

OGC/ISO Coverage / Datacube Standards in a GEOINT Context

2026 Joint OGC – OSGeo – ASF Code Sprint

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Constructor University | rasdaman GmbH

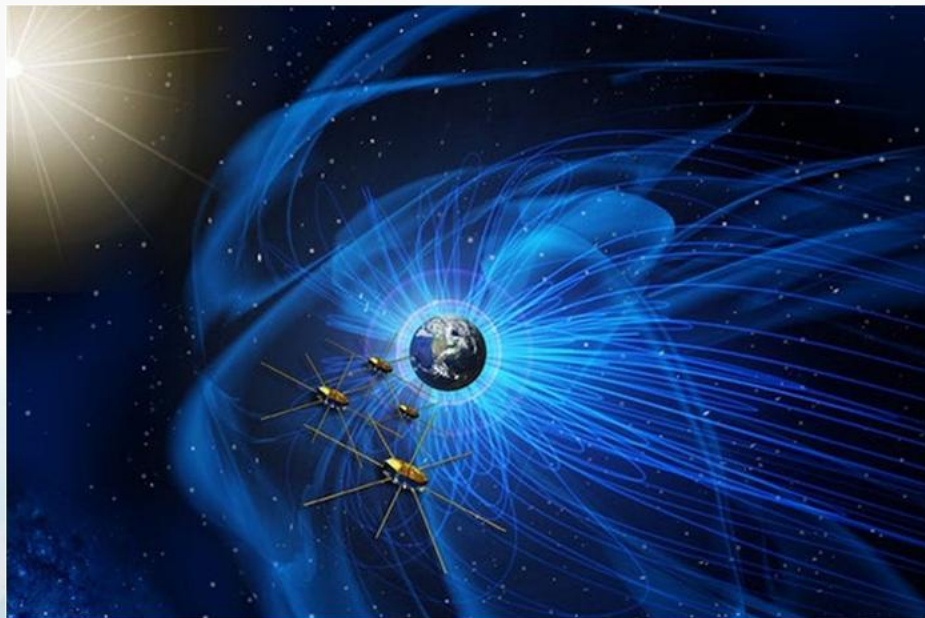


What's in a Coverage?

Coverage Concept

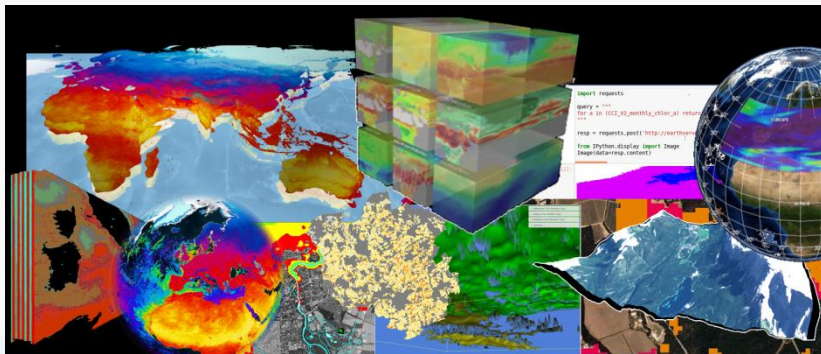
- Like “field” in physics:
 - Spatially extended, temporally varying (optionally)
- Sensor & simulated data
 - Imagery, DEMs, weather forecasts, ...
- Technically:
 - Regular & irregular grids
 - Point clouds
 - Geometric meshes
- ISO 19123-1 = OGC AT6.1

