

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:



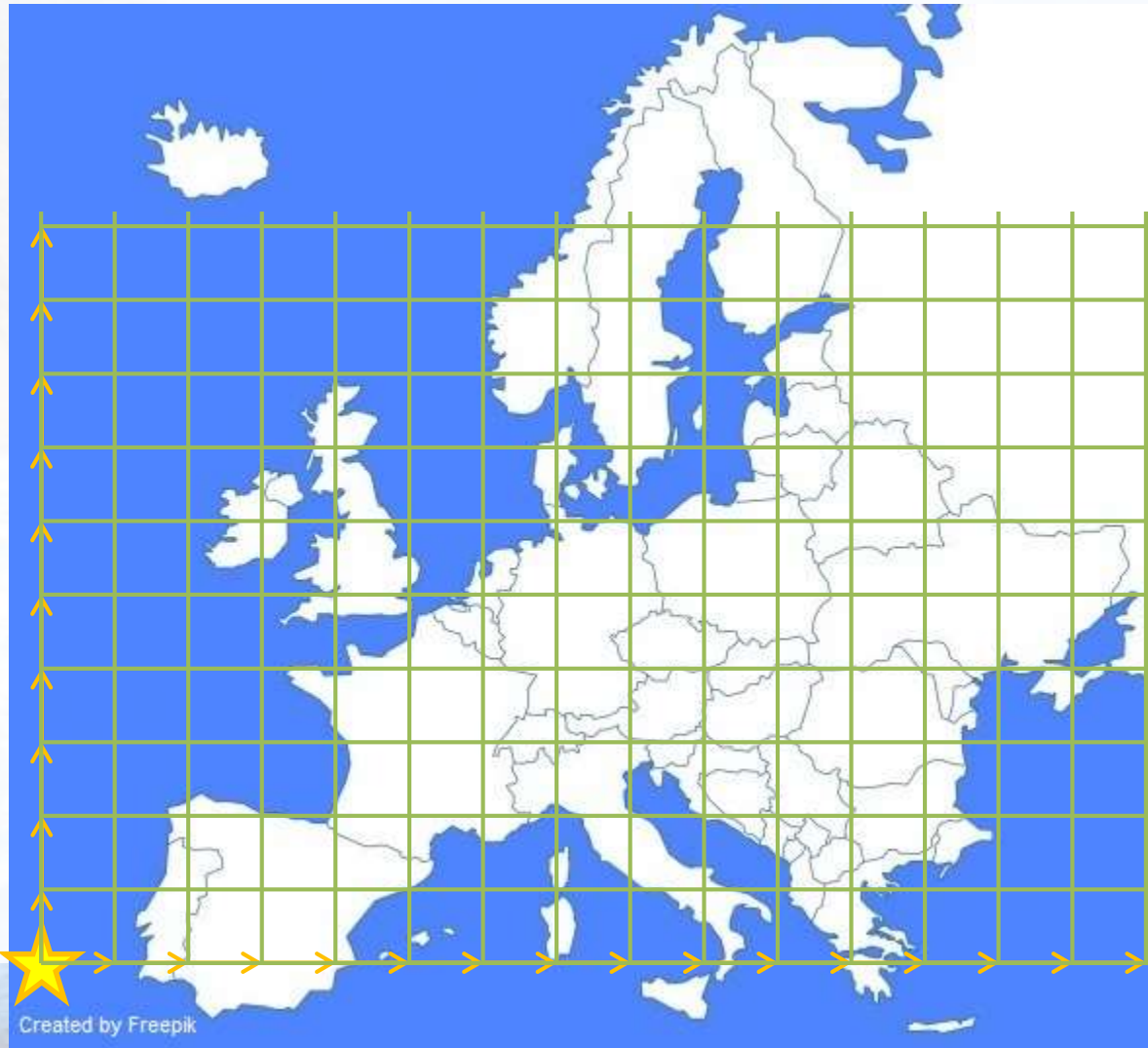
Offsets:



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

Dimension

Polygon

1 Polygon per Grid Cell (5

Coordinate Pairs)

