGRS at level 4 for parent zone B6-2, for Viewfinder Panoramas, visualized in QGIS

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/ISEA9R/zones?zone-level=8&parent-zone=E6-317&compact-zones=false

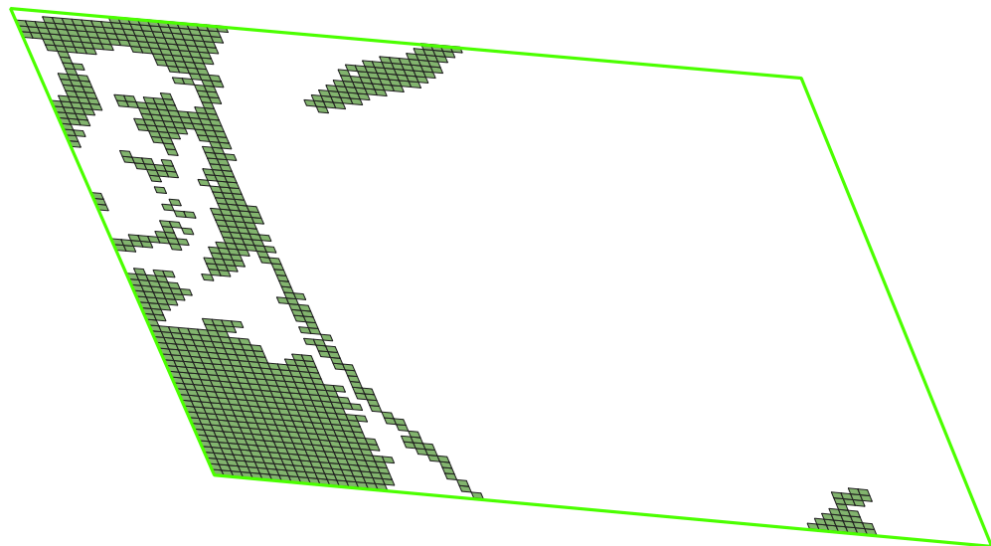


Figure C.15 – GeoJSON response for zone query for ISEA9R DGGRS at level 8 for parent zone E6-317, for Viewfinder Panoramas, visualized in QGIS

Although ISEA9R is axis-aligned, it is also perfectly equal area.

C.5.6. GNOSIS Global Grid (WGS84 rectangles) Zone Queries

The next zone query examples use the GNOSIS Global Grid DGGRS. The GNOSIS Global Grid is also axis-aligned, with the axes being the geographic latitude and longitude. On a plate

carée projection, the zones are shaped as rectangles, which conveniently correspond to typical EPSG:4326 / CRS84 bounding boxes.

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/ISEA3H/zones?zone-level=5&compact-zones=false



Figure C.16 — GeoJSON response for zone query for GNOSIS Global Grid DGGRS at level 5 for a Viewfinder Panoramas land elevation collection visualized in QGIS

<https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/GNOSISGlobalGrid/zones?bbox=30,40,50,60&zone-level=7&compact-zones=false>

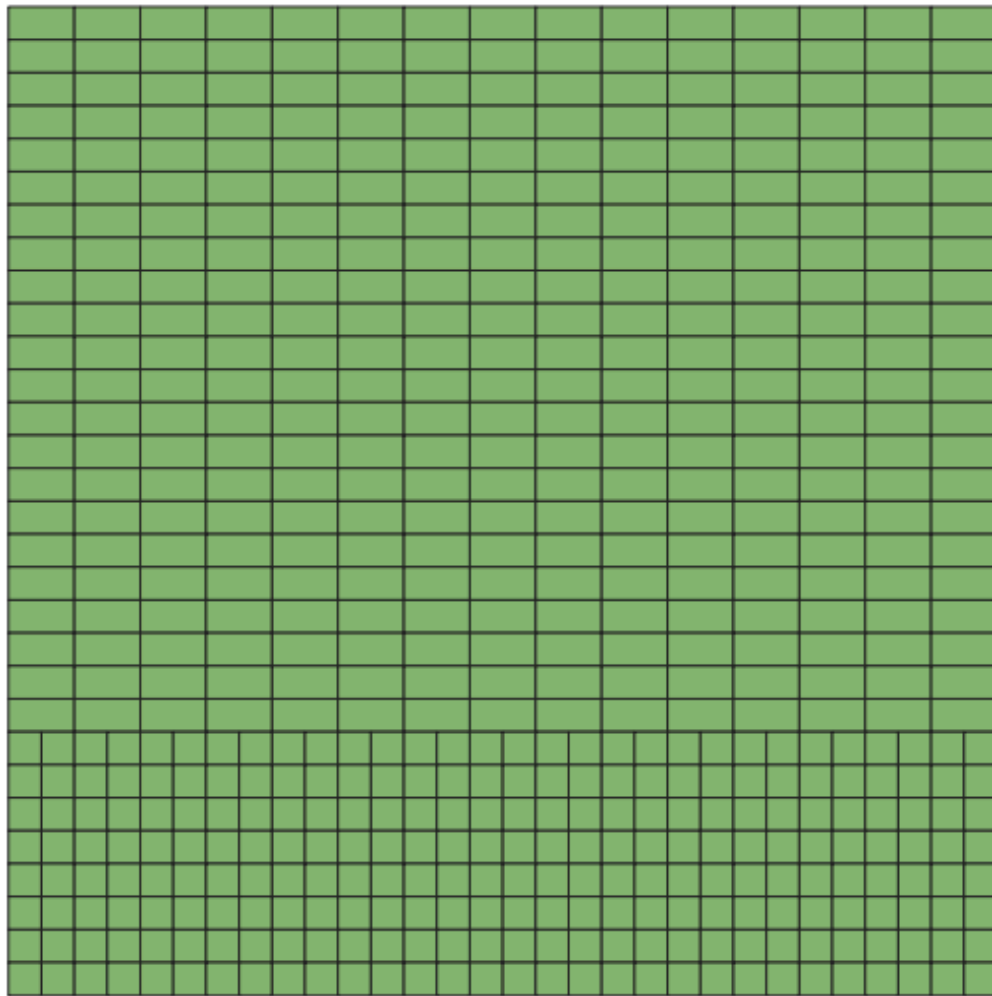


Figure C.17 — GeoJSON response for zone query for GNOSIS Global Grid DGGRS at level 7 for a (40°N, 30°E) to (60°N,50°E) bounding box visualized in QGIS

[https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/
GNOSISGlobalGrid/zones?zone-level=8&parent-zone=2-2-9&compact-zones=false](https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/GNOSISGlobalGrid/zones?zone-level=8&parent-zone=2-2-9&compact-zones=false)



Figure C.18 — GeoJSON response for zone query for GNOSIS Global Grid DGGRS at level 8 for parent zone 2-2-9, for Viewfinder Panoramas, visualized in QGIS

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/GNOSISGlobalGrid/zones?zone-level=13&parent-zone=6-1F-98&compact-zones=false



Figure C.19 — GeoJSON response for zone query for GNOSIS Global Grid DGGRS at level 13 for parent zone [6-1F-98](#), for [Viewfinder Panoramas](#), visualized in QGIS

C.6. Compact zone queries

The following examples are reprises of some of the earlier examples leaving compact zones enabled. These examples showcase how the zone compacting mechanism allows to communicate the same spatial area using fewer zones.

C.6.1. ISEA3H compact zone queries

Compacting ISEA3H zones is complicated by sub-zones not being fully congruent. The approach demonstrated here skips a refinement level, taking advantage of the fact that seven of the grandchildren of a zone are congruent. Overlaps are seen, as six holes are left at the vertices of the grandparent, each occupying $1/3$ rd the size of a congruent grandchild. Note how $7 + 6 \times 1/3 = 9$ (3×3), which corresponds to the two subsequent refinements at the refinement ratio of 3. If the neighboring grandparent of the same refinement level cannot be used, then the non-congruent vertex children must be included, resulting in these overlaps.

<https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/ISEA3H/zones?bbox=30,40,50,60&zone-level=8>

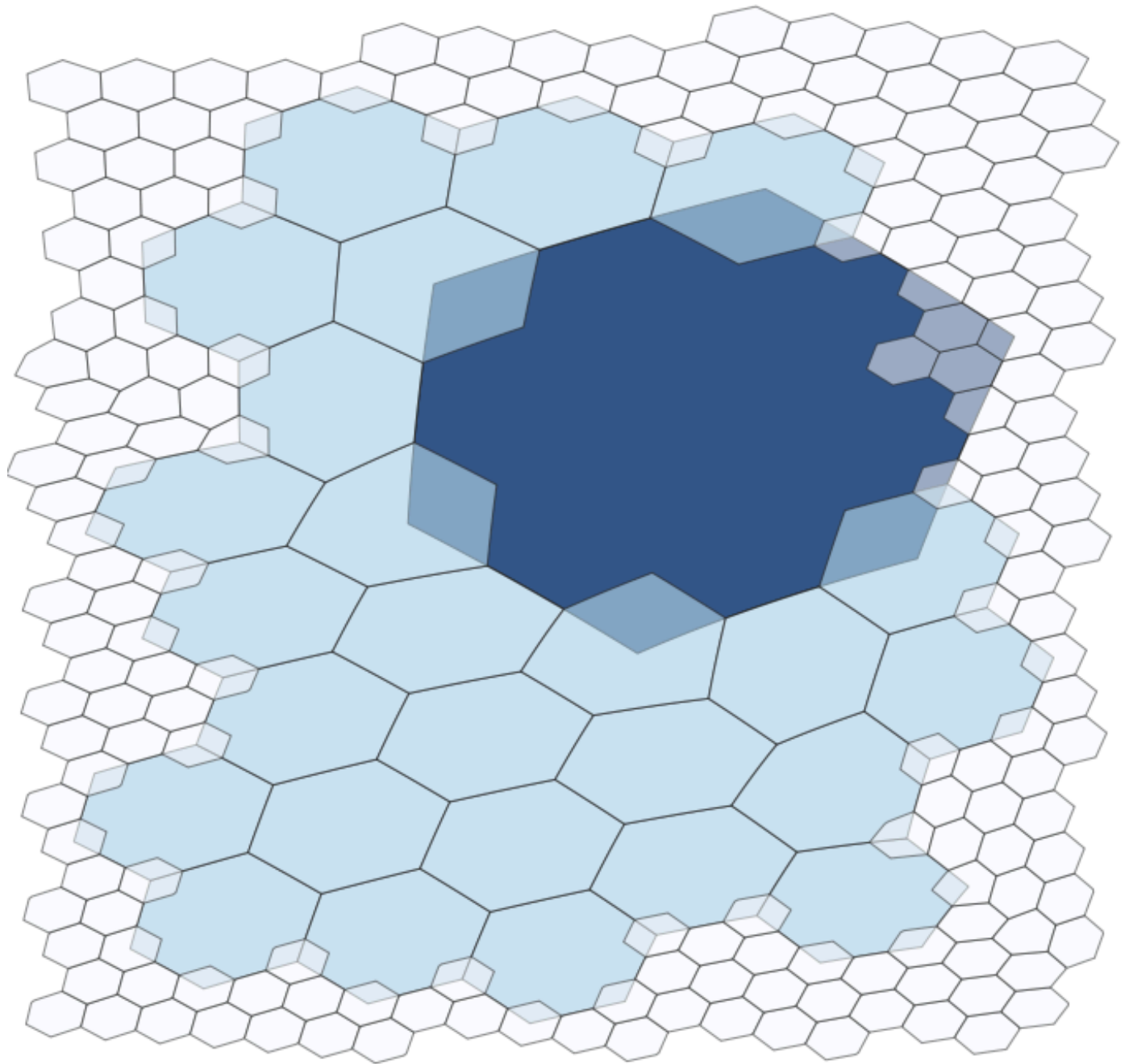


Figure C.20 – GeoJSON compact zones response querying ISEA3H DGGRS at level 8 for a (40°N, 30°E) to (60°N,50°E) bounding box

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/ISEA3H/zones?zone-level=6

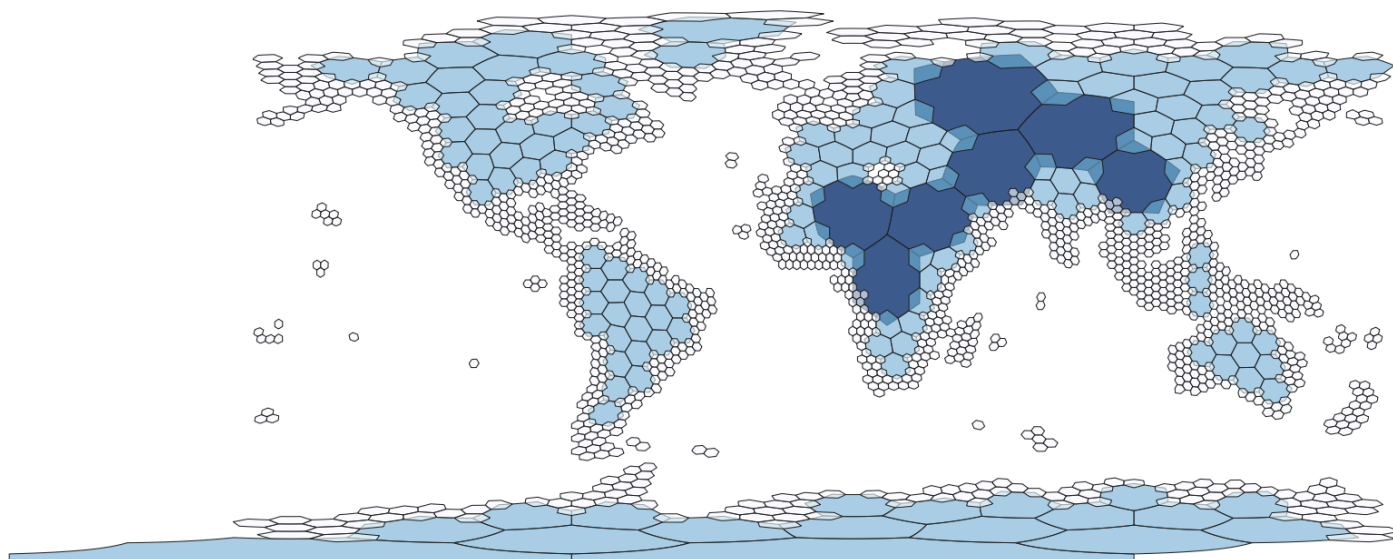


Figure C.21 – GeoJSON compact zones response for querying ISEA3H DGGRS at level 6 for a Viewfinder Panoramas land elevation collection, visualized in QGIS

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/ISEA3H/zones?zone-level=10&bbox=30,40,50,50

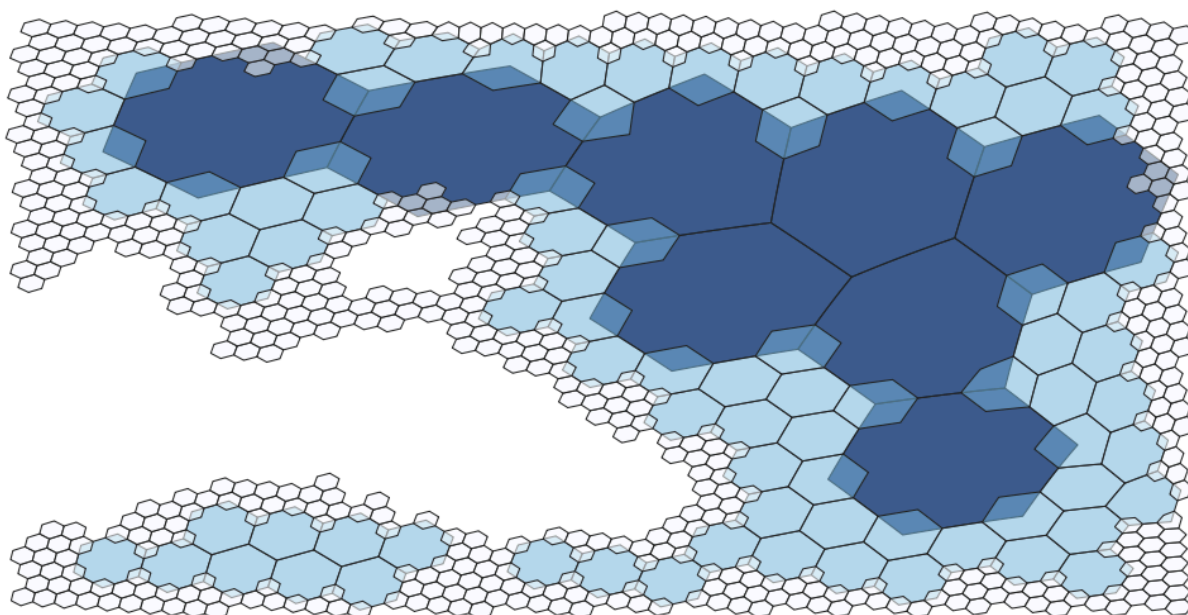


Figure C.22 – GeoJSON compact zones response for querying ISEA3H DGGRS at level 10, using a (40°N, 30°E) to (40°N,50°E) bounding box, for a Viewfinder Panoramas land elevation collection, visualized in QGIS

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/ISEA3H/zones?zone-level=16&parent-zone=E6-317-A

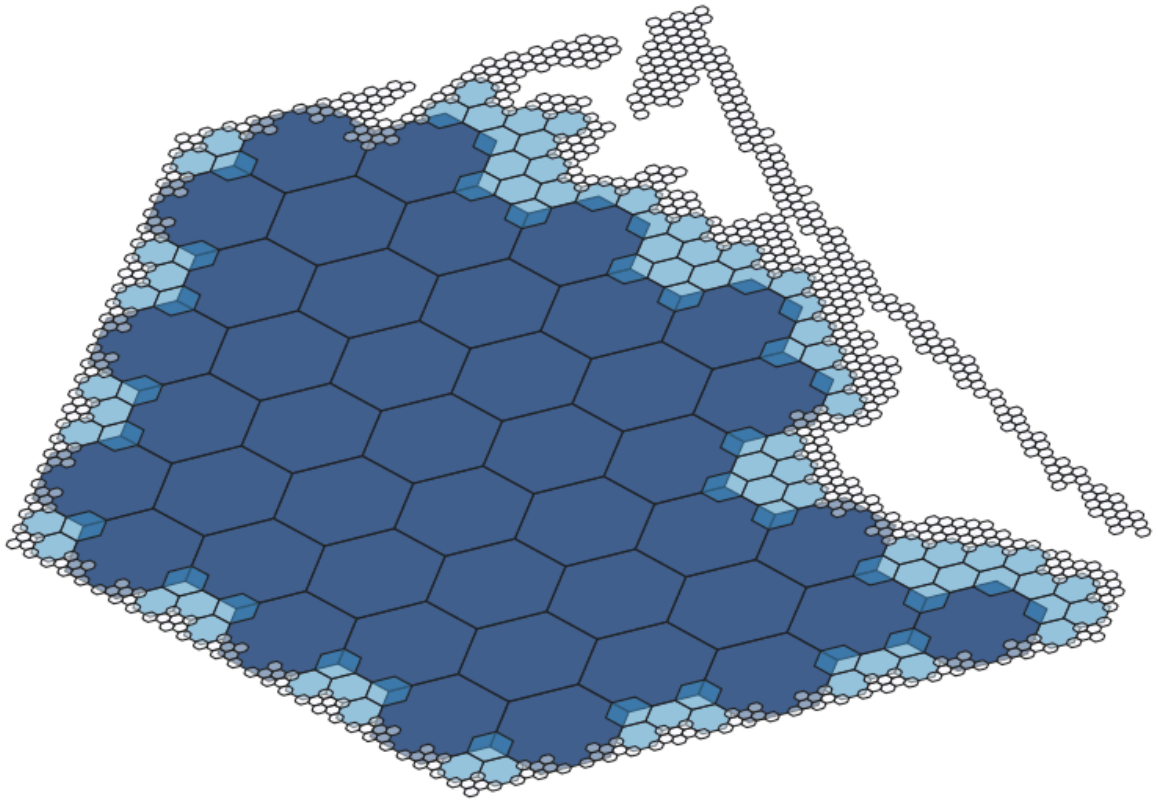


Figure C.23 — GeoJSON compact zones response for querying ISEA3H DGGRS at level 16, for parent zone E6-317-A, for a Viewfinder Panoramas land elevation collection, visualized in QGIS

C.6.2. ISEA9R compact zone queries

Compacting ISEA9R zones can be achieved quite simply given that all sub-zones are fully congruent.

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/ISEA9R/zones?zone-level=3

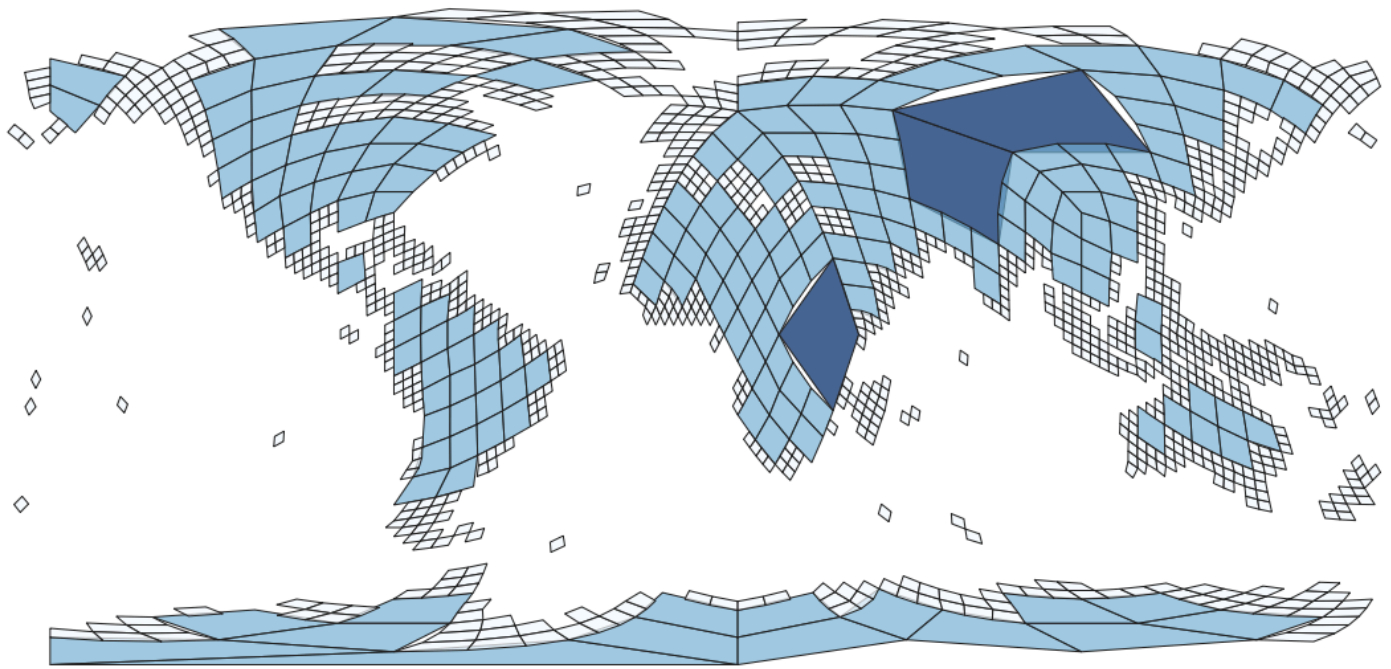


Figure C.24 — GeoJSON compact zones response for querying ISEA9R DGGRS at level 3 for a [Viewfinder Panoramas](#) land elevation collection visualized in QGIS

<https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/ISEA9R/zones?bbox=30,40,50,60&zone-level=4>

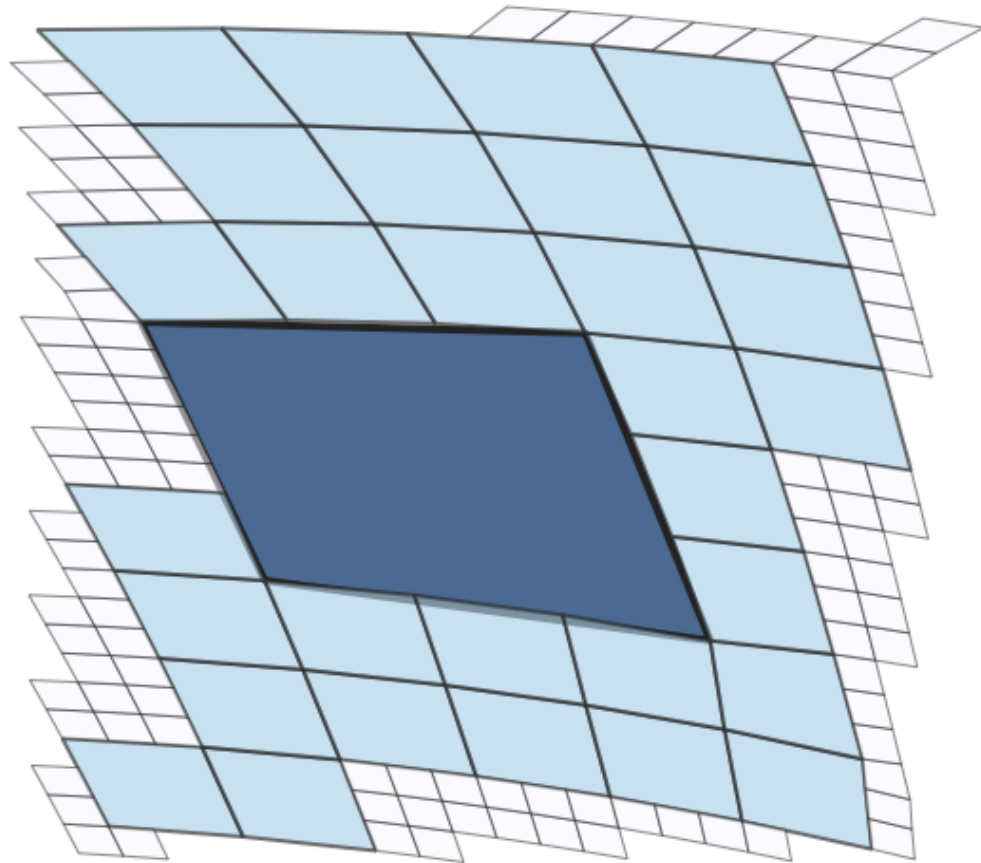


Figure C.25 — GeoJSON compact zones response for querying ISEA9R DGGRS at level 4 for a (40°N, 30°E) to (60°N,50°E) bounding box visualized in QGIS

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/ISEA9R/zones?zone-level=4&parent-zone=B6-2

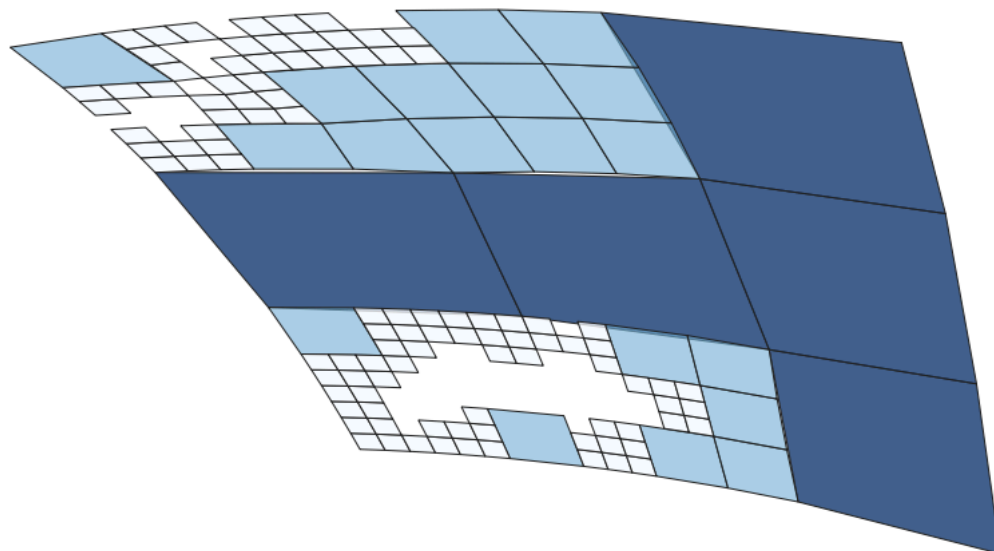


Figure C.26 — GeoJSON compact zones response for querying ISEA9R DGGRS at level 4 for parent zone B6-2, for Viewfinder Panoramas, visualized in QGIS

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/ISEA9R/zones?zone-level=8&parent-zone=E6-317

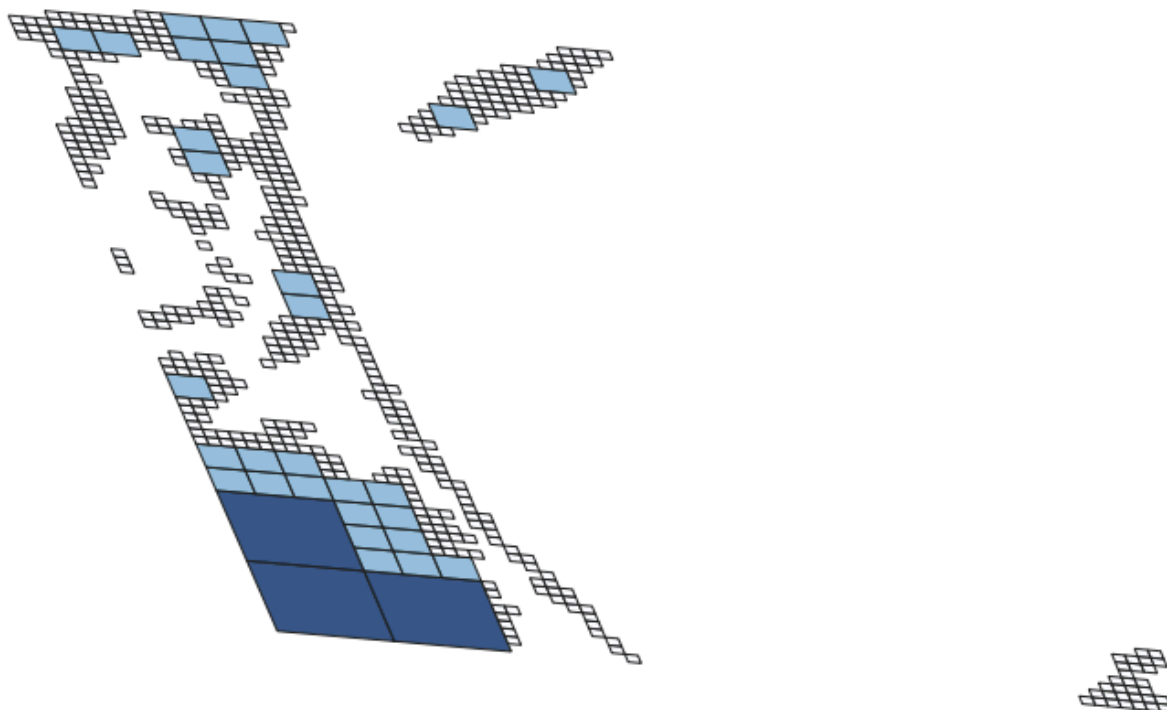


Figure C.27 — GeoJSON compact zones response for querying ISEA9R DGGRS at level 8 for parent zone E6-317, for Viewfinder Panoramas, visualized in QGIS

C.6.3. GNOSIS Global Grid compact zone queries

Compacting GNOSIS Global Grid zones is also simple to achieve since sub-zones are also fully congruent.

To illustrate how the width of the zones attempts to remain equal to the height, the following examples are visualized using the world Mercator projection. As with the previous examples for ISEA3H and ISEA9R, the zones of a given refinement level are filled with the same color. Note that the zones closer to the poles are wider in longitude than zones closer to the equator, and can be seen in a 2-to-1 configuration at jumps in the variable widths coalescence factor such as at the 45° parallel, but these zones still occupy a similar area within the error budget. However, in these illustrations, the polar zones appear much larger than zones of the same level closer to the equator because the Mercator projection enlarges features away from the equator.