datacubes



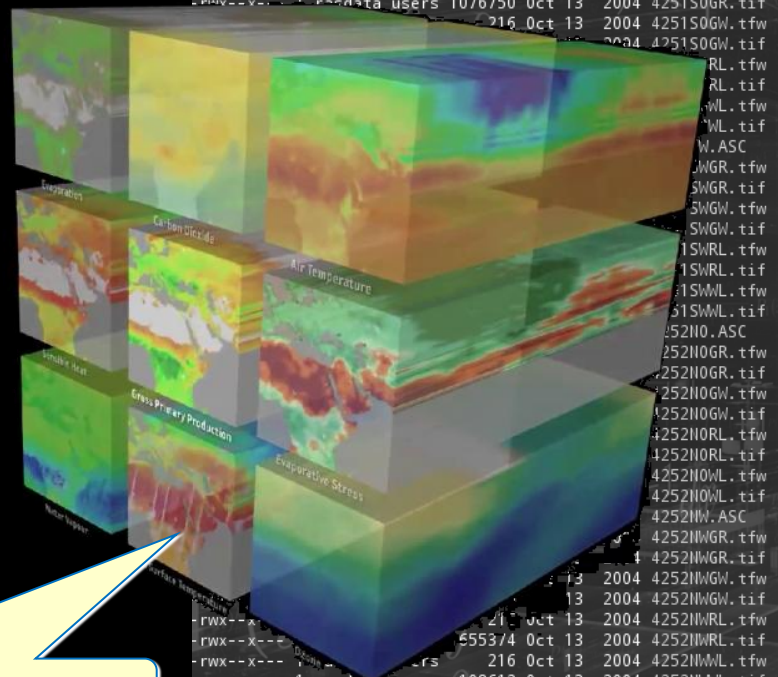
Coverages Everywhere...

- Databricks: intuitive, human-centric
 - Also easier for tools
- Sensor, image, simulation output, statistics data



pioneered by rasdaman team, 200+ papers

P. Baumann: **Language Support for Raster Image Manipulation in Databases.**
Proc. Int. Workshop on Graphics Modeling, Visualization in Science & Technology,
Darmstadt/Germany, April 13 - 14, 1992, pp. 236 - 245



-FWX--X--	1	rasdata	users	1485	Oct 13	2004	4251HW.ASC
-FWX--X--	1	rasdata	users	216	Oct 13	2004	4251HWGR.tfw
-FWX--X--	1	rasdata	users	640432	Oct 13	2004	4251HWGR.tif
-FWX--X--	1	rasdata	users	216	Oct 13	2004	4251HWGW.tfw
-FWX--X--	1	rasdata	users	779368	Oct 13	2004	4251HWGW.tif
-FWX--X--	1	rasdata	users	216	Oct 13	2004	4251HWRL.tfw
-FWX--X--	1	rasdata	users	712492	Oct 13	2004	4251HWRL.tif
-FWX--X--	1	rasdata	users	216	Oct 13	2004	4251HWWL.tfw
-FWX--X--	1	rasdata	users	62830	Oct 13	2004	4251HWWL.tif
-FWX--X--	1	rasdata	users	1498	Oct 13	2004	4251S0.ASC
-FWX--X--	1	rasdata	users	216	Oct 13	2004	4251S0GR.tfw
-FWX--X--	1	rasdata	users	1076750	Oct 13	2004	4251S0GR.tif

rasdaman: Distributed infrastructure for spatio-temporal Big Data

- pioneer Big Datacube **Management & Analytics** engine

- Scalable, secure, interoperable, federated, AI
- Reference Implementation & Good Practice

