



Coverages in INSPIRE

Making things Simpler



Coverage Features in INSPIRE

- **EnergyResources:** RenewableAndWastePotentialCoverage.
- **Natural Risk Zones:** ExposedElementCoverage, HazardCoverage, ObservedEventCoverage, RiskCoverage.
- **Elevation:** ElevationGridCoverage.
- **Land Cover:** LandCoverGridCoverage.
- **Land Use:** ExistingLandUseGrid.
- **Orthoimagery:** OrthoimageCoverage.
- **Soil:** SoilThemeCoverage, SoilThemeDescriptiveCoverage.
- **Geology (Hydrogeology):** HydrogeologicalSurface.



What is a Coverage?

- Historically:
 - Satellite images
 - Orthoimagery
 - Could be subsumed as „Rastered Images from on high“*
- Increasingly for various types of gridded data
- Often utilizes image formats (i.e. TIF, JPG with geospatial additions), but also supports numeric values

What is a Coverage?

- Coverage is described by:
 - The grid for which values will be provided (the Domain)
 - Description of the values being provided
 - The values of each grid cell (the Range)
 - Additional Metadata

What is a Coverage Domain?

- The Domain (Grid) is defined by:
 - The Origin (bottom left corner)
 - The Offsets (length and width of the individual grid cells)
 - Limit (number of cells; length and width of the entire grid)

What is a Coverage Domain?

Origin:



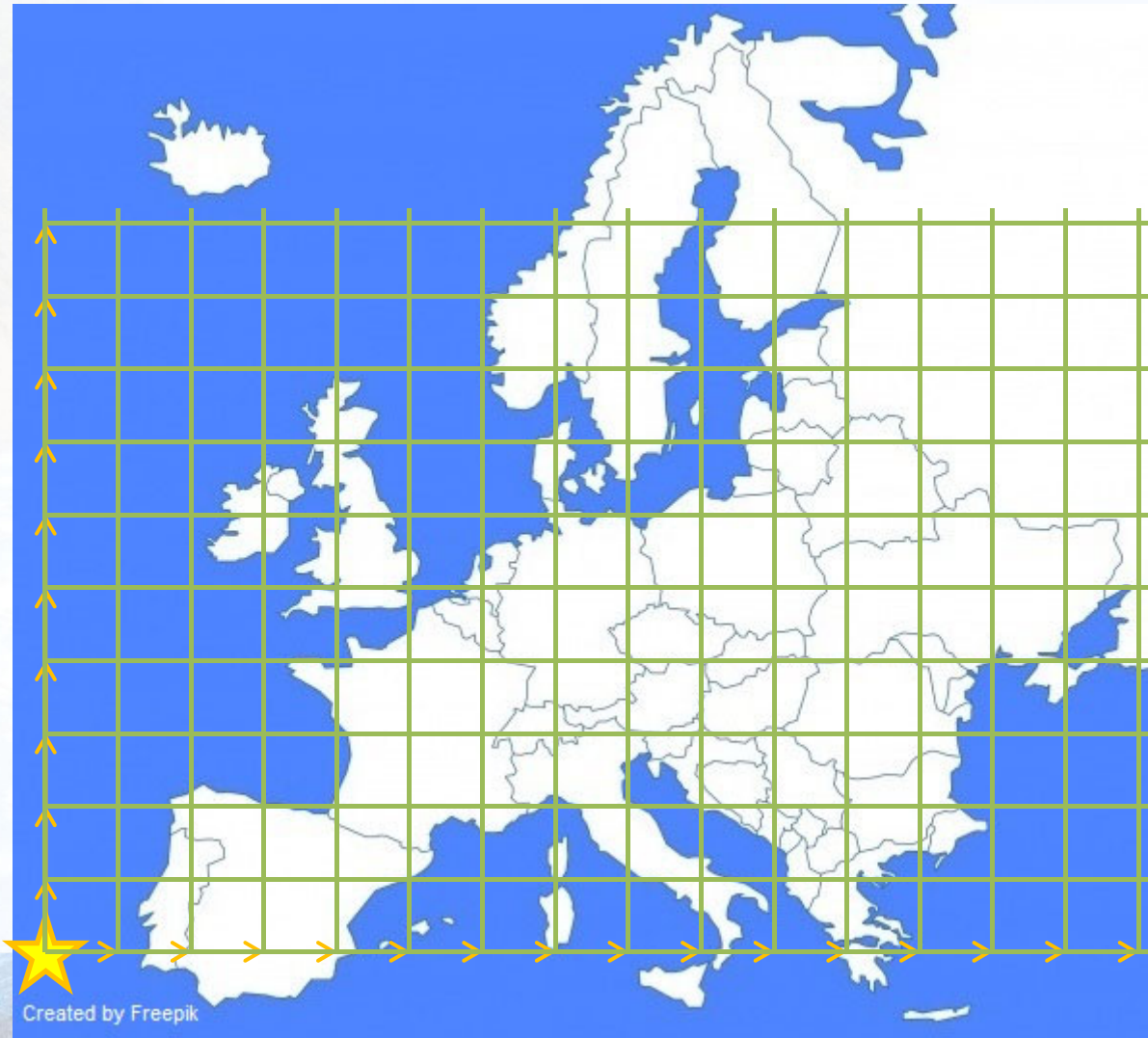
Offsets:



Limits:

N: 10

E: 15



What is a Coverage Domain?

Coverage Domain

Origin: Coordinate Pair

Offsets: 1 Vector per
Dimension

Limits: one Integer per
Dimension

Example: 1km Eurostat grid

1 Coordinate Pair

2 Vectors

2 Integers

Polygon Grid

One Polygon per Grid Cell (5
Coordinate Pairs)