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/ISEA3H/zones?zone-level=5

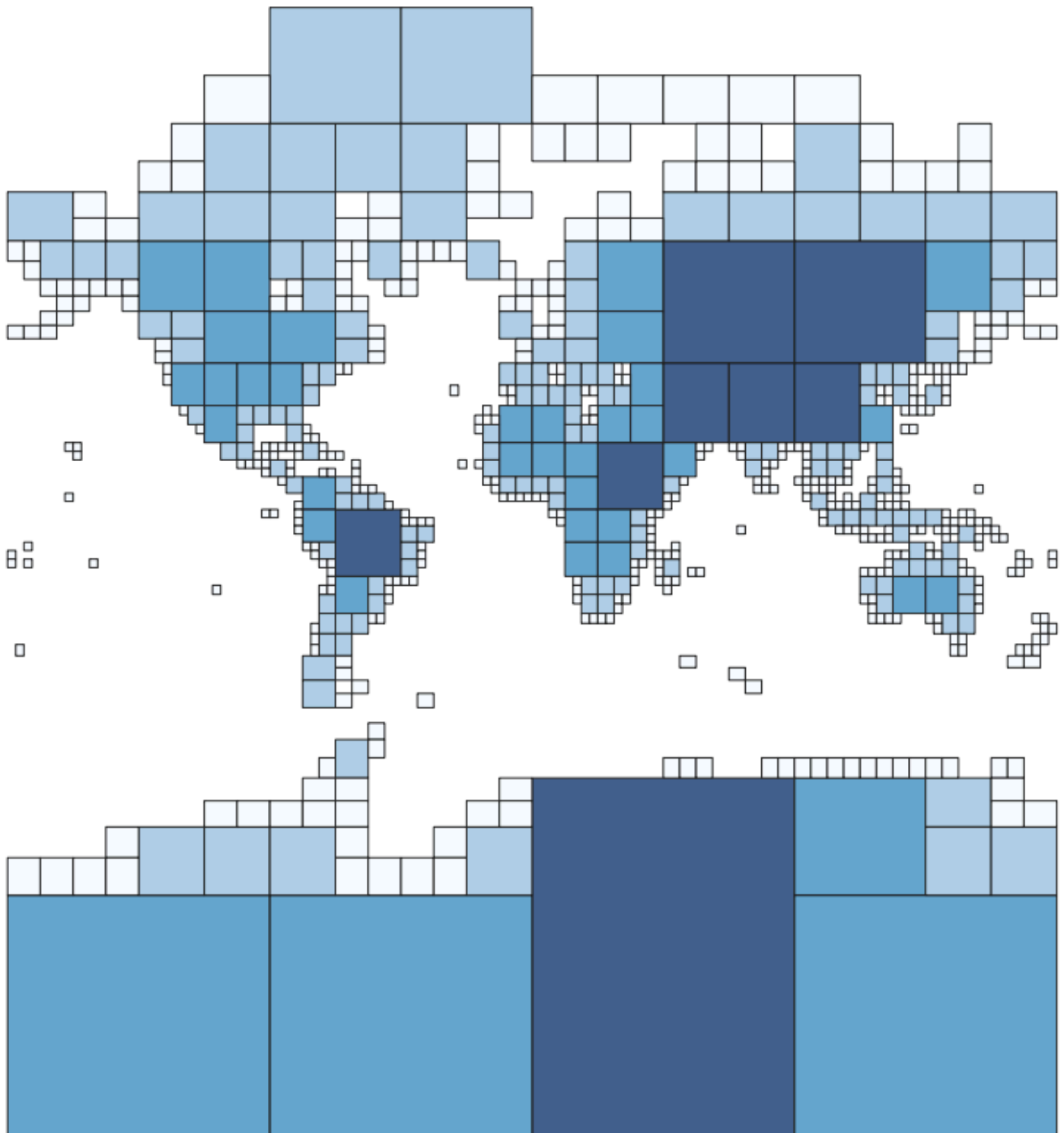


Figure C.28 — GeoJSON compact zones response for querying GNOSIS Global Grid DGGRS at level 5 for a Viewfinder Panoramas land elevation collection visualized in QGIS

<https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/GNOSISGlobalGrid/zones?bbox=30,40,50,60&zone-level=7>

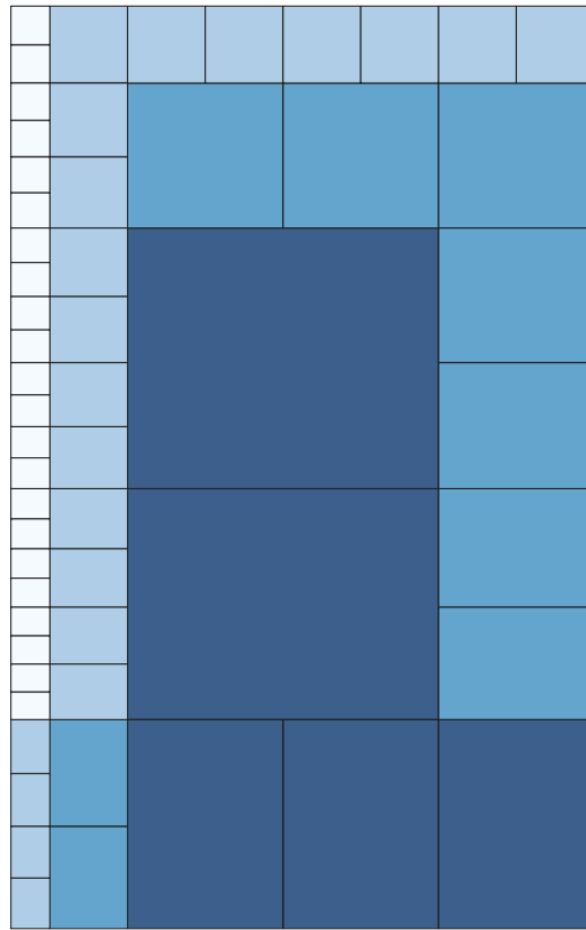


Figure C.29 — GeoJSON compact zones response for querying GNOSIS Global Grid DGGRS at level 7 for a (40°N, 30°E) to (60°N,50°E) bounding box visualized in QGIS

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/GNOSISGlobalGrid/zones?zone-level=8&parent-zone=2-2-9

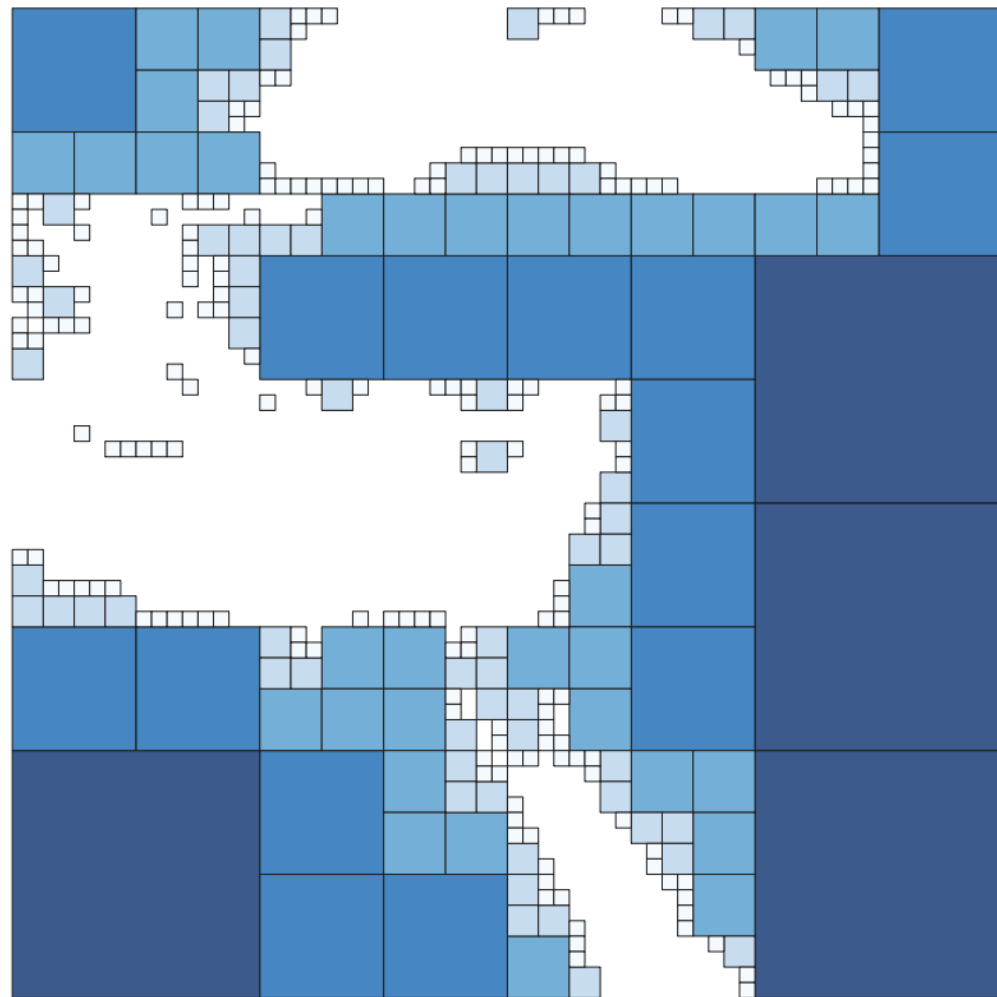


Figure C.30 — GeoJSON compact zones response for querying GNOSIS Global Grid DGGRS at level 8 for parent zone 2-2-9, for Viewfinder Panoramas, visualized in QGIS

https://maps.gnosis.earth/ogcapi/collections/SRTM_ViewFinderPanorama/dggs/GNOSISGlobalGrid/zones?zone-level=13&parent-zone=6-1F-98

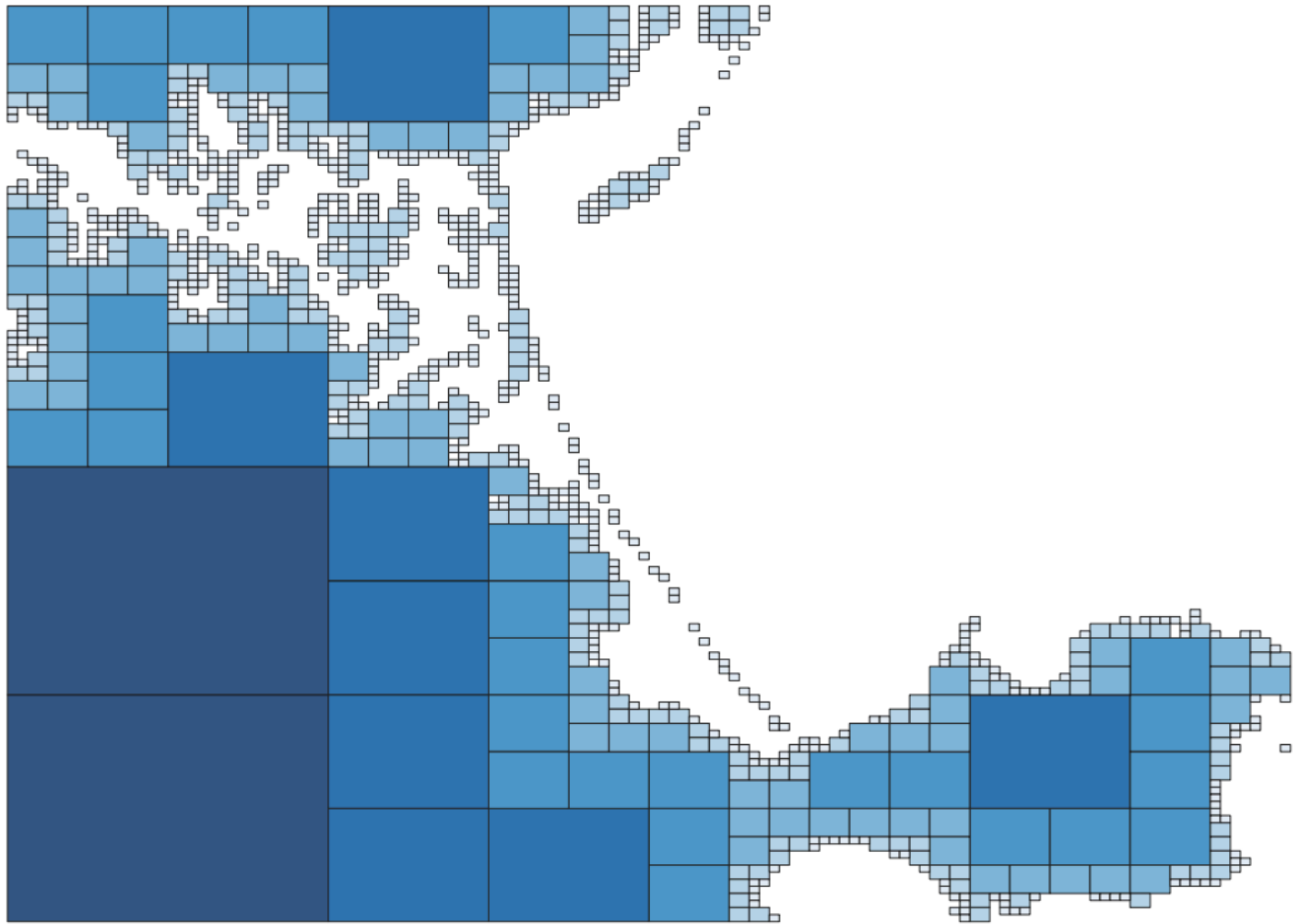


Figure C.31 — GeoJSON compact zones response for querying GNOSIS Global Grid DGGRS at level 13 for parent zone 6-1F-98, for Viewfinder Panoramas, visualized in QGIS

C.7. Filtering zone queries using CQL2 expressions

The Zone Query capabilities are most useful for use cases where the retrieved zone list is the result of some operation, whether a processing workflow or the evaluation of a query expressed by the client. The CQL2 filter capability supports expressing such queries using the OGC Common Query Language (CQL2). Note that the processing workflow could also itself include CQL2 expressions using input/output field modifiers.

The CQL2 requirements class in the OGC API — DGGs Standard specifically calls for the CQL2-Text encoding, which is an intuitive representation with many similarities to SQL. CQL2 defines minimum capabilities (Basic CQL2) as well as additional optional capabilities, such as arithmetic operations and spatial relation functions. A DGGs API implementation's conformance resource

(/conformance as defined in [OGC API — Common — Part 1: Core](#) “Landing Page” requirements class) enables the client to know which capabilities are supported.

Basic CQL2 includes support for logical operators as well as to compare the value of queryables against literals using relational operators. The following examples will use the same GEBCO collection as earlier examples to illustrate these capabilities. The previous simple zone queries using this collection were not particularly interesting since the collection covers the entire globe, but the use of CQL2 will enable the use of its data values. First, the client would retrieve the queryables by following the [ogc-rel:queryables] link from the collection description:

<https://maps.gnosis.earth/ogcapi/collections/gebco/queryables>

The application/schema+json response would look like so:

```
{
  "$schema" : "https://json-schema.org/draft/2020-12/schema",
  "$id" : "https://maps.gnosis.earth/ogcapi/collections/gebco/queryables",
  "title" : "General Bathymetric Chart of the Oceans",
  "type" : "object",
  "properties" : {
    "Elevation" :
    {
      "type" : "number",
      "x-ogc-propertySeq" : 1,
      "x-ogc-definition": "https://qudt.org/vocab/quantitykind/Altitude",
      "x-ogc-unit": "m"
    },
    "rec.geom" : {
      "x-ogc-role" : "primary-geometry",
      "format" : "geometry-point"
    }
  }
}
```

This informs the client that an Elevation queryable is available for use in CQL2 expressions. Although this collection is a gridded coverage, a rec.geom queryable is still included in the schema which represents the geometry of each individual grid cell. Since the value associated with these cells represent a point in this collection, the format indicates geometry-point. Later examples will make use of this rec.geom property.

The client could then submit the following zone query to return only zones where elevation is below sea level (Elevation < 0), at refinement level 6:

[https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/isea3h/zones?filter=Elevation < 0&zone-level=6](https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/isea3h/zones?filter=Elevation<0&zone-level=6)

The following image is a visualization of the list of zones returned.

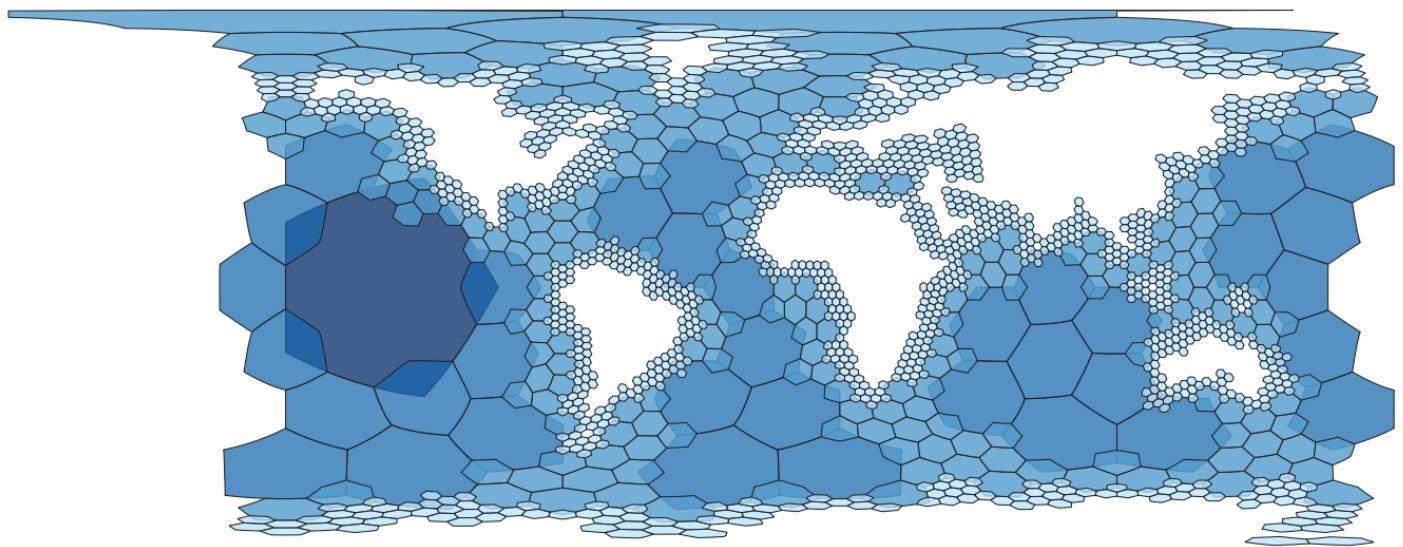


Figure C.32 – GeoJSON compact zones response for querying ISEA3H DGGRS for GEBCO 2014 bathymetry with CQL2 expression `Elevation < 0` visualized in QGIS

The client could also request deeper elevations e.g., `Elevation < -4000`:

[https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/isea3h/zones?filter=Elevation < -4000&zone-level=6](https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/isea3h/zones?filter=Elevation%20%3C%20-4000&zone-level=6)

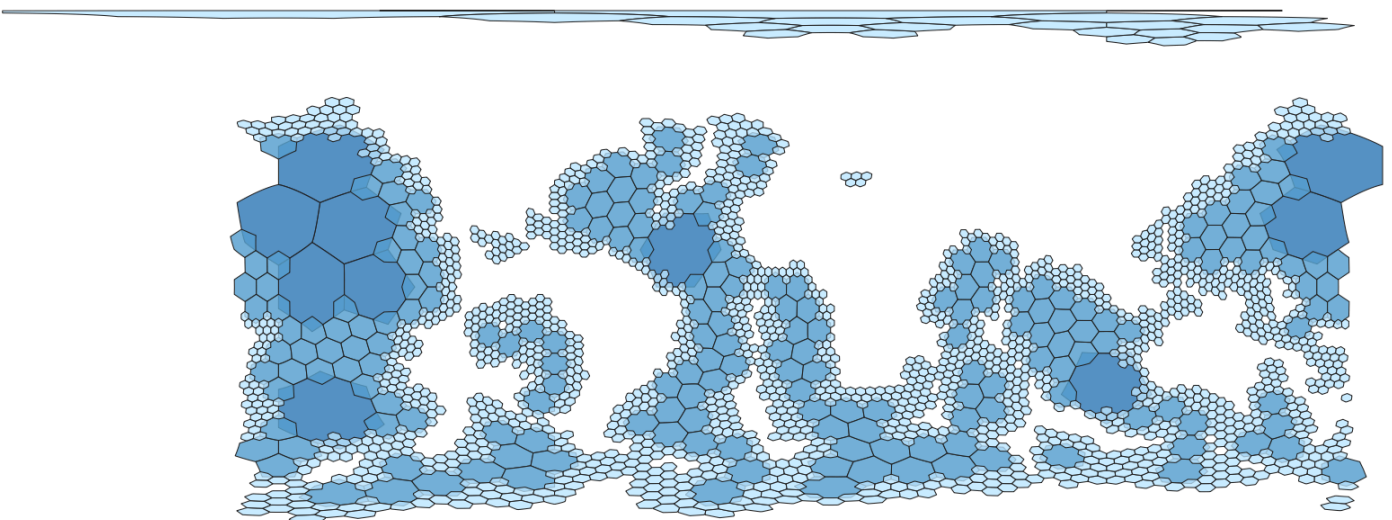


Figure C.33 – GeoJSON compact zones response for querying ISEA3H DGGRS for GEBCO 2014 bathymetry with CQL2 expression `Elevation < -4000` visualized in QGIS

or for high elevations e.g., `Elevation > 3000`:

[https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/isea3h/zones?filter=Elevation > 3000&zone-level=6](https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/isea3h/zones?filter=Elevation%20%3E%203000&zone-level=6)

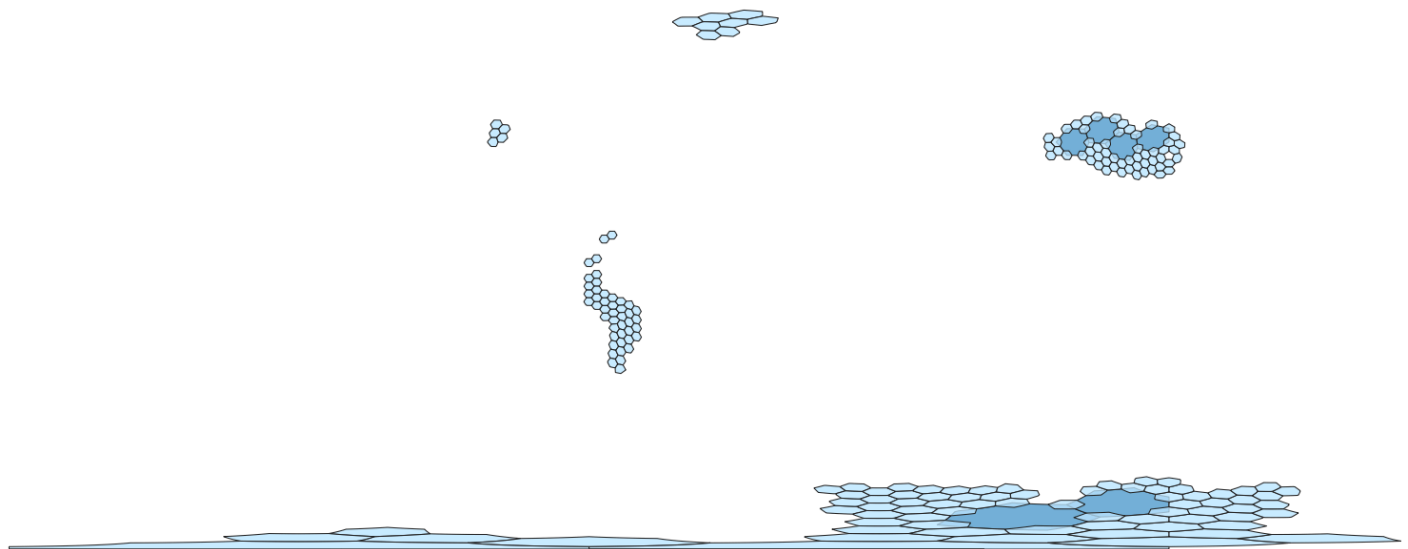


Figure C.34 – GeoJSON compact zones response for querying ISEA3H DGGRS for GEBCO 2014 bathymetry with CQL2 expression `Elevation > 3000` visualized in QGIS

or for either deep or high elevations e.g., `Elevation < -4000` or `Elevation > 3000`:

[https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/isea3h/zones?filter=Elevation < -4000 or Elevation > 3000&zone-level=6](https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/isea3h/zones?filter=Elevation%20%3C%20-4000%20or%20Elevation%20%3E%203000&zone-level=6)

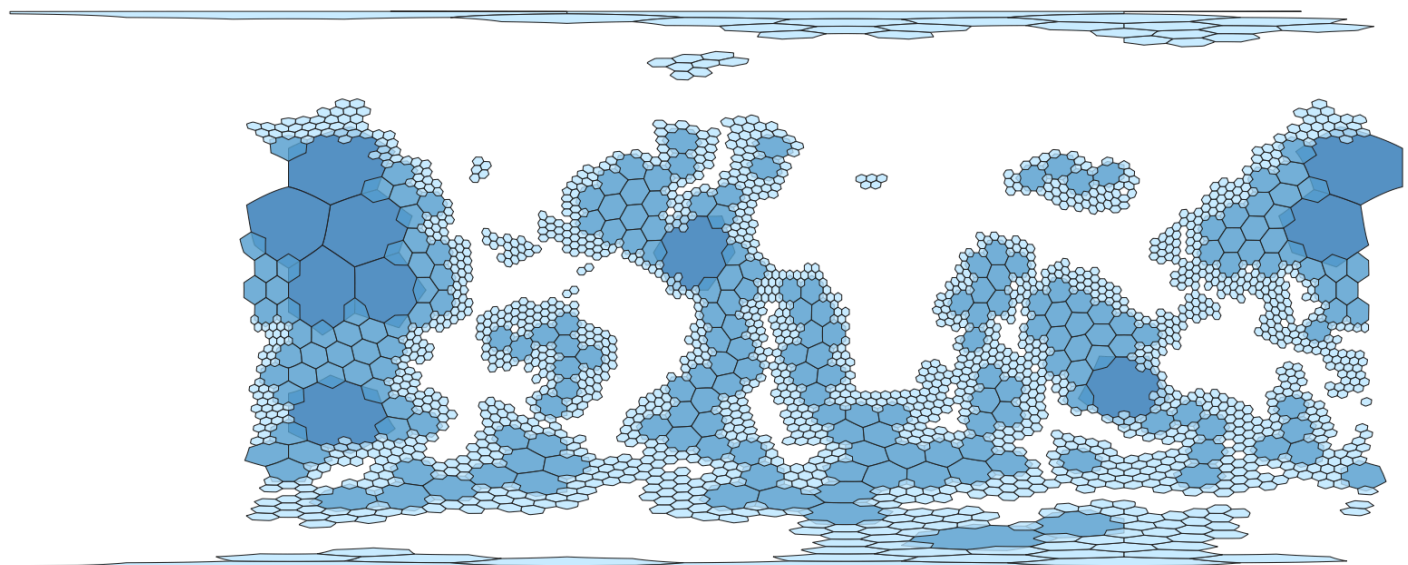


Figure C.35 – GeoJSON compact zones response for querying ISEA3H DGGRS for GEBCO 2014 bathymetry with CQL2 expression `Elevation < -4000` or `Elevation > 3000` visualized in QGIS

This last visualization highlights the fact that the Andes and Antarctica mountains are actually very close to a very deep sea.

If the implementation supports spatial relation functions, a query could test intersection with a geometry. In CQL2-Text, spatial geometries are expressed using Well-Known Text (WKT) literals.

The following example returns zones intersecting the Bermuda Triangle, making use of the `rec.geom` queryable, which represents the geometry of the individual coverage grid cells, mentioned earlier, at refinement level 9.

[https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/isea3h/zones?zone-level=9&filter=S_INTERSECTS\(rec.geom,POLYGON-64.8 32.3,-65.5 18.3,-80.3 25.2,-64.8 32.3\)](https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/isea3h/zones?zone-level=9&filter=S_INTERSECTS(rec.geom,POLYGON-64.8 32.3,-65.5 18.3,-80.3 25.2,-64.8 32.3))

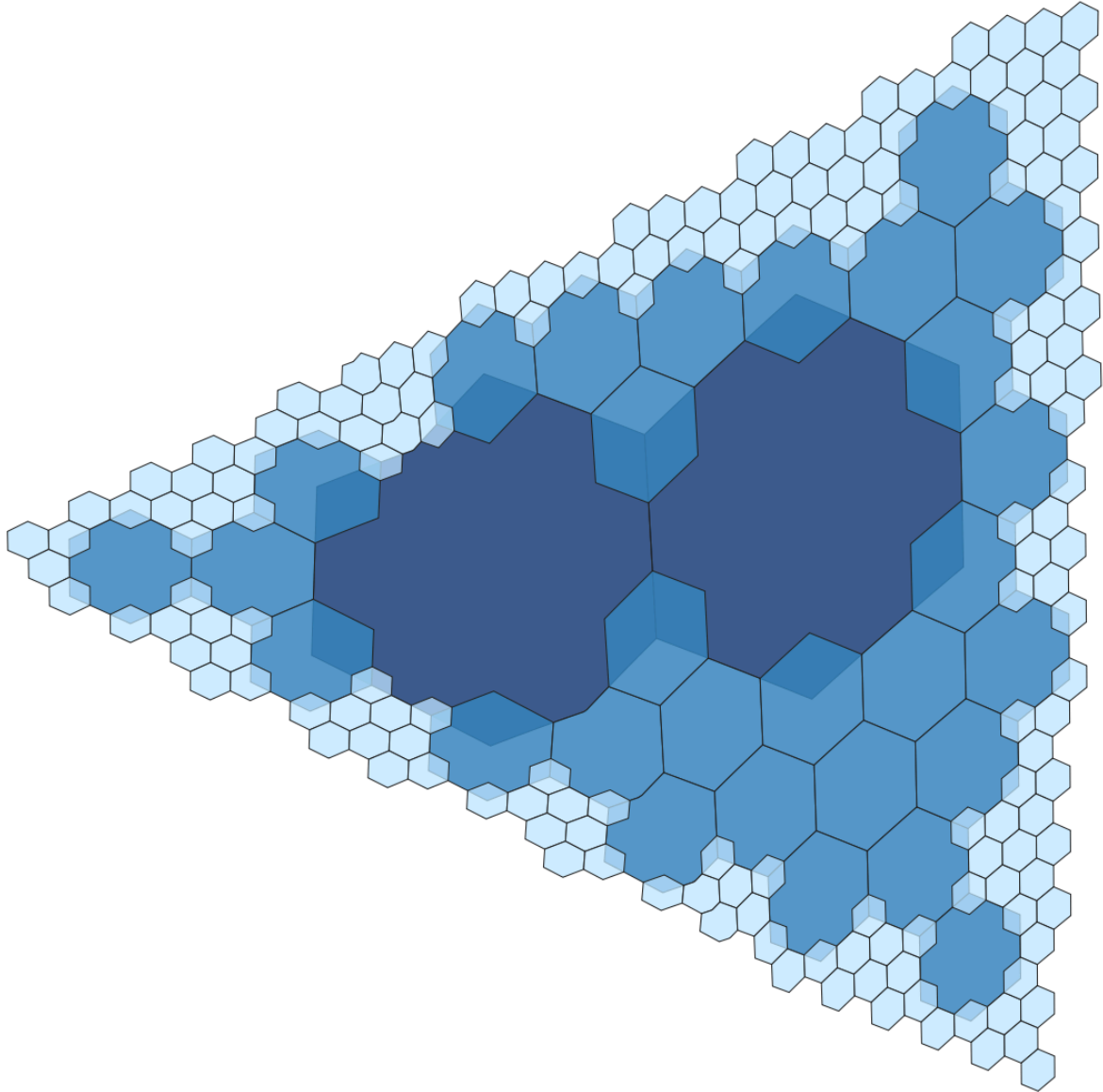


Figure C.36 – GeoJSON compact zones response for querying ISEA3H DGGRS for GEBCO 2014 bathymetry with a CQL2 expression using `S_INTERSECTS()` for a WKT triangular polygon visualized in QGIS

This spatial filter could also be combined with a relational operator as in the following query for `Elevation < -5500` within the Bermuda Triangle:

[https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/isea3h/zones?zone-level=11&filter=Elevation < -5500 and S_INTERSECTS\(rec.geom,POLYGON-64.8 32.3,-65.5 18.3,-80.3 25.2,-64.8 32.3\)](https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/isea3h/zones?zone-level=11&filter=Elevation < -5500 and S_INTERSECTS(rec.geom,POLYGON-64.8 32.3,-65.5 18.3,-80.3 25.2,-64.8 32.3))

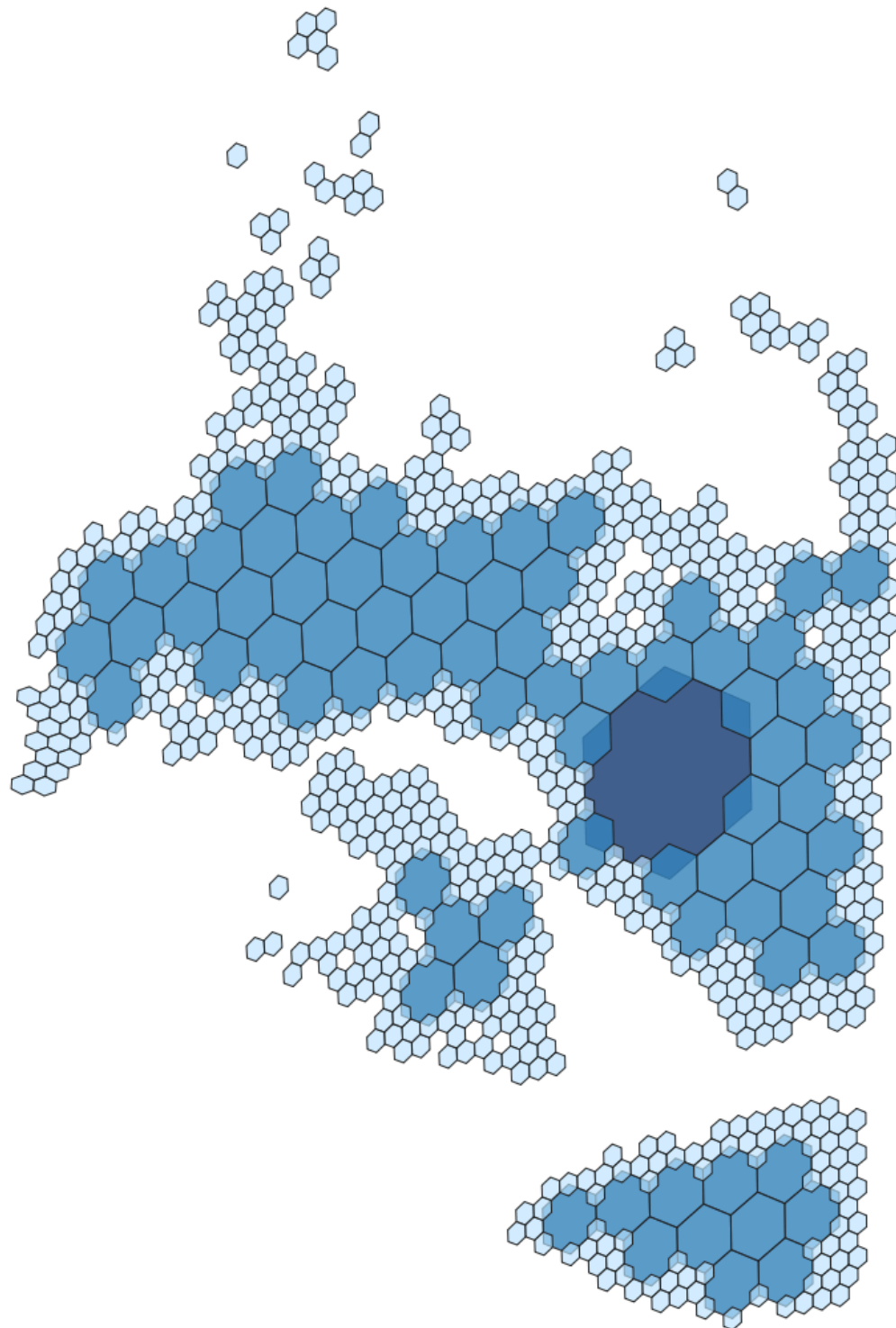


Figure C.37 — GeoJSON compact zones response for querying ISEA3H DGGRS for GEBCO 2014 bathymetry with a CQL2 expression using both `Elevation < -5500` as well as `S_INTERSECTS()` for a WKT polygon visualized in QGIS

To illustrate the use of CQL2 arithmetic operators, the following example uses a collection of daily climate CMIP5 data from the [Copernicus Climate Data Store](#). The request is for zones where the difference between two different fields of the coverage, the maximum (tasmax) and minimum (tasmin) daily near-surface air temperature, is greater than 10 degrees Kelvin. In addition, this request uses the datetime parameter to subset the temporal dimension for June 1, 2023.

[https://maps.gnosis.earth/ogcapi/collections/climate:cmip5:singlePressure/dggs/isea3h/zones?zone-level=7&filter=\(tasmax-tasmin\)>10&datetime=2023-06-01](https://maps.gnosis.earth/ogcapi/collections/climate:cmip5:singlePressure/dggs/isea3h/zones?zone-level=7&filter=(tasmax-tasmin)>10&datetime=2023-06-01)

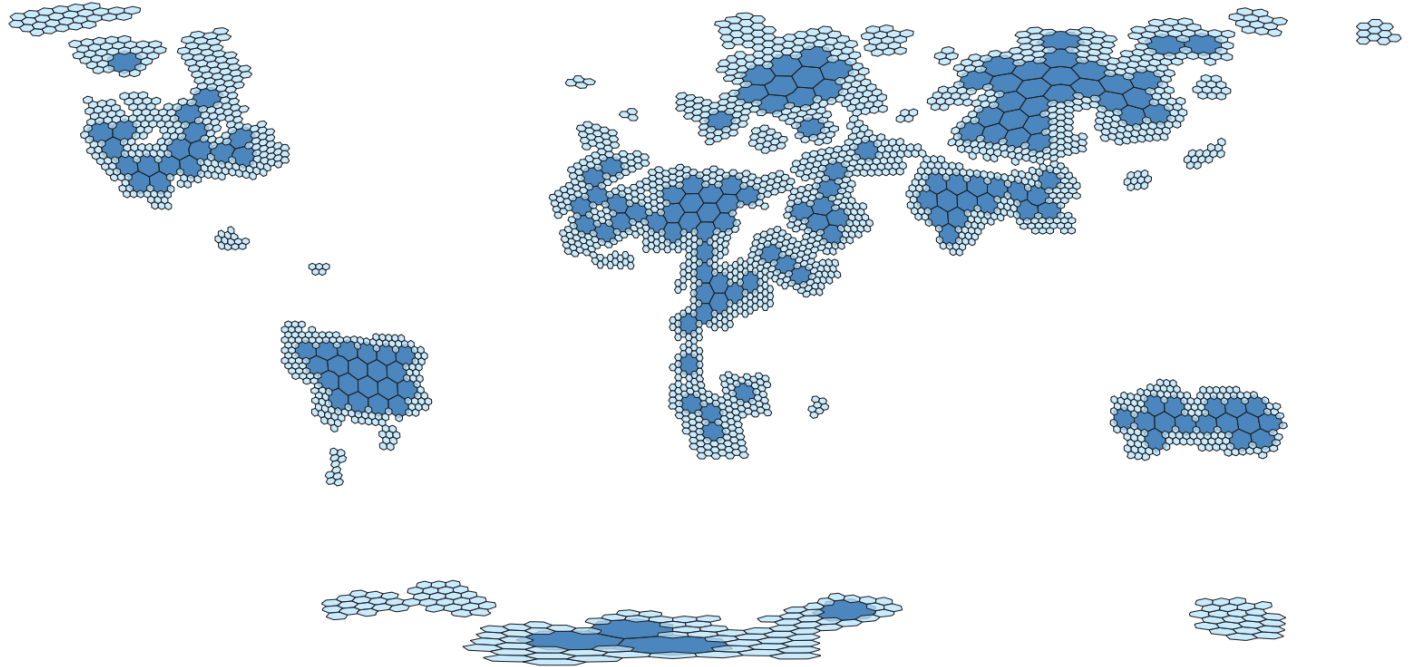


Figure C.38 – GeoJSON compact zones response for querying ISEA3H DGGRS for CMIP5 daily surface temperature from [Copernicus Climate Data Store](#) comparing delta with CQL2 expression $(tasmax - tasmin) > 10$ visualized in QGIS

CQL2 expressions can also be used for queries using attributes of vector features. The following examples use a collection of building polygon features in Ottawa extracted from the OpenStreetMap dataset, filtering buildings using both a spatial subset and the name attribute of the features.