**Very compact
Domain**

**Handfull of Bytes
vs.**

Many many MB

Example: 1

1 Coordinate Pair

2 Vectors

2 Integers

4471 Cells on X

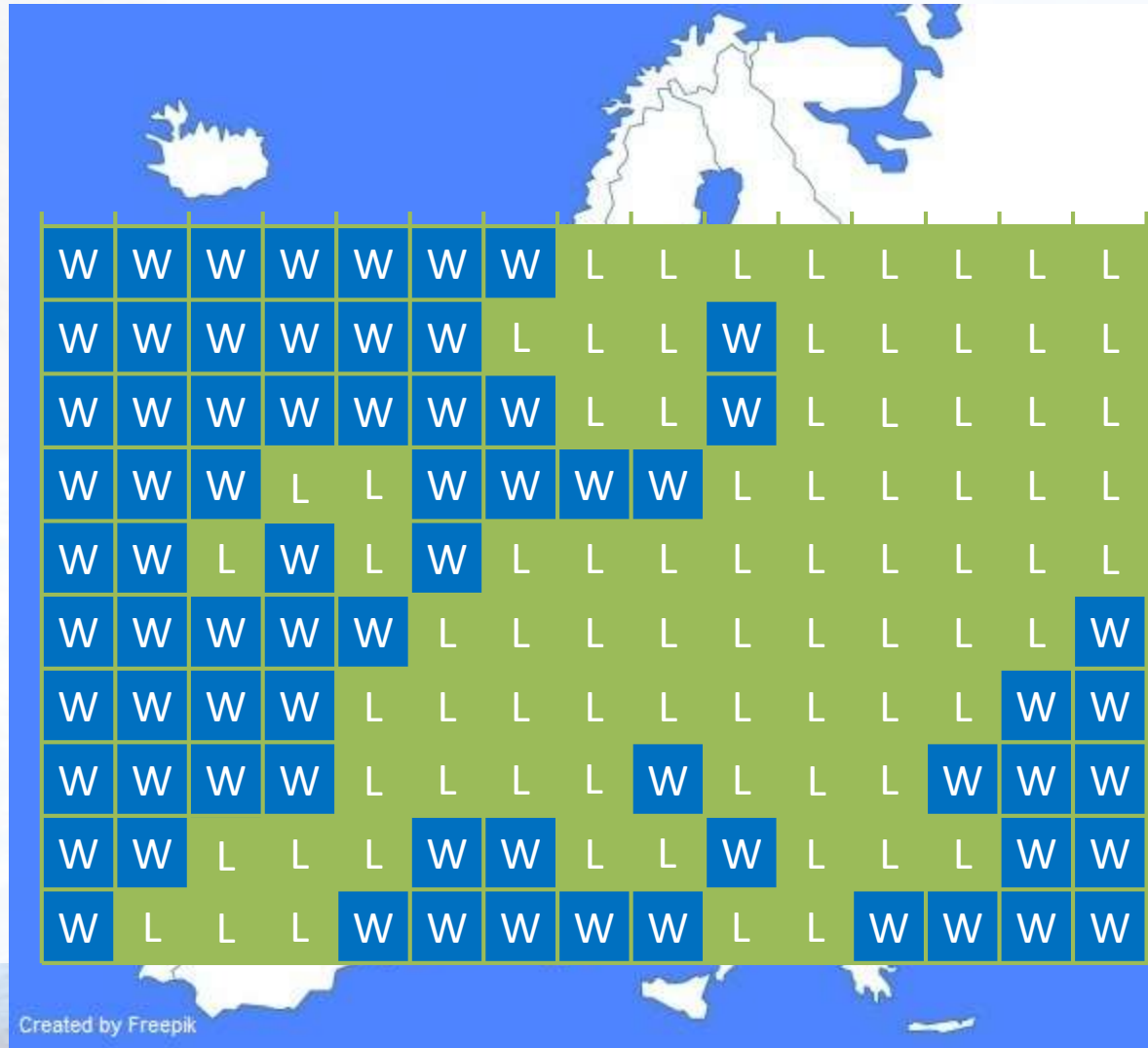
558 Cells on Y

→ ~25M Polygons!

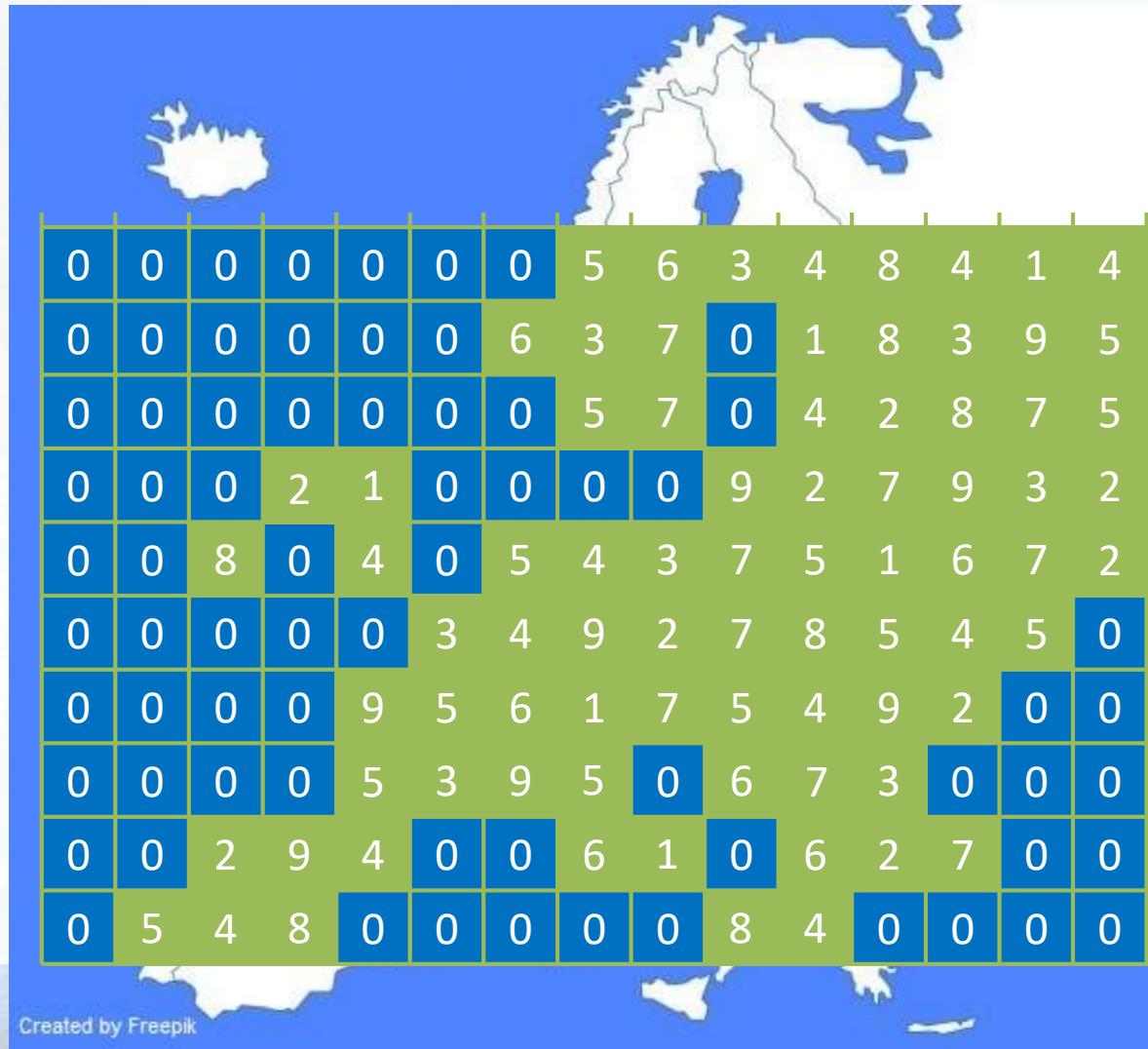
What is a Coverage Domain?