Example: 1km Eurostat grid

4471 Cells on X

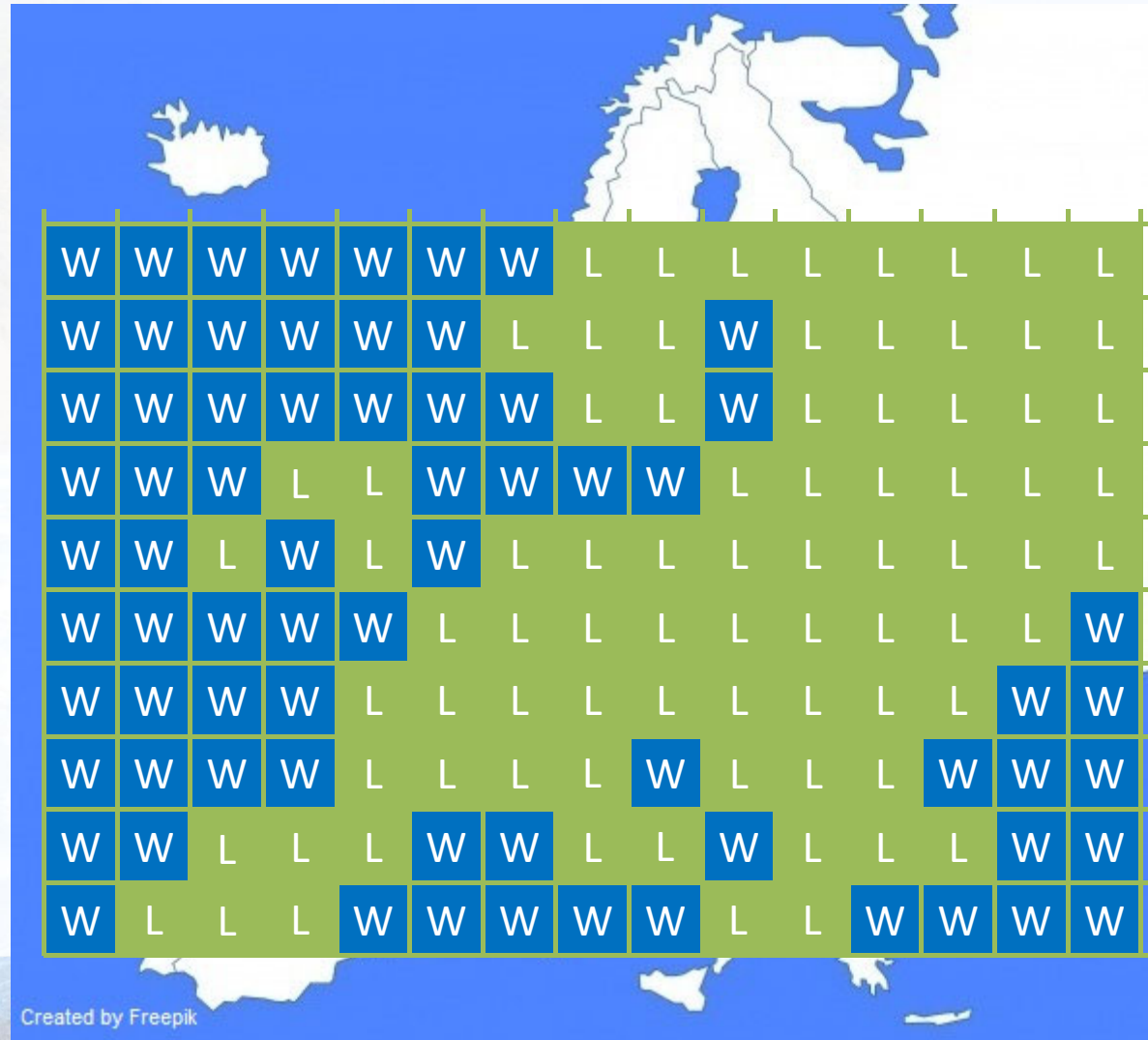
5558 Cells on Y

→ ~25M Polygons!

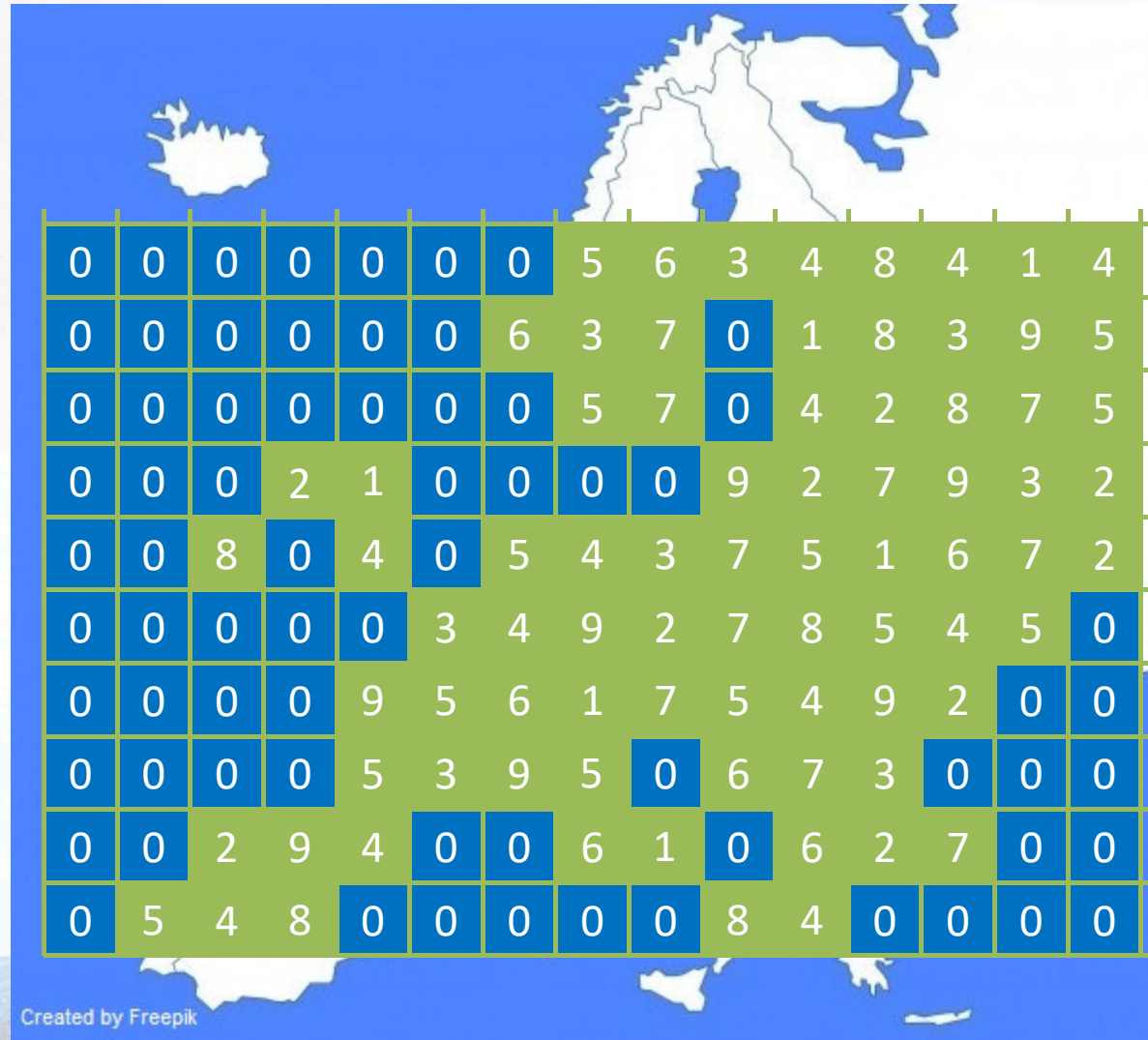
What is a Coverage Domain?

- Coverage Domain can have many dimensions.
Examples:
 - Time: daily satellite image, yearly land cover result
 - Other stratification, examples from demography:
 - Age
 - Gender
 - Education
 - Under CIS 1.1, not even a requirement to have Lat/Long (could refer to Administrative Units)

What is a Coverage Range?



What is a Coverage Range?



What is a Coverage Range?

Range Formats:

- GeoTIFF or JPEG 2000: formally graphics format, compressed binary format
- NetCDF, GRIB: useful as much tooling available, especially in the scientific community
- XML, JSON, RDF: compact formats providing direct access to range values

What is a Coverage Range Type?

Description of the values provided in the Range.

Depending on the data to be provided, this could be:

- RGB values for image formats
- Codelist Categories, i.e. Land Cover Types
- Numeric Values, i.e. Population

What is Coverage Metadata

Coverage Metadata

- WCS gives the user full control over the metadata
- Currently an issue in INSPIRE as not properly defined

Coverage Function

- Sequence in which the Range values are provided (i.e. Axis order)

What can we do with a Coverage?

WMS: you all know that!