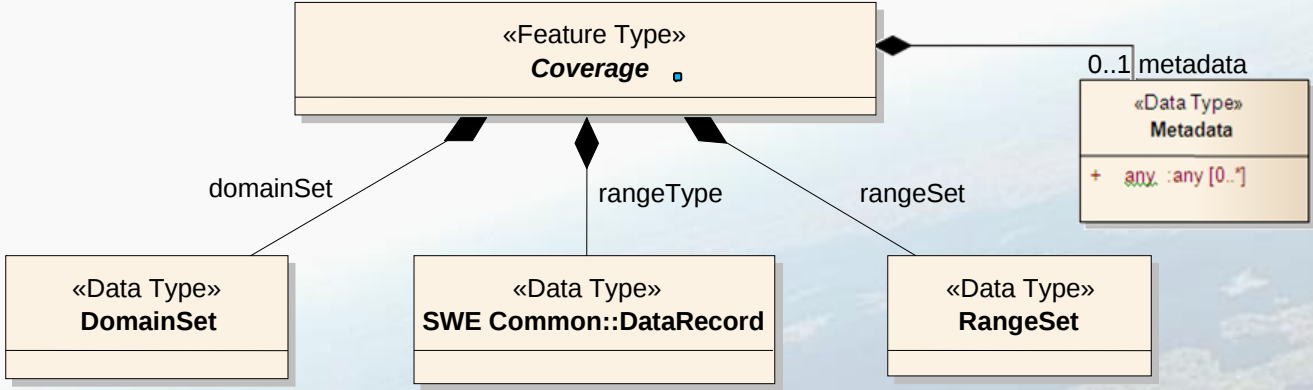
- Used by public authorities, industry, research

- EU, USA, Taiwan



Defence
Innovation
Challenge

Basic Coverage Structure



A Simple Coverage, in GML

```
<generalGridCoverage ... gml:id="CIS_001">
  <domainSet>
    <generalGrid srsName="http://www.opengis.net/def/crs-compound?
      1=http://www.opengis.net/def/crs/EPSSG/0/4979
      &2=http://www.opengis.net/def/crs/OGC/0/AnsiDate"
      axisLabels="Lat Long h date">
      <regularAxis axisLabel="Lat" uomLabel="deg" lowerBound="40" upperBound="60" resolution="10"/>
      <regularAxis axisLabel="Long" uomLabel="deg" lowerBound="-10" upperBound="10" resolution="10"/>
      <irregularAxis axisLabel="h" uomLabel="m">
        <c> 0</c>
        <c>100</c>
      </irregularAxis>
      <irregularAxis axisLabel="date" uomLabel="d">
        <c>2015-12-01</c>
        <c>2015-12-02</c>
      </irregularAxis>
      <gridLimits srsName="http://www.opengis.net/def/crs/OGC/0/Index4D" axisLabels="i j k l">
        <indexAxis axisLabel="i" lowerBound="0" upperBound="2"/>
        <indexAxis axisLabel="j" lowerBound="0" upperBound="2"/>
        <indexAxis axisLabel="k" lowerBound="0" upperBound="1"/>
        <indexAxis axisLabel="l" lowerBound="0" upperBound="1"/>
      </gridLimits>
    </generalGrid>
  </domainSet>

  <rangeSet>
    <dataBlock>
      <v>01</v> <v>02</v> <v>03</v> <v>04</v> <v>05</v> <v>06</v> <v>07</v> <v>08</v> <v>09</v>
      <v>01</v> <v>02</v> <v>03</v> <v>04</v> <v>05</v> <v>06</v> <v>07</v> <v>08</v> <v>09</v>
      <v>01</v> <v>02</v> <v>03</v> <v>04</v> <v>05</v> <v>06</v> <v>07</v> <v>08</v> <v>09</v>
      <v>01</v> <v>02</v> <v>03</v> <v>04</v> <v>05</v> <v>06</v> <v>07</v> <v>08</v> <v>09</v>
    </dataBlock>
  </rangeSet>

  <rangeType>
    <swe:DataRecord>
      <swe:field name="panchromatic">
        <swe:Quantity definition="http://opengis.net/def/property/OGC/0/Radiance">
          <swe:uom code="W.m-2.sr-1.nm-1"/>
        </swe:Quantity>
      </swe:field>
    </swe:DataRecord>
  </rangeType>
</generalGridCoverage>
```