- 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 Format

- GeoTIFF or JPEG2000: commonly graphics format, compressed format
- NetCDF, Binary, etc.: many formats available, especially in scientific community
- XML, JSON, CSV: compact formats providing direct access to range values



Many different
result formats

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!

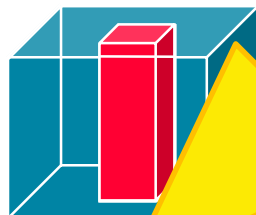
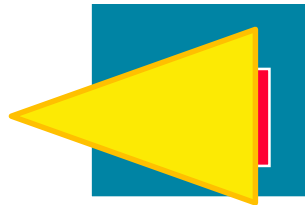
WCS:

- 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 spatio-temporal coverage subsets

- Encoding on the fly
- subset = trim



Access the data you need, and **ONLY** the data you need!

Large, growing implementation basis:
rasdaman, GDAL, QGIS, ...
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
- Combines data from multiple coverages

Access not the the
data you need, but
ONLY the results
you require!

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
- ...

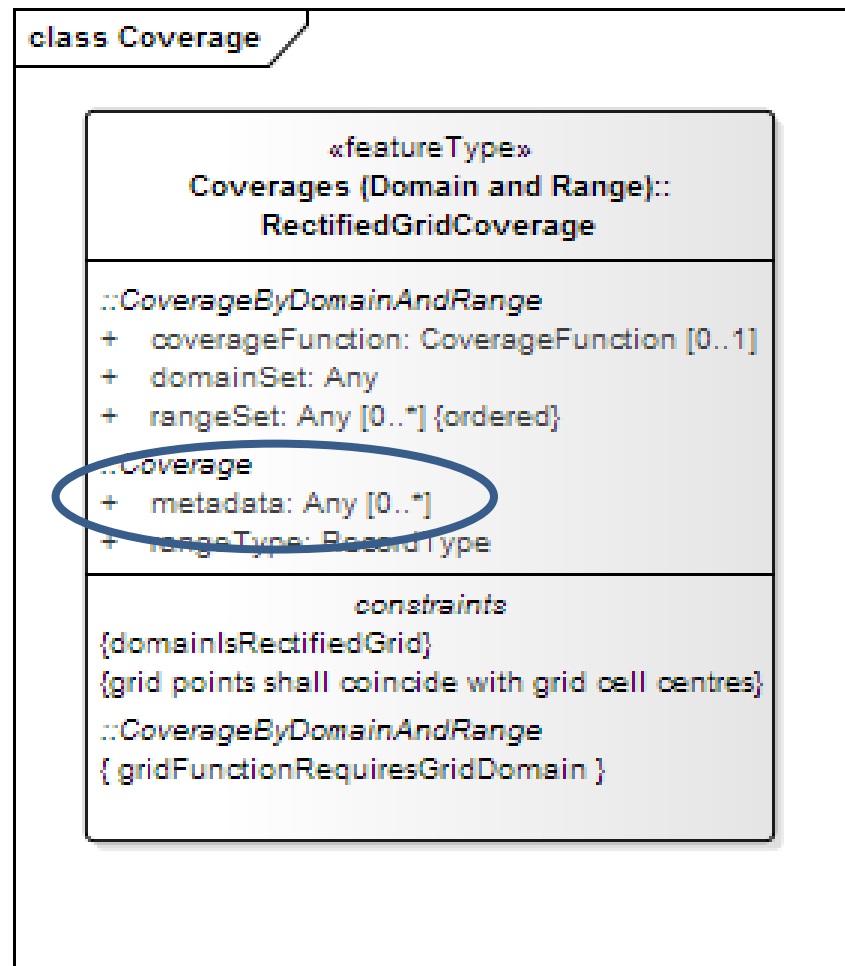
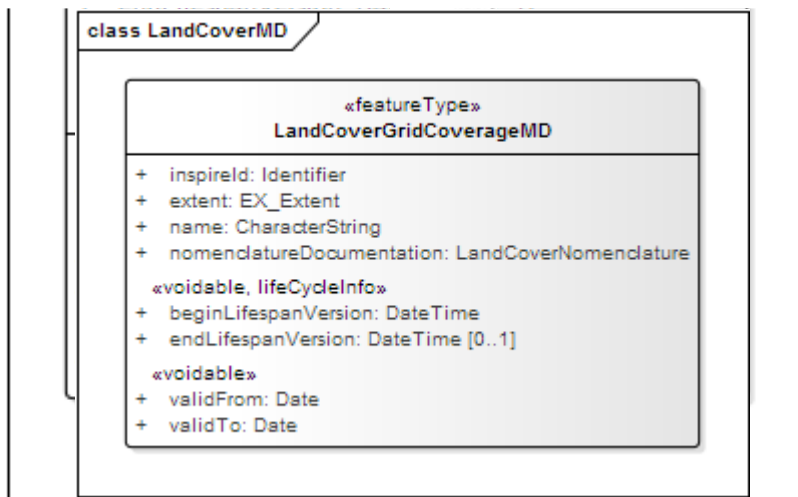
Trigonometric