WCS:

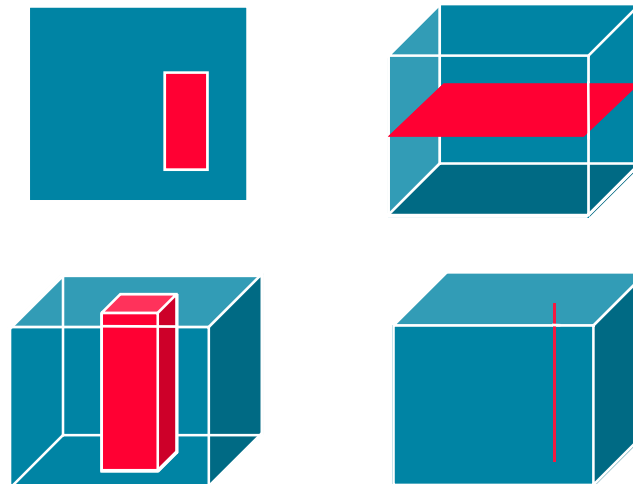
- Access Coverage information separately from Values
 - **DescribeCoverage** provides Domain, Range Type, Metadata
 - **GetCoverage** provides values
- All sorts of interesting subsetting

OGC Web Coverage Service (WCS)

- WCS **Core**: access to spatio-temporal coverages & subsets

- Encoding on the fly

- subset = **trim** | **slice**



Large, growing implementation basis:
 rasdaman, GDAL, QGIS, OpenLayers, OPeNDAP, MapServer, GeoServer, GMU, NASA WorldWind, EOx-Server; Pyxis, ERDAS, ArcGIS, ...

- WCS **Extensions**: optional functionality facets

- from extraction up to flexible analytics

What can we do with a Coverage?

Web Coverage Processing Service (WCPS):

- Allows for server side processing
 - only download the data you need
- Combine data from different coverages

What can we do with a Coverage?

WCPS coverage processing language

- Simple scripting language for creating and processing coverages
- Arithmetic and logical operators:
and, or, not, xor, +, -, *, /, =, <, >, <=, >=, !=,
overlay
- Function Calls

What can we do with a Coverage?

WCPS Function Types

Metadata:

- getMetaData
- setMetaData

Administrative:

- encodedCoverage
- store

Coverage Scope:

- trim
- slice
- extend
- clip

Geo:

- crsTransform
- scale

Calculations:

- reduce
- trigonometric
- exponential
- numericScalar
- unaryArithmetic
- boolean

<http://service.datacove.eu/WCPS>

What can we do with a Coverage?

WCPS Function Calls (exemplary)

Reduce

- add
- avg
- min
- max
- count
- all
- some

Exponential

- exp
- ln, log
- ...

Trigonometric

- sin, cos, tan
- arcsin, arccos, arctan
- sinh, cosh

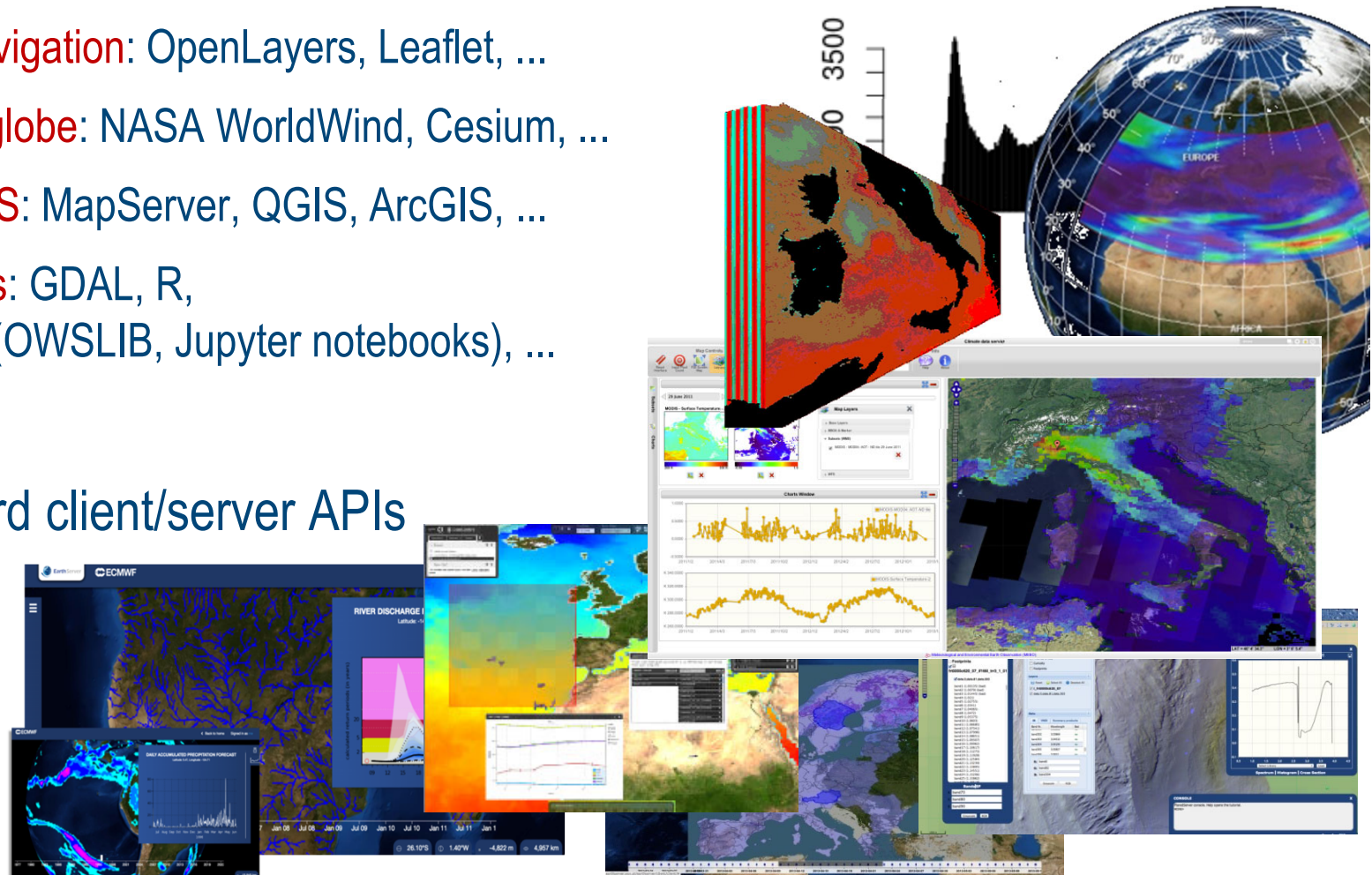
Issues in INSPIRE

- INSPIRE coverage extensions
 - Additional information to OGC coverages shall be provided as Coverage Metadata (not extending the coverage class).
- Identifier and scope issues
 - What exactly is a dataset?
 - Do subsets require identifiers?
- Coverage aggregation
- Orthoimage mosaic elements