This first example illustrates querying for the National Arts Centre at ISEA3H level 30:

[https://maps.gnosis.earth/ogcapi/collections/osm:ottawa:buildings/dggs/ISEA3H/zones?subset=Lat\(45.4198:45.4264\),Lon\(-75.704:-75.6935\)&filter=name='National Arts Centre'&zone-level=30](https://maps.gnosis.earth/ogcapi/collections/osm:ottawa:buildings/dggs/ISEA3H/zones?subset=Lat(45.4198:45.4264),Lon(-75.704:-75.6935)&filter=name='National Arts Centre'&zone-level=30)

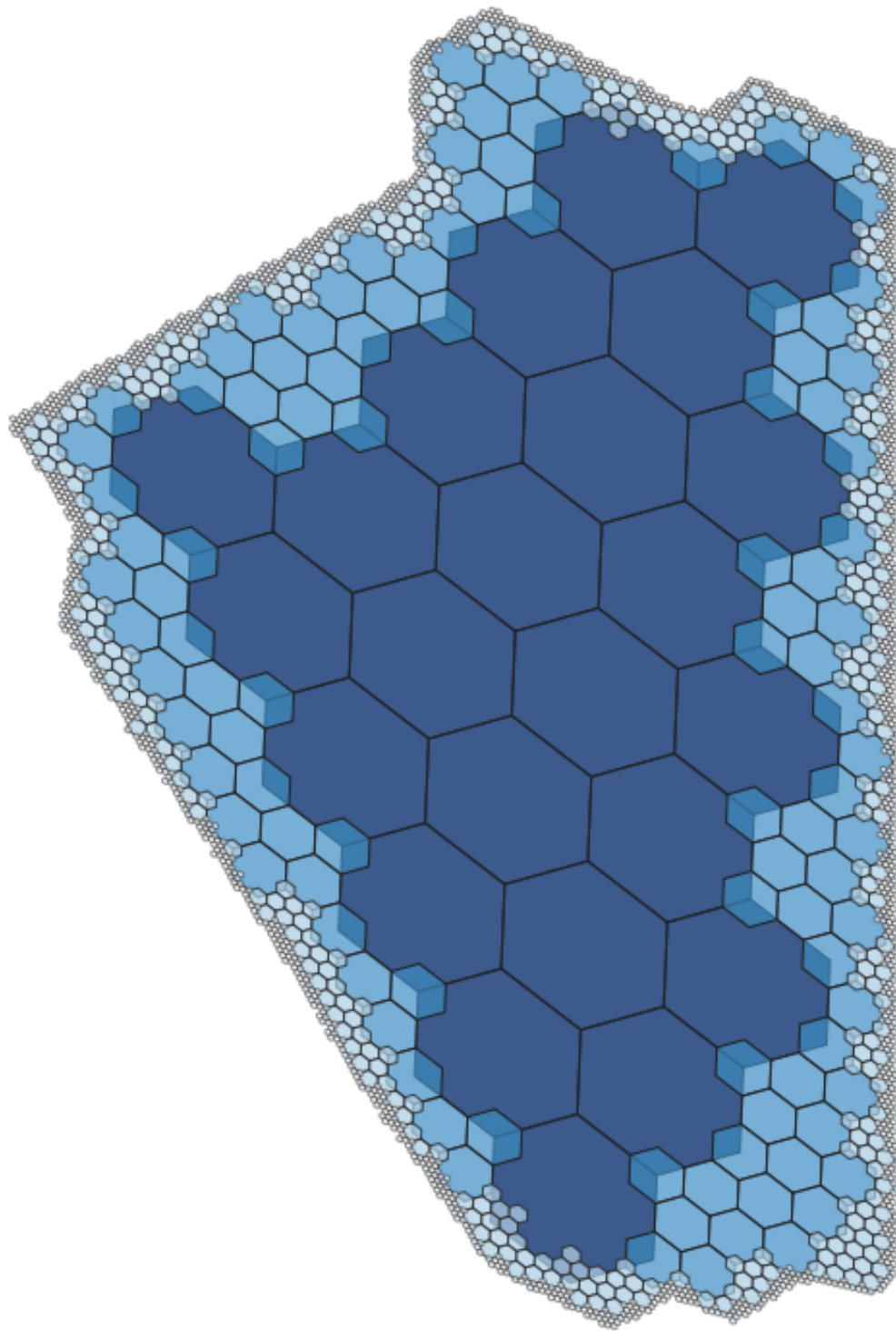


Figure C.39 — GeoJSON compact zones response for querying ISEA3H DGRS for Ottawa buildings (© [OpenStreetMap](#) contributors) with CQL2 expression name='National Arts Centre' at level 30, visualized in QGIS

This second example illustrates querying for the East Block at ISEA9R level 15 (corresponding to ISEA3H level 30):

[https://maps.gnosis.earth/ogcapi/collections/osm:ottawa:buildings/dggs/ISEA9R/zones?subset=Lat\(45.4198:45.4264\),Lon\(-75.704:-75.6935\)&filter=name='East Block'&zone-level=15](https://maps.gnosis.earth/ogcapi/collections/osm:ottawa:buildings/dggs/ISEA9R/zones?subset=Lat(45.4198:45.4264),Lon(-75.704:-75.6935)&filter=name='East Block'&zone-level=15)

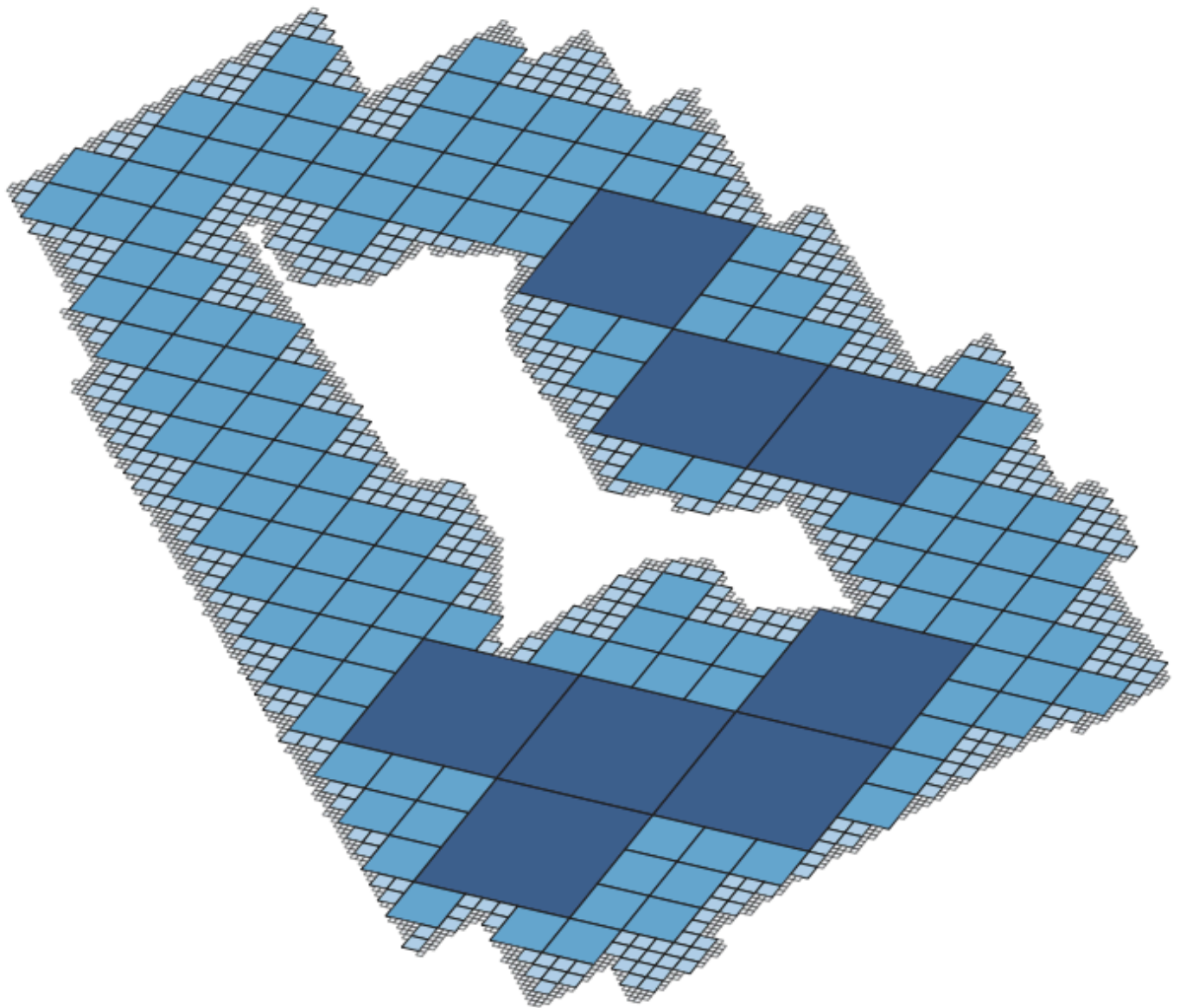


Figure C.40 – GeoJSON compact zones response for querying ISEA9R DGGRS for Ottawa buildings (© [OpenStreetMap](#) contributors) with CQL2 expression name= 'East Block' at level 15, visualized in QGIS

This third example illustrates querying for the Centre Block at GNOSIS Global Grid level 24 (corresponding approximately to same resolution):

[https://maps.gnosis.earth/ogcapi/collections/osm:ottawa:buildings/dggs/GNOSISGlobalGrid/zones?subset=Lat\(45.4198:45.4264\),Lon\(-75.704:-75.6935\)&filter=name='Centre Block'&zone-level=24](https://maps.gnosis.earth/ogcapi/collections/osm:ottawa:buildings/dggs/GNOSISGlobalGrid/zones?subset=Lat(45.4198:45.4264),Lon(-75.704:-75.6935)&filter=name='Centre Block'&zone-level=24)

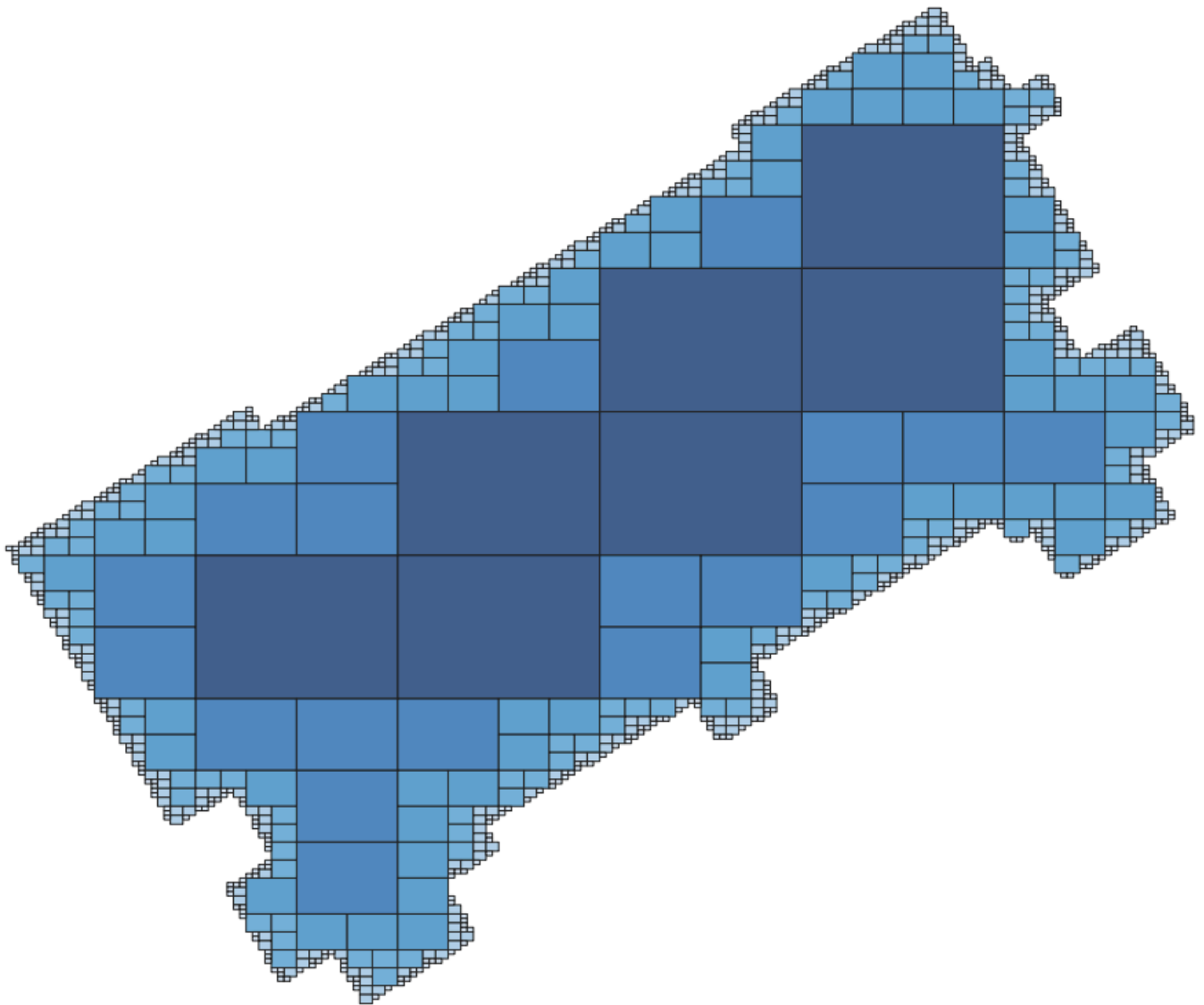


Figure C.41 — GeoJSON compact zones response for querying GNOSIS Global Grid DGGRS for Ottawa buildings (© [OpenStreetMap](#) contributors) with CQL2 expression name= 'Centre Block' at level 24, visualized in QGIS

A future extension could also enable cross-collection queries, possibly using a `joinCollections` parameter which would make queryables from different collections available.

C.8. Retrieving data for a DGGRS Zone

Data can be retrieved for a parent zone of interest, including values for all sub-zones within it, at the `.../dggs/{dggrsId}/zones/{zoneId}/data` resource path.

The following examples illustrate this capability for different DGGRSs, representation encodings, CRSs, and other parameters.

C.8.1. Retrieving data from an ISEA3H DGGRS

Examples in this section retrieve data for pentagonal and hexagonal zones of an ISEA3H DGGRS, based on the ISEA projection.

This first example retrieves elevation data for the GEBCO collection for ISEA3H zone A2-0-A at a relative depth of 8. The default zone depth is 10 for this DGGRS in this particular deployment of a DGGS API, as specified in the `defaultDepth` property of the ISEA3H DGGRS description response). These requests override this default by using the `zone-depth` parameter defined in the “Data Custom Depths” requirements class.

C.8.1.1. DGGS-JSON Examples

<https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/ISEA3H/zones/A2-0-A/data?zone-depth=8>

A snippet of the DGGS-JSON response follows, including an array of elevation values ordered as per the deterministic zone order defined by this ISEA3H DGGRS.

```
{
  "dggrs" : "https://www.opengis.net/def/dggrs/OGC/1.0/ISEA3H",
  "zoneId" : "A2-0-A",
  "depths" : [ 8 ],
  "values" : {
    "Elevation" : [
      {
        "depth" : 8,
        "shape" : { "count" : 5536, "subZones" : 5536 },
        "data" : [ -14.209265189621, 57.2747655762701, ...,
2075.7176486103044 ]
      }
    ]
  }
}
```

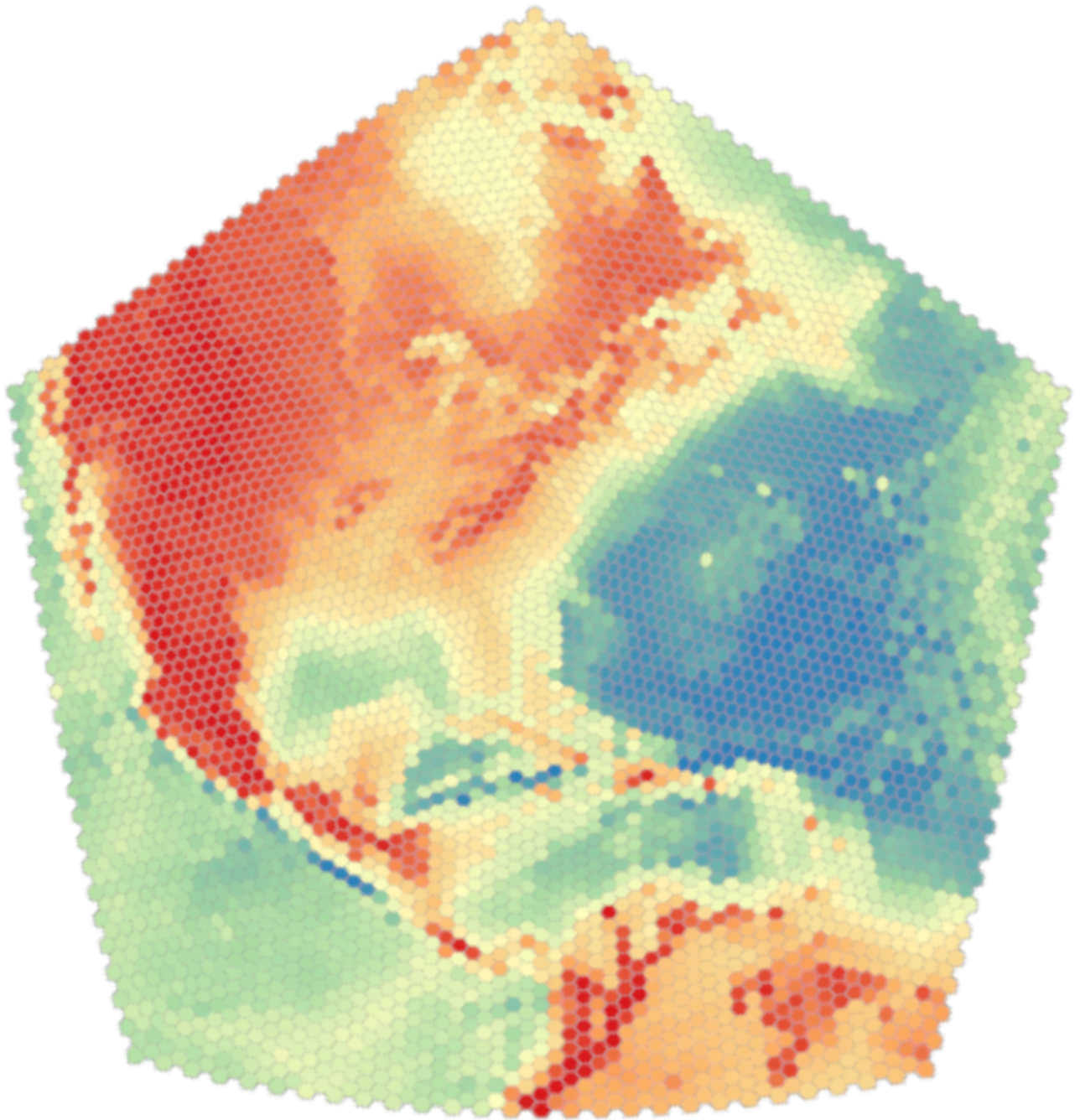



Figure C.42 — Visualization of a DGGs-JSON response for retrieving data for ISEA3H DGGs zone A2-0-A of GEBCO 2014 bathymetry at a relative depth of 8

C.8.1.2. GeoTIFF Examples

In a GeoTIFF representation, rather than being quantized to sub-zones, the Elevation would be quantized to the closest rectilinear gridded coverage cells, at a resolution high enough to include at least one value per corresponding sub-zones. The data may still be clipped to the shape of the

zone geometry. By default, this implementation of the DGGs API Standard returns the data in an OGC:CRS84 CRS.

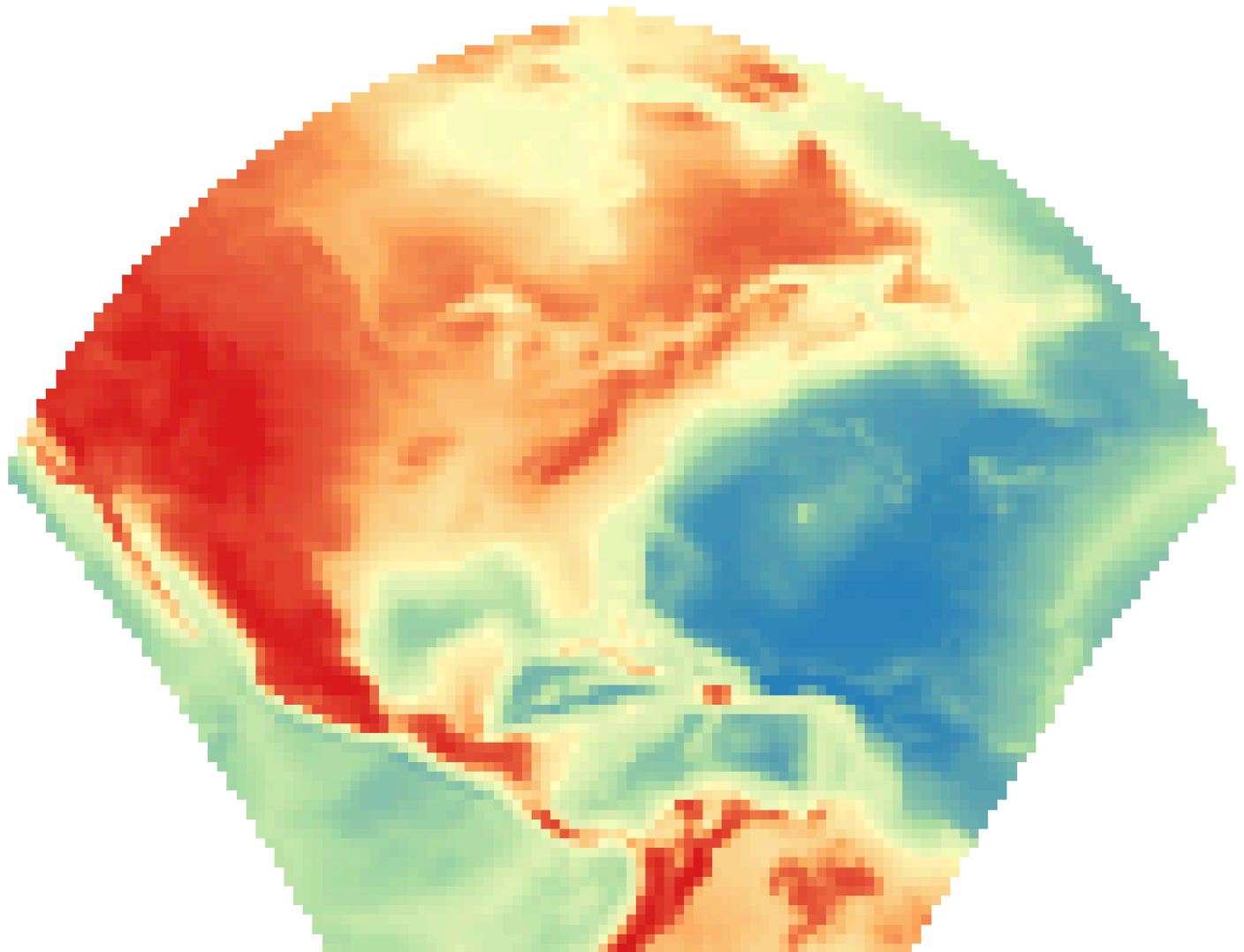


Figure C.43 – Visualization of a CRS84 GeoTIFF response for retrieving data for ISEA3H DGGRS zone A2-0-A of GEBCO 2014 bathymetry at a relative depth of 8

Visualizing this data on 3D globe would look like the following image.

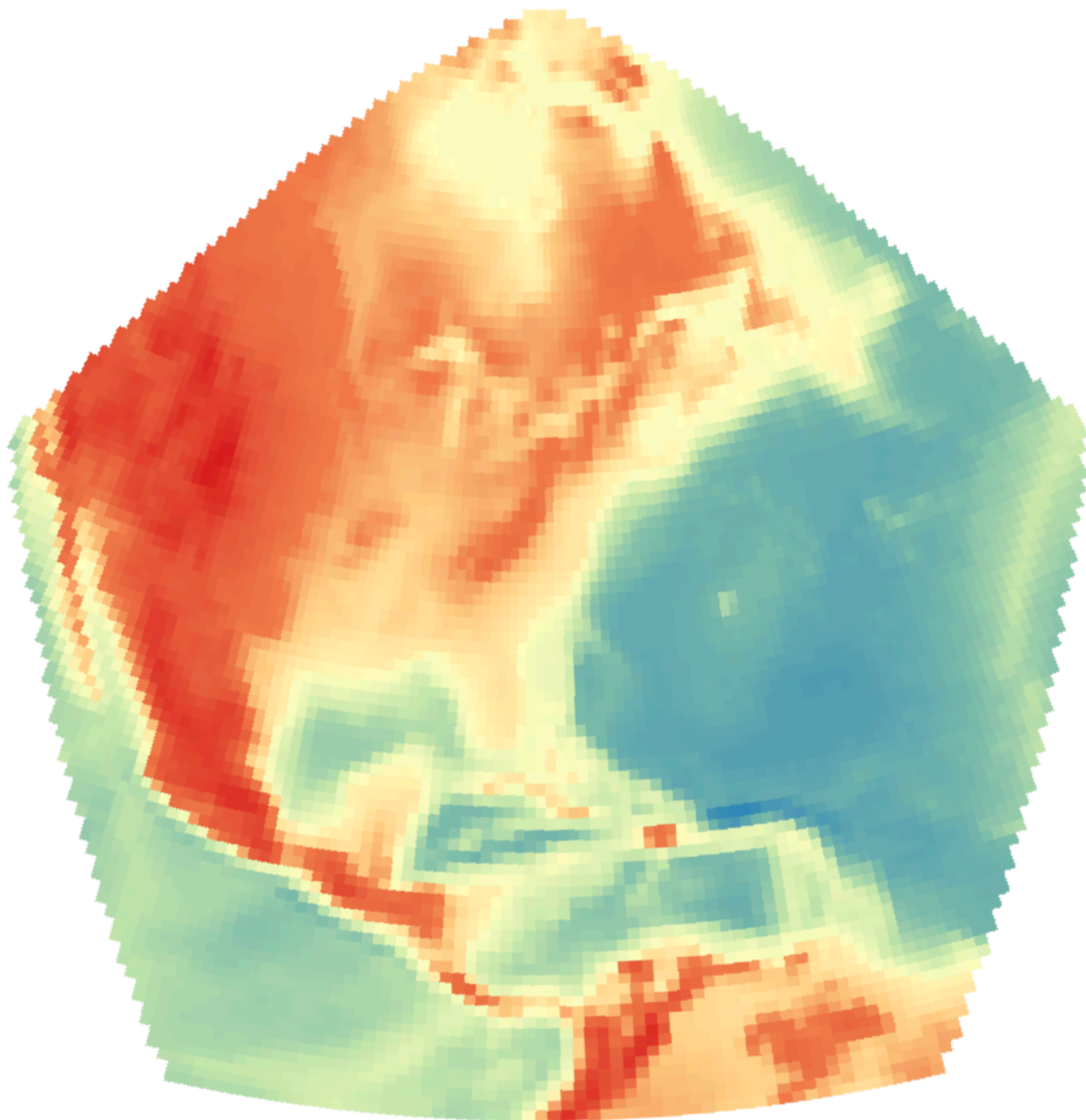


Figure C.44 — Visualization on a 3D Globe of a GeoTIFF response for retrieving data for ISEA3H DGGRS zone A2-0-A of GEBCO 2014 bathymetry at a relative depth of 8

Alternatively, the DGGS API implementation also supports the `crs` parameter to select the ISEA planar projection as an alternate CRS. In this CRS, this pentagonal zone spans the interruption between two triangles of the base icosahedron.

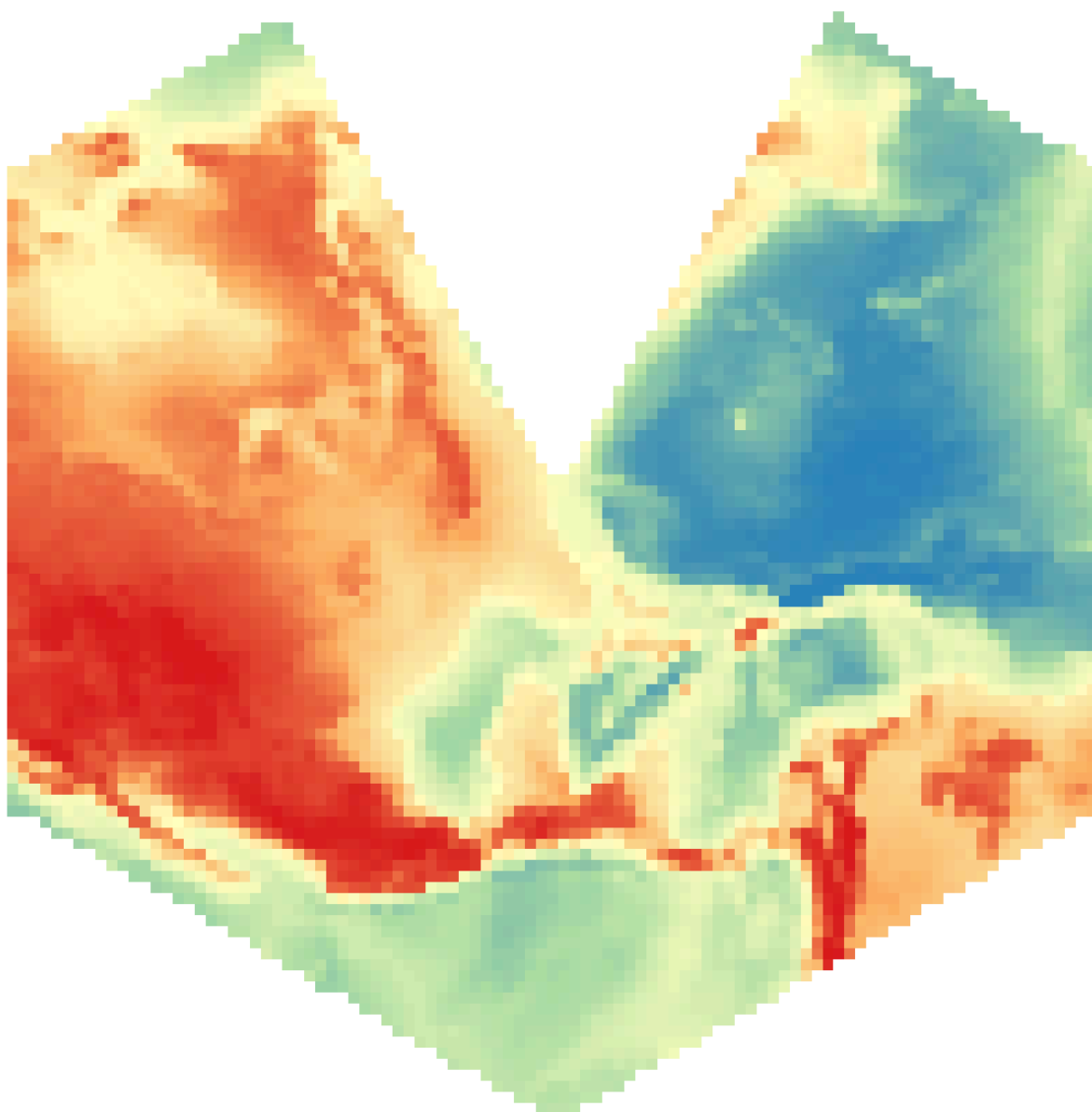


Figure C.45 — Visualization of an ISEA planar projection GeoTIFF response for retrieving data for pentagonal ISEA3H DGGRS zone A2-0-A of GEBCO 2014 bathymetry at a relative depth of 8

A major inconvenience of the ISEA planar projection is that hexagonal zones further along the interruptions will be split on each side on the interruption, resulting in a large separation between the two halves of the data, as illustrated for example with zone C2-4-A.

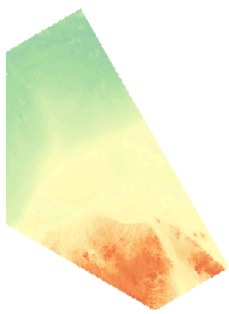


Figure C.46 — Visualization of an ISEA planar projection GeoTIFF response for retrieving data for ISEA3H DGGRS zone C2-4-A (a hexagon split across an ISEA interruption) of GEBCO 2014 bathymetry

On the other hand, a hexagon not spanning an interruption will appear in the ISEA planar projection as typical hexagons with two edges aligned with either the horizontal (for odd parent zone levels) or vertical axis (for even levels).