- 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

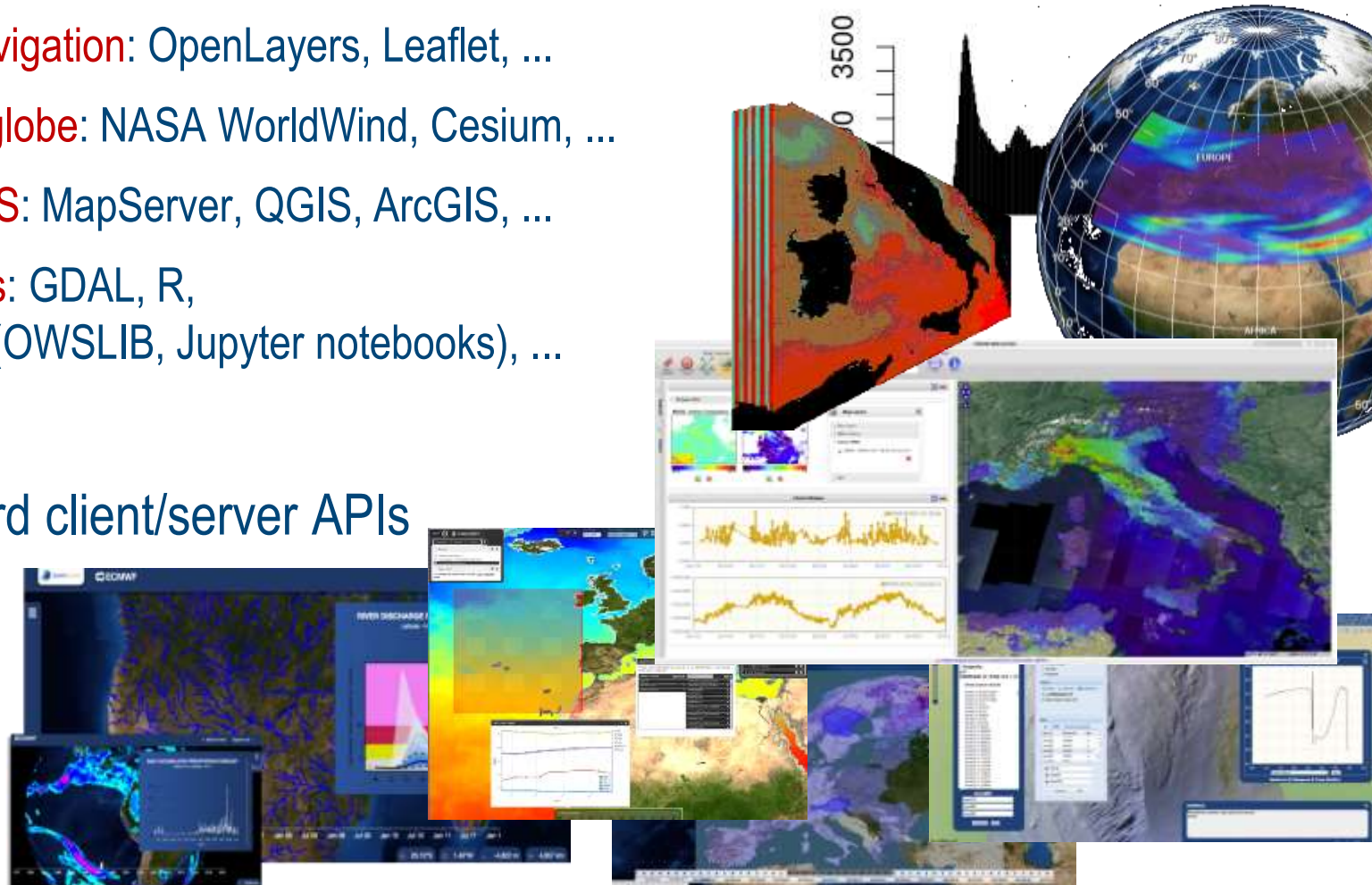
Coverage Metadata Model



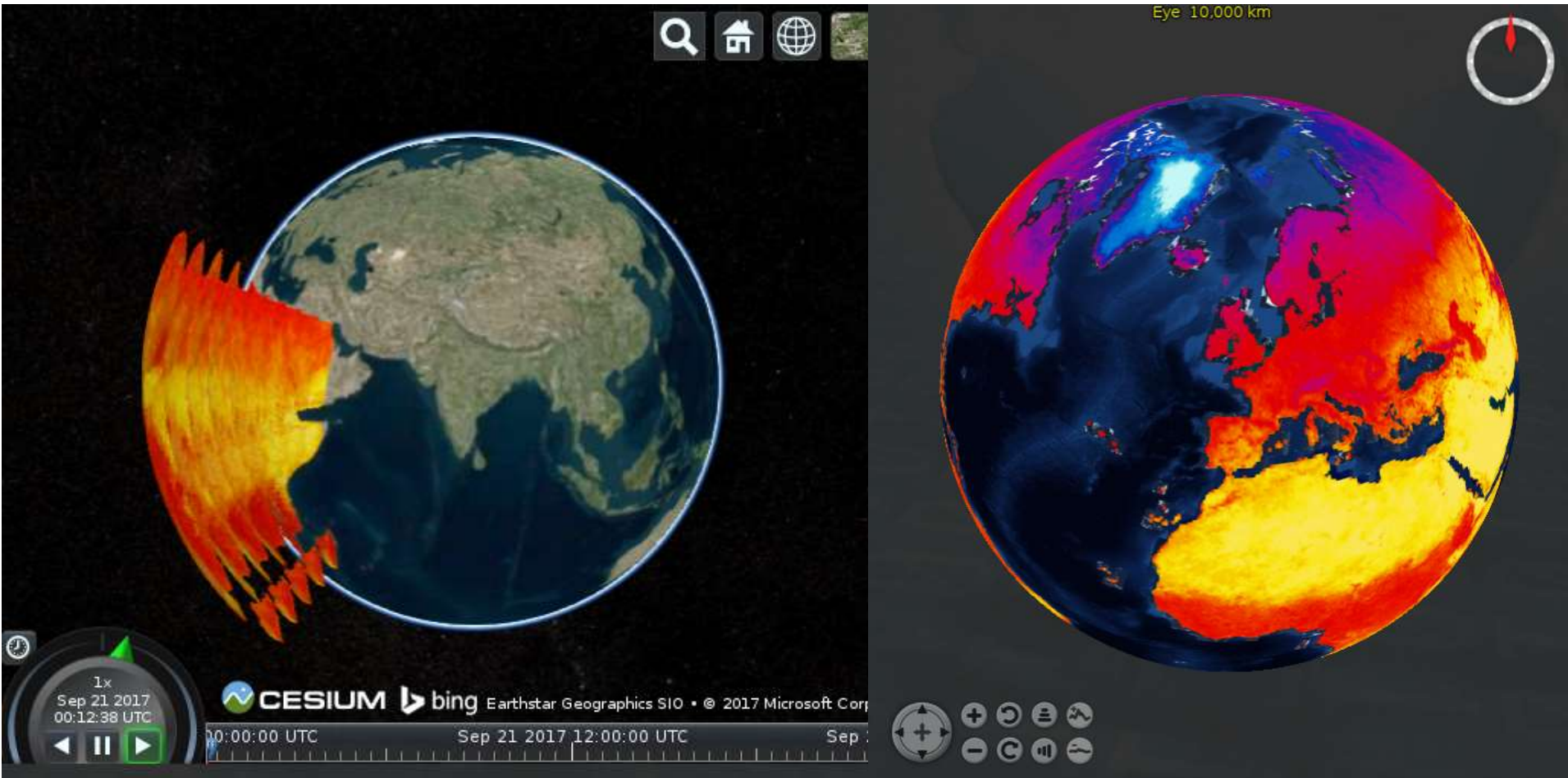
...But That's Not What You Want to See

- 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), ...