...But That's Not What You Want to See

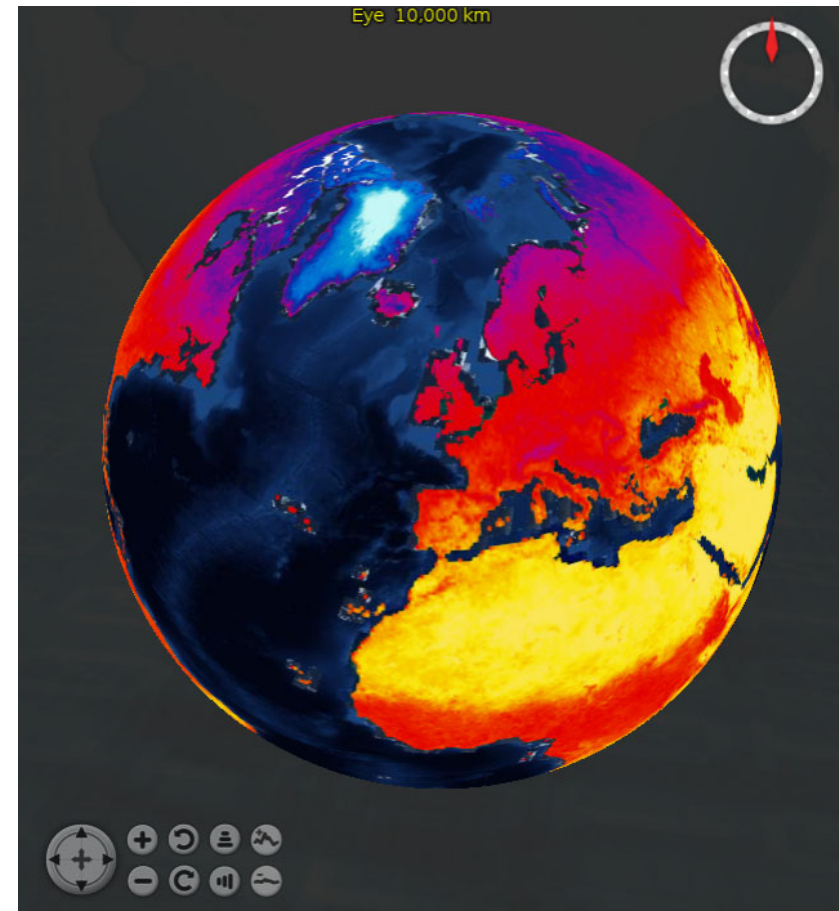
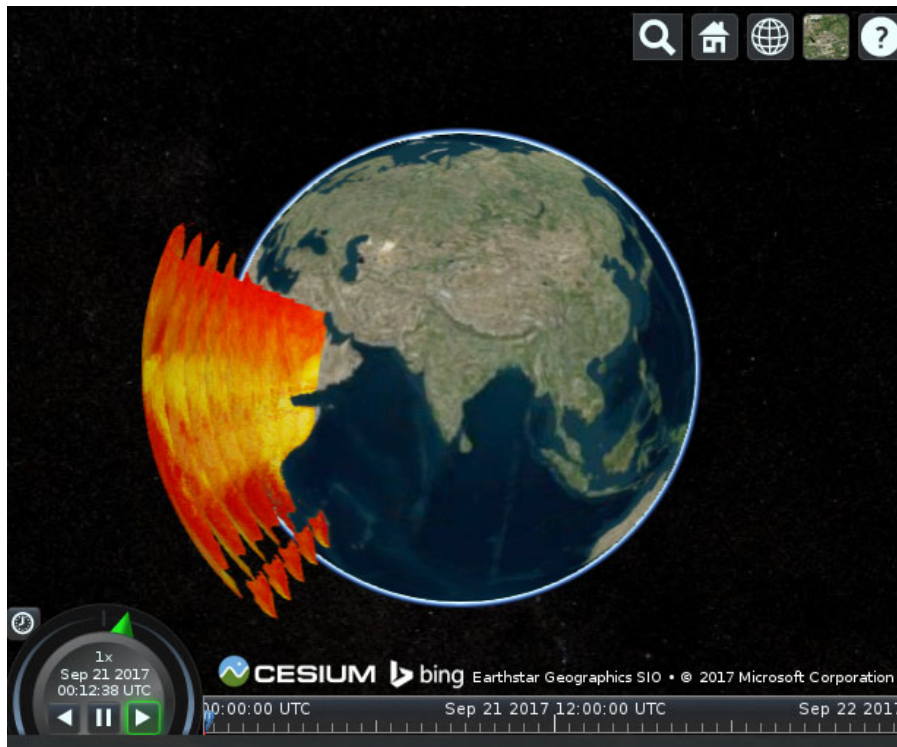
- Let users remain in comfort zone of well-known tools
 - **Map navigation:** OpenLayers, Leaflet, ...
 - **Virtual globe:** NASA WorldWind, Cesium, ...
 - **Web GIS:** MapServer, QGIS, ArcGIS, ...
 - **Analysis:** GDAL, R, python (OWSLIB, Jupyter notebooks), ...

- ...via W*S
as standard client/server APIs



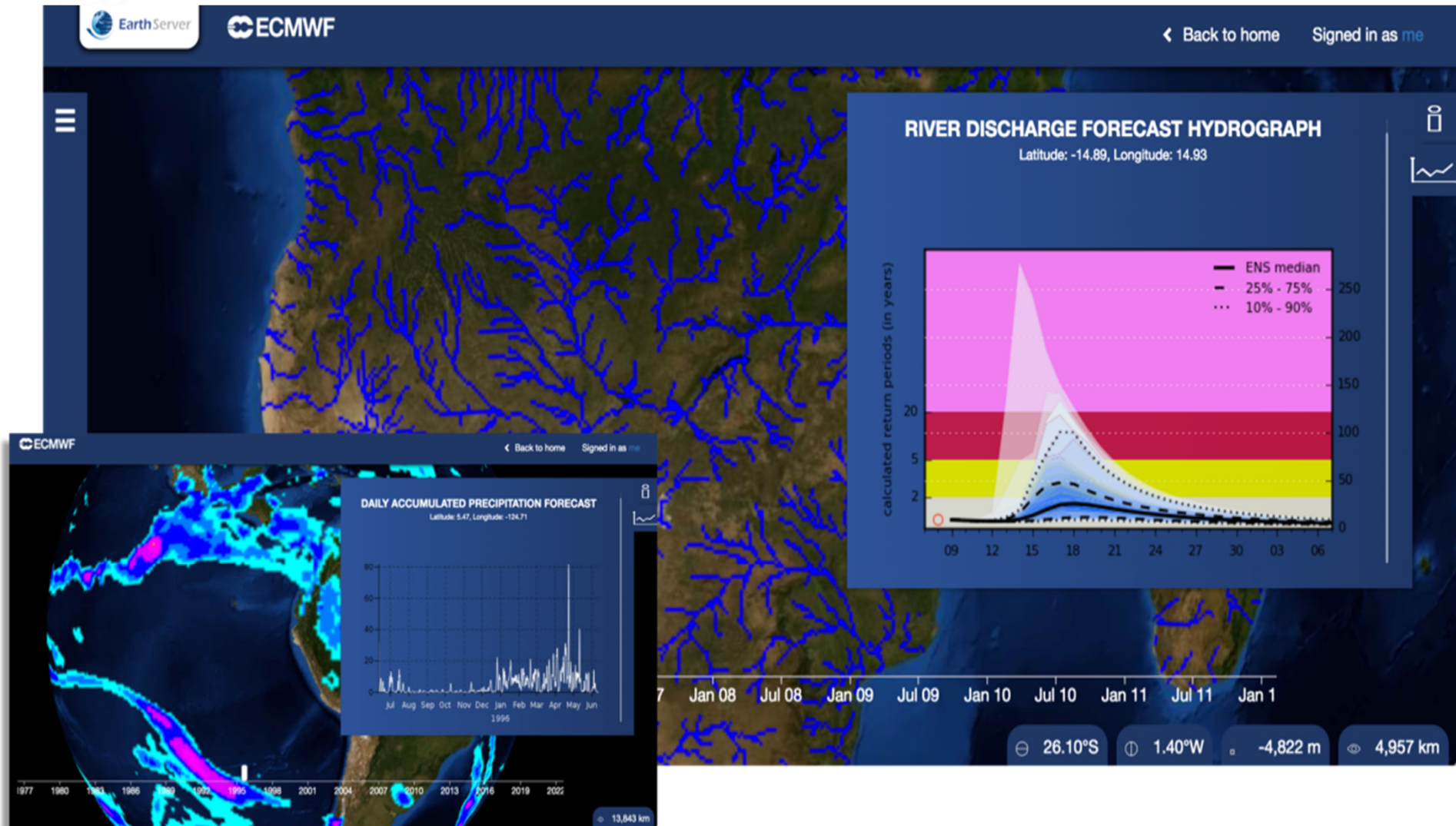
[screenshots: rasdaman-based portals]