A Simple Coverage, in JSON

```
{
  "id": "CIS_10",
  "coverageStructure": "coverageByDomainAndRange",
  "domainSet": {
    "domainType": "generalGrid", "srsName": "[EPSG:4326]", "axisLabels": ["Lat", "Lon"], "uomLabels": ["deg", "deg"],
    "axes": [
      { "axisLabel": "Lat", "uomLabel": "deg", "axisType": "regular", "lowerBound": -80, "upperBound": -70, "resolution": 5 },
      { "axisLabel": "Lon", "uomLabel": "deg", "axisType": "regular", "lowerBound": 0, "upperBound": 10, "resolution": 5 }
    ]
  },
  "rangeSet": [ 1,2,3,4,5,6,7,8,9 ],
  "rangeType": {
    "field":[{"name": "itemCount", "definition": "integer", "type": "Count"}]
  }
}
```

A Simple Coverage, in WCPS

- Web Coverage Processing Service = geo **datacube query language**, model-based
 - textual **description** of [result] coverages – **human readable**, no encoding garbage

[demo](#)

```
coverage WindSpeed
domain
  crs "[EPSG:4326],[OGC:unixTime]" with
  Lat regular (10:30) resolution -0.5 interpolation linear,
  Lon regular (10:30) resolution 0.5 interpolation linear,
  Date irregular ( "2020-01-01", "2020-02-01", "2020-03-01", "2020-04-01", "2020-07-01", "2020-11-01" )
range type speed quantity float
range sqrt( pow( $w.u, 2 ) + pow( $w.v, 2 ) )
```

- ISO 19123-3 = OGC AT6.3, based on OGC WCPS 1.1

Demo:

WCPS Coverage Constructor

Encoding Coverages

- Single file encoding:

- Textual: XML, JSON, RDF, ...
 - Caveat: GeoJSON, CoverageJSON *not* compatible
- Binary: GeoTIFF, NetCDF, JPEG2000, GRIB, ...

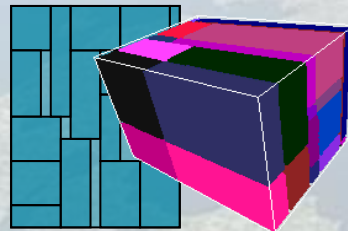
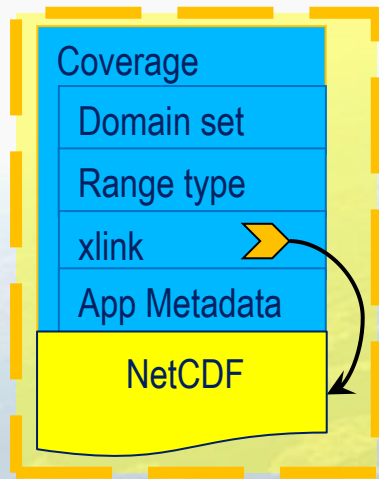
- Multipart: container("header" + file1 + file2 + ...)

- Multipart/MIME, zip, GMLJP2, SAFE, GeoPackage, ...
- Useful for collections, tiling, ...

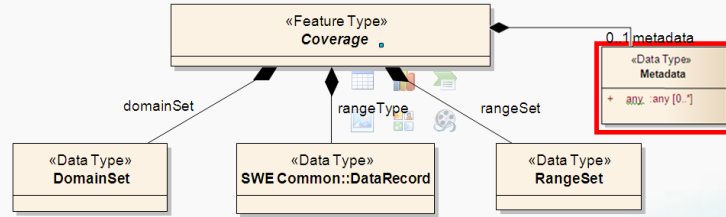
CIS is not yet another data format,
but an interoperable way to use your favourite format



add GIMI here



PS: Metadata



- Any (valid) structure, typically: XML, JSON
- Caveat: metadata format not subject to encoding choice
 - XML metadata will remain XML, also in a JSON coverage

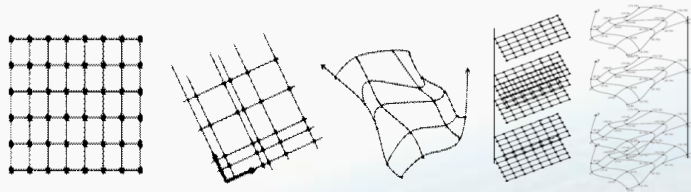
Demo:
<https://inspire-wcs.eu>

Coverage Data Model: Summary

■ Coverage

datacubes

= spatio-temporal **grids**, point clouds, meshes



■ Coverage Implementation Schema: OGC CIS = ISO 19123-2

- Coverage-**tuned** service standards: WCS, WCPS

■ OGC & ISO in sync:

- Concepts & terminology: OGC AT6.1 = ISO 19123-1
- Data structure: OGC CIS = ISO 19123-2
- Processing: OGC AT6.3 = ISO 19123-3

new ISO version,
coming to OGC

cf. OGC WCPS

Federated Coverages in Action

Demo:

Earth Datacube Playground

<https://earthlook.org>

Demo:

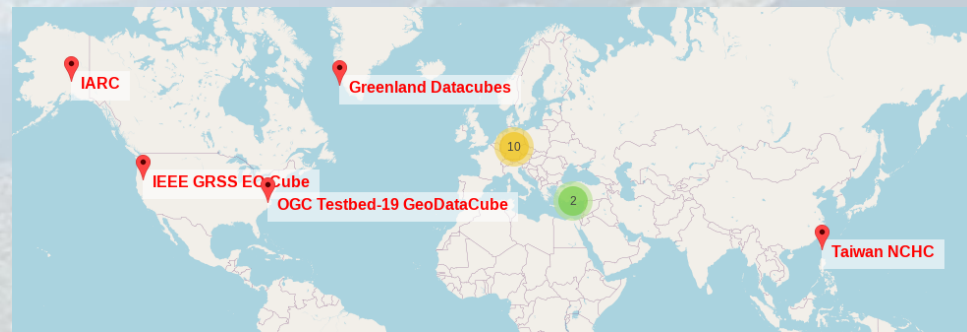
Aviation Datacubes

cube4envsec.org



EarthServer

- Datacube provider federation
- Multi-PB location-transparent data space
- Independent, autonomous institutions:
USA, Europe, Asia
- Open standards, zero-coding



Cloud/Edge Integration

■ Moving Data Sources & Consumers

- Airborne drone
- Ship
- Nanosat, demonstrated in orbit
- 64-cluster of Raspberry Pi

■ EU EFRE project SkyFed



Outlook: AI-Cubes

AI-Cubes

Seamless integration of AI models with datacubes

- low/zero-coding: ML inference = WCPS function call, automatic pre-checks

- integrated model management

- Ex: 110 lines Python → 2 lines WCPS

```
for $c in (RGB_coverage)
return rsllava.chat( $c, "Describe this scene." )
```

"A river flows through farmland, surrounded by green fields and trees on both sides."

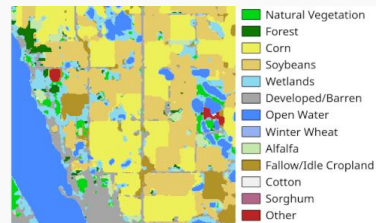
- Model fencing: server estimates model applicability in query