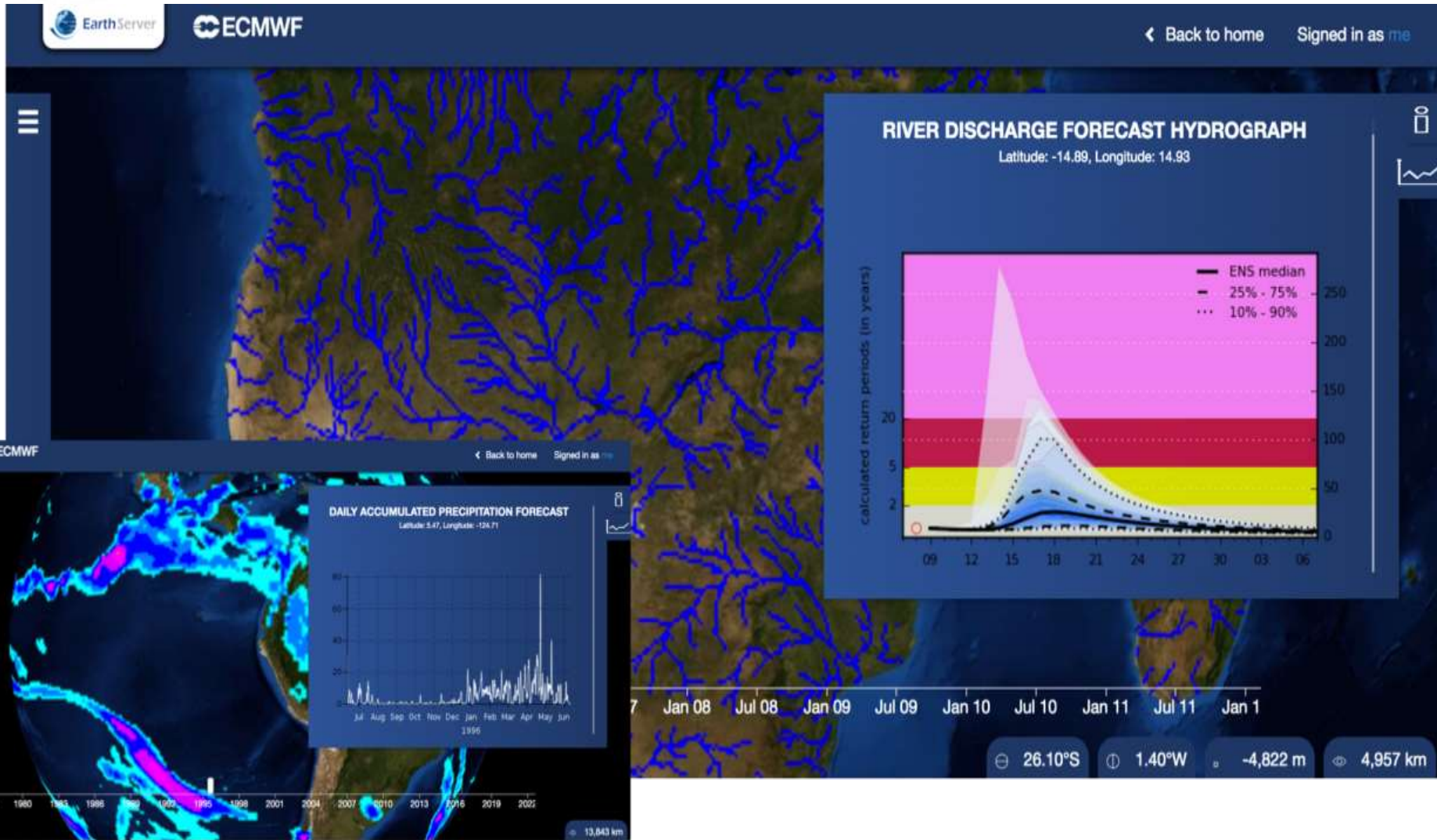
- ...via W*S
as standard client/server APIs