rasdaman Datacubes on Virtual Globes



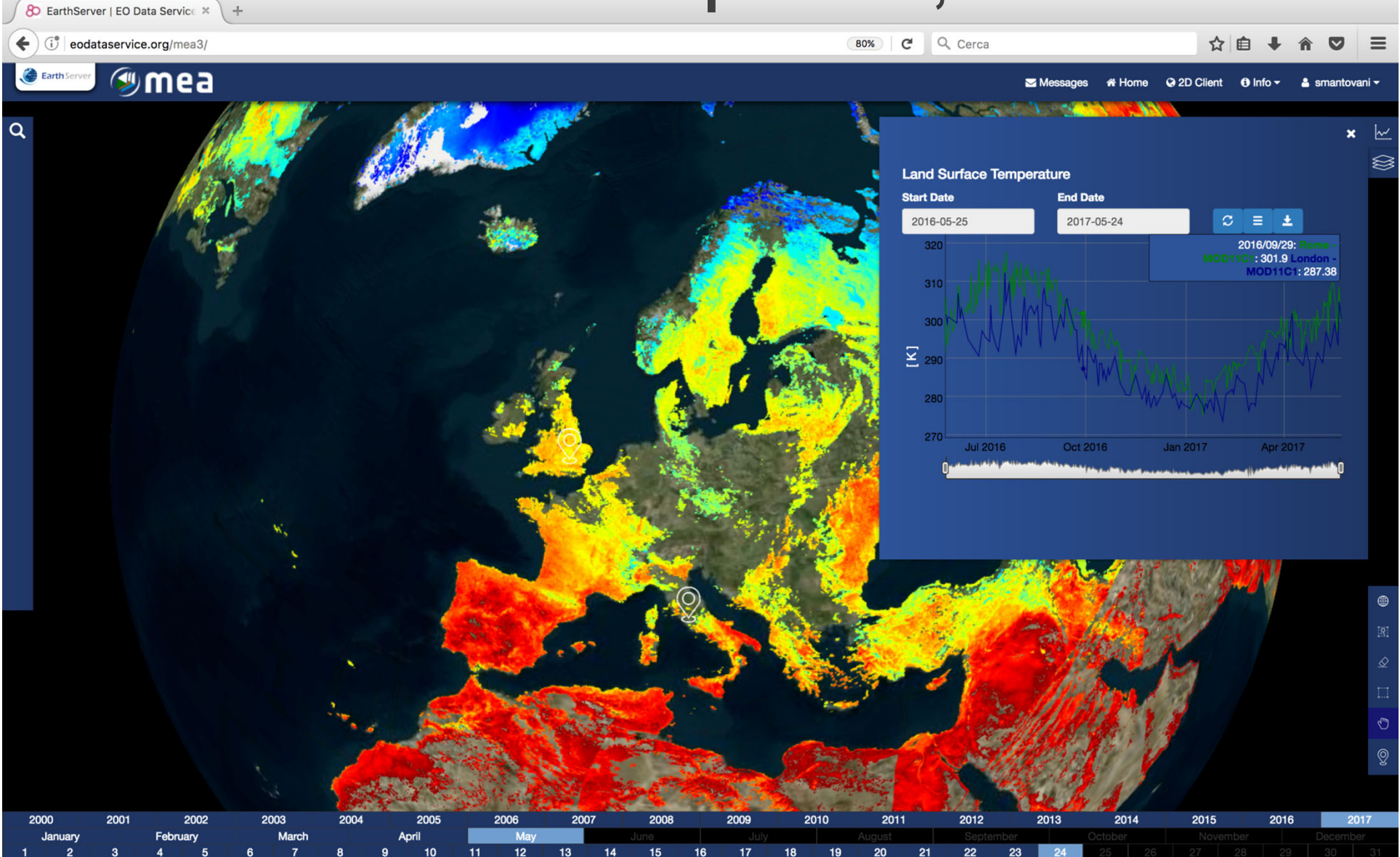
[rasdaman backend]

ECMWF: River Discharge



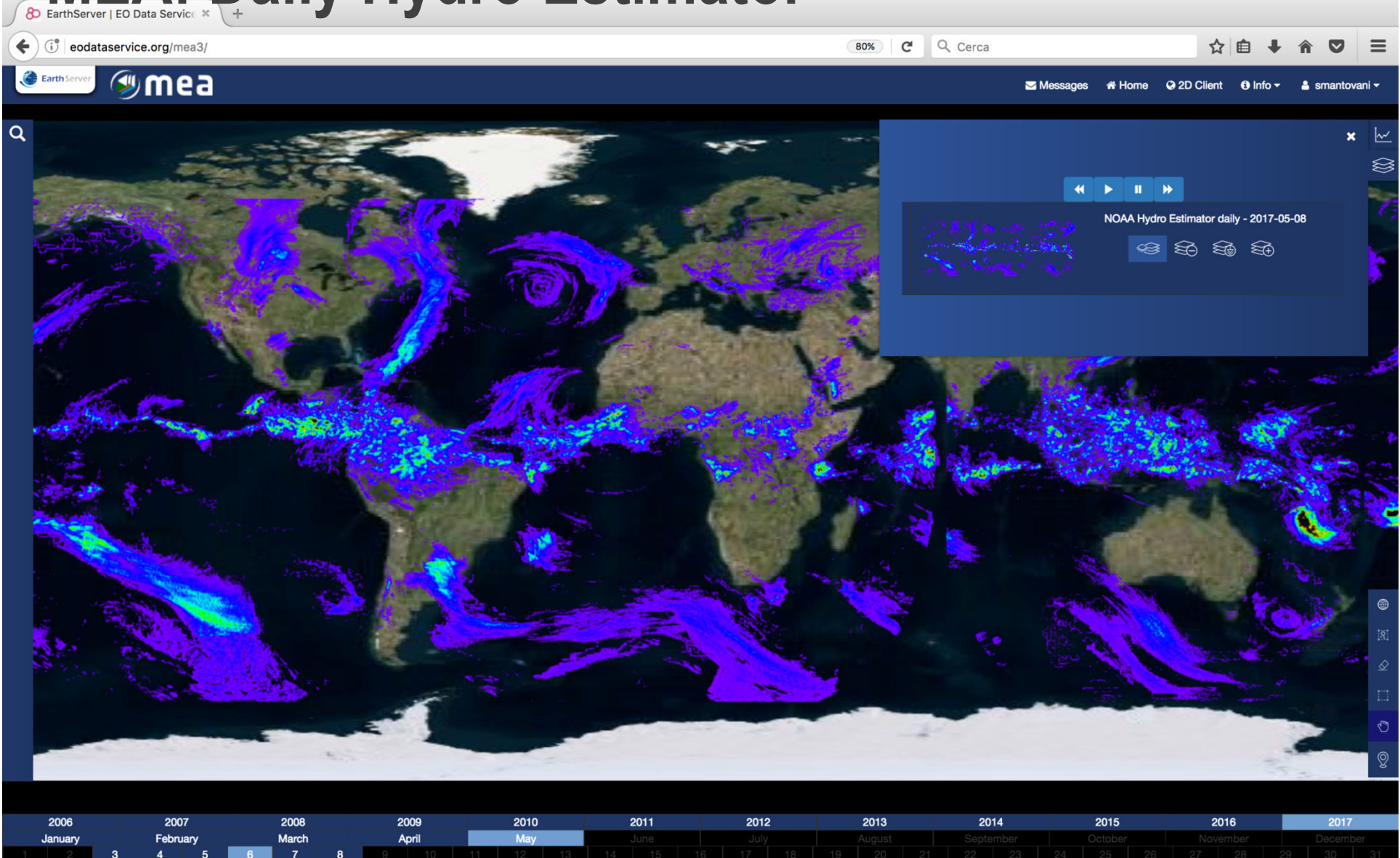
[rasdaman backend]