ChatCUBE query assistant

Goal: AI-as-commodity → democratize AI

Project FAIRgeo

Co-funded by
the European Union



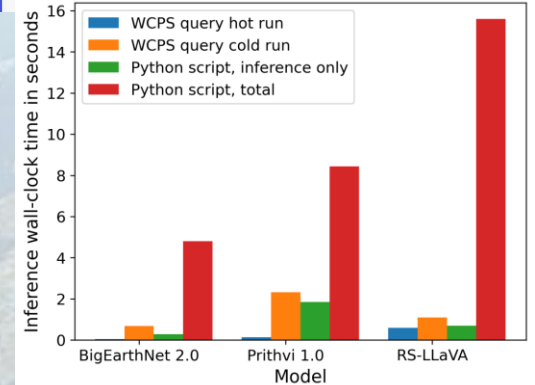
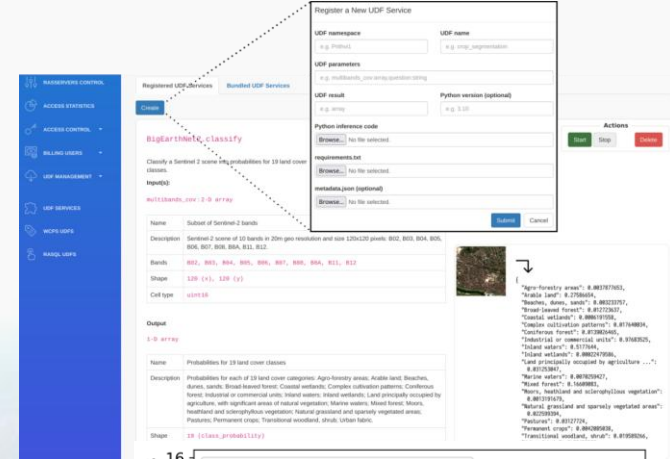
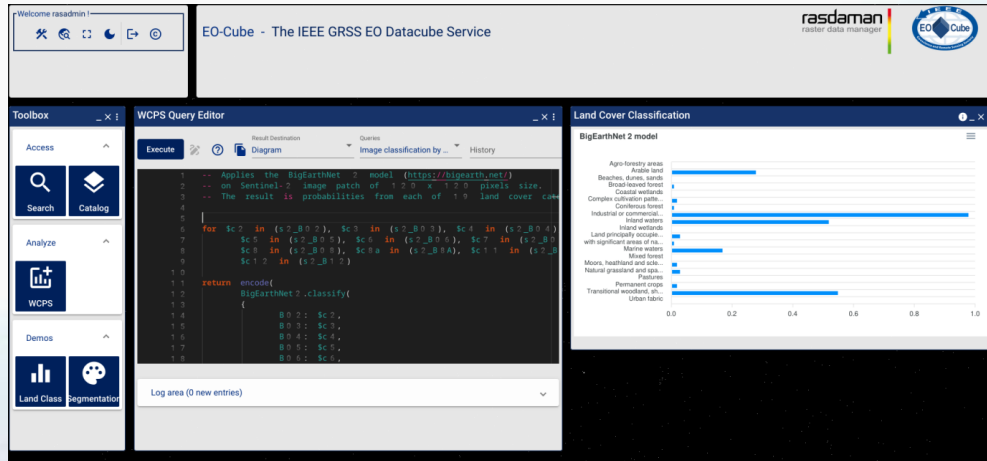
Say Hello
to Datacubes

Let AI write & explain
datacube analytics

Demo:
<https://ai-cu.be>

Preliminary Results

- Machine-readable ML metadata
- UDF auto code generation per model family
- Inference queries on large EO datacubes in rasdaman



Demo:
<https://ai-cu.be/chatcube>

Summary

Summary

- Geo imagery – it's all about **datacubes**!
 - OGC/ISO/INSPIRE coverages; details: <https://myogc.org/go/coveragesDWG>
 - WCPS: geo datacube analytics
 - *Powerful, mature, proven, deployed*
 - Optimal for GEOINT: interop, flexibility, speed
- **Code sprint**: Multi-TB datacubes available
 - <https://earthlook.org>, <https://cube4envsec.org>
- Relevant challenges:
 - Do cool stuff with WCPS **queries**; **documentation** improvements, extensions, ...
 - <https://myogc.org/go/coveragesDWG>, <https://earthserver.world/wcs>



contact: baumann@rasdaman.com

Coverage Relevance for GEOINT

- multi-domain GEOINT, **FMN information fusion**: "from any source to any consumer, anytime"
- **Interoperability & flexibility**: large number of formats for coverage encoding
 - from small JSON to large netCDF ...always same semantics
- With CIS & WCPS, enabling:
 - **low/zero coding** exploitation through non-coders and low-capacity clients
 - **location-transparent federation**
 - **cloud/edge integration**: demonstrated on 7+ PB on ground and in orbit → [SkyFed](#)
 - **AI on datacubes**, without algorithmic overhead → [FAIRgeo](#)
 - **security**, down to single pixel level