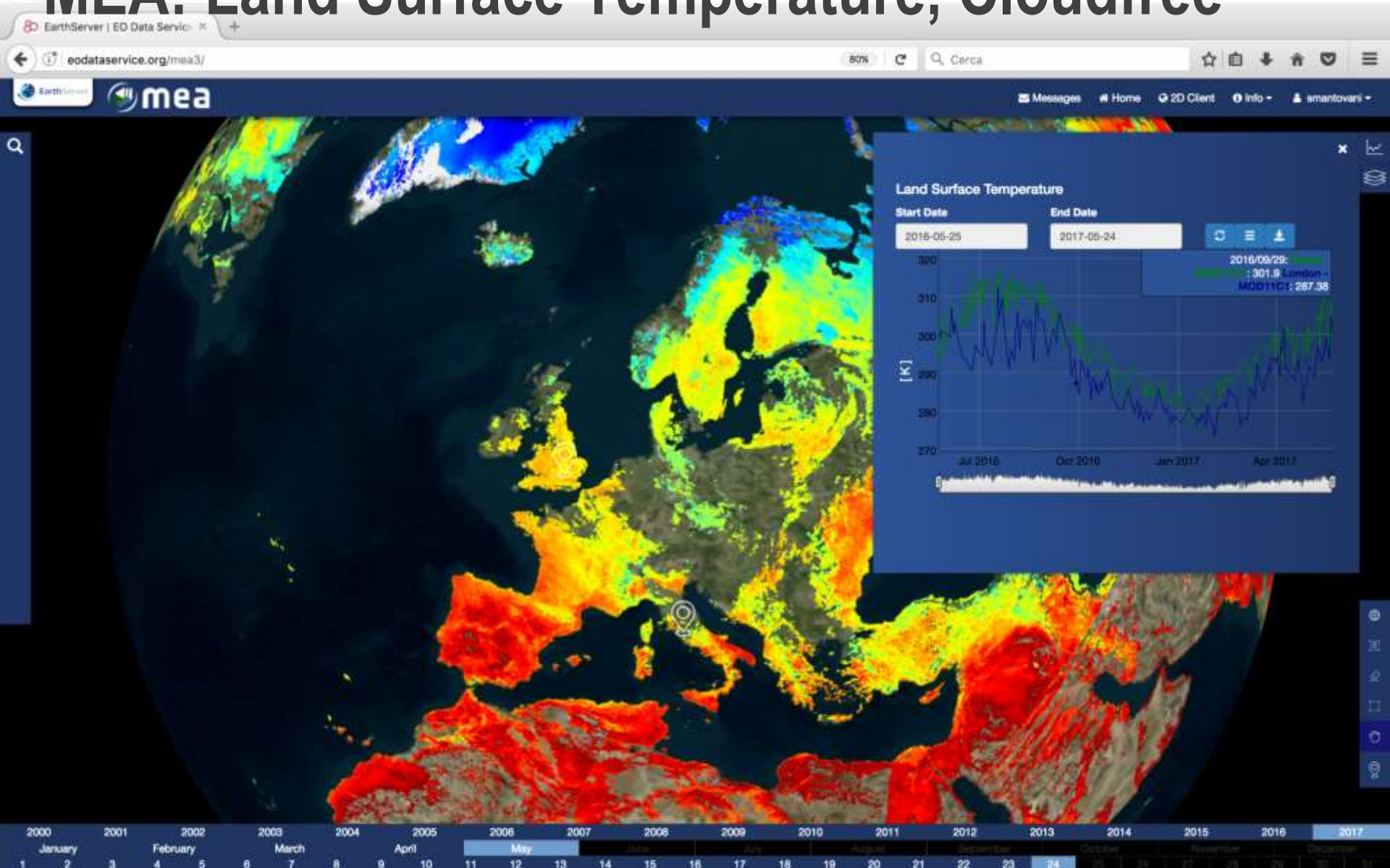
rasdaman Datacubes on Virtual Globes



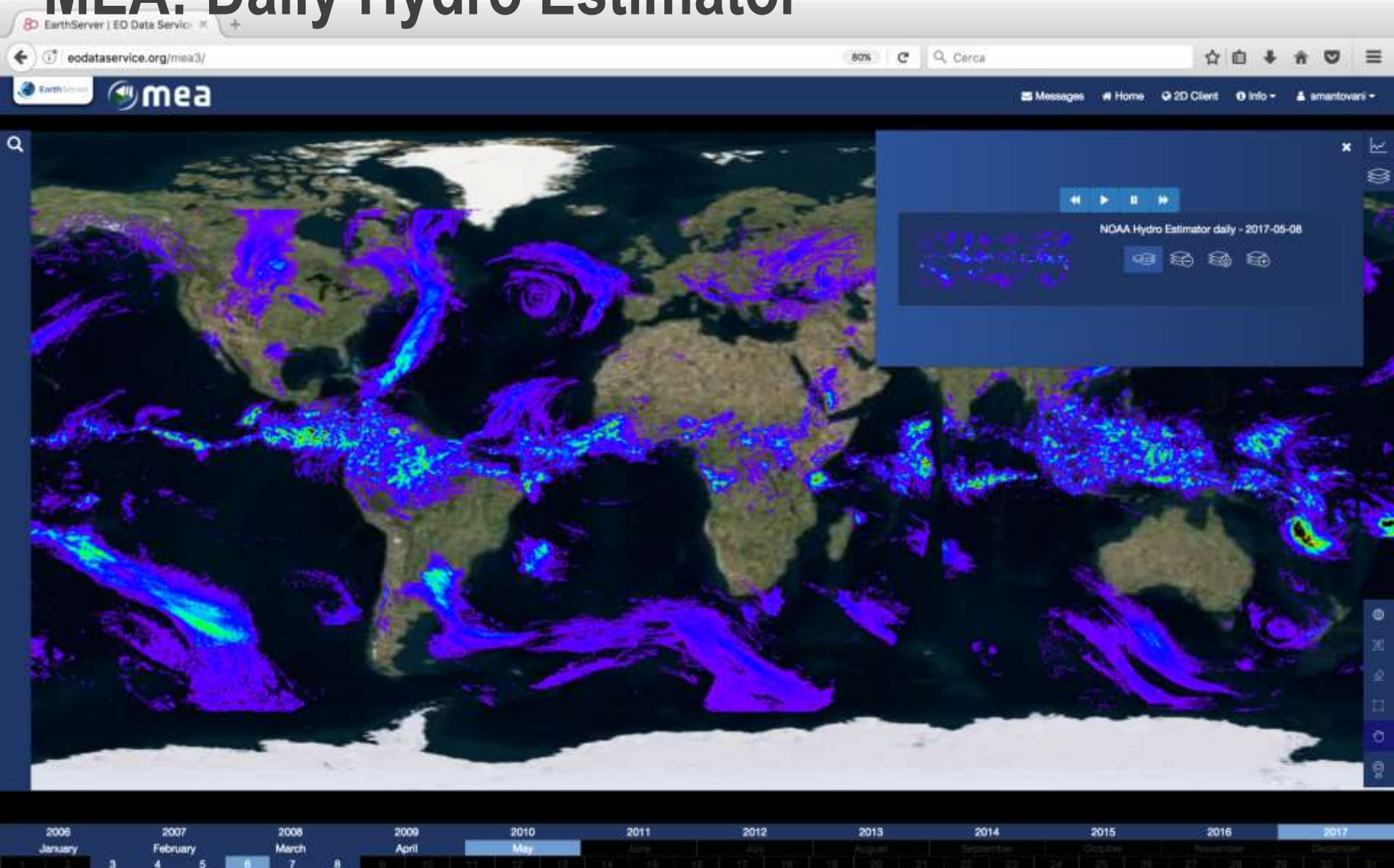
ECMWF: River Discharge



MEA: Land Surface Temperature, Cloudfree



MEA: Daily Hydro Estimator



[rasdaman backend]