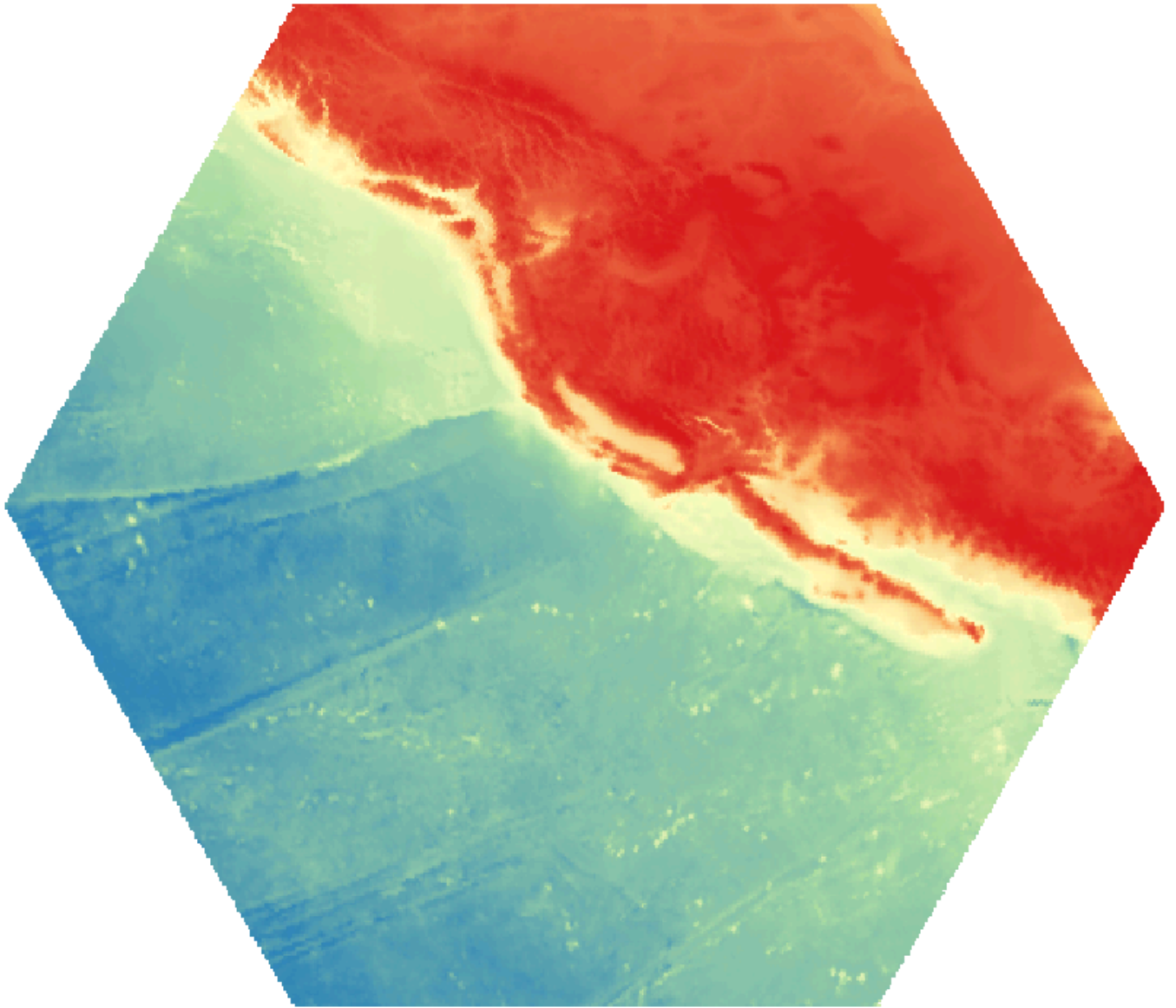


Figure C.47 — Visualization of an ISEA planar projection GeoTIFF response for retrieving data for ISEA3H DGGRS zone A0-0-F of GEBCO 2014 bathymetry

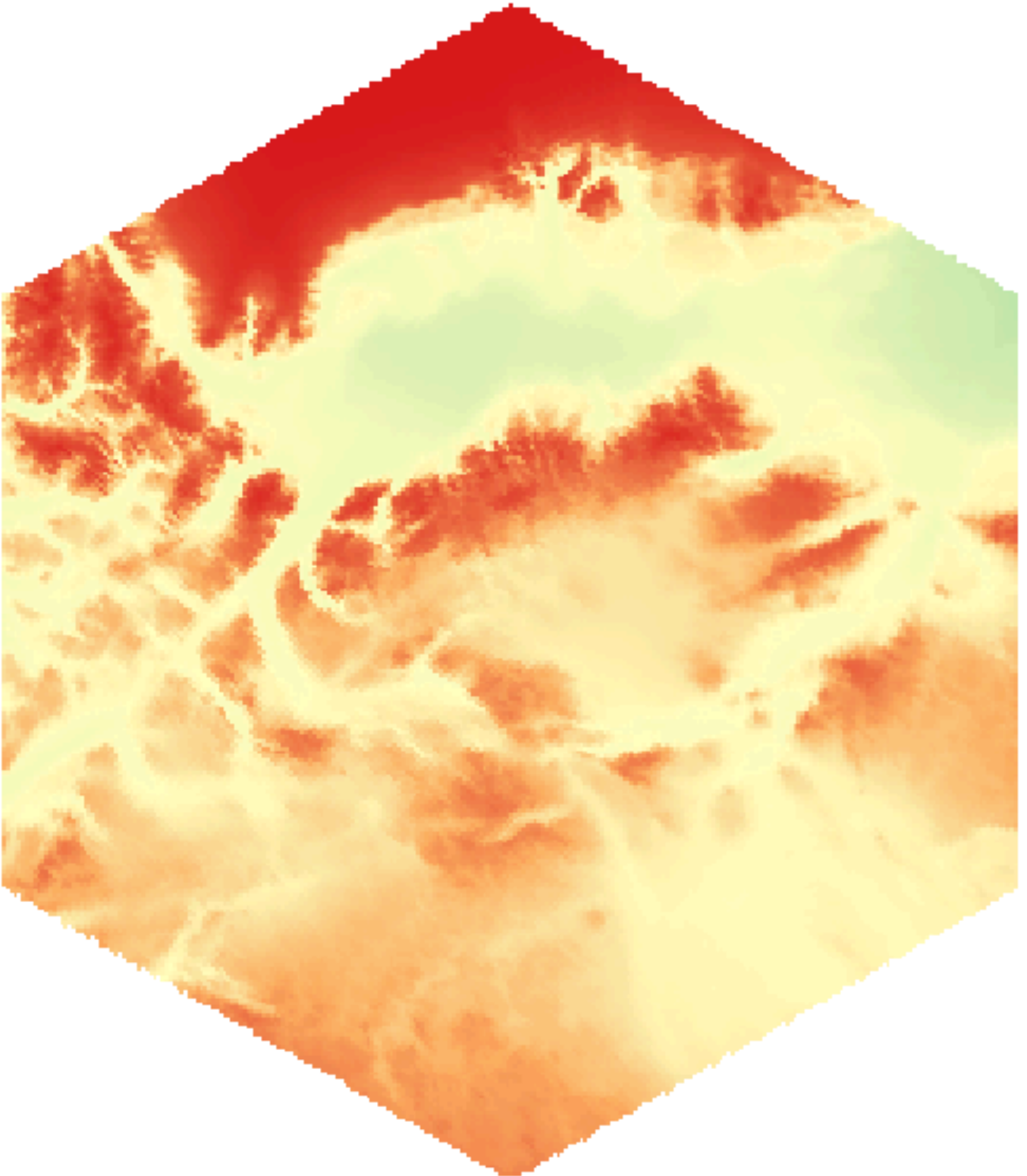


Figure C.48 — Visualization of an ISEA planar projection GeoTIFF response for retrieving data for ISEA3H DGGRS zone B0-5-A of GEBCO 2014 bathymetry

whereas the same zones in OGC:CRS84 will have various shapes not easily recognizable as hexagons:

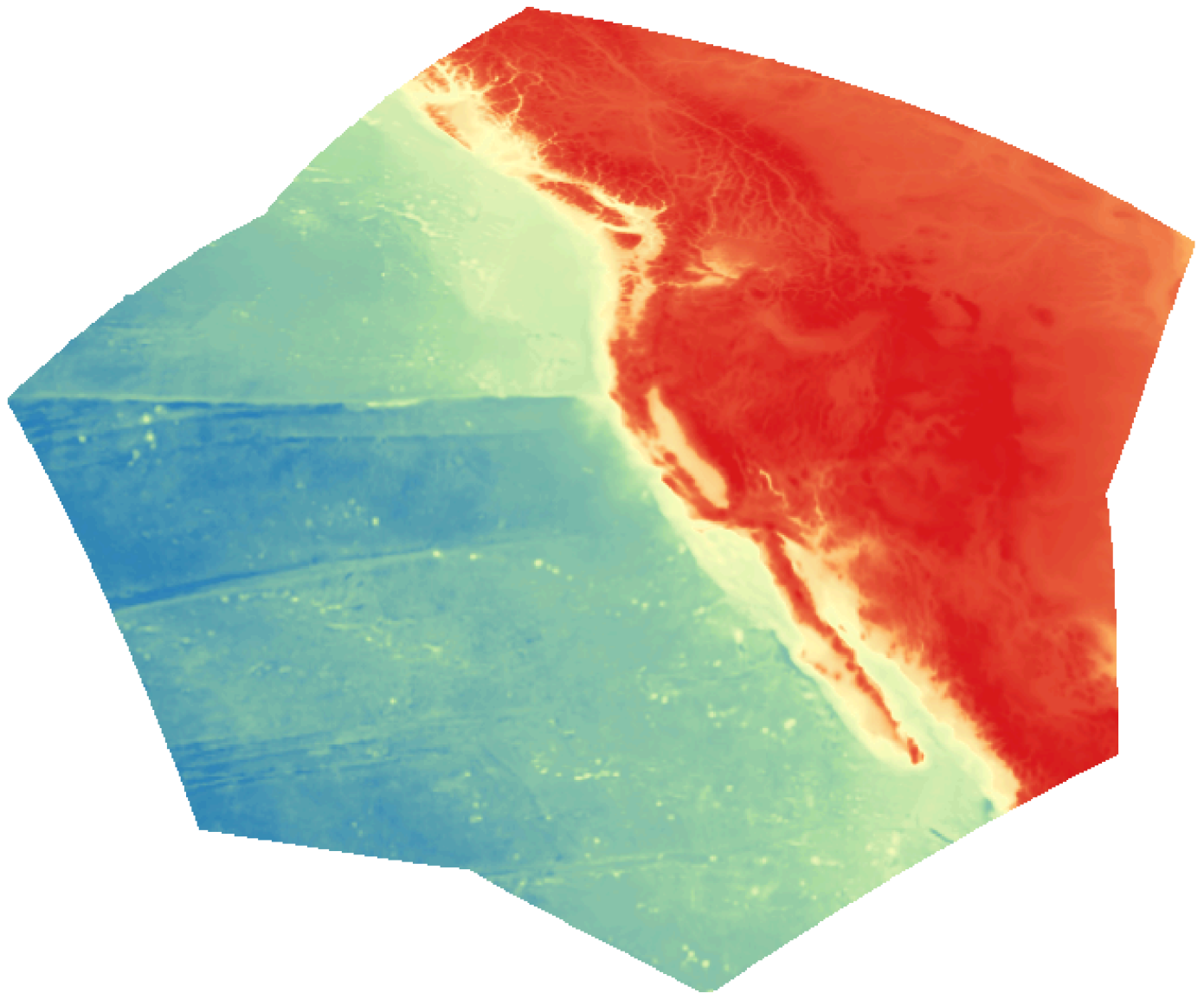


Figure C.49 — Visualization of a GeoTIFF response in OGC:CRS84 for retrieving data for ISEA3H DGGRS zone A0-0-F (odd level 1) of GEBCO 2014 bathymetry

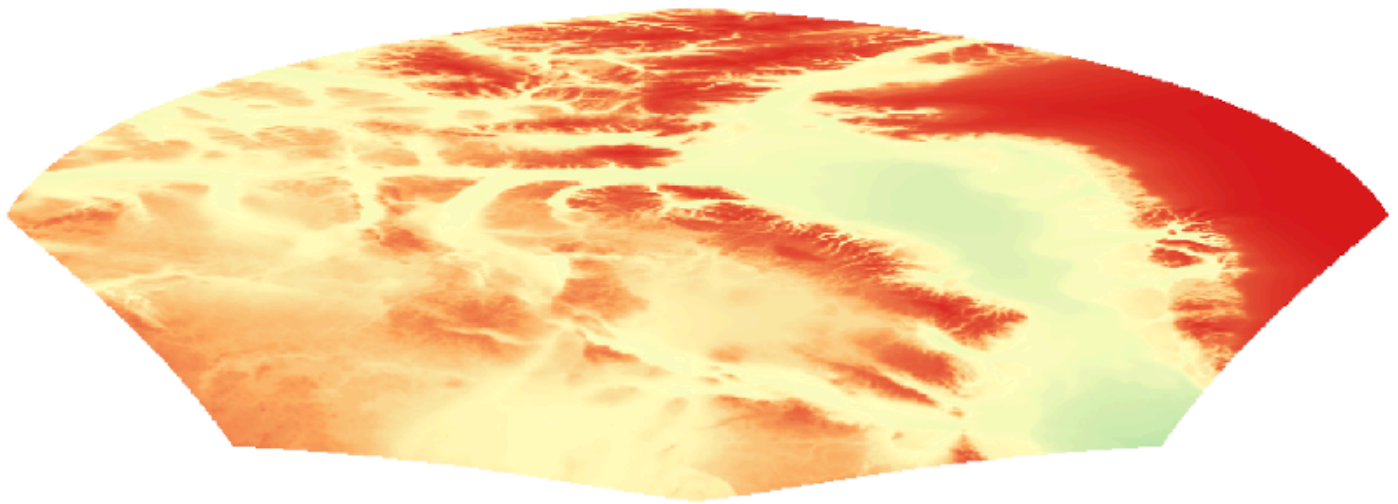


Figure C.50 — Visualization of a GeoTIFF response in OGC:CRS84 for retrieving data for ISEA3H DGGRS zone B0-5-A (even level 2) of GEBCO 2014 bathymetry

While both DGGs-JSON and GeoTIFF are encodings appropriate for raster data, DGGs-JSON is better suited for representing values quantized to the hierarchical discrete global grids. Encoding vector data in these formats essentially implies rasterizing the vector features, using either a selection of the feature properties as values, or numerical feature identifiers for which associated properties may be queryable elsewhere (e.g., in an OGC API — Features deployment).

C.8.1.3. GeoJSON Examples

Although gridded elevation and bathymetry data is better suited to raster formats such as DGGs-JSON and GeoTIFF, a GeoJSON and/or Features Geometry JSON representation could also be offered where each zone is represented as a feature, with the associated property providing the data values such as the elevation. This would be equivalent to the GeoJSON representation for a zone list where `compact-zones` is set to `false`, the `parent-zone` is the zone for which data is requested, and the `zone-level` is the sum of the parent zone plus the relative zone depth at which data is requested (the default depth or `zone-depth` parameter), with the addition of these properties associating data values with each zone.

If the geometry for these zone features is provided as polygons (`geometry=zone-region`), visualizing this vector data would produce an output like the following partial response, which would result in a visualization identical to Figure C.42.

```
{
  "type" : "FeatureCollection",
  "features" : [ {
    "type" : "Feature",
    "id" : 1,
    "geometry" : {
      "type" : "Polygon",
      "coordinates" : [ [
        [-77.51874470, 68.96298626], [-77.598412, 68.94863327],
        [-77.67832934, 68.93432964], [-77.75852144, 68.92009304],
        [-77.83901433, 68.90594517], [-77.91983505, 68.8919127],
        ...
      ] ]
    }
  }
]
```

```

        [-77.52048177, 68.99500861], [-77.51874470, 68.96298626]
    ],
    },
    "properties" : {
        "Elevation" : -14.209265189621,
        "zoneID" : "E0-8C1-A"
    },
    },
    {
        "type" : "Feature",
        "id" : 2,
        ...

```

Alternatively, the geometry of each zone could also be provided as a single point for its centroid (geometry=zone-centroid), in which case the response and associated visualization would look like the following:

```

{
    "type" : "FeatureCollection",
    "features" : [ {
        "type" : "Feature",
        "id" : 1,
        "geometry" : {
            "type" : "Point",
            "coordinates" : [-78.7500000030306, 69.2228046463321]
        },
        "properties" : {
            "Elevation" : -14.209265189621,
            "zoneID" : "E0-8C1-A"
        }
    }, {
        "type" : "Feature",
        "id" : 2,
        "geometry" : {
            "type" : "Point",
            "coordinates" : [-82.3566944995815, 68.4176458502864]
        },
        "properties" : {
            "Elevation" : 57.2747655762701,
            "zoneID" : "E0-911-A"
        }
    },
    ...

```

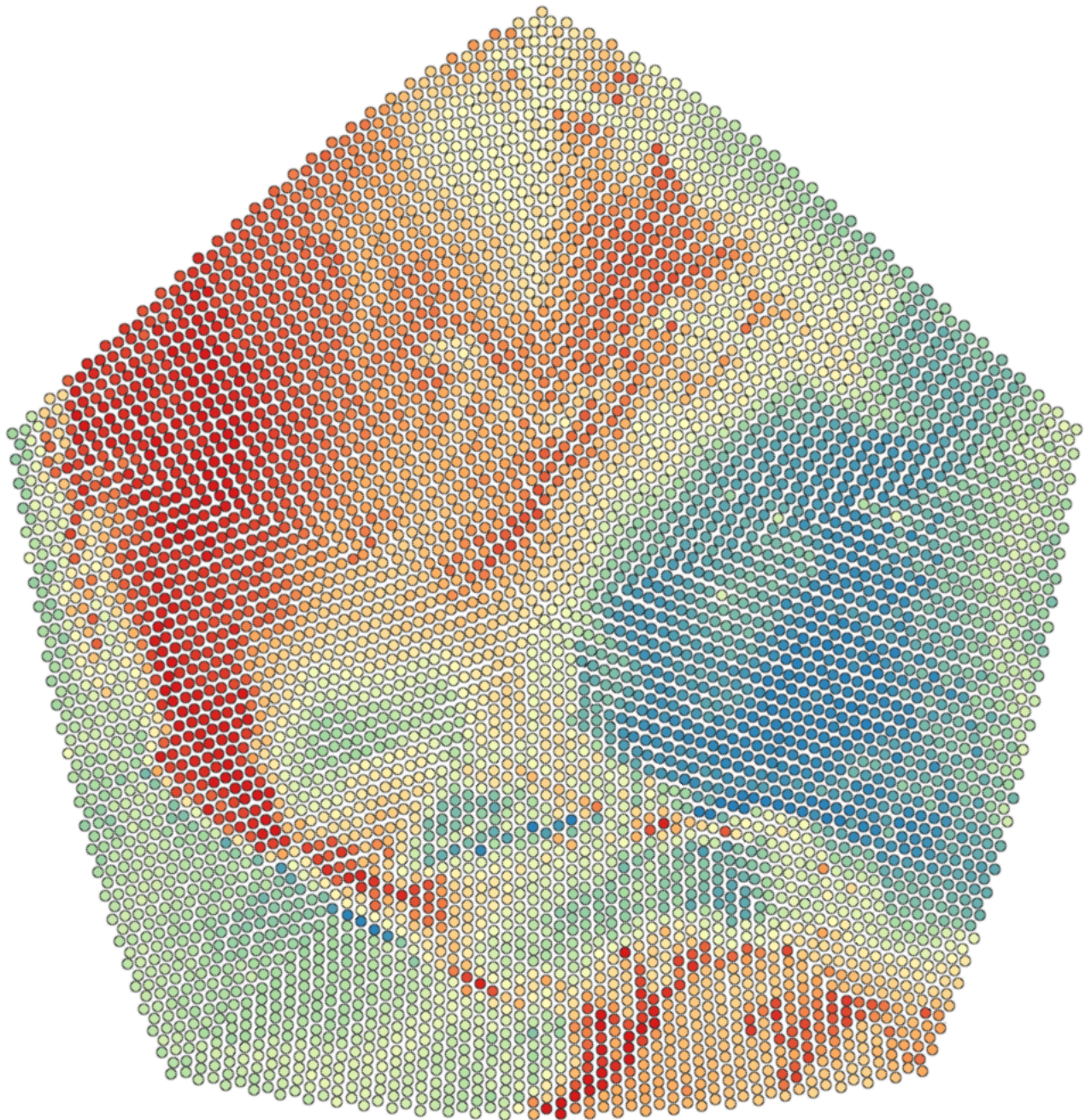



Figure C.51 — Visualization of a GeoJSON point features response for data retrieved from ISEA3H DGGRS zone A2-0-A of GEBCO 2014 bathymetry at a relative depth of 8

For data of a vector nature, a vector format such as GeoJSON allows to encode zone data response in a more compact manner without having to rasterize the data. Ideally, especially for features spanning a large spatial extent (such as country boundaries, or the coastline of a large landmass), the features would be clipped to the geometry of the zone for which data is being requested, or as least to limited extent around the zone. Unfortunately, GeoJSON and FG-JSON do not yet have a standard mechanism to identify artificial edges which may result from such clipping. This complicates re-joining features spread across multiple zones, and may result in

rendering artifacts for polygonal features when rendered with a stroke, as the stroke would also be drawn on those artificial segments at the bound edges.

The following response for a zone data request and its visualization illustrates vector features in Ottawa from OpenStreetMap returned as GeoJSON. The features and geometry coordinates in this case have no relation to sub-zones, and are only clipped to the zone for which data is being requested. The zone depth (default zone depth of 10 in this case) can however control cartographic generalization of the geometry. This could potentially include filtering point features, based on rules associated with the dataset, as decided by the implementation, as well as the precision of the coordinates.

<https://maps.gnosis.earth/ogcapi/collections/osm:ottawa:roads/dggs/ISEA3H/zones/I0-1EFA652-D/data>

```
{
  "type" : "FeatureCollection",
  "features" : [ {
    "type" : "Feature",
    "id" : 2305843009218664049,
    "geometry" : {
      "type" : "LineString",
      "coordinates" : [
        [-75.70190343, 45.42180362],
        [-75.70214786, 45.4220908],
        [-75.70255148, 45.42257149]
      ]
    },
    "properties" : {
      "highway" : "service",
      "name" : "Parliament Road",
      "name:fr" : "chemin Parliament",
      "access" : "no"
    }
  }, {
    "type" : "Feature",
    "id" : 2305843009218664071,
    "geometry" : {
      "type" : "LineString",
      "coordinates" :
    ...
  }
```

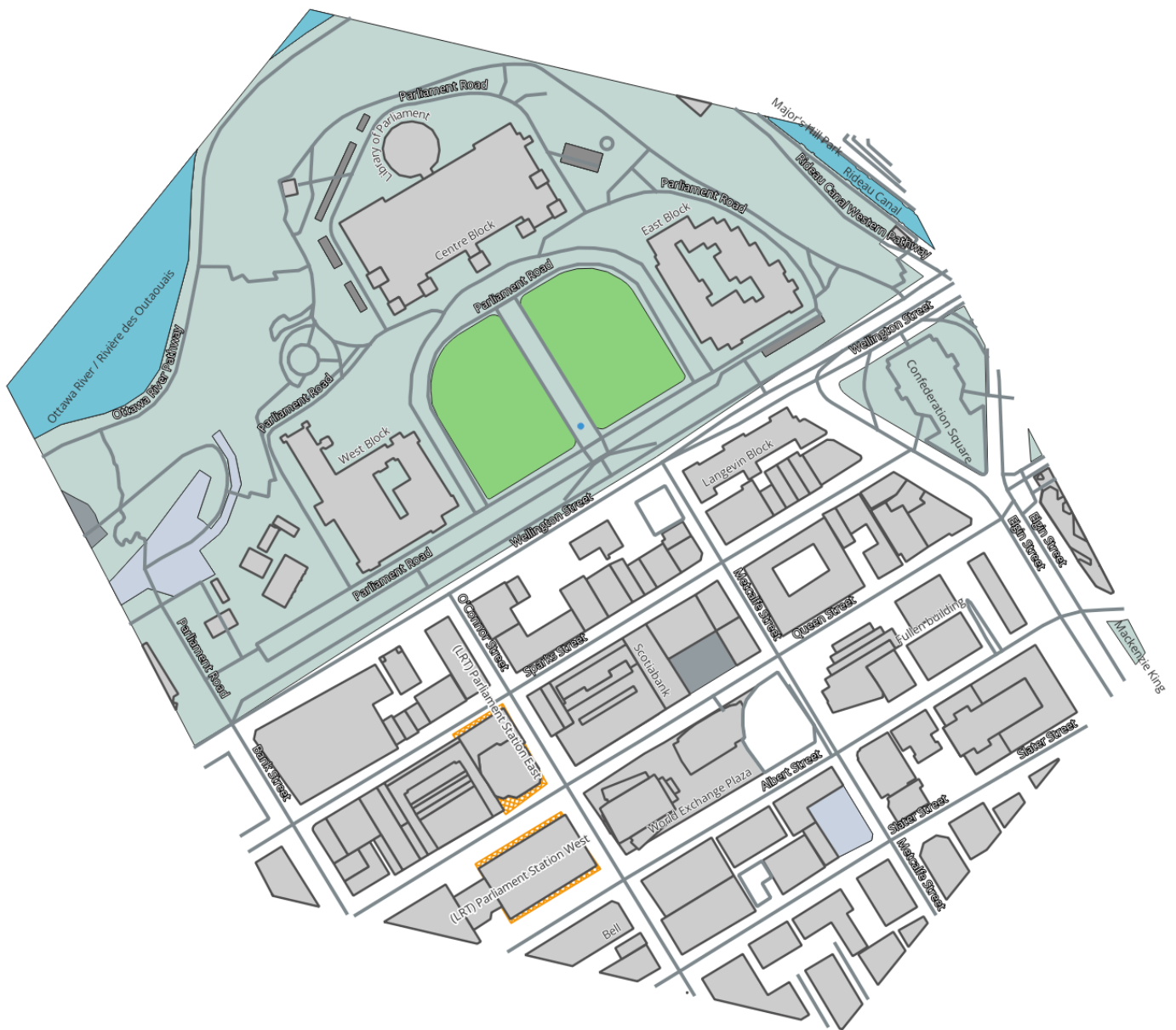


Figure C.52 — Visualization in a world Mercator projection of a GeoJSON feature collection with mixed geometry types for data retrieved from ISEA3H DGGRS zone [I0-1EFA652-D](#) of [OpenStreetMap](#) (c) OpenStreetMap contributors

In an ISEA planar projection, the same data could be visualized as follows.

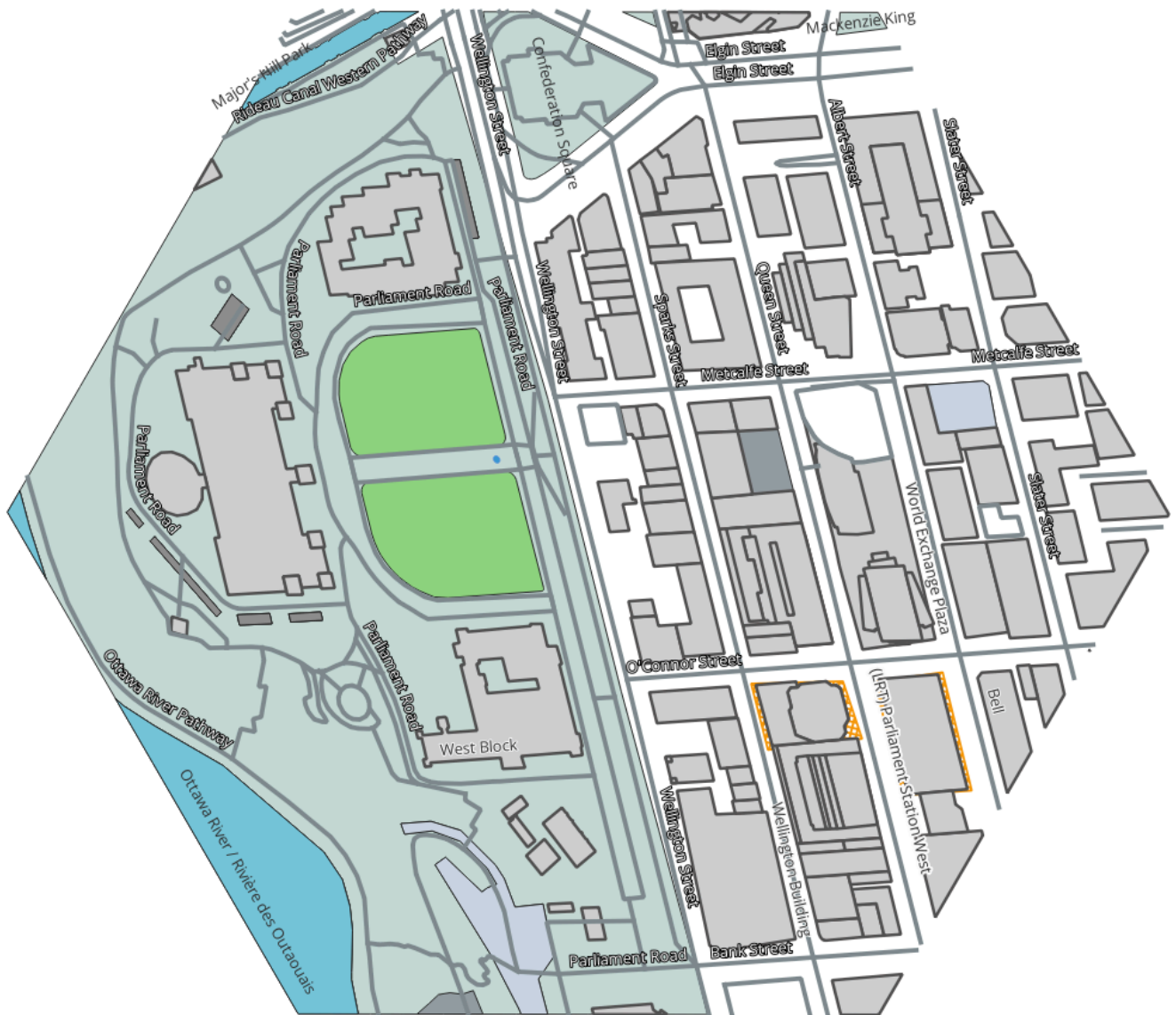


Figure C.53 – Visualization in an ISEA planar projection of a GeoJSON feature collection with mixed geometry types for data retrieved from ISEA3H DGGRS zone I0-1EFA652-D of OpenStreetMap (c) OpenStreetMap contributors

The following zone data request is for bathymetry polygons from the Natural Earth physical features.

https://maps.gnosis.earth/ogcapi/collections/NaturalEarth:physical:bathymetry:ne_10m_bathymetry_L_0/dggs/ISEA3H/zones/B0-5-A/data

```
{
  "type": "FeatureCollection",
  "features": [
    {
      "type": "Feature",
      "id": 1,
      "properties": {
        "scalerank": 0,

```

```

    "featurecla": "Bathymetry"
  },
  "geometry": {
    "type": "MultiPolygon",
    "coordinates": [
      [
        [
          [ -55.63744954, 59.87006944 ], [ -56.91595155, 59.7924323 ],
          [ -58.19026295, 59.70335469 ], [ -59.45970834, 59.60311811 ],
          [ -60.72365746, 59.49204741 ], [ -61.98152851, 59.37051649 ],
          ...
        ]
      ]
    ]
  }
}

```

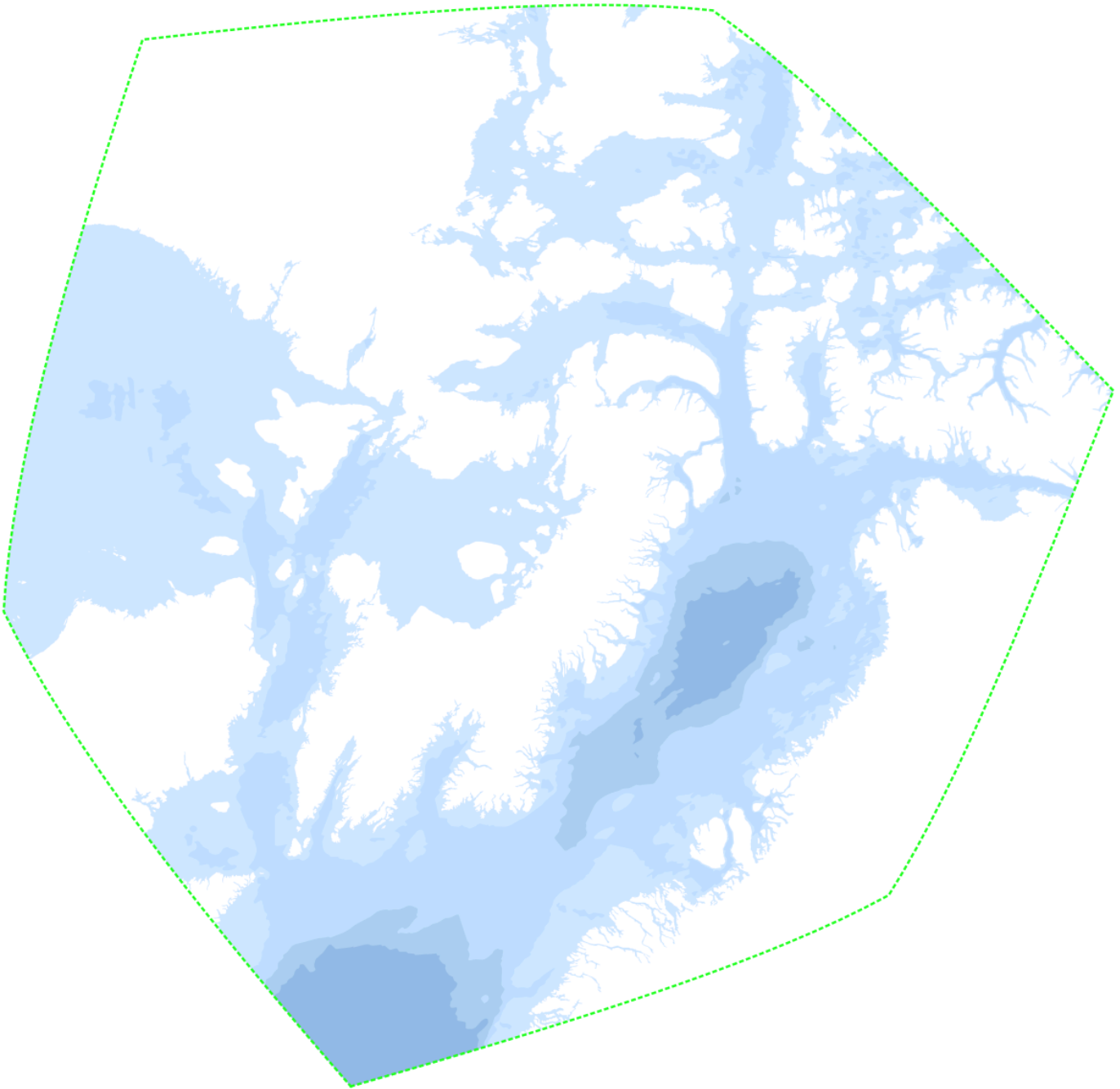


Figure C.54 — Visualization in a North polar projection of GeoJSON polygon contour features for data retrieved from ISEA3H DGGRS zone [B0-5-A](#) of [Natural Earth](#) bathymetry contours.

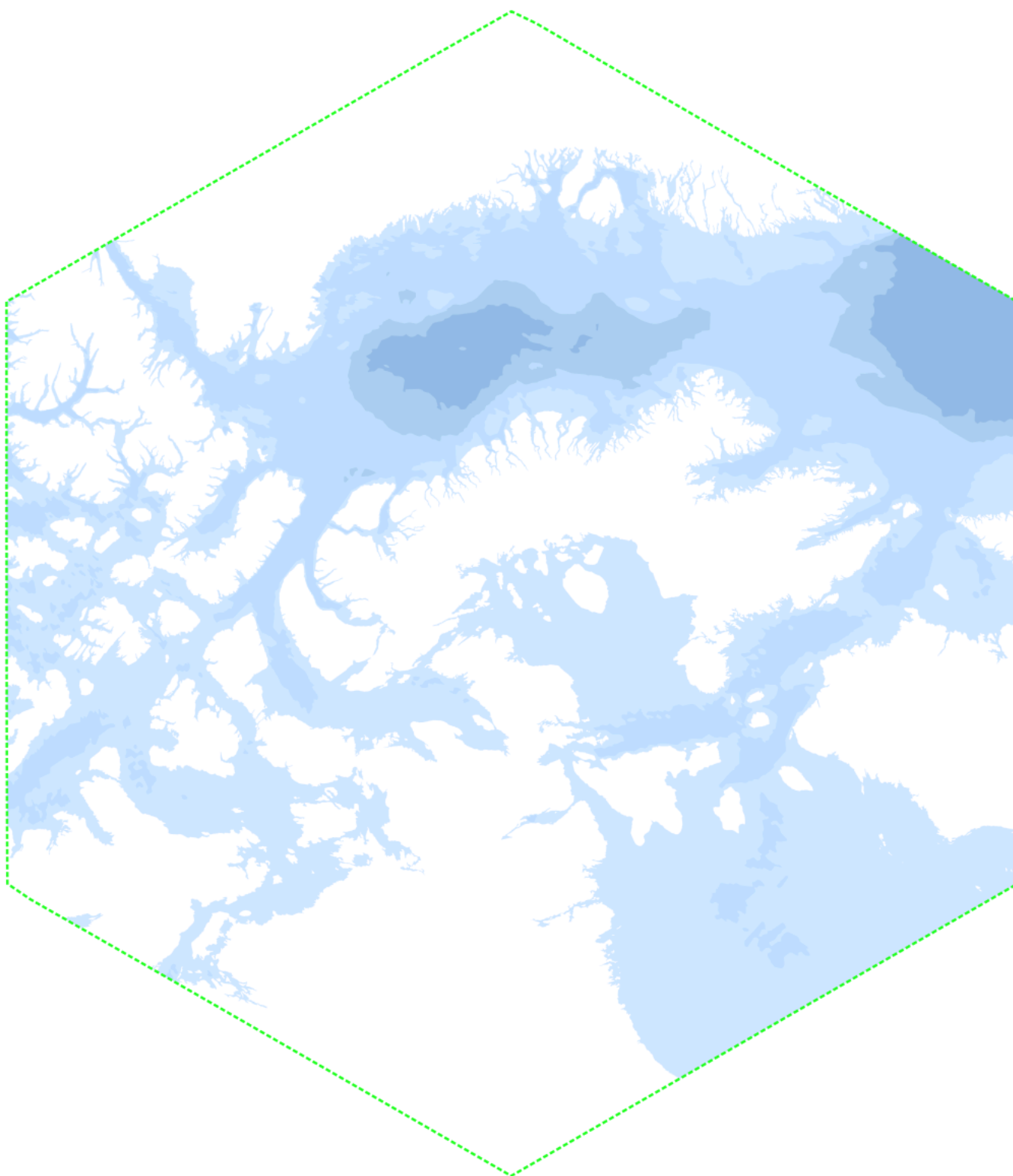


Figure C.55 — Visualization in an ISEA planar projection of GeoJSON polygon contour features for data retrieved from ISEA3H DGGRS zone [B0-5-A](#) of [Natural Earth](#) bathymetry contours.

C.8.1.4. DGGS-FG-JSON Examples

The DGGS-FG-JSON format is the vector counterpart to DGGS-JSON, leveraging the same concepts of DGGRS, parent zone, sub-zones at a given relative depth, and deterministic sub-zone order, while also building on top of the familiar Features Geometry JSON and GeoJSON formats, which are themselves built on OGC Simple Features.

In DGGS-FG-JSON, spatial coordinates of the feature geometries corresponding to the spatial dimensions of the DGGRS are encoded as integer sub-zone order indices ranging from 1 to the number of sub-zones at the selected relative depth. This relative depth corresponds to the precision of the coordinates at which geometry is being defined, analogous to the number of decimals that would be used in GeoJSON or FG-JSON. Because this essentially corresponds to a coordinate system local to the zone for which data is being retrieved, high precision can be achieved with much fewer information than is required to address the entire globe.

This representation also addresses the issue of artificial segments. This is done by using a special zone order index value of 0 for representing coordinates outside of the zone, which facilitates merging geometry across adjacent zones and easily identifying artificial segments of polygon contours. For polygons, rather than tracing points along the clipping zone edge(s), only the exit and entry points will exist with a single 0 coordinate value in between, indicating that the portion of the zone edge(s) between those two points is within the contour. A DGGS-FG-JSON representation is requested using the `application/fg+json` media type together with the `geometry=quantized` (or `geometry=quantized-zoneids`) query parameter.