MEA: Land Surface Temperature, Cloudfree



[rasdaman backend]

MEA: Daily Hydro Estimator



[rasdaman backend]

NCI Australia: Landsat8

GetCapabilities

DescribeCoverage

GetCoverage

ProcessCoverages

DeleteCoverage

InsertCoverage

WCS service endpoint:

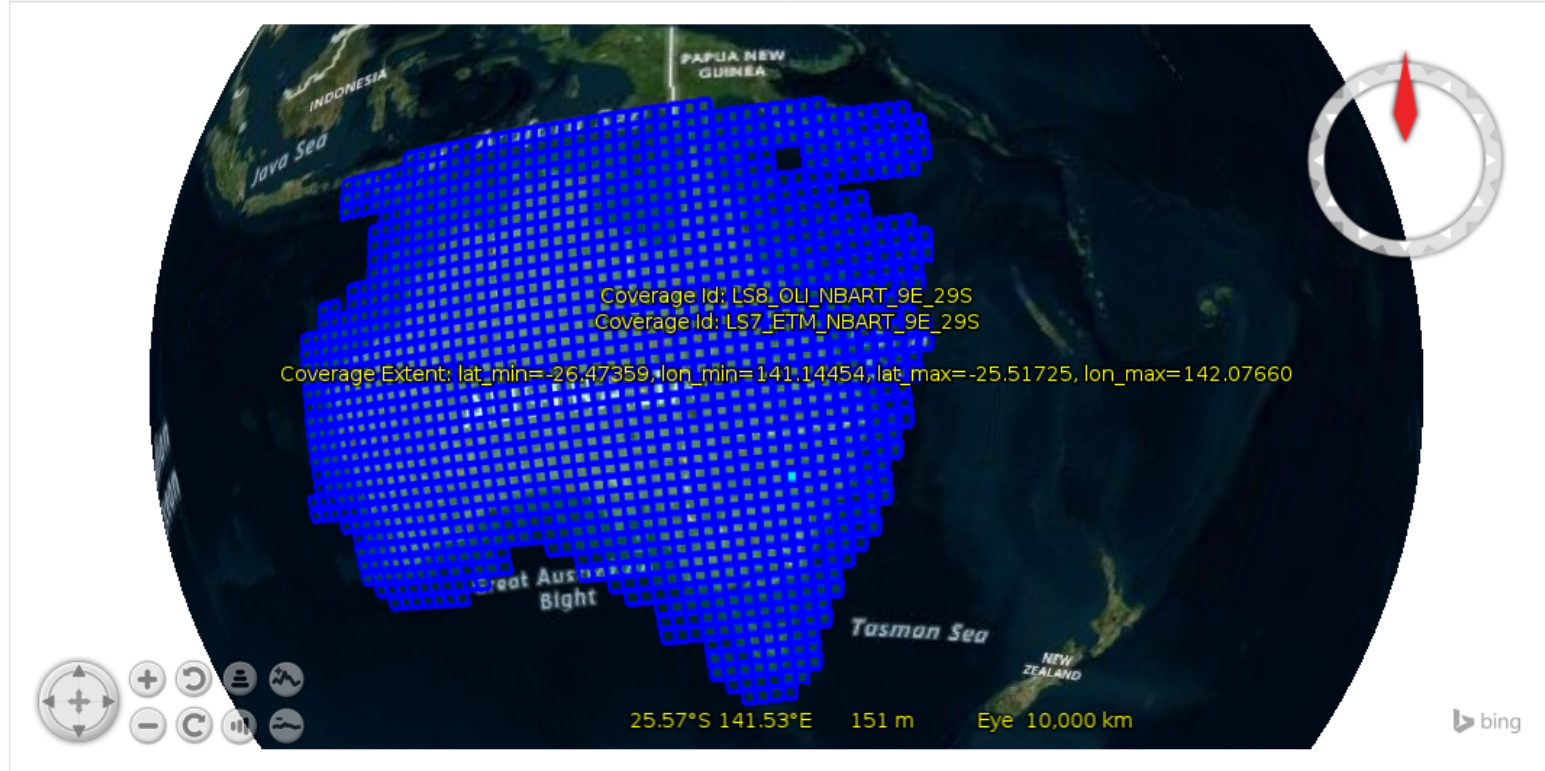
<http://rasdaman.nci.org.au/rasdaman/ows>

Get Capabilities

Available coverages



Footprint of geo-referenced coverages



PlanetServer

The screenshot displays the PlanetServer web interface with several key components:

- PROJECTIONS:** A dropdown menu set to "3D".
- AVAILABLE BASE MAPS:** A dropdown menu set to "MOLA Colored".
- SEARCH LOCATION:** Input fields for Region, Product Id, Latitude, and Longitude, each with a "Go" button.
- RGB COMBINATOR:** A panel with "Selected Footprints*", "Coverage Bands*", and "WCPS Custom Queries*" buttons. It includes color selection options for Red Band, Green Band, and Blue Band, each with a "Change" button, and a "Combine" button at the bottom.
- Main View:** A 3D topographic map of Mars with red dots indicating footprint locations.
- Inset View (Top Right):** A detailed view of a footprint showing a grayscale image and a spectral reflectance graph. The graph plots Reflectance (0.0 to 0.8) against Wavelength (µm) (1,800 to 3,750). The coverage name is "FRT0000A0AC_07_0165L_TRR3" with coordinates Latitude: 0.04, Longitude: -0.03.
- Inset View (Bottom Right):** A 2D map of Mars showing various landing sites with their names, dates, and coordinates. Examples include:
 - Name: Luna 2, Date: 13 Sep 1959, Lat: 20.00, Lon: 10.00
 - Name: Apollo 16, Date: 16 Jul 1971, Lat: 20.00, Lon: 10.00
 - Name: Luna 21, Date: 15 Jan 1973, Lat: 20.00, Lon: 30.36
 - Name: Apollo 17, Date: 11 December 1972, Lat: 20.00, Lon: 30.36
 - Name: Ranger 8, Date: 20 February 1965, Name: Surveyor 5, Date: 10 November 1967, Name: Surveyor 3, Date: 05 May 1967, Name: Surveyor 1, Date: 03 May 1966
- Bottom Panel:** A navigation bar with coordinates (3.83°N, 17.09°E), scale (603 m), and a distance indicator (7,616 km).

[rasdaman backend]

Coverages - Advantages

- More Compact encoding
 - Domain: only description, not polygons
 - Range: compact encoding
- Various standardized result types
- Selective data access
- WCPS – server side processing