NCI Australia: Landsat8

GetCapabilities

DescribeCoverage

GetCoverage

ProcessCoverages

DeleteCoverage

InsertCoverage

WCS service endpoint:

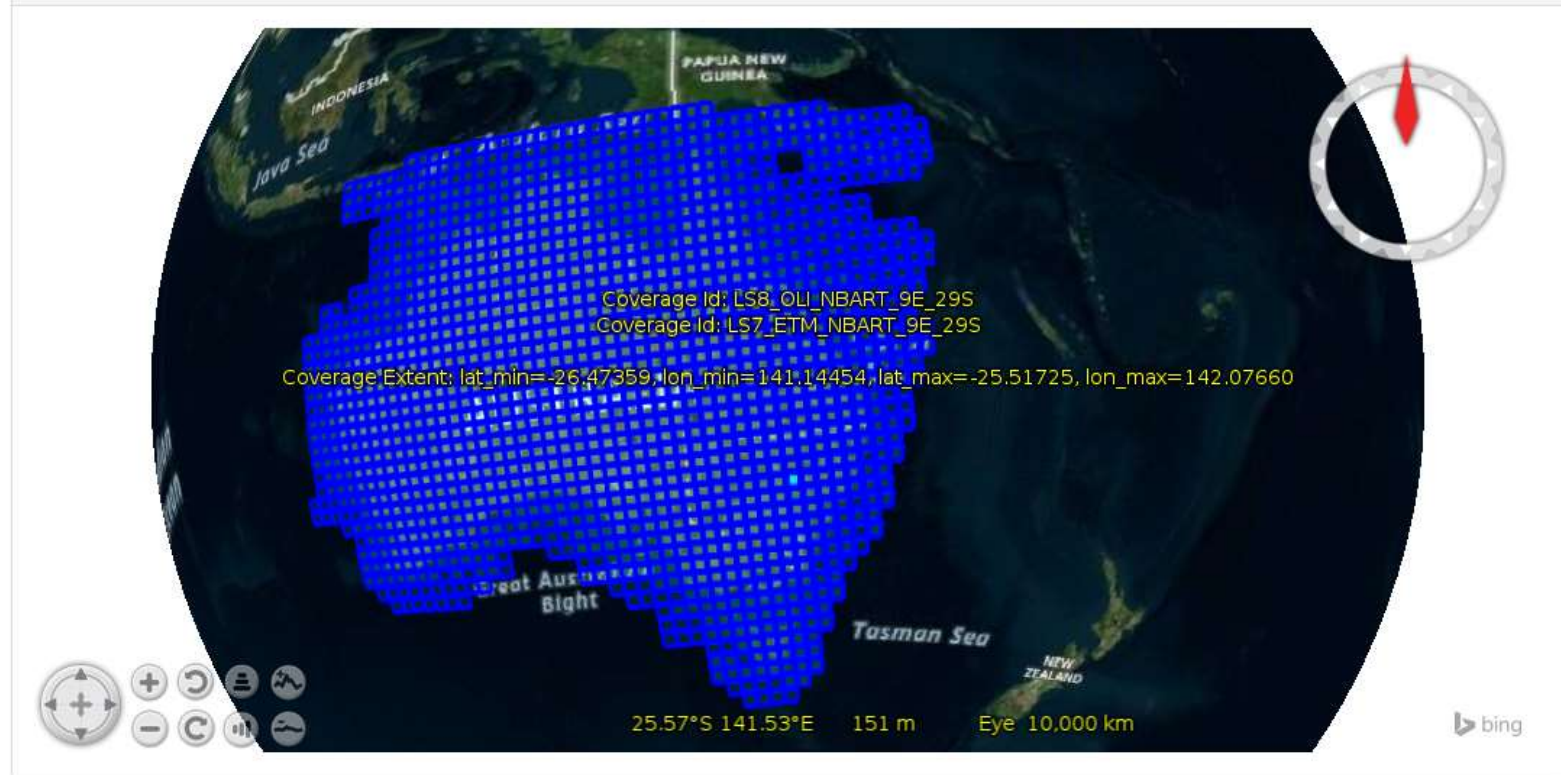
<http://rasdaman.nci.org.au/rasdaman/ows>

Get Capabilities

Available coverages



Footprint of geo-referenced coverages



PlanetServer

The image displays the PlanetServer web interface. On the left, a control panel includes sections for PROJECTIONS (set to 3D), AVAILABLE BASE MAPS (set to MOLA Colored), and SEARCH LOCATION (with fields for Region, Product Id, Latitude, and Longitude). Below these is an RGB COMBINATOR with buttons for Selected Footprints, Coverage Bands, and WCFS Custom Queries, and input fields for Red, Green, and Blue bands. The main area shows a 3D globe of Mars with a blue footprint outline. An inset window on the right shows a topographic profile with a graph of elevation (0 to 11) versus distance (0 to 1000). A bottom-right inset shows a detailed map with various annotations and a control panel for PROJECTIONS, AVAILABLE BASE MAPS, AVAILABLE LAYERS, and SEARCH LOCATION. The bottom status bar shows coordinates (3.81°N, 17.09°E), altitude (603 m), and distance (7.616 km).

b

Coverages