The DGGS-FG-JSON representation for the previous OpenStreetMap example extract follows, at a relative depth precision of 15, resulting in coordinates within a ~275 cm² region, ~16 cm precision, with sub-zone indices between 1 and 14,355,469 (roughly equivalent to latitude and longitude with six decimal places).

```
{
  "conformsTo": [
    "https://www.opengis.net/spec/json-fg-1/0.2/conf/core",
    "https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-dggs-fgjson"
  ],
  "dggrs": "[ogc-dggrs:ISEA3H]",
  "zoneId": "I0-1EFA652-D",
  "depth": "15",
  "type": "FeatureCollection",
  "features": [ {
    "type": "Feature",
    "id": 2305843009218664049,
    "geometry": null,
    "place": null,
    "time": null,
    "dggsPlace": {
      "type": "LineString",
      "coordinates": [ 13866054, 13899376, 13953688 ]
    },
    "properties": {
      "highway": "service",
      "name": "Parliament Road",
      "name:fr": "chemin Parliament",
      "access": "no"
    }
  }
]
```



```

}, {
  "type" : "Feature",
  "id" : 2305843009218664071,
  "geometry" : null,
  "place" : null,
  "time" : null,
  "dggsPlace" : {
    "type" : "LineString",
    "coordinates" :
    ...

```

The DGGS-FG-JSON representation for the previous arctic bathymetry polygons example extract follows, at a relative depth precision of 15, resulting in coordinates within a ~0.39 km² region (the size of the previous OpenStreetMap example level 17 zone), ~627 m precision, with sub-zone indices between 1 and 14,355,469 (equivalent to decimal latitude and longitude between two and three decimal places).

```

{
  "conformsTo": [
    "https://www.opengis.net/spec/json-fg-1/0.2/conf/core",
    "https://www.opengis.net/spec/ogcapi-dggs-1/1.0/conf/data-dggs-fgjson"
  ],
  "dggrs": "[ogc-dggrs:ISEA3H]",
  "zoneId": "B0-5-A",
  "depth": "15",
  "geometryDimension": 2,
  "type": "FeatureCollection",
  "features": [
    {
      "type": "Feature",
      "id": 1,
      "properties": {
        "scalerank": 0,
        "featurecla": "Bathymetry"
      },
      "geometry" : null,
      "place": null,
      "time" : null,
      "dggsPlace": {
        "type": "MultiPolygon",
        "coordinates": [
          [ 14355360, 14355250, 14355141, 14355032, 14354922, 14354813, .
          ..

```

C.8.2. Retrieving data from an ISEA9R DGGRS

Examples in this section retrieve data for rhombic zones of an ISEA9R DGGRS, based on the ISEA projection.

C.8.2.1. DGGS-JSON Examples

The following request is for data from the A2-0 level 0 rhombic ISEA9R zone at a relative depth of 4 in DGGS-JSON:

<https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/ISEA9R/zones/A2-0/data?zone-depth=4>

```
{
  "dggrs" : "https://www.opengis.net/def/dggrs/OGC/1.0/ISEA9R",
  "zoneId" : "A2-0",
  "depths" : [ 4 ],
  "values" : {
    "Elevation" : [
      {
        "depth" : 4,
        "shape" : { "count" : 6561, "subZones" : 6561 },
        "data" : [ -684.1801215563401, -725.808053553661, ..., -
4279.7074446855995 ]
      }
    ]
  }
}
```

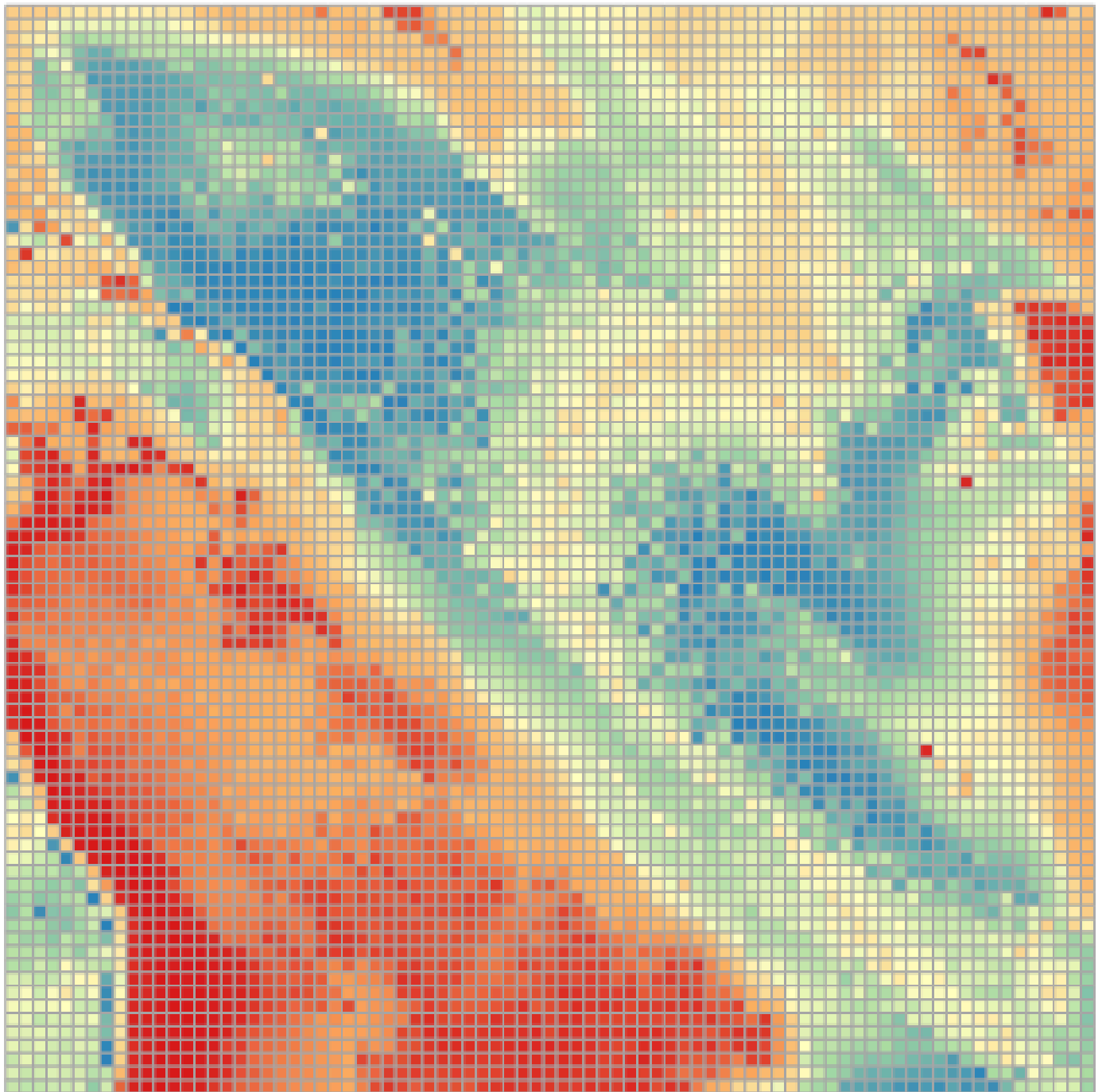



Figure C.56 — Visualization in the ISEA 5x6 rotated and sheared space of a DGGS-JSON response for retrieving data for ISEA9R DGGRS zone A2-0 of GEBCO 2014 bathymetry at a relative depth of 4

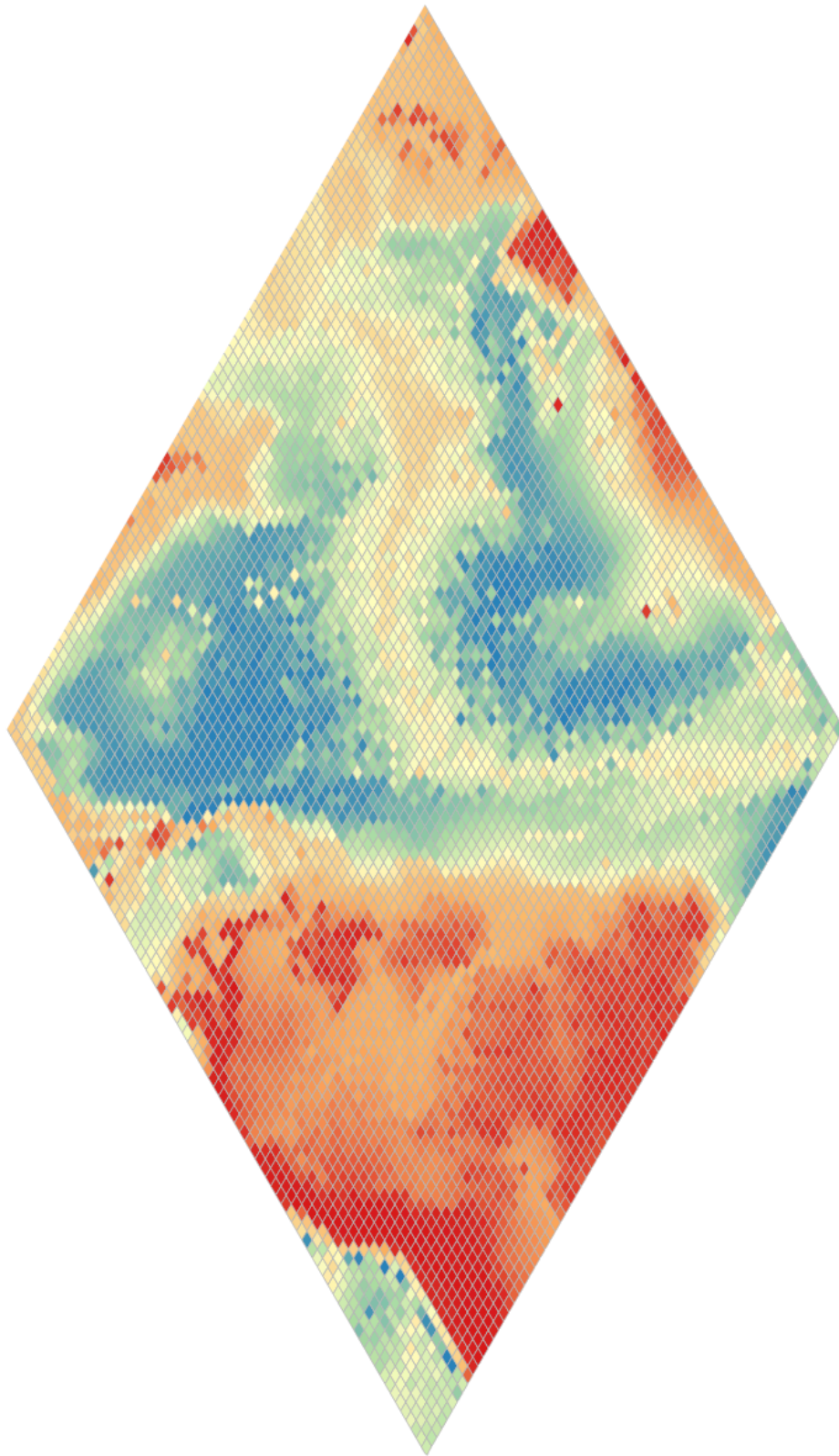


Figure C.57 — Visualization in an ISEA planar projection of a DGGs-JSON response for retrieving data for ISEA9R DGGs zone A2-0 of GEBCO 2014 bathymetry at a relative depth of 4

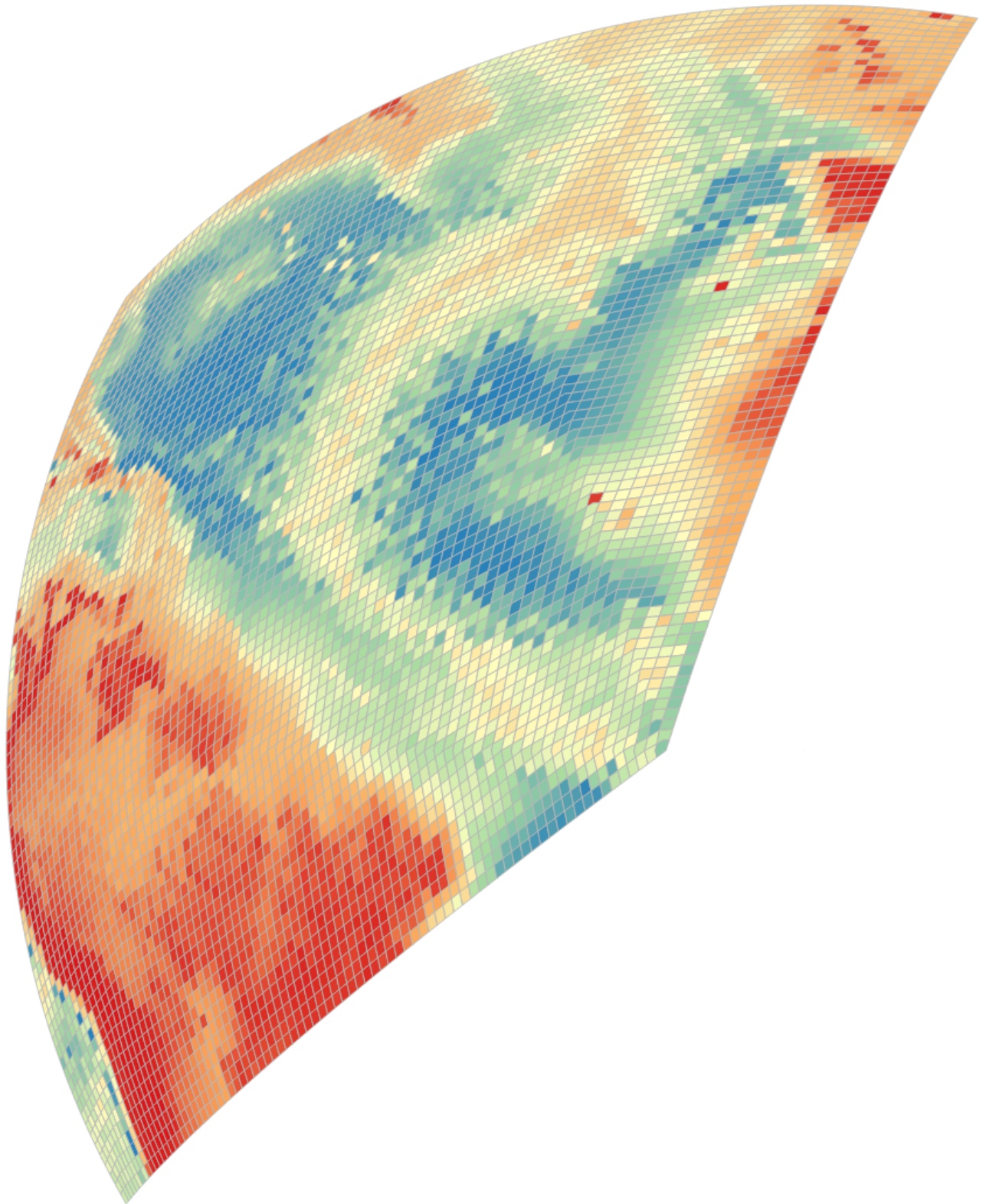


Figure C.58 — Visualization in an orthographic projection of a DGGs-JSON response for retrieving data for ISEA9R DGGRS zone A2-0 of GEBCO 2014 bathymetry at a relative depth of 4

C.8.2.2. GeoTIFF Examples

The following illustrates the GeoTIFF response for requesting data from the same A2-0 ISEA9R zone at same relative depth of 4 in three different CRSs: 5×6 ISEA rotated and sheared space, ISEA planar projection, and CRS84.

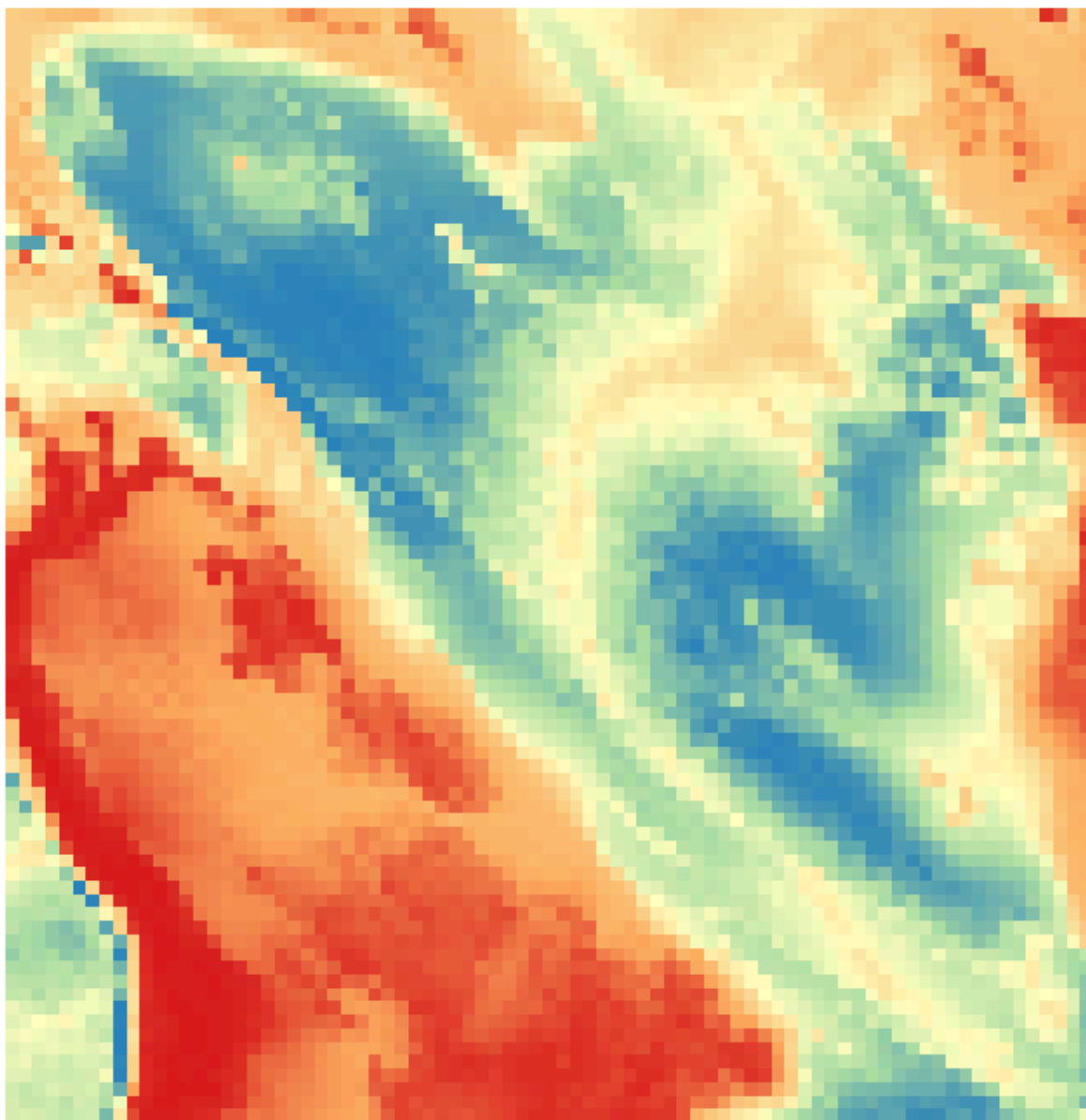


Figure C.59 – Visualization in the ISEA 5x6 rotated and shared space of a GeoTIFF response for retrieving data for ISEA9R DGGRS zone A2-0 of GEBCO 2014 bathymetry at a relative depth of 4

Because ISEA9R zone edges are fully aligned with the axes of the ISEA 5×6 rotated and sheared space and the rhombic zones are square in this

space, a GeoTIFF representation provides a one-to-one mapping of zones to rectilinear gridded coverage cells, as can be seen by comparing this previous visualization of the GeoTIFF response with the visualization of the DGGS-JSON responses. For the same reason, an ISEA9R 2D Tile Matrix Set can be defined in this 5×6 space, which supports implementing the OGC API – Tiles Standard as an alternative or complementary access mechanism to implementing the Zone Data Retrieval requirements class of this DGGS API.

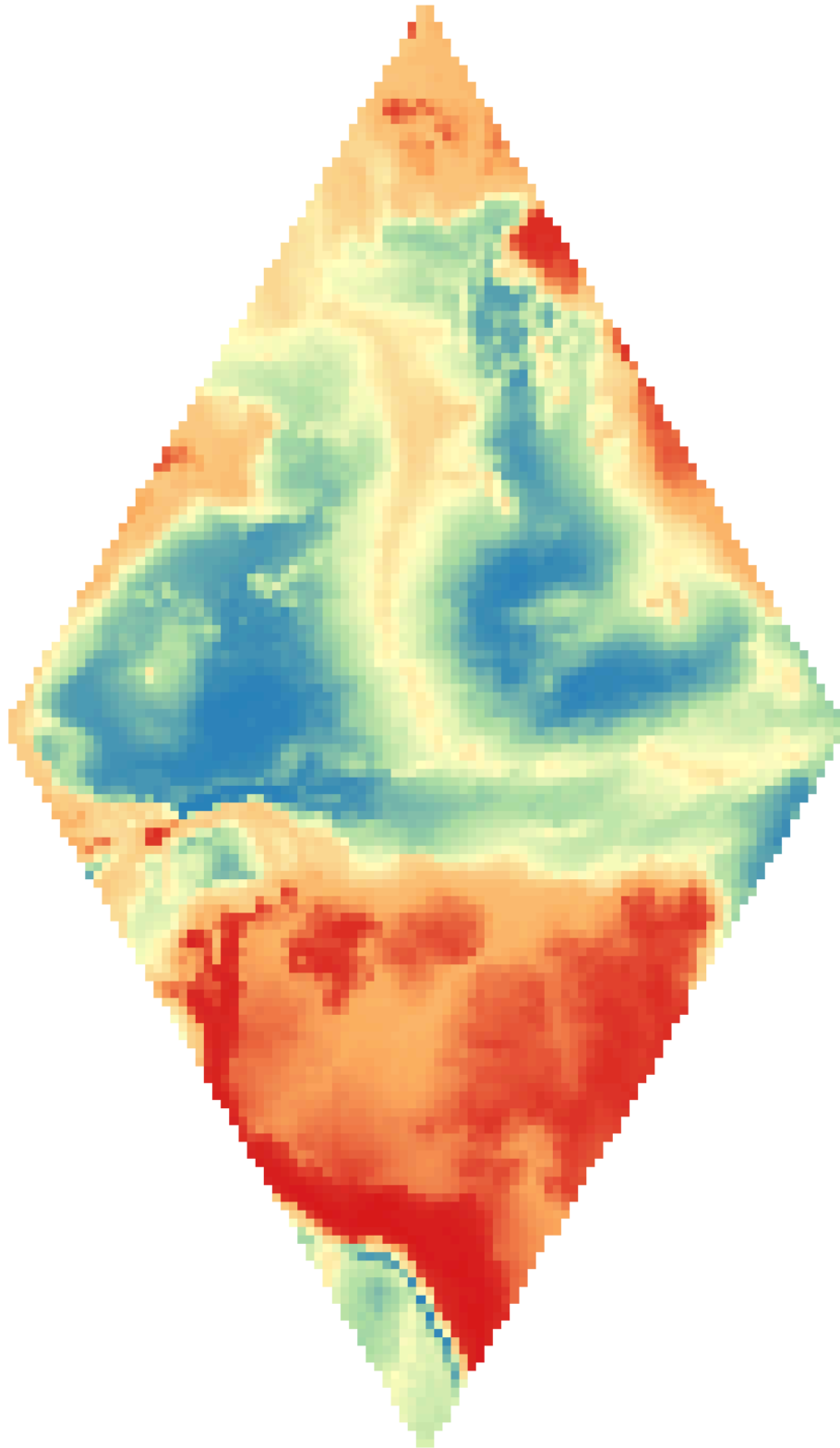


Figure C.60 — Visualization of an ISEA planar projection GeoTIFF response for retrieving data for ISEA9R DGGRS zone A2-0 of GEBCO 2014 bathymetry at a relative depth of 4

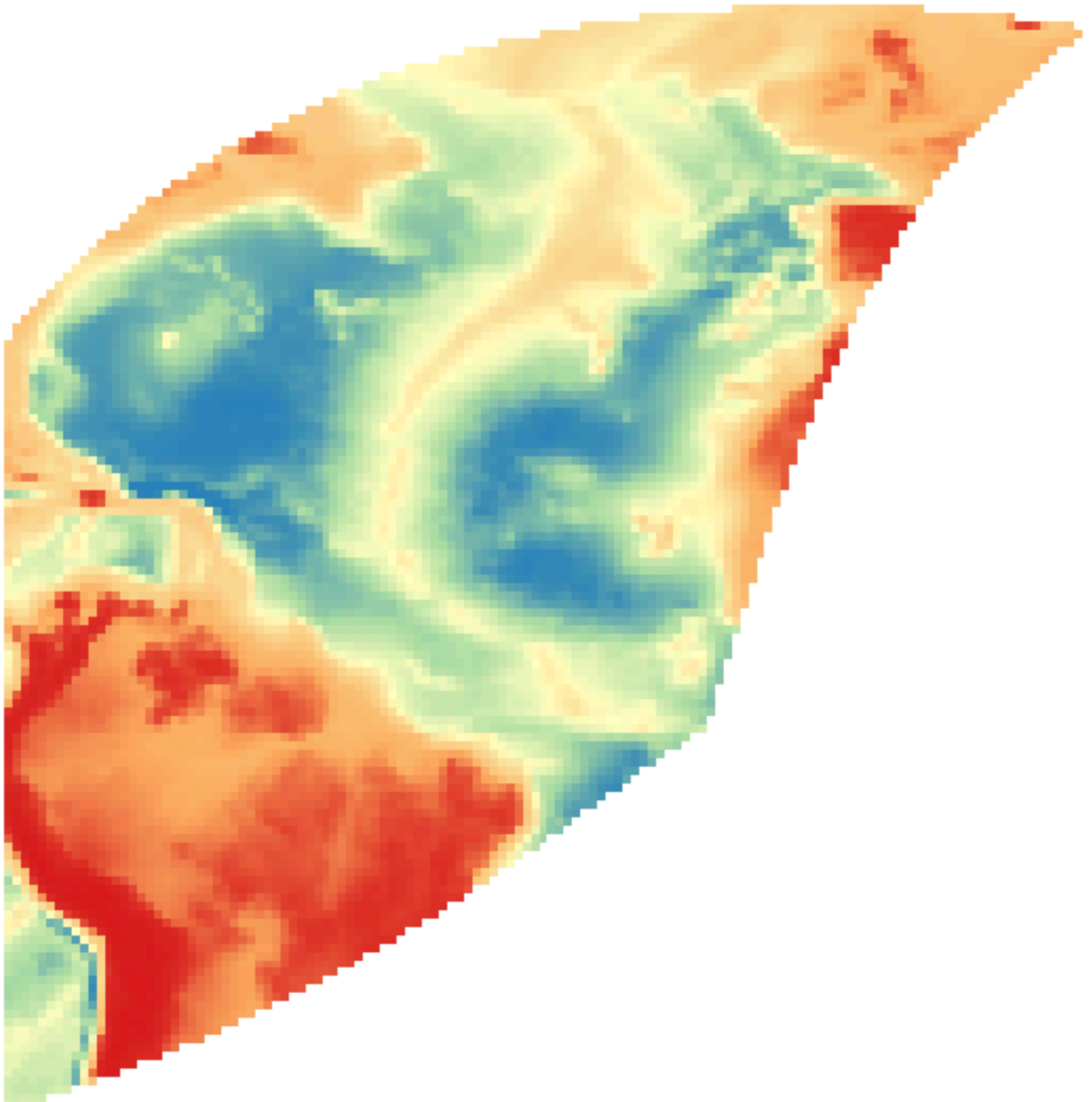


Figure C.61 — Visualization of a CRS84 GeoTIFF response for retrieving data for ISEA9R DGGRS zone A2-0 of GEBCO 2014 bathymetry at a relative depth of 4

In these two previous visualizations, the server returned a response in the ISEA planar projection and CRS84, respectively. If the affine transformation from the ISEA 5×6 rotated and sheared space is done on the client side

instead, the rhombic shape of the individual sub-zones would be preserved, as in the corresponding visualizations of the DGGs-JSON representation.

C.8.2.3. GeoJSON Examples

Using centroid points for the geometry of each zone (geometry=zone-centroid), the GeoJSON response and associated visualization would look like the following:

```
{
  "type" : "FeatureCollection",
  "features" : [ {
    "type" : "Feature",
    "id" : 1,
    "geometry" : {
      "type" : "Point",
      "coordinates" : [-78.3336155911744, 31.7735879687561]
    },
    "properties" : {
      "Elevation" : -684.1801215563401,
      "zoneID" : "E2-0"
    }
  }, {
    "type" : "Feature",
    "id" : 2,
    ...
  }
```

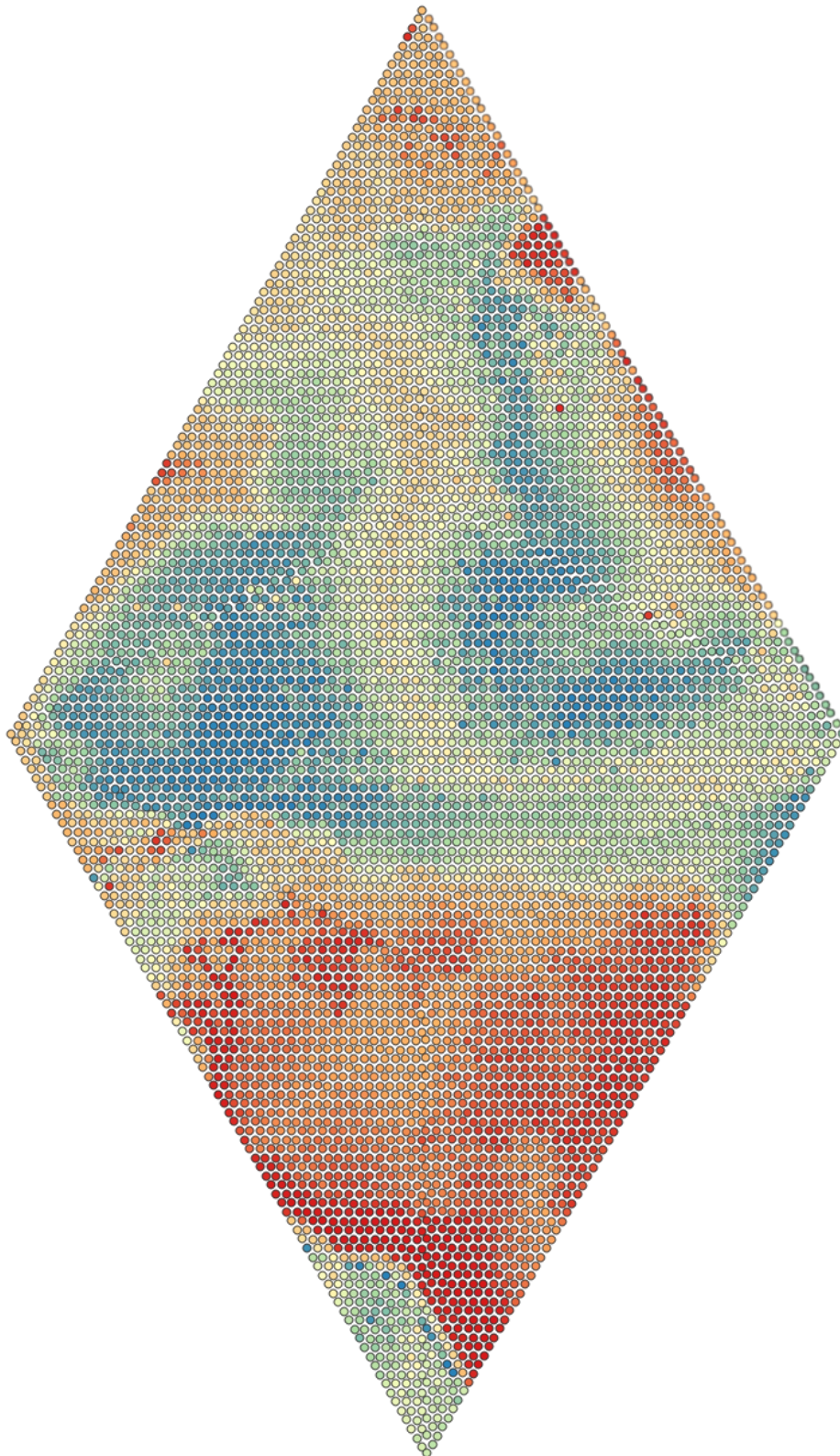



Figure C.62 — Visualization of a GeoJSON point features response for data retrieved from ISEA9R DGGRS zone A2-0 of GEBCO 2014 bathymetry at a relative depth of 4

The following GeoJSON feature collection is requested from an OpenStreetMap dataset of Ottawa for ISEA9R zone J0-116C0097, and illustrated as visualized in different projections.