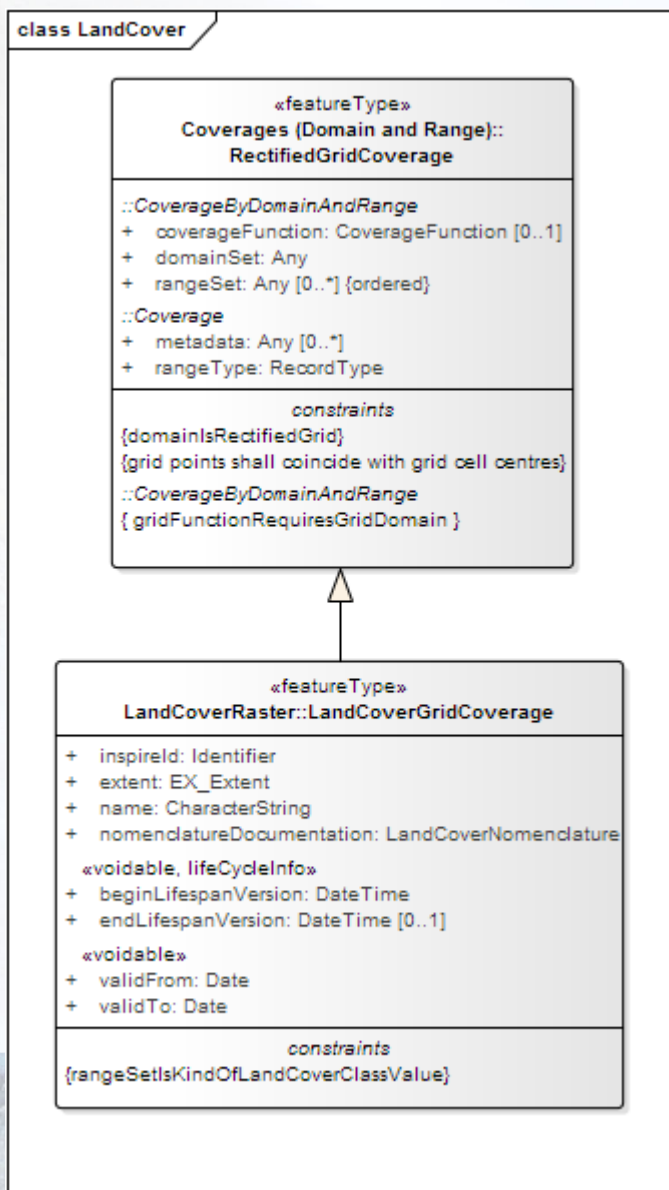
Thanks for your attention!

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A revised model for INSPIRE coverages



A revised model for INSPIRE coverages

class LandCoverExpanded

«featureType»

LandCoverRaster::LandCoverGridCoverage

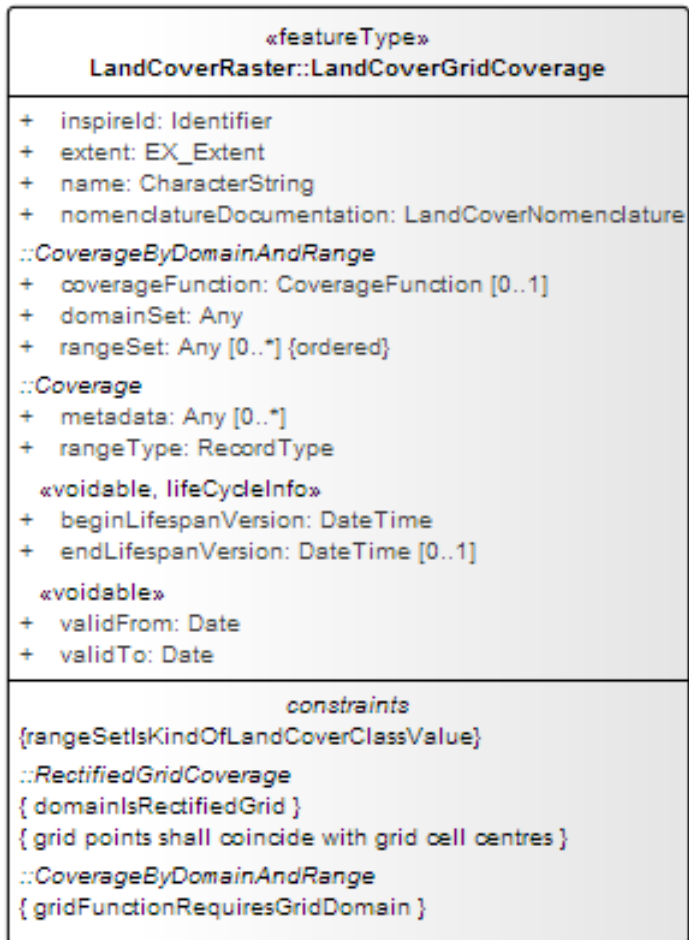
+ inspireId: Identifier
+ extent: EX_Extent
+ name: CharacterString
+ nomenclatureDocumentation: LandCoverNomenclature
::CoverageByDomainAndRange
+ coverageFunction: CoverageFunction [0..1]
+ domainSet: Any
+ rangeSet: Any [0..*] {ordered}
::Coverage
+ metadata: Any [0..*]
+ rangeType: RecordType
«avoidable, lifecycleInfo»
+ beginLifespanVersion: DateTime
+ endLifespanVersion: DateTime [0..1]
«avoidable»
+ validFrom: Date
+ validTo: Date

constraints

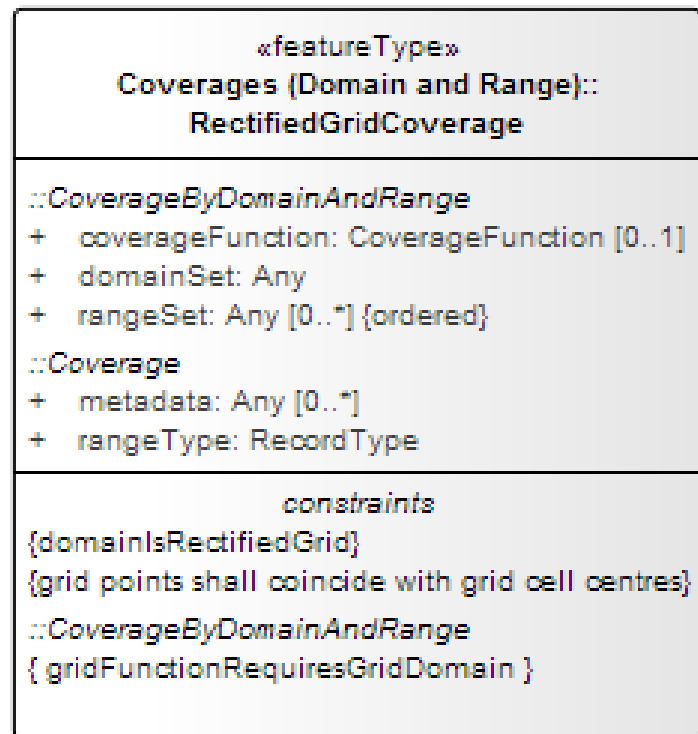
{rangeSetsIsKindOfLandCoverClassValue}
::RectifiedGridCoverage
{ domainsRectifiedGrid }
{ grid points shall coincide with grid cell centres }
::CoverageByDomainAndRange
{ gridFunctionRequiresGridDomain }

A revised model for INSPIRE coverages

class LandCoverExpanded

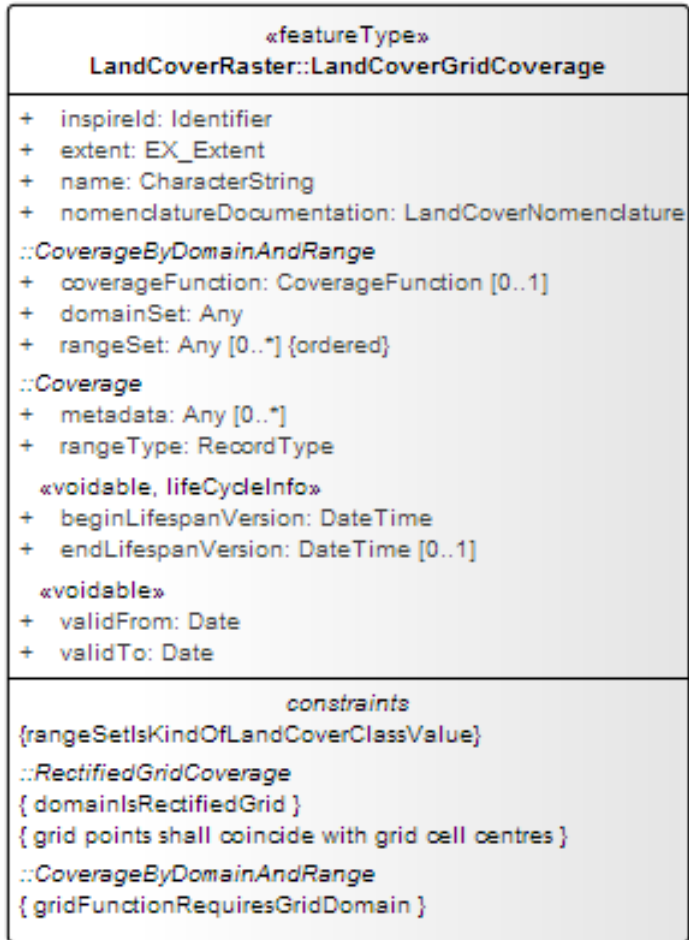


class Coverage

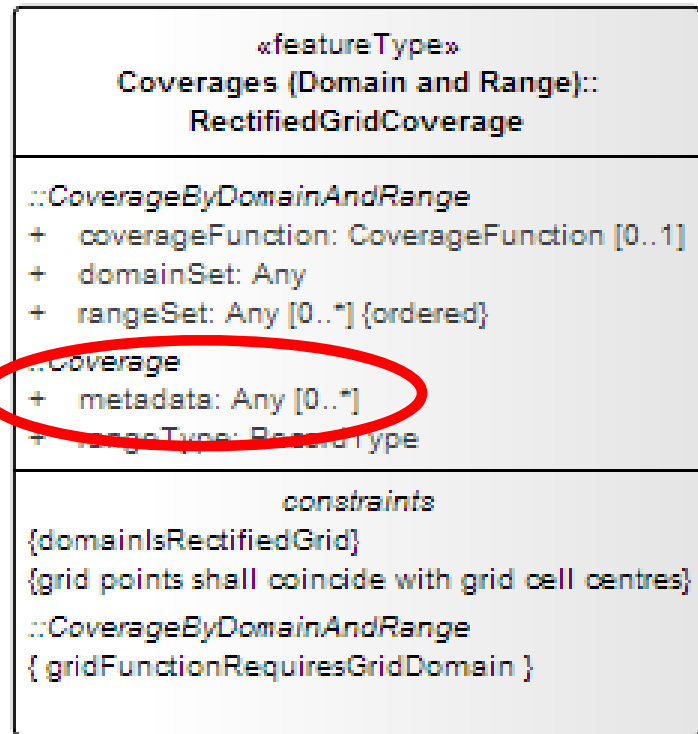


A revised model for INSPIRE coverages

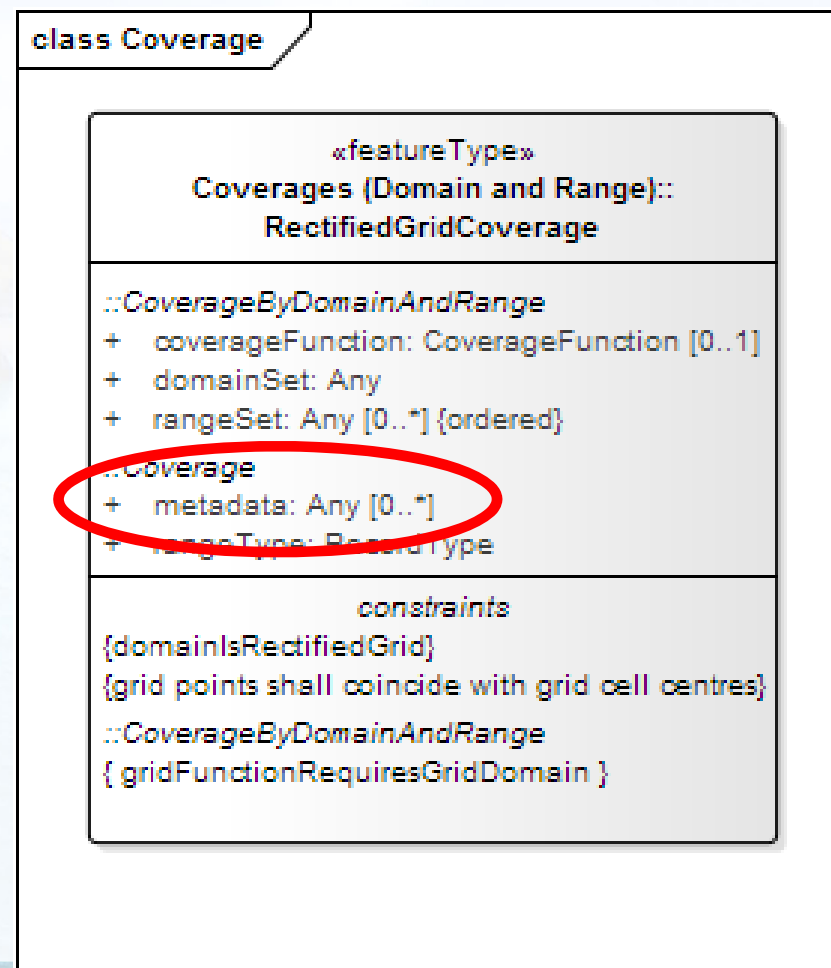
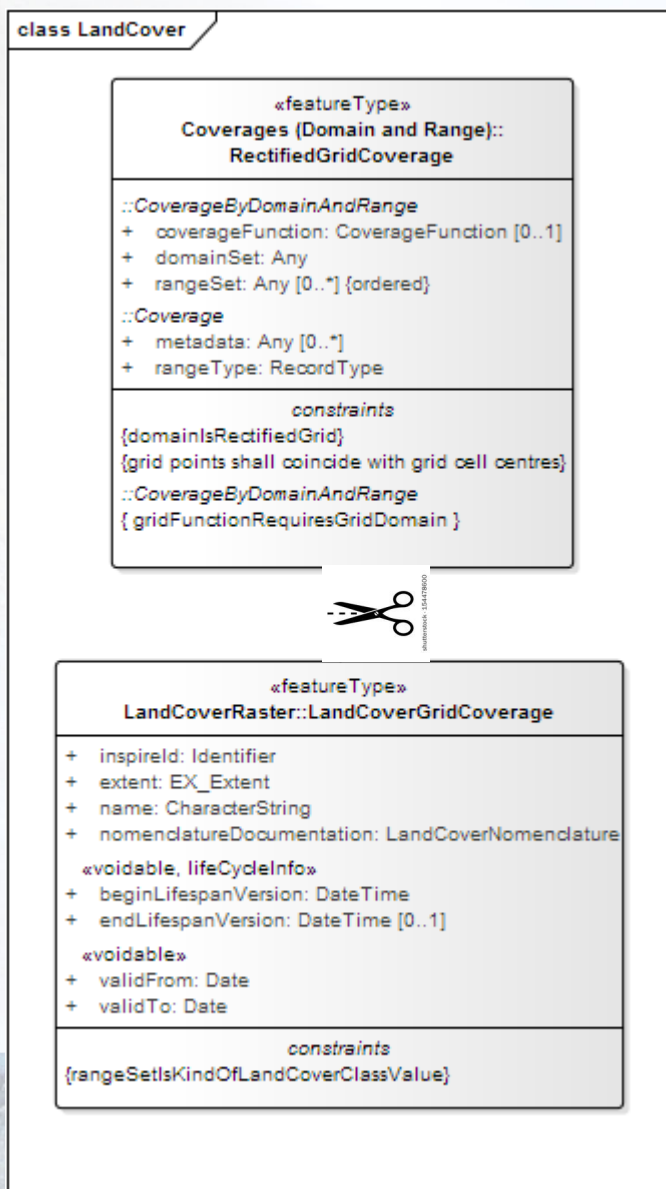
class LandCoverExpanded



class Coverage



A revised model for INSPIRE coverages



A revised model for INSPIRE coverages