<https://maps.gnosis.earth/ogcapi/collections/osm:ottawa:roads/dggs/ISEA9R/zones/J0-116C0097/data>

```
{
  "type": "FeatureCollection",
  "features": [ {
    "type": "Feature",
    "id": 2305843009253710926,
    "geometry": {
      "type": "LineString",
      "coordinates": [
        [ -75.69465583, 45.42431289 ],
        [ -75.69500353, 45.42453159 ],
        [ -75.69543003, 45.4247375 ]
      ]
    },
    "properties": {
      "highway": "path",
      "name": "Rideau Canal Western Pathway",
      "surface": "asphalt",
      "bicycle": "yes",
      "foot": "yes",
      "tunnel": "yes",
      "width": "6"
    }
  }, {
    "type": "Feature",
    "id": 2305843009253711182,
    "geometry": {
      "type": "LineString",
      "coordinates":
    ...
  }
```

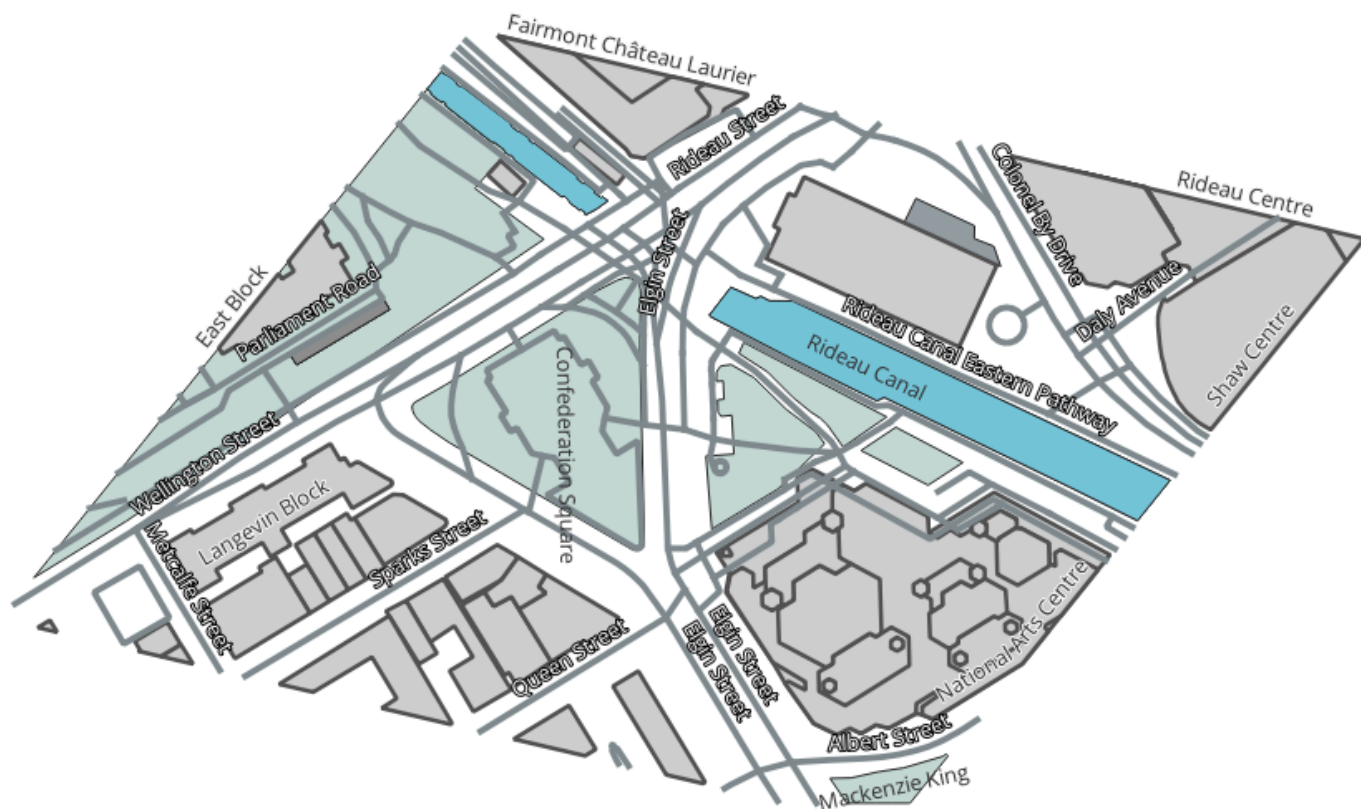


Figure C.63 — Visualization in a world Mercator projection of a GeoJSON feature collection with mixed geometry types for data retrieved from ISEA9R DGGRS zone [J0-116C0097](#) of [OpenStreetMap](#) (c) OpenStreetMap contributors

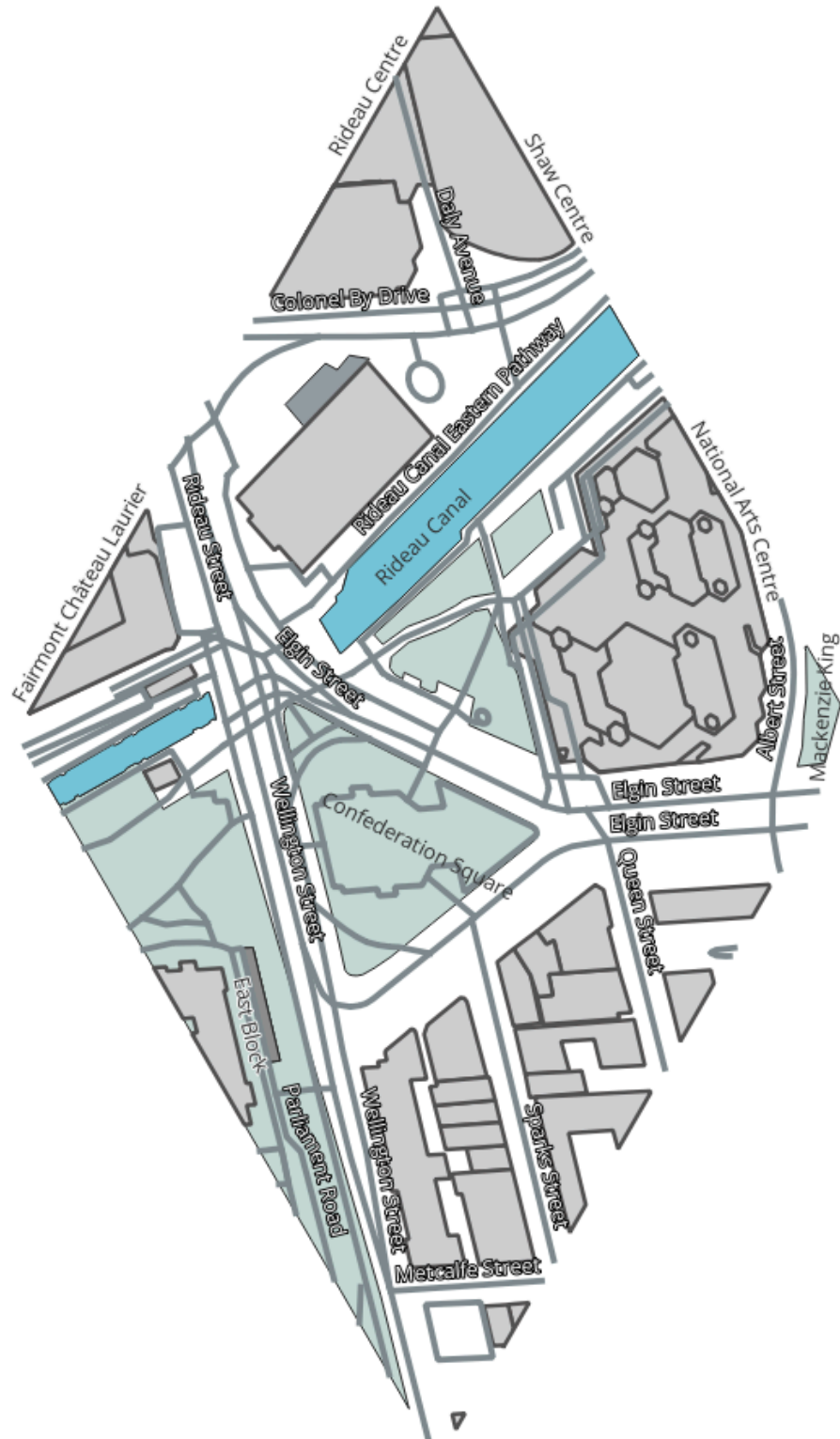


Figure C.64 — Visualization in an ISEA planar projection of a GeoJSON feature collection with mixed geometry types for data retrieved from ISEA9R DGRS zone J0-116C0097 of OpenStreetMap (c) OpenStreetMap contributors

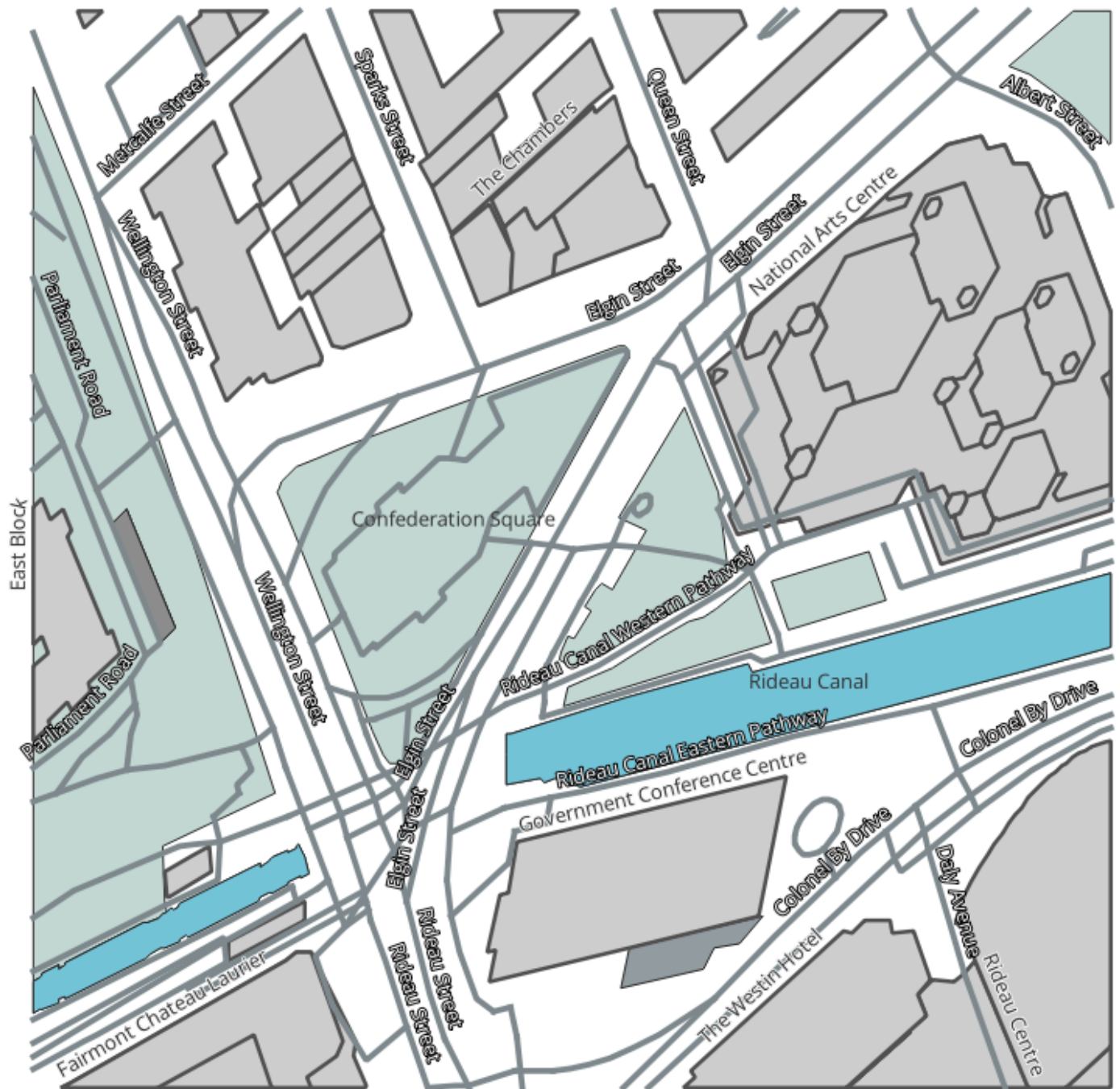


Figure C.65 — Visualization in ISEA 5x6 rotated and sheared space of a GeoJSON feature collection with mixed geometry types for data retrieved from ISEA9R DGRS zone [J0-116C0097](#) of [OpenStreetMap](#) (c) OpenStreetMap contributors

```
{
  "type": "FeatureCollection",
  "features": [ {
    "type": "Feature",
    "id": 1,
    "properties": {
      "scalerank": 0,
```

```

    "featurecla": "Bathymetry"
  },
  "geometry": {
    "type": "MultiPolygon",
    "coordinates": [
      [
        [ -176.462294193695101, 51.573747730189602 ],
        [ -176.299702455578142, 51.743306963471383 ],
        [ -176.29463468229261, 51.738291979490903 ],
        [ -176.292808119410552, 51.75049674056649 ],
        [ -176.271367699388492, 51.77285594050052 ],
        ...
      ]
    ]
  }
}

```

The following GeoJSON polygon contours are requested from Natural Earth bathymetry for ISEA9R zone A9-0.

[https://maps.gnosis.earth/ogcapi/collections/
NaturalEarth:physical:bathymetry:ne_10m_bathymetry_L_0/dggs/ISEA9R/zones/A9-0/data](https://maps.gnosis.earth/ogcapi/collections/NaturalEarth:physical:bathymetry:ne_10m_bathymetry_L_0/dggs/ISEA9R/zones/A9-0/data)

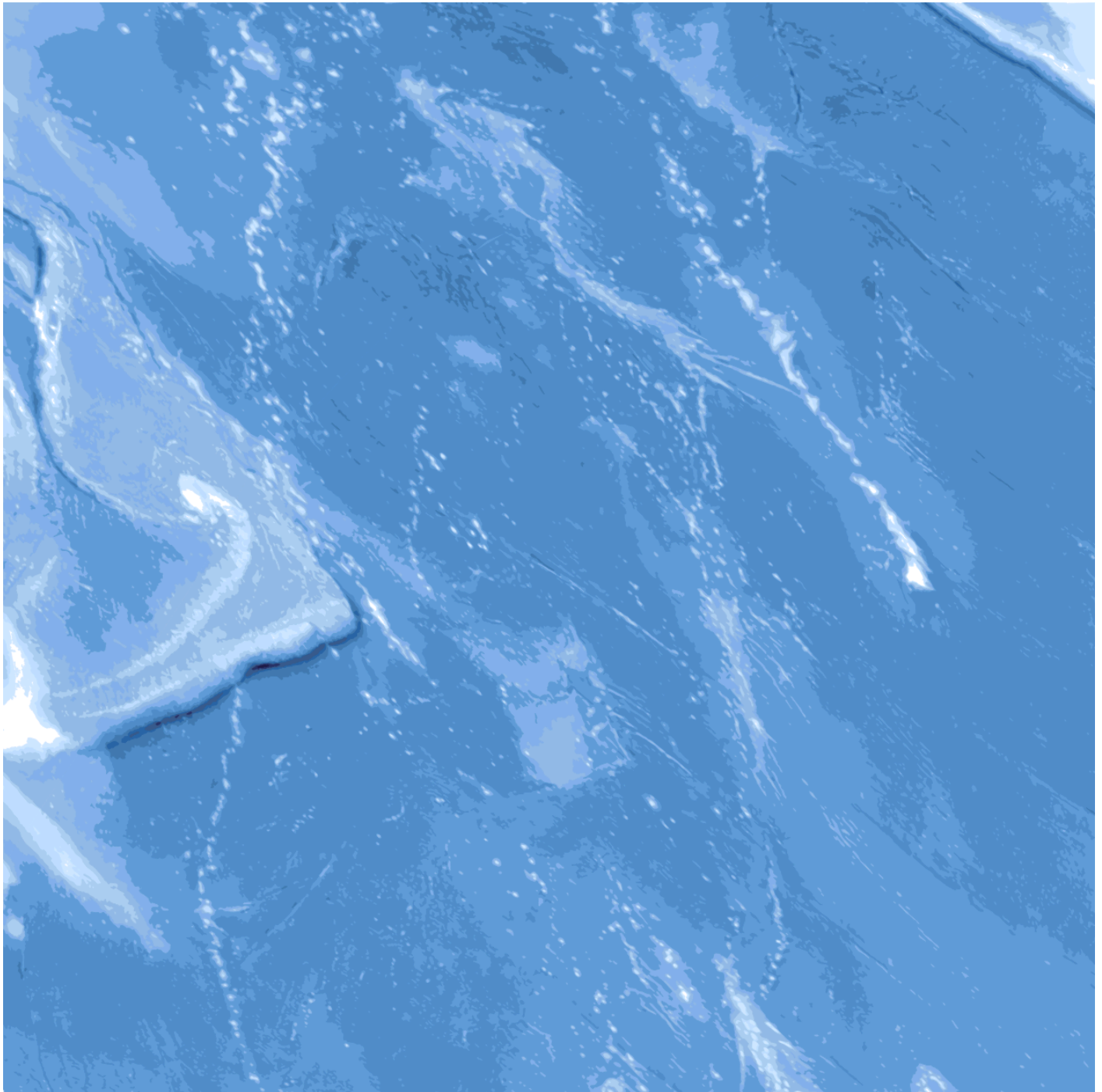


Figure C.66 – Visualization in the ISEA 5x6 rotated and sheared space of GeoJSON polygon contour features for data retrieved from ISEA9R DGGRS zone A9-0 of Natural Earth bathymetry contours.

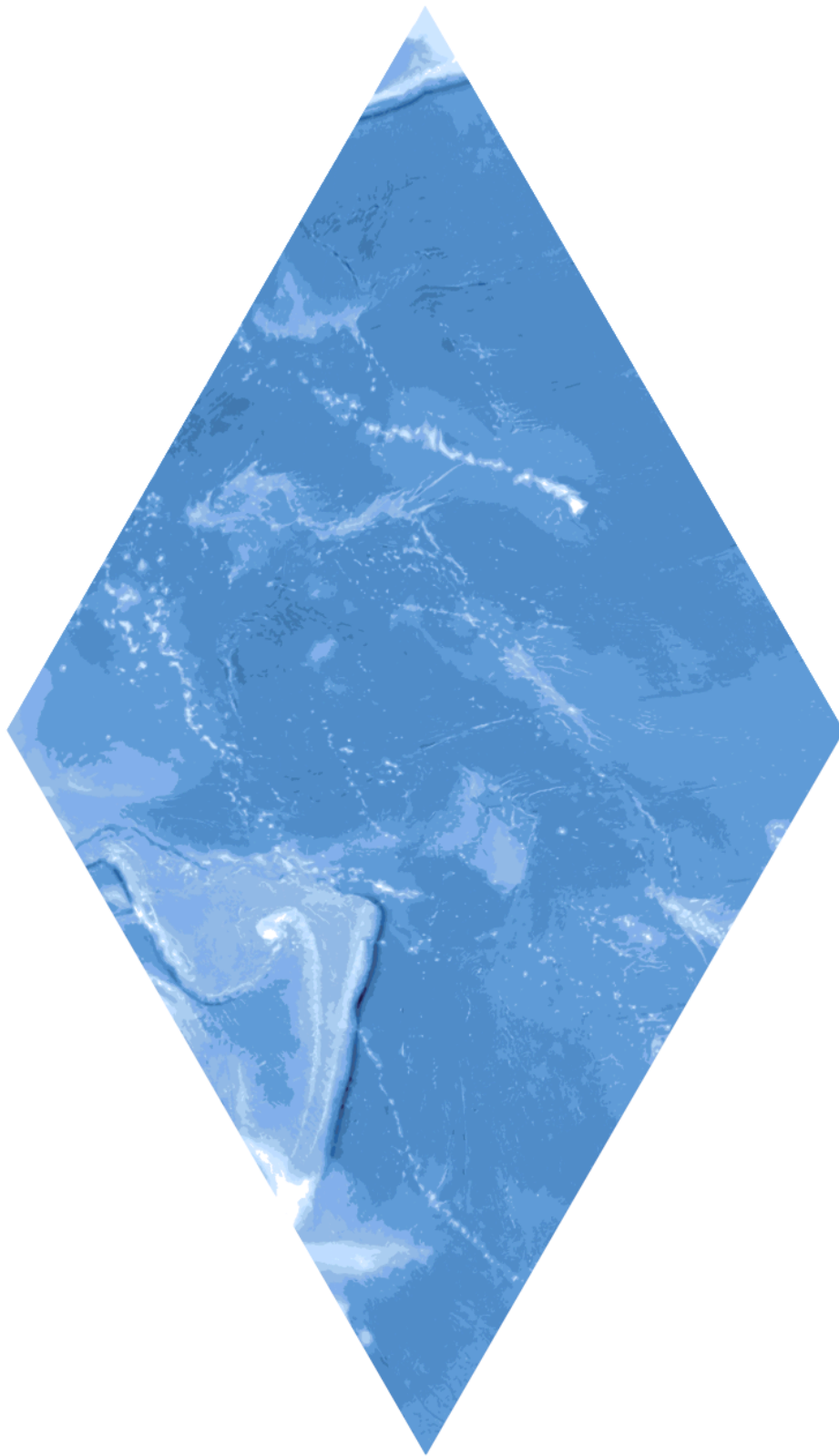


Figure C.67 — Visualization in an ISEA planar projection of GeoJSON polygon contour features for data retrieved from ISEA9R DGGRS zone A9-0 of Natural Earth bathymetry contours.

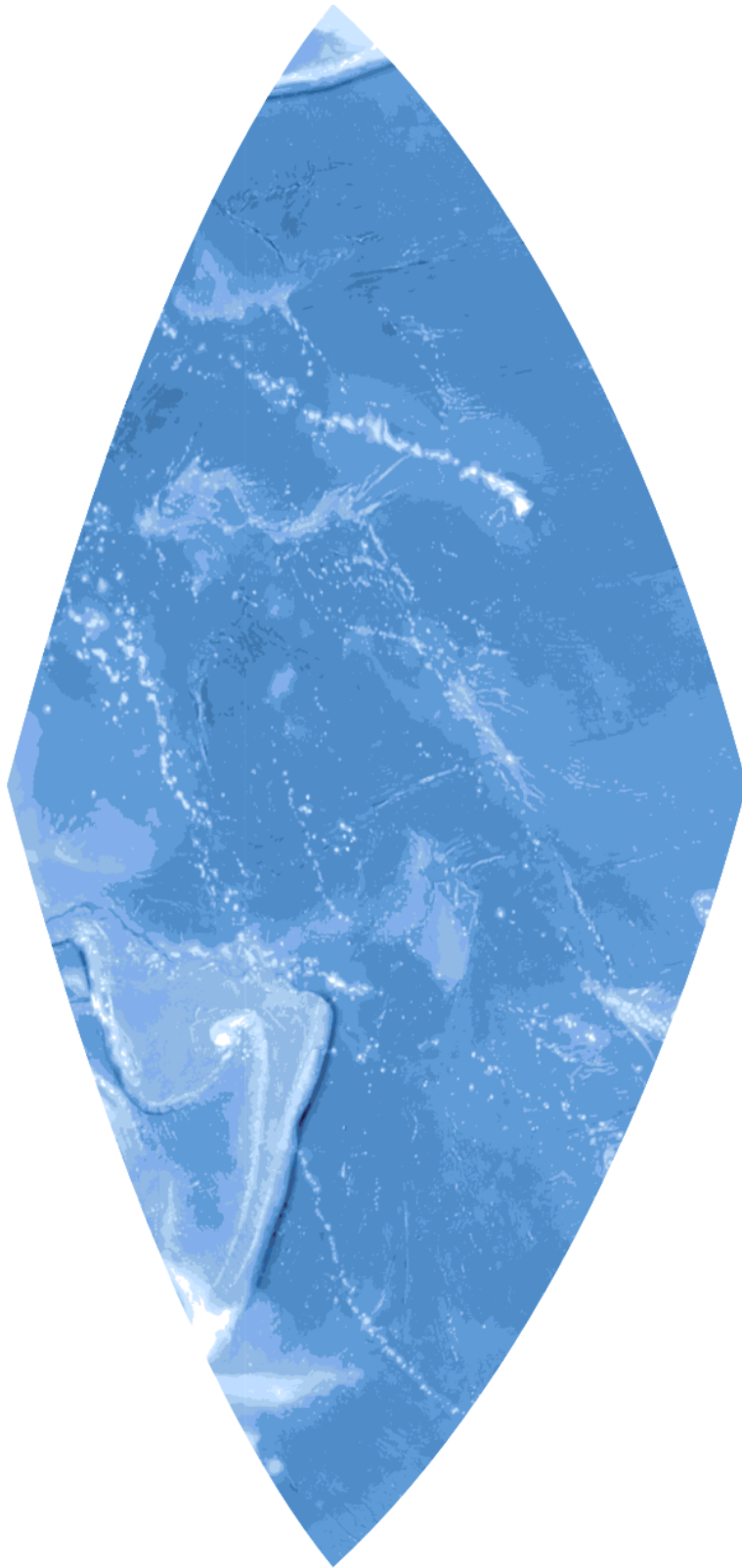


Figure C.68 — Visualization in a Mollweide projection of GeoJSON polygon contour features for data retrieved from ISEA9R DGGRS zone A9-0 of Natural Earth bathymetry contours.

C.8.3. Retrieving data from a GNOSIS Global Grid DGGRS

Examples in this section retrieve data for rectangular zones of a GNOSIS Global Grid DGGRS, with edges aligned to the geographic latitude and longitude axes.

C.8.3.1. DGGS-JSON Examples

The following request is for data from the 0-1-3 level 0 GNOSIS Global Grid zone in DGGS-JSON at a relative depth of 7:

<https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/GNOSISGlobalGrid/zones/0-1-3/data?zone-depth=7>

```
{
  "dggrs" : "https://www.opengis.net/def/dggrs/OGC/1.0/GNOSISGlobalGrid",
  "zoneId" : "0-1-3",
  "depths" : [ 7 ],
  "values" : {
    "Elevation" : [
      {
        "depth" : 7,
        "shape" : { "count" : 10923, "subZones" : 10923 },
        "data" : [ -4062.7933481641721, -4645.8313990445513, ...,
2878.8939861844092 ]
      }
    ]
  }
}
```

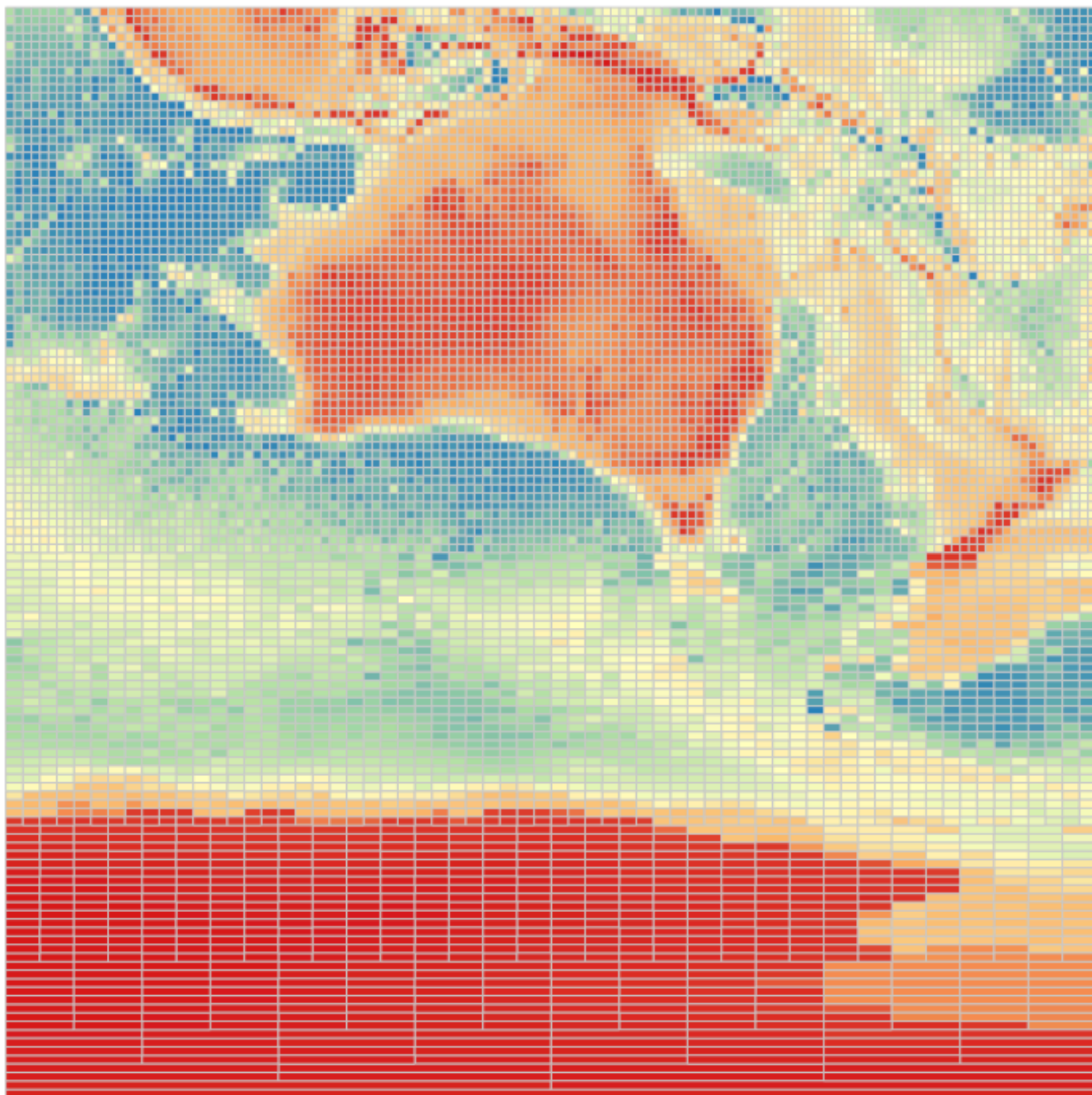


Figure C.69 — Visualization of CRS84 DGGs-JSON response for retrieving data for GNOSIS Global Grid DGGRS zone 0-1-3 of GEBCO 2014 bathymetry at a relative depth of 7

Notice how there are fewer zones per rows approaching the poles, until there is a single zone at the final polar row. While not achieving the 1% error budget allowed for a DGGH to qualify as being equal area, the use of the Variable Width 2D Tile Matrix Set concept allows the GNOSIS Global Grid to maintain a divergence in area from mean zone surface area below 50%

up to a high refinement level, with zones aligned to the geodetic latitude and longitude axes. This in turn greatly facilitates data integration from other discrete global grid hierarchies as well as arbitrary data sources, as no re-projection is needed for WGS84 coordinates.

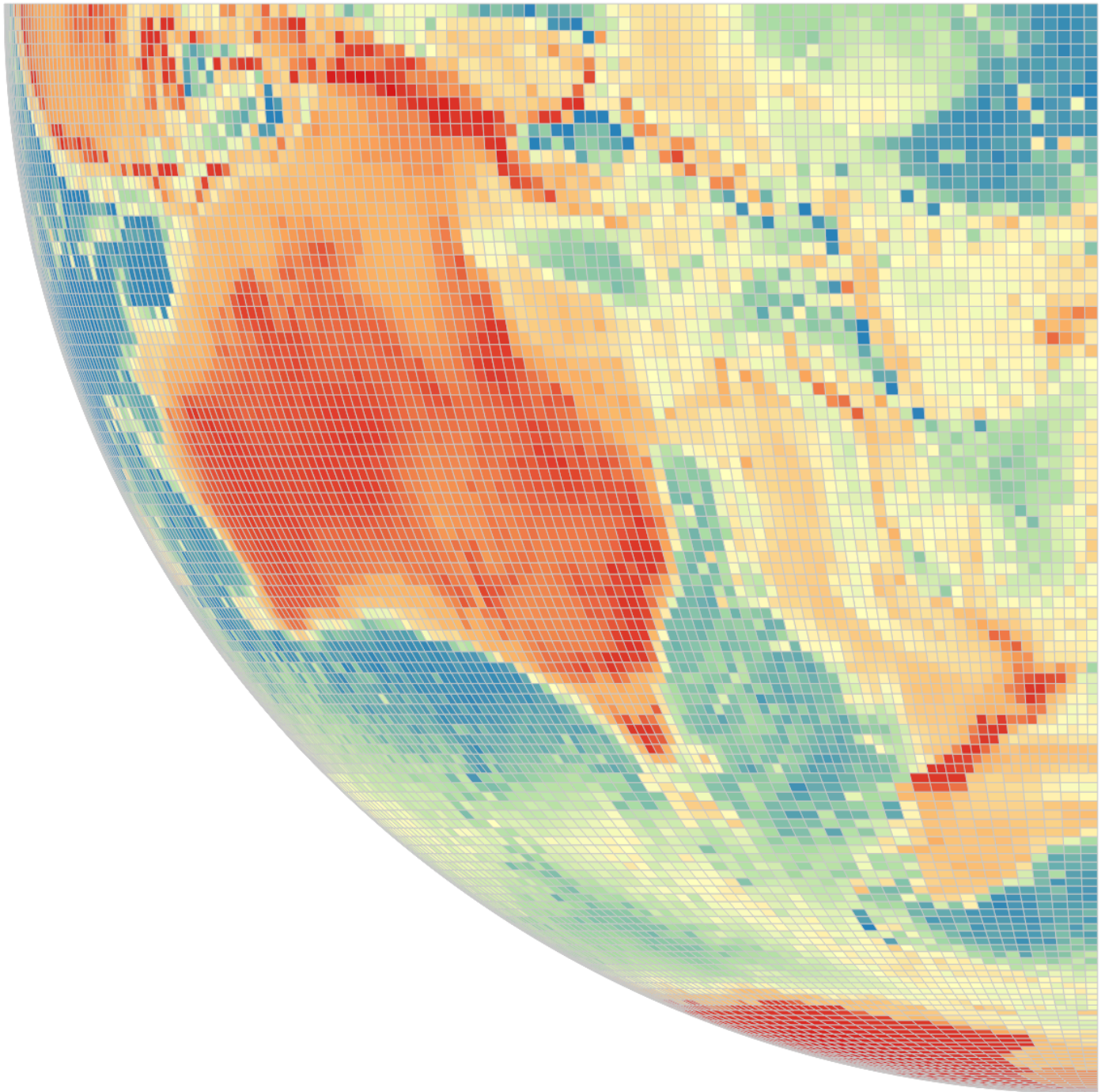


Figure C.70 – Visualization in an orthographic projection of a DGGS-JSON response for retrieving data for GNOSIS Global Grid DGGRS zone 0-1-3 of GEBCO 2014 bathymetry at a relative depth of 7

C.8.3.2. GeoTIFF Examples

The following illustrates the [GeoTIFF response](#) for requesting data from the same 0-1-3 GNOSIS Global Grid zone at same relative depth of 7, visualized below in both its native CRS84 and an orthographic projection.

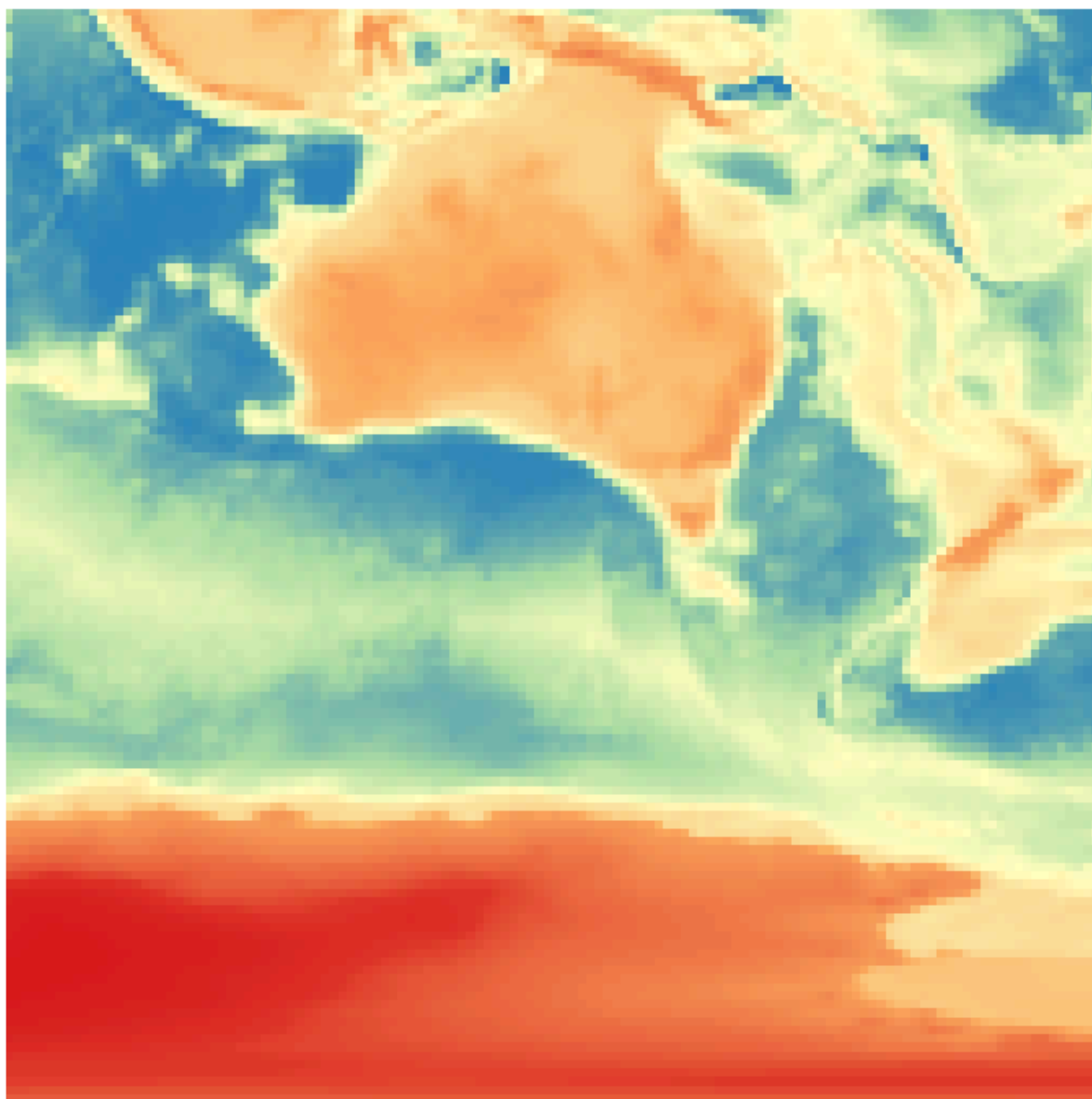


Figure C.71 — Visualization of CRS84 GeoTIFF response for retrieving data for GNOSIS Global Grid DGGRS zone 0-1-3 of [GEBCO 2014 bathymetry](#) at a relative depth of 7

As can be seen by comparing this previous visualization of the GeoTIFF response with the visualization of the DGGs-JSON responses, because the GNOSIS Global Grid zone edges are fully aligned with geographic latitude and longitude, a GeoTIFF representation provides a one-to-one mapping of

zones to rectilinear gridded coverage cells, with the exception of the GeoTIFF representation having a fixed width, requiring to duplicate the values of zones approaching the pole.

A registered [GNOSIS Global Grid 2D Tile Matrix Set](#) is defined which supports implementing the [OGC API – Tiles Standard](#) as an alternative or complementary access mechanism to implementing the [Zone Data Retrieval requirements class](#) of this DGGs API.

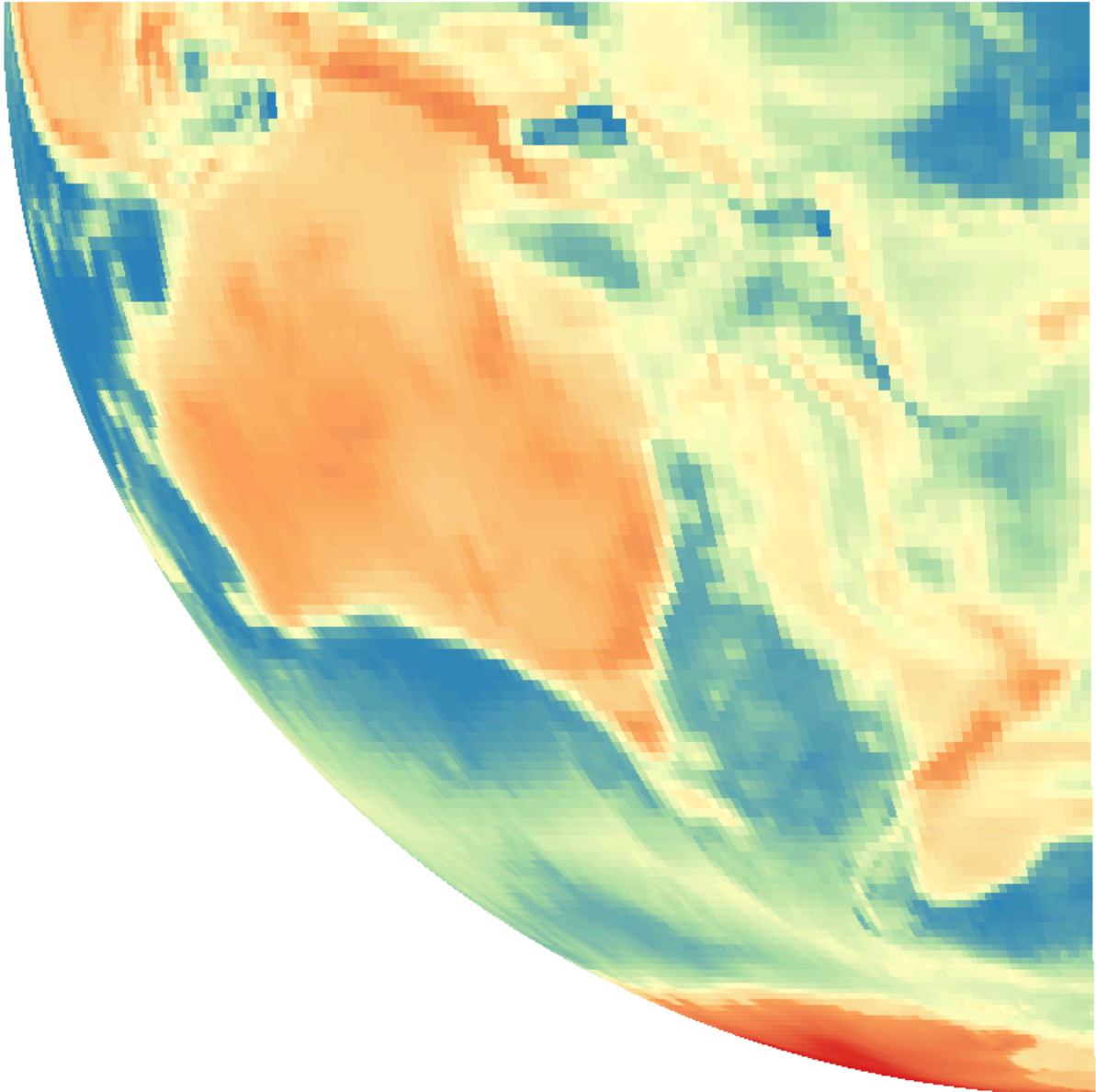


Figure C.72 — Visualization in an orthographic projection of GeoTIFF response for retrieving data for GNOSIS Global Grid DGGRS zone [0-1-3](#) of [GEBCO 2014 bathymetry](#) at a relative depth of 7

C.8.3.3. GeoJSON Examples

Using centroid points for the geometry of each zone (geometry=zone-centroid), the GeoJSON response and associated visualization would look like the following:

```
{
  "type" : "FeatureCollection",
  "features" : [ {
    "type" : "Feature",
    "id" : 1,
    "geometry" : {
      "type" : "Point",
      "coordinates" : [90.3515625, -0.3515625]
    },
    "properties" : {
      "Elevation" : -4062.7933481641721,
      "zoneID" : "7-80-180"
    }
  }, {
    "type" : "Feature",
    "id" : 2,
    ...
  }
]
```

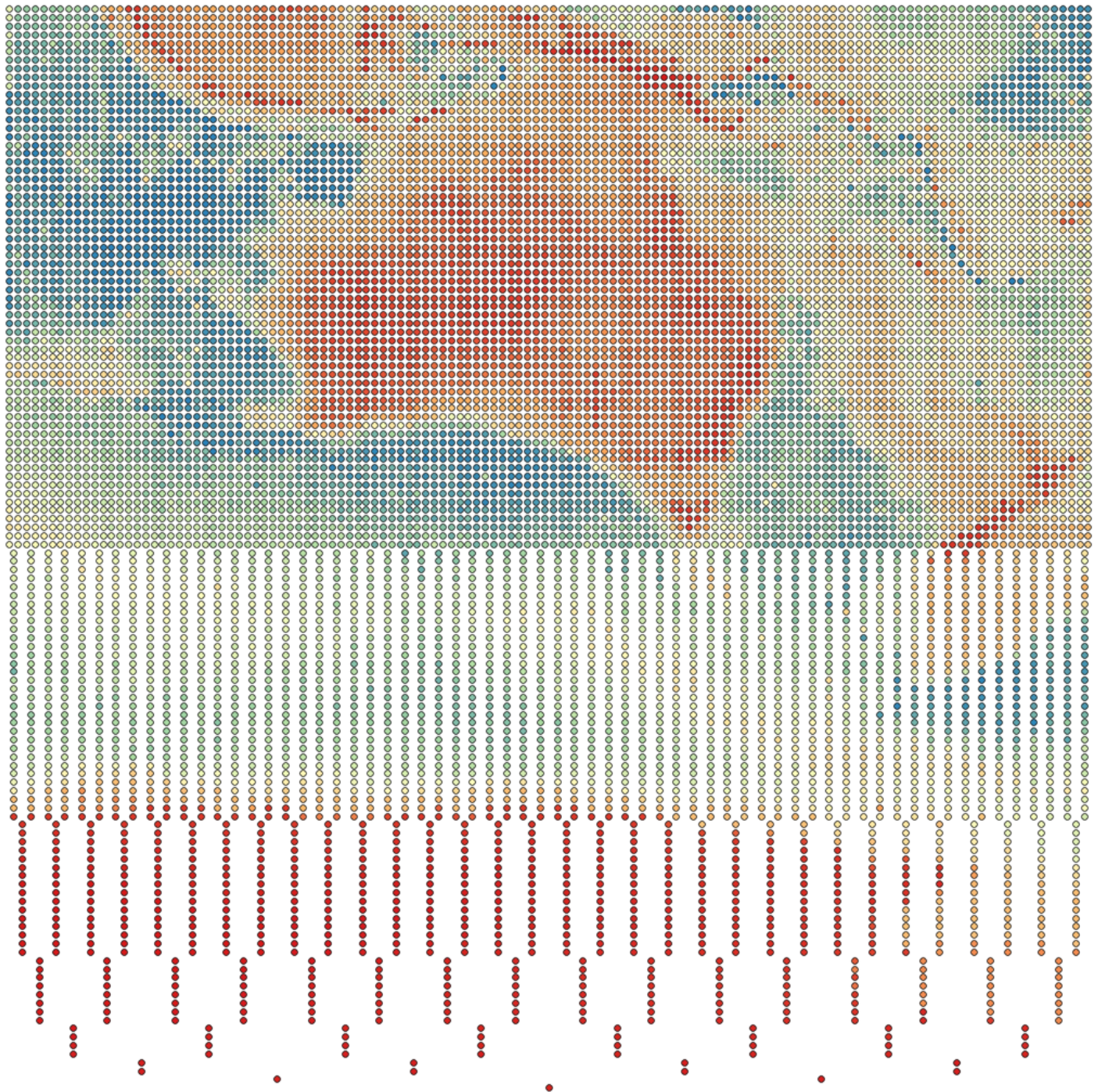


Figure C.73 – Visualization of a GeoJSON point features response for data retrieved from GNOSIS Global Grid DGGRS zone 0-1-3 of GEBCO 2014 bathymetry at a relative depth of 7

The fewer zones approaching the poles based on the [Variable Width 2D Tile Matrix Set](#) concept are especially noticeable in these visualizations of the sub-zone centroids as points, illustrating how the GNOSIS Global Grid

achieves a rough approximation of equal area despite zone edges being aligned to geographic latitude and longitude.

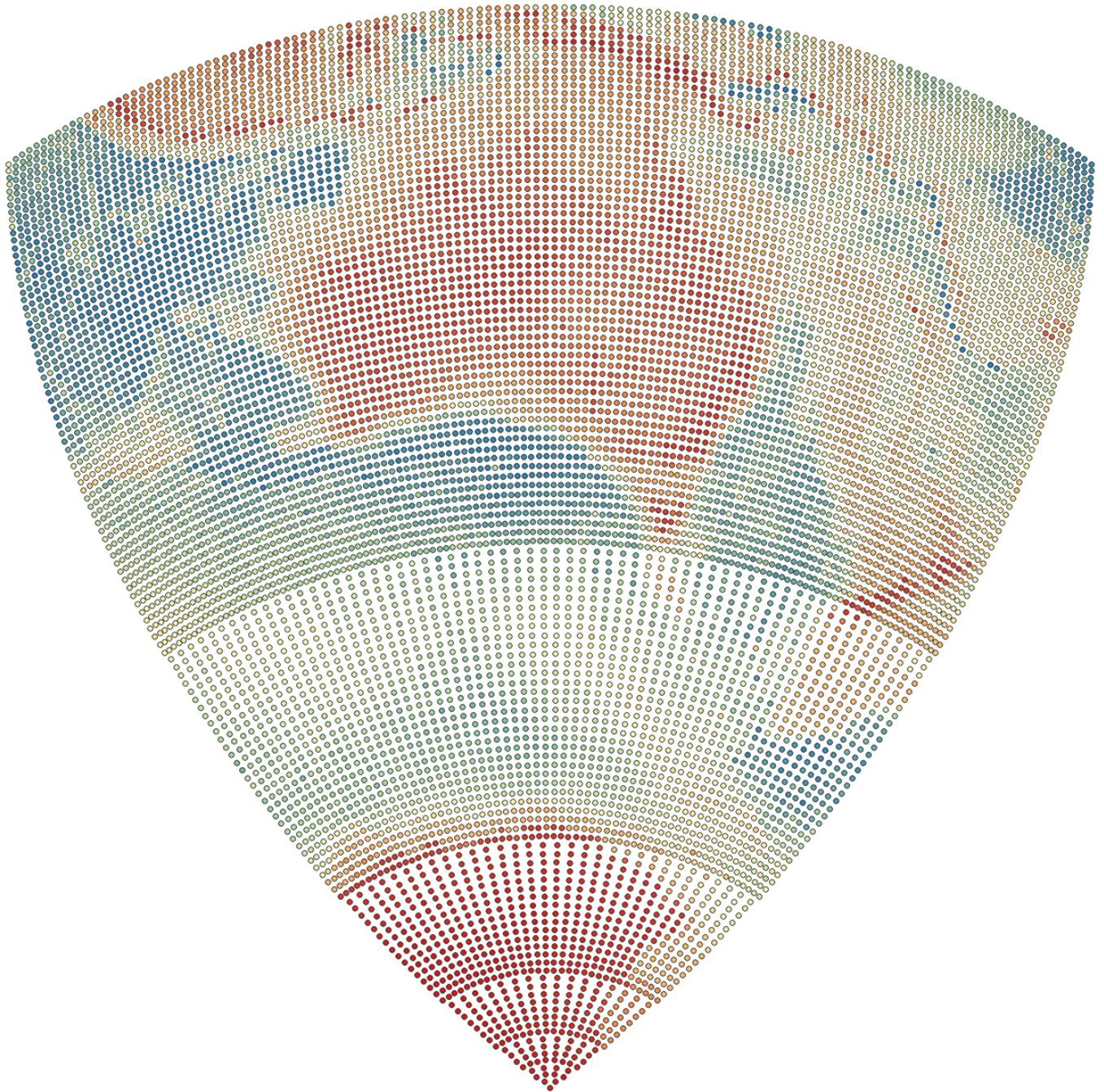


Figure C.74 — Visualization in an orthographic projection of a GeoJSON point features response for data retrieved from GNOSIS Global Grid DGGRS zone 0-1-3 of GEBCO 2014 bathymetry at a relative depth of 7

The following GeoJSON feature collection is requested from an OpenStreetMap dataset of Singapore for GNOSIS Global Grid level 12 zone C-FC5-3276:

<https://maps.gnosis.earth/ogcapi/collections/osm:singapore:roads/dggs/GNOSISGlobalGrid/zones/C-FC5-3276/data>

The map below visualizes that zone together with the zone immediately East of it, C-FC5-3277:

<https://maps.gnosis.earth/ogcapi/collections/osm:singapore:roads/dggs/GNOSISGlobalGrid/zones/C-FC5-3277/data>

```
{
  "type" : "FeatureCollection",
  "features" : [ {
    "type" : "Feature",
    "id" : 2305843009223282082,
    "geometry" : {
      "type" : "LineString",
      "coordinates" :
        [ [103.842845400531, 1.2916332189689], [103.8427734375,
1.2916700596819] ]
    },
    "properties" : {
      "highway" : "residential",
      "name" : "Unity Street",
      "surface" : "asphalt",
      "lanes" : "2",
      "turn:lanes:forward" : "through",
      "lanes:backward" : "1",
      "lanes:forward" : "1",
      "turn:lanes:backward" : "left"
    }
  }, {
    "type" : "Feature",
    "id" : 2305843009223284260,
    ...
  }
```

Notice the artificial edge drawn with a grey stroke splitting the Flower Dome in two, around the middle of the map. With the artificial edge information of DGGs-FG-JSON, a client could avoid such visualization artifacts, and could more easily recombine geometry split across separate zones.

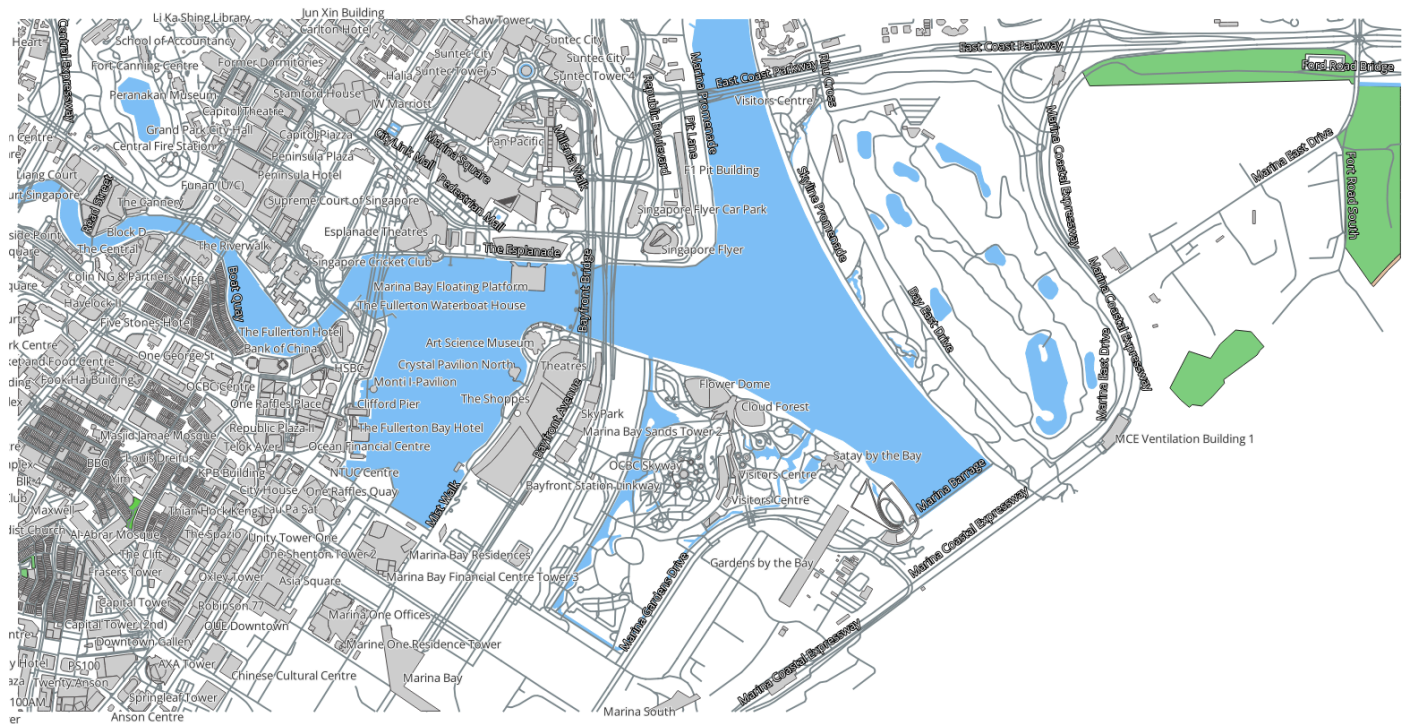


Figure C.75 – Visualization of a GeoJSON feature collection with mixed geometry types for data retrieved from GNOSIS Global Grid DGGRS zones C-FC5-3276 and C-FC5-3277 of OpenStreetMap (c) OpenStreetMap contributors

The following GeoJSON polygon contours are requested from Natural Earth bathymetry for GNOSIS Global Grid level 0 zone 1-1-7.

https://maps.gnosis.earth/ogcapi/collections/NaturalEarth:physical:bathymetry:ne_10m_bathymetry_L_0/dggs/GNOSISGlobalGrid/zones/1-1-7/data

```
{
  "type" : "FeatureCollection",
  "features" : [ {
    "type" : "Feature",
    "id" : 1,
    "geometry" : {
      "type" : "Polygon",
      "coordinates" : [
        [ [136.0693439846182, 33.8470804339864],
          [136.0242801226881, 33.75],
          [135.9791304248306, 33.6527478941586],
          [135.9583581303791, 33.6329197949094],
          [135.9327790239883, 33.6112033052555],
          ...
        ]
      ]
    }
  }
]
```

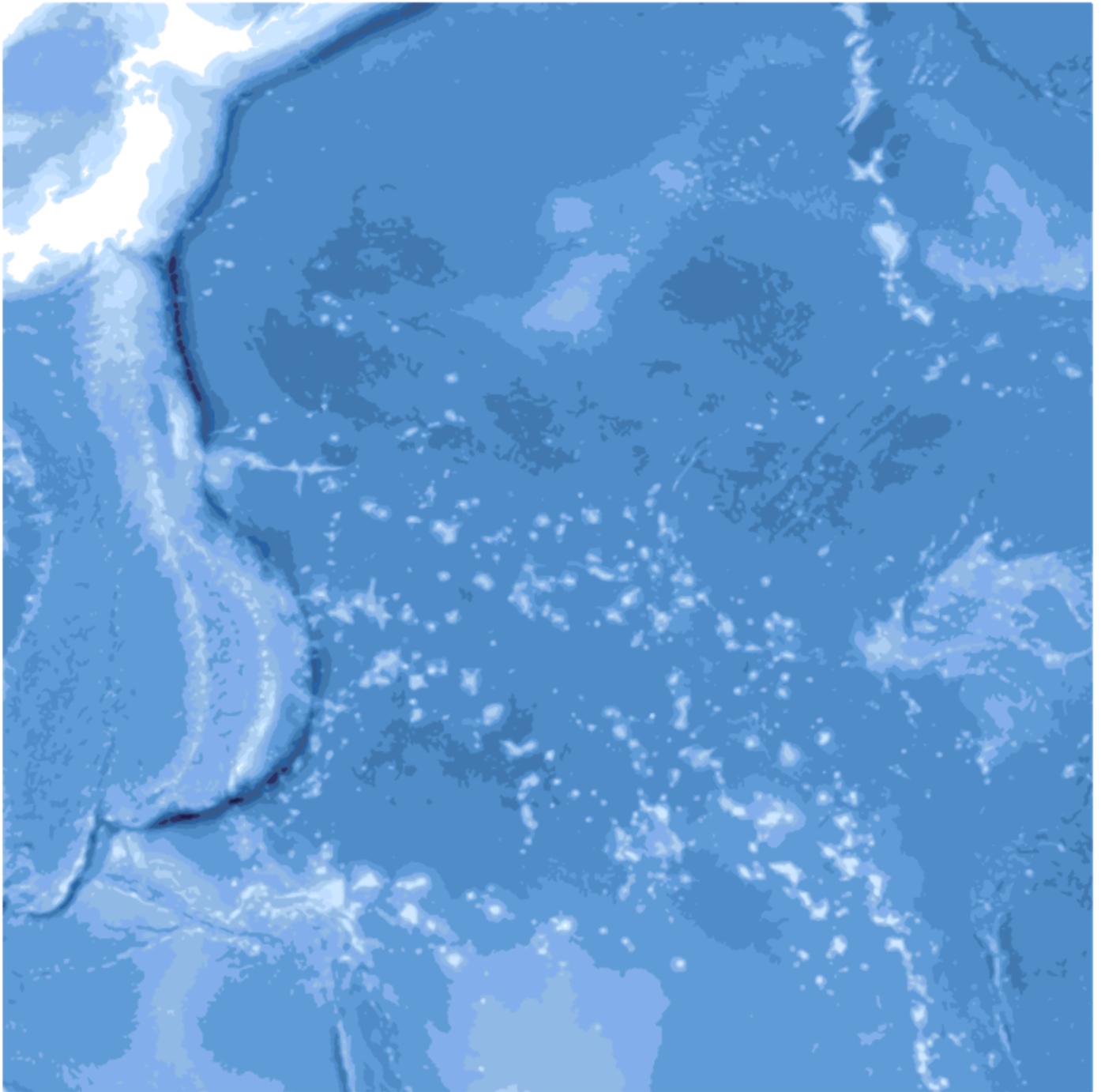


Figure C.76 — Visualization of GeoJSON polygon contour features for data retrieved from GNOSIS Global Grid DGGRS zone 1-1-7 of Natural Earth bathymetry contours.

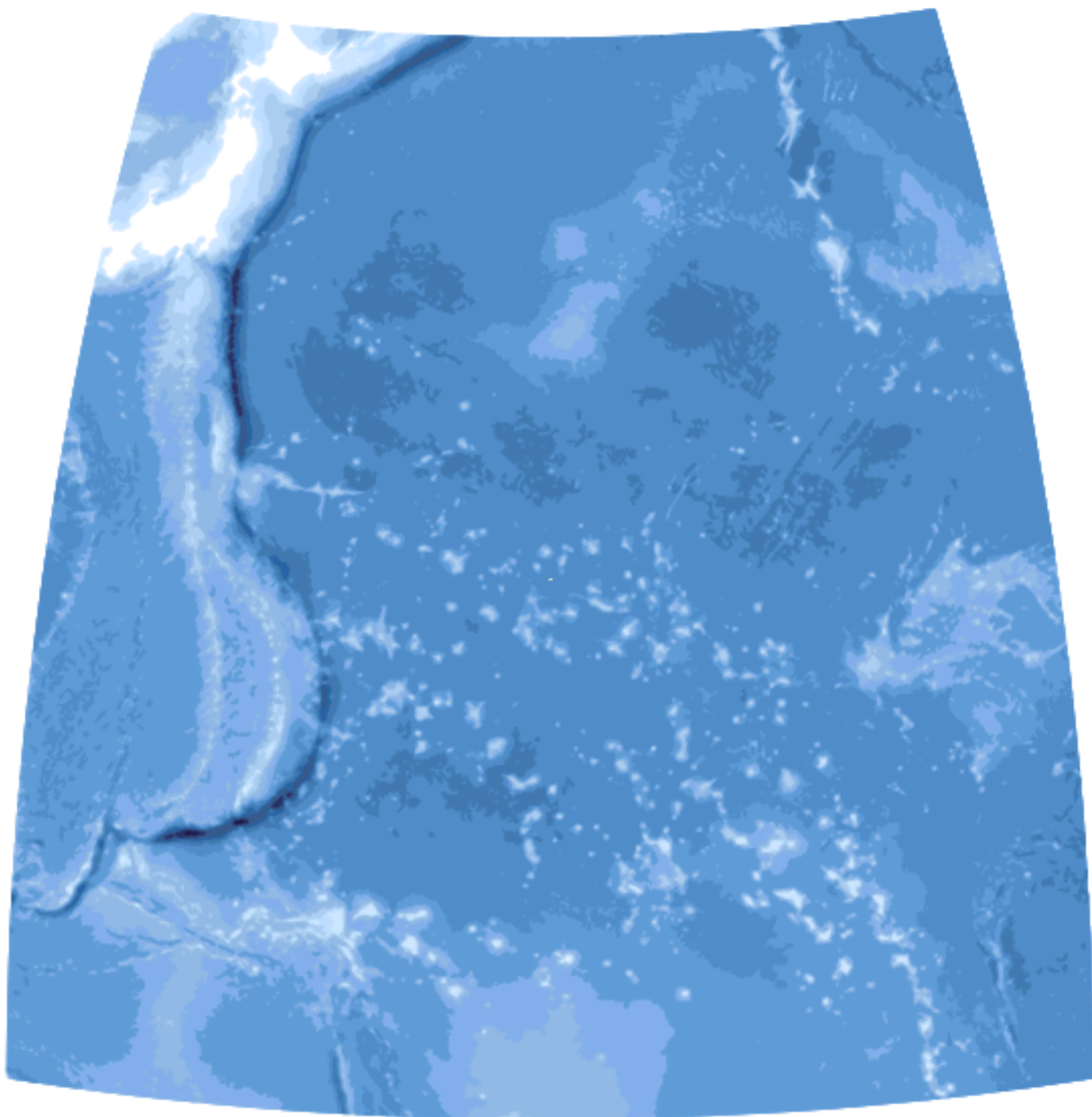


Figure C.77 — Visualization in an orthographic projection of GeoJSON polygon contour features for data retrieved from GNOSIS Global Grid DGRS zone 1-1-7 of Natural Earth bathymetry contours.

C.9. Subsetting and filtering zone data

In addition to the basic retrieval of zone data, implementations can support additional parameters for the `.../zones/{zoneId}/data` resources to return only a portion of the data associated with the zone. The `subset`, `datetime` and `properties` query parameters are defined in the Data Subsetting requirements class, while the `filter` query parameter is defined in the Filtering Zone Data with CQL2 requirements class.

C.9.1. Temporal subsetting

It is possible to retrieve only a portion of a temporal datasets using one of two query parameters: `datetime`, or `subset` with the time dimension. The temporal subset can be either a slice specified using a single time instant, or a trim using a lower and upper bound.

The following examples retrieve data from a sentinel-2 collection for the 28th of April, May and June 2022, at relative depth of 12, for ISEA3H zone E7-17D1-A in New Zealand. Since the sentinel-2 dataset does not have imagery for the whole globe at every instant, the server will return the latest imagery available before the specified time instant.

<https://maps.gnosis.earth/ogcapi/collections/sentinel2-l2a/dggs/ISEA3H/zones/E7-17D1-A/data?zone-depth=12&datetime=2022-04-28>

<https://maps.gnosis.earth/ogcapi/collections/sentinel2-l2a/dggs/ISEA3H/zones/E7-17D1-A/data?zone-depth=12&datetime=2022-05-28>

<https://maps.gnosis.earth/ogcapi/collections/sentinel2-l2a/dggs/ISEA3H/zones/E7-17D1-A/data?zone-depth=12&datetime=2022-06-28>

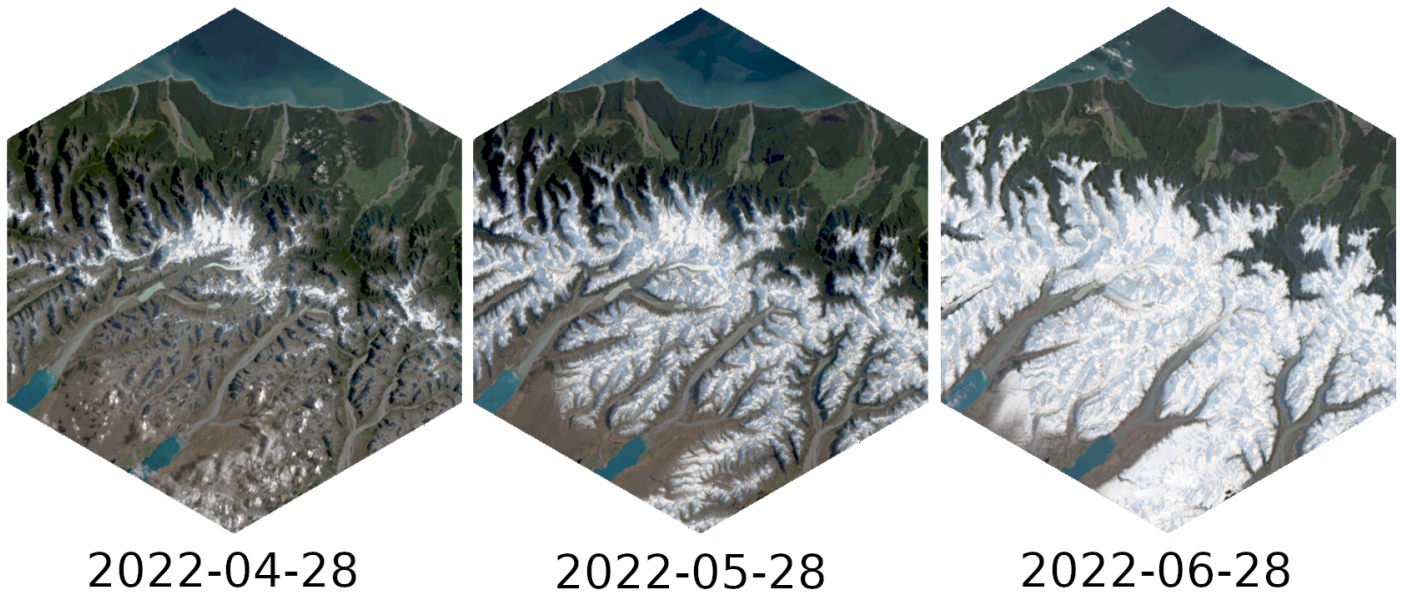


Figure C.78 — Visualization of different temporal slices for ISEA3H zone E7-17D1-A (New Zealand) from Copernicus SENTINEL-2 operated by ESA

Although the examples illustrated here are all for rasterized data, temporal subsetting (whether using the `datetime` or `subset=time(...)` syntax) can also be applied to feature collections with vector geometry with a primary temporal property.

The following examples retrieve data from a sentinel-2 collection for the 15th of February and May 2021, and for the 28th of October 2022, at relative depth of 12, for ISEA3H zone G7-66F79-F in K'gari, Australia.

<https://maps.gnosis.earth/ogcapi/collections/sentinel2-l2a/dggs/ISEA3H/zones/G7-66F79-F/data?zone-depth=12&datetime=2021-02-15>

<https://maps.gnosis.earth/ogcapi/collections/sentinel2-l2a/dggs/ISEA3H/zones/G7-66F79-F/data?zone-depth=12&datetime=2021-05-15>

<https://maps.gnosis.earth/ogcapi/collections/sentinel2-l2a/dggs/ISEA3H/zones/G7-66F79-F/data?zone-depth=12&datetime=2022-10-28>



Figure C.79 – Visualization of different temporal slices for ISEA3H zone G7-66F79-F (K'gari, Australia) from Copernicus SENTINEL-2 operated by ESA

The following examples retrieve data from a daily CMIP5 climate dataset for the time interval between October 6th to October 10th, 2022 for ISEA3H zone A1-0-E, at a relative depth of 8.

<https://maps.gnosis.earth/ogcapi/collections/climate:cmip5:singlePressure/dggs/ISEA3H/zones/A1-0-E/data?zone-depth=8&datetime=2022-10-06/2022-10-10>

The following JSON data illustrates an extract of a DGGs-JSON response for this request for the precipitation and wind speed variables. In addition to the sub-zones, this DGGs-JSON sample has temporal dimension for the 7 days of the response.

```
{
  "dggrs" : "[ogc-dggrs:ISEA3H]",
  "zoneId" : "A1-0-E",
  "depths" : [ 8 ],
  "schema":
  {
    "$schema" : "https://json-schema.org/draft/2020-12/schema",
    "$id" : "https://maps.gnosis.earth/ogcapi/collections/climate:cmip5:singlePressure/schema",
    "title" : "Climate variables",
    "type": "object",
    "properties":
    {
      ...
    }
  }
}
```



```

    "pr": {
      "type": "number",
      "title": "Mean precipitation flux",
      "description": "Amount of water per unit area and time",
      "x-ogc-propertySeq": 2,
      "x-ogc-unit": "kg/m2/s",
      "x-ogc-definition": "https://qudt.org/vocab/quantitykind/Flux"
    },
    ...
    "sfcWind": {
      "type": "number",
      "title": "Wind speed",
      "description": "Magnitude of the two-dimensional horizontal air
velocity near the surface",
      "x-ogc-propertySeq": 6,
      "x-ogc-unit": "m/s",
      "x-ogc-definition": "https://qudt.org/vocab/quantitykind/Speed"
    },
    ...
  },
  "dimensions" : [ {
    "name": "time",
    "interval" : [ "2022-10-06", "2022-10-10" ],
    "grid" : { "cellsCount" : 5, "resolution" : "P1D" }
  } ],
  "values" : {
    "pr" : [ {
      "depth" : 8,
      "shape" : { "count" : 33215, "subZones" : 6643, "dimensions" : { "time"
: 5 } },
      "data" : [
        0.0003729638805, 0.0004226717055, 0.0007104640621, 0.0008059472461,
        0.0000912571239,
        0.0005371499461, 0.0005135724622, 0.0008003884381, 0.0007072870373,
        0.0000603493833,
        ...,
        0.0000608985125, 0.0000827684982, 0.0000371927567, 0.0000246966925,
        0.0000095615553
      ]
    } ],
    "sfcWind" : [ {
      "depth" : 8,
      "shape" : { "count" : 33215, "subZones" : 6643, "dimensions" : { "time"
: 5 } },
      "data" : [
        5.1973060025736, 7.541365875696, 10.7034694149118, 13.1711771530757,
        9.8653782764459,
        6.7253713877706, 7.922387440188, 10.7766137018728, 12.3413589506021,
        9.2283374128277,
        ...,
        2.4033131921971, 2.5349241545049, 2.4223932801007, 2.3289998661706,
        2.7221016029128
      ]
    } ],
    ...
  }
}

```

The following example requests a single day, October 9, 2022, from the same dataset.

<https://maps.gnosis.earth/ogcapi/collections/climate:cmip5:singlePressure/dggs/ISEA3H/zones/A1-0-E/data?zone-depth=8&datetime=2022-10-09>

The DGGs-JSON extract from the response for this single slice of time does not include an additional time dimension.

```
{
  "dggrs" : "[ogc-dggrs:ISEA3H]",
  "zoneId" : "A1-0-E",
  "depths" : [ 8 ],
  "values" : {
    "pr" : [ {
      "depth" : 8,
      "shape" : { "count" : 6643, "subZones" : 6643 },
      "data" : [ 0.0008059472461, 0.0007072870373, ..., 0.0000246966925 ]
    } ],
    "sfcWind" : [ {
      "depth" : 8,
      "shape" : { "count" : 6643, "subZones" : 6643 },
      "data" : [ 13.1711771530757, 12.3413589506021, ..., 2.3289998661706 ]
    } ],
    ...
  }
}
```

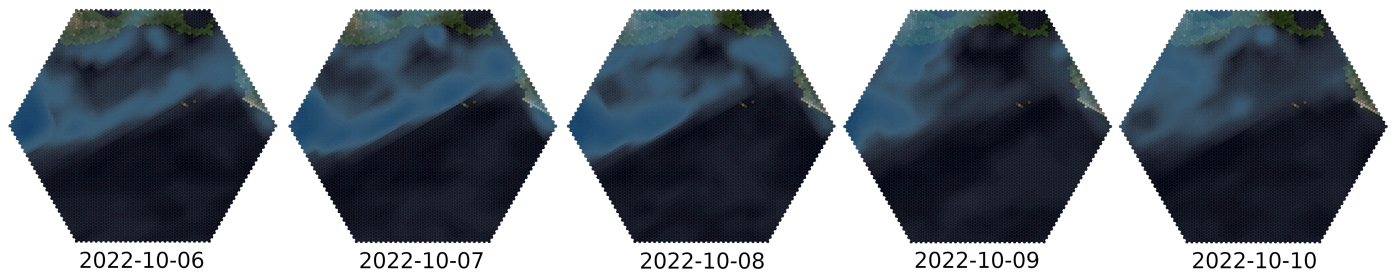


Figure C.80 — Visualization of precipitations from 2022-10-06 to 2022-10-10 for ISEA3H zone A1-0-E from Copernicus Climate Data Store CMIP5 daily data on single levels

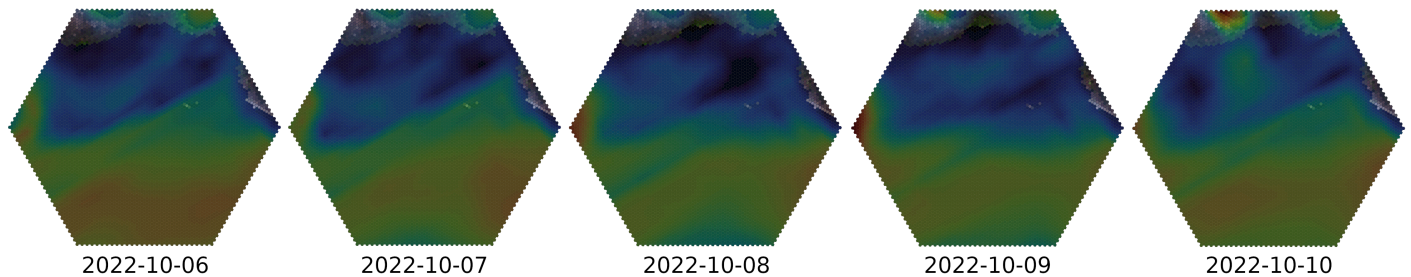


Figure C.81 — Visualization of wind speed from 2022-10-06 to 2022-10-10 for ISEA3H zone A1-0-E from Copernicus Climate Data Store CMIP5 daily data on single levels

Temporal subsetting for a slice can also be achieved using the equivalent `subset=time("2022-10-06": "2022-10-10")` syntax for trimming, and `subset=time("2022-10-06")` for slicing.

C.9.2. Subsetting arbitrary dimensions

In addition to spatial and temporal dimensions, datasets may be comprised of additional dimensions, such as atmospheric pressure. These dimensions can also be subset in a similar manner using the subset parameter.

The following request is for relative humidity from an ERA5 dataset at 11:00 PM on April 6th, 2023 at pressure levels between 750 hPa and 900 hPa (inclusively).

[https://maps.gnosis.earth/ogcapi/collections/climate:era5:relativeHumidity/dggs/ISEA3H/zones/A4-0-A/data?zone-depth=8&datetime=2023-04-06T23:00:00&subset=pressure\(750:900\)](https://maps.gnosis.earth/ogcapi/collections/climate:era5:relativeHumidity/dggs/ISEA3H/zones/A4-0-A/data?zone-depth=8&datetime=2023-04-06T23:00:00&subset=pressure(750:900))

The partial DGGS-JSON response below contains an additional pressure dimension, with 7 of the 37 pressure levels available from the collection.

```
{
  "dggrs" : "[ogc-dggrs:ISEA3H]",
  "zoneId" : "A4-0-A",
  "depths" : [ 8 ],
  "schema":
  {
    "$schema" : "https://json-schema.org/draft/2020-12/schema",
    "$id" : "https://maps.gnosis.earth/ogcapi/collections/climate:era5:
relativeHumidity/schema",
    "title" : "ERA5 Relative humidity",
    "type": "object",
    "properties":
    {
      "r": {
        "type": "number",
        "title": "Relative humidity",
        "description": "Water vapour pressure as a percentage of the value
at which the air becomes saturated",
        "x-ogc-propertySeq" : 1,
        "x-ogc-unit": "%",
        "x-ogc-definition": "https://qudt.org/vocab/quantitykind/
RelativeHumidity"
      }
    }
  },
  "dimensions" : [ {
    "name": "pressure",
    "title": "Atmospheric pressure",
    "x-ogc-unit": "hPa",
    "x-ogc-definition": "https://qudt.org/vocab/quantitykind/
AtmosphericPressure"
    "interval" : [ 750, 900 ],
    "grid" : { "cellsCount" : 7, "coordinates" : [ 750, 775, 800, 825, 850,
875, 900 ] }
  } ],
  "values" : {
    "r" : [ {
      "depth" : 8,
      "shape" : { "count" : 38752, "subZones" : 5536, "dimensions" : {
"pressure" : 7 } } },
    "data" : [
```

```

83.0640563964844, 84.7935791015625, 89.8955307006836,
94.8348999023438, 96.1357727050781, 92.2027587890625, 88.4226226806641,
50.4869918823242, 62.970329284668, 71.4487152099609,
77.9791564941406, 79.6762161254883, 82.0418395996094, 84.0924987792969,
...,
10.35546875, 6.8243680000305, 11.2714557647705, 28.403600692749,
73.5849151611328, 87.5920486450195, 86.5950088500977
]
} ]
}
}

```

The following request is for the 900 hPa slice only. The corresponding DGGS-JSON response below does not include a pressure dimension.

[https://maps.gnosis.earth/ogcapi/collections/climate:era5:relativeHumidity/dggs/ISEA3H/zones/A4-0-A/data?zone-depth=8&datetime=2023-04-06T23:00:00&subset=pressure\(900\)](https://maps.gnosis.earth/ogcapi/collections/climate:era5:relativeHumidity/dggs/ISEA3H/zones/A4-0-A/data?zone-depth=8&datetime=2023-04-06T23:00:00&subset=pressure(900))

```

{
  "dggrs" : "[ogc-dggrs:ISEA3H]",
  "zoneId" : "A4-0-A",
  "depths" : [ 8 ],
  "values" : {
    "r" : [ {
      "depth" : 8,
      "shape" : { "count" : 5536, "subZones" : 5536 },
      "data" : [ 88.4226226806641, 84.0924987792969, ..., 86.5950088500977 ]
    } ]
  }
}

```

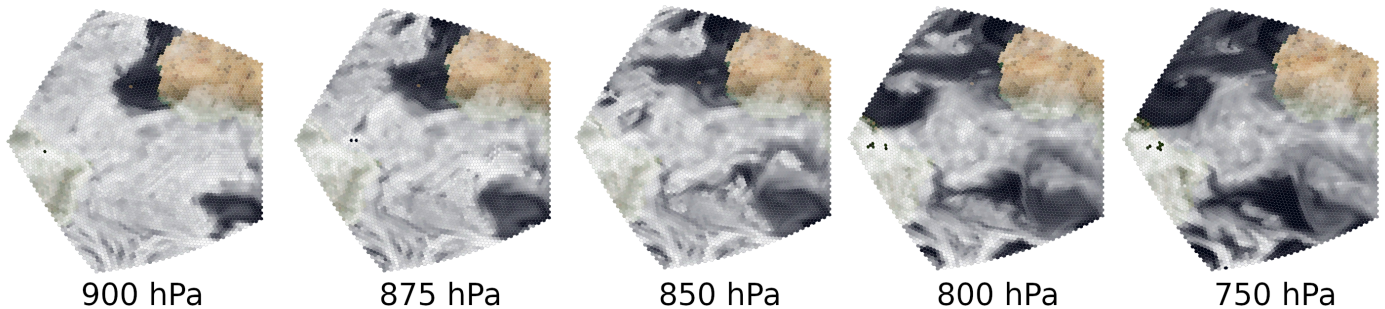


Figure C.82 — Visualization of relative humidity for ISEA3H zone A4-0-A from ERA5 hourly data on pressure levels from 1940 to present from Copernicus Climate Data Store

C.9.3. Field selection

Some data has multiple properties for a feature, or fields for a given cell or position, such as the precipitation and windspeed variables in the CMIP5 dataset illustrated above. It is possible to retrieve only some of these available fields using the `properties` query parameter. The following request retrieves only the red (B04), green (B03) and blue (B02) bands from a sentinel-2 dataset for ISEA3H zone G7-66F79-F at a relative depth of 8.

<https://maps.gnosis.earth/ogcapi/collections/sentinel2-l2a/dggs/ISEA3H/zones/G7-66F79-F/data?zone-depth=8&datetime=2022-10-28&properties=B04,B03,B02>

The following is a partial DGGs-JSON response for this previous request. This collection has twelve other fields available (which are not returned by default, in this case).

```
{
  "dggrs" : "[ogc-dggrs:ISEA3H]",
  "zoneId" : "G7-66F79-F",
  "depths" : [ 8 ],
  "values" : {
    "B02" : [ {
      "depth" : 8,
      "shape" : { "count" : 6643, "subZones" : 6643 },
      "data" : [ 655.101806640625, 744.5323486328125, ..., 2609.4609375 ]
    } ],
    "B03" : [ {
      "depth" : 8,
      "shape" : { "count" : 6643, "subZones" : 6643 },
      "data" : [ 511.2943725585938, 653.875732421875, ..., 2645.6328125 ]
    } ],
    "B04" : [ {
      "depth" : 8,
      "shape" : { "count" : 6643, "subZones" : 6643 },
      "data" : [ 223.4036102294922, 236.1580047607422, ..., 2563.61083984375 ]
    } ]
  }
}
```

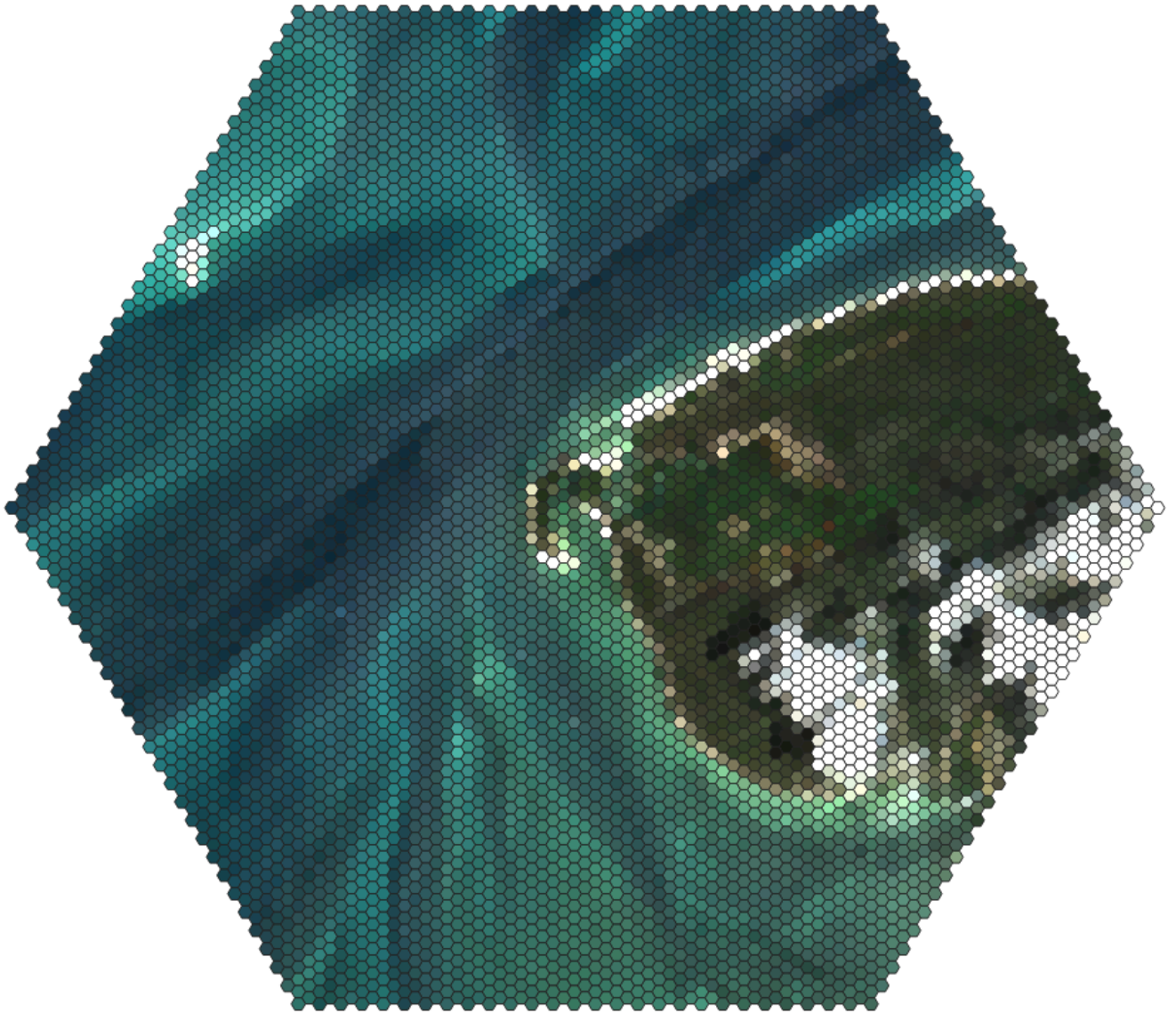



Figure C.83 — Visualization of different B04 (red), B03 (green) and B02 (blue) bands for ISEA3H zone G7-66F79-F (K'gari, Australia) from Copernicus SENTINEL-2 operated by ESA

The following request retrieves only the Scene Classification Layer (SCL) for the same zone. This field has a lower resolution than the other bands, and could be returned at a lower depth than the other fields if requesting multiple fields at a zone-depth beyond the resolution of the SCL field.

<https://maps.gnosis.earth/ogcapi/collections/sentinel2-l2a/dggs/ISEA3H/zones/G7-66F79-F/data?zone-depth=8&datetime=2022-10-28&properties=SCL>

Scene Classification Layer

-  Cloud Shadows
-  Vegetation
-  Bare Soils
-  Water
-  Unclassified (low clouds probability)
-  Clouds medium probability
-  Clouds high probability

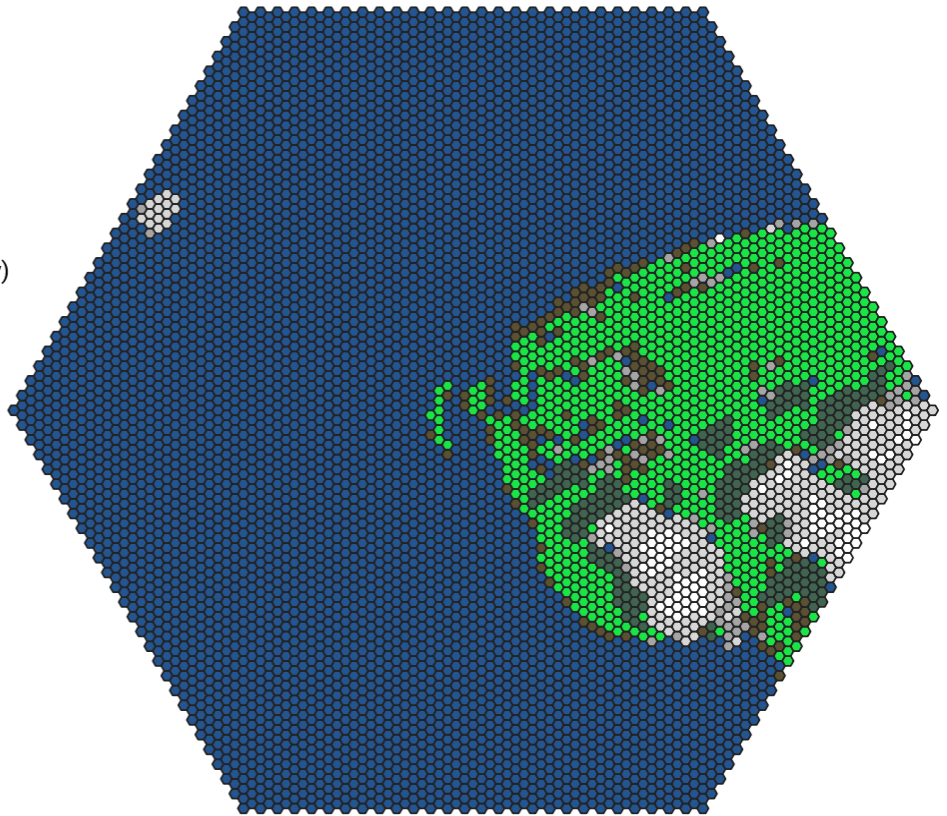


Figure C.84 – Visualization of SCL (Scene Classification Layer) field for ISEA3H zone G7-66F79-F (K'gari, Australia) from Copernicus SENTINEL-2 operated by ESA

The following request retrieves only the near-infrared (B08) band for the same zone.

<https://maps.gnosis.earth/ogcapi/collections/sentinel2-l2a/dggs/ISEA3H/zones/G7-66F79-F/data?zone-depth=8&datetime=2022-10-28&properties=B08>

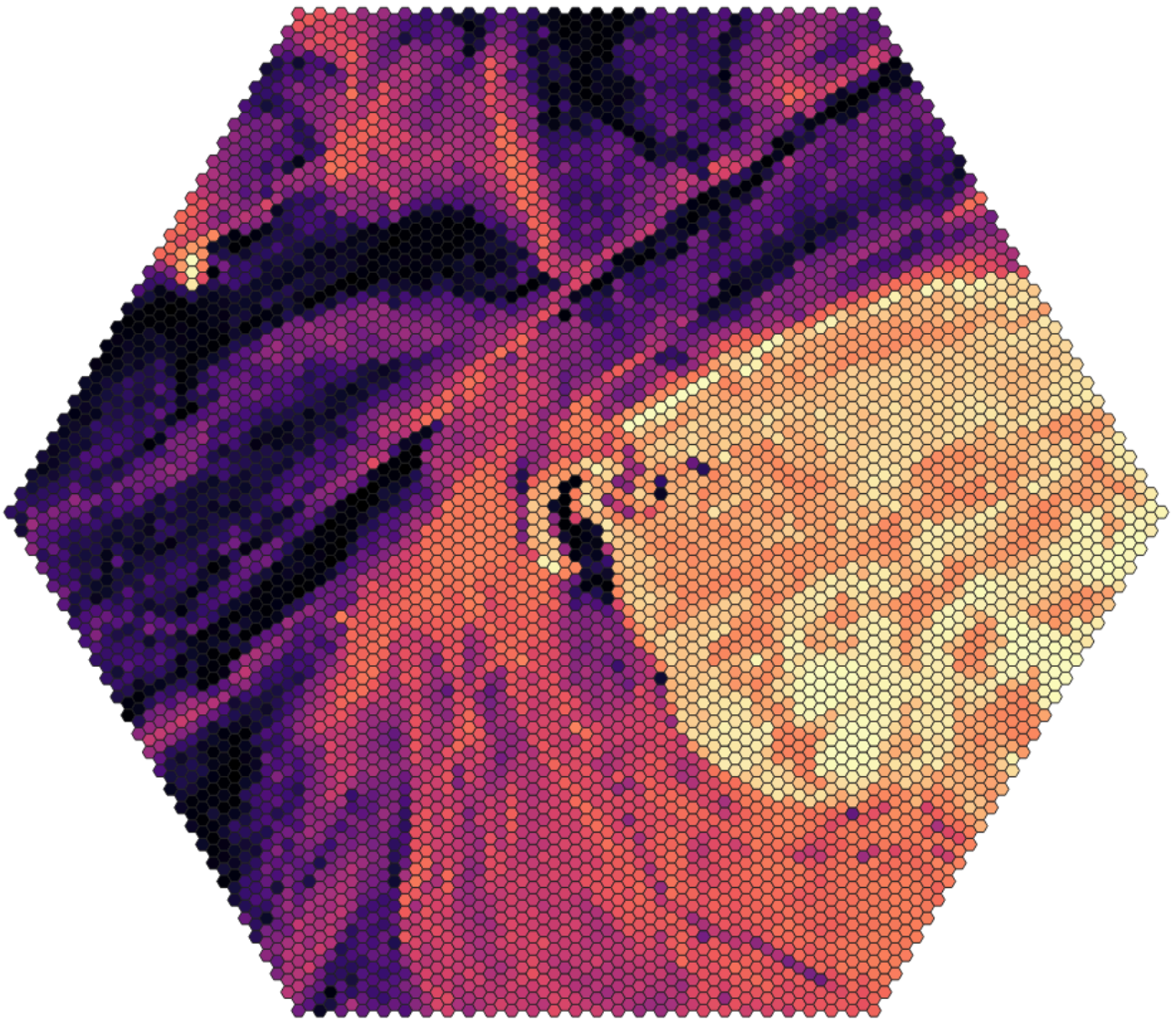


Figure C.85 — Visualization of B08 (near-infrared) band for ISEA3H zone G7-66F79-F (K'gari, Australia) from Copernicus SENTINEL-2 operated by ESA

Although the examples illustrated here are all for rasterized data, field selection can also be applied to feature collection outputs so select which properties to include.

C.9.4. Filtering zone data using CQL2 expressions

The `filter` query parameter can be used to only include data matching a CQL2 expression, which can reference the queryables of the collections, such as the feature properties or fields.

In a DGGs-JSON output, sub-zones which are not a match get replaced by a `null` value. In a GeoTIFF output, pixel values get replaced by a `NODATA` value.

Although the examples illustrated here are all for rasterized data, a CQL2 expression filter can also be applied to feature collections to select which feature to include in the output.

The following request retrieves bathymetry data for ISEA3H zone A8-0-F at a relative depth of 8 without a filter.

<https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/ISEA3H/zones/A8-0-F/data?zone-depth=8>

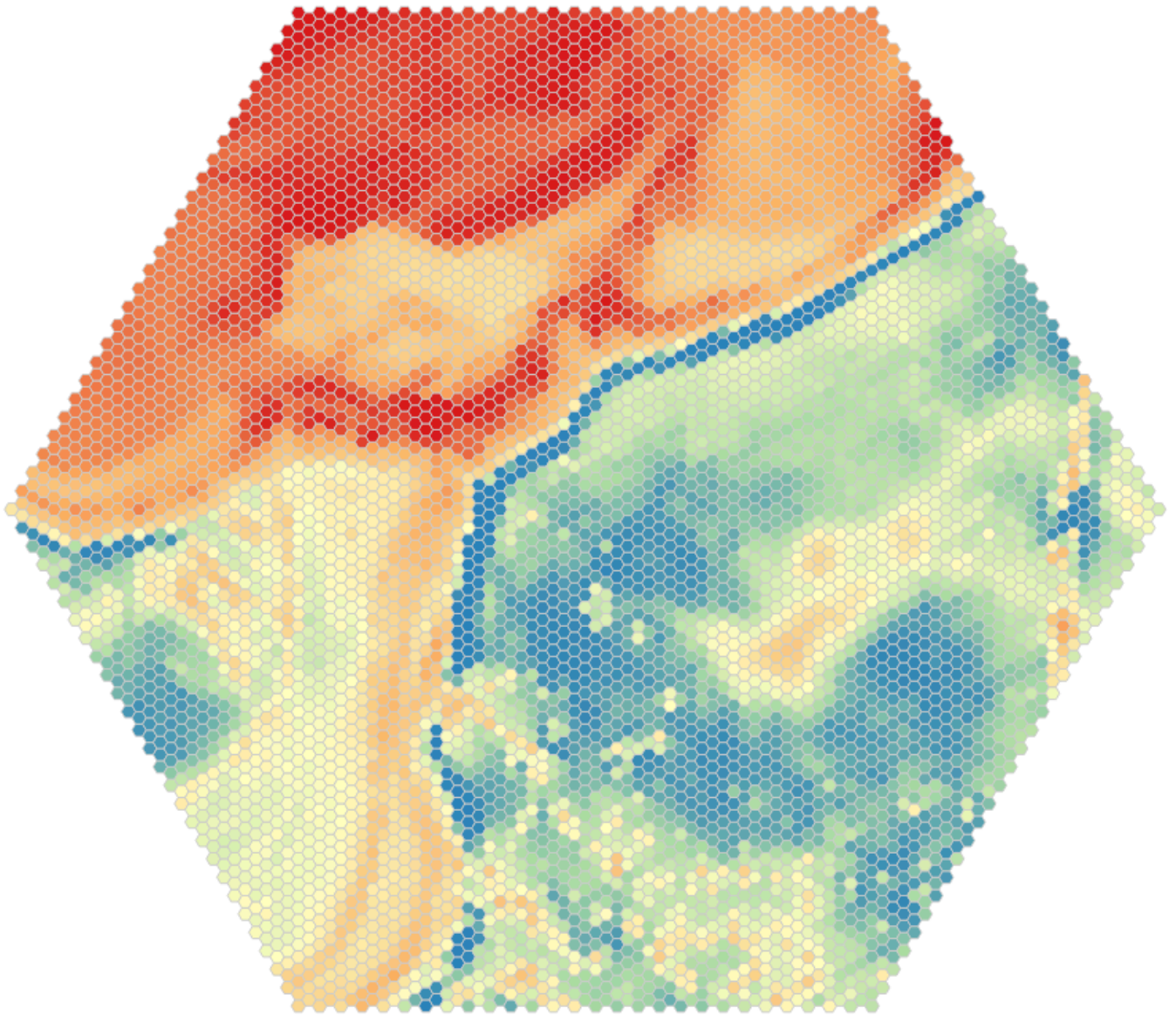


Figure C.86 — Visualization of ISEA3H zone A8-0-F from GEBCO 2014 bathymetry without a filter

The following request retrieves bathymetry data for the same zone with a filter for sea depths greater than 4000 meters.

<https://maps.gnosis.earth/ogcapi/collections/gebco/dggs/ISEA3H/zones/A8-0-F/data?zone-depth=8&filter=Elevation < -4000>

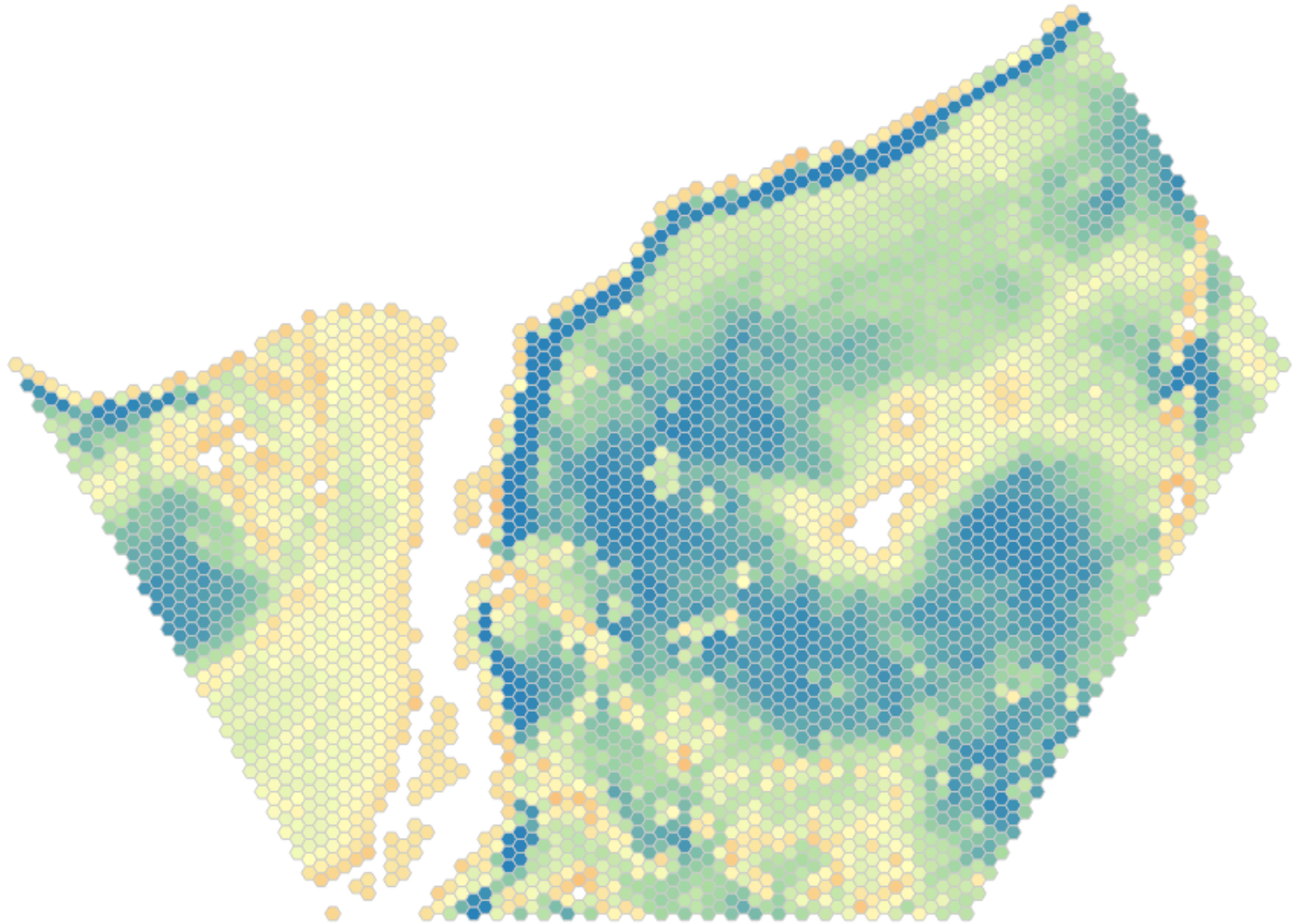


Figure C.87 – Filtering of ISEA3H zone A8-0-F from GEBCO 2014 bathymetry for depths 4000 meters below sea level

When retrieving a temporal slice with a filter, the server may fill in the filtered out sub-zones with earlier imagery not excluded by the filter. This can be used for example to replace cloudy sub-zones with the closest earlier cloud-free imagery. The following requests retrieve sentinel-2 data for zone G7-66F79-F on April 15, 2021 at a relative depth of 12 with:

no filter:

<https://maps.gnosis.earth/ogcapi/collections/sentinel2-l2a/dggs/ISEA3H/zones/G7-66F79-F/data?zone-depth=12&datetime=2021-04-15>

filtering only high probability clouds (SCL = 8):

<https://maps.gnosis.earth/ogcapi/collections/sentinel2-l2a/dggs/ISEA3H/zones/G7-66F79-F/data?zone-depth=12&datetime=2021-04-15&filter=SCL <> 9>

also filtering out medium probability clouds (SCL = 9):

<https://maps.gnosis.earth/ogcapi/collections/sentinel2-l2a/dggs/ISEA3H/zones/G7-66F79-F/data?zone-depth=12&datetime=2021-04-15&filter=SCL <> 8 and SCL <> 9>

also filtering out cirrus clouds (SCL = 10):

[https://maps.gnosis.earth/ogcapi/collections/sentinel2-l2a/dggs/ISEA3H/zones/G7-66F79-F/data?zone-depth=12&datetime=2021-04-15&filter=SCL not in \(8, 9, 10\)](https://maps.gnosis.earth/ogcapi/collections/sentinel2-l2a/dggs/ISEA3H/zones/G7-66F79-F/data?zone-depth=12&datetime=2021-04-15&filter=SCL not in (8, 9, 10))

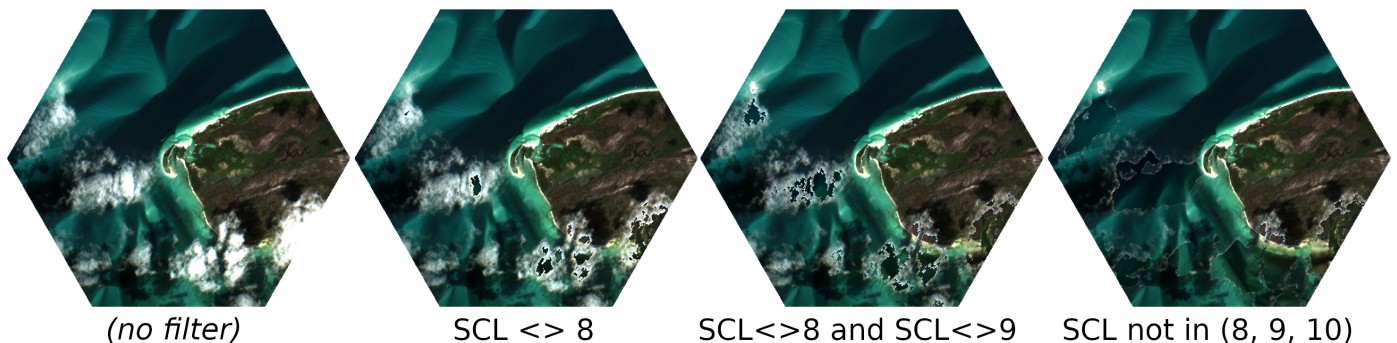


Figure C.88 — Filtering out high probability clouds, medium probability clouds, and cirrus clouds for ISEA3H zone G7-66F79-F (K'gari, Australia) from Copernicus SENTINEL-2 operated by ESA

The following request specifies a more complex filter using CQL2 arithmetic expressions to filter for a normalized difference vegetation index (NDVI) greater than 0.3, computed using the near-infrared (B08) and red bands (B04) using the expression $(B08 - B04) / (B08 + B04)$:

[https://maps.gnosis.earth/ogcapi/collections/sentinel2-l2a/dggs/ISEA3H/zones/G6-E046-D/data?zone-depth=9&filter=\(B08-B04\)/\(B08+B04\)>0.3](https://maps.gnosis.earth/ogcapi/collections/sentinel2-l2a/dggs/ISEA3H/zones/G6-E046-D/data?zone-depth=9&filter=(B08-B04)/(B08+B04)>0.3)

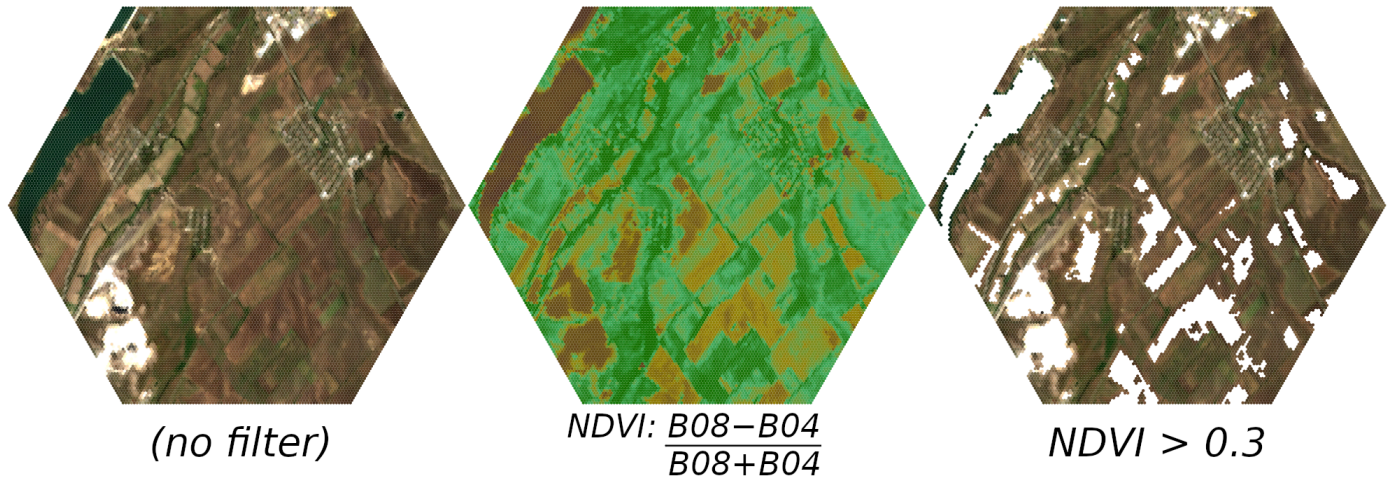


Figure C.89 — Filtering based on a minimum normalized difference vegetation index (NDVI) for ISEA3H zone G6-E046-D from Copernicus SENTINEL-2 operated by ESA



ANNEX D (INFORMATIVE) REVISION HISTORY

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DATE	RELEASE	EDITOR	PRIMARY CLAUSES MODIFIED	DESCRIPTION
2021-05-17	0.1	Matthew Purss	all	initial version
2022-07-22	0.3	Jerome St Louis	all	Renamed Part 1 to core (316d37f) Initial set up of conformance classes clauses (b76073c)
2022-07-26	0.4	Gobe Hobona	all	Fixes problem that was breaking auto-build (a13c2a8)
2022-10-04	0.5	Jerome St Louis	7-Data Retrieval	Initial take at Data Retrieval Conformance Class (b67f290)
2022-11-11	0.10	Jerome St Louis	all	Split multi-zone retrieval into separate conformance class (06a4260). Initial progress on Zone Query conformance class (a208502) Added preface, abstract, Jerome added as editor (71e76c6) Clarification regarding resolution (c43bfad) Clarifications (cee3685)
2023-02-17	0.11	Jerome St Louis	7-Data Retrieval	Added zone-depth parameter (2b8fa58)
2024-06-18	0.12	Jerome St Louis	all	Draft ready for presentation at Montréal Members Meeting
2024-08-24	1.0.0rc1	Jerome St Louis	all	Complete Zone Data examples. New Zarr requirements class. Clarify DGGS/DGGH terminology and related DGGRS schema adjustments. New DGGS-FG-(UB)JSON encoding for efficient vector format with coordinates quantized to sub-zones. filter parameter for zone data. Initial draft ready for OAB review.
2024-09-20	1.0.0rc2	Carl Reed, Jerome St Louis	all	Applied suggested edits from Carl Reed's review. Draft ready for public comment period.



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BIBLIOGRAPHY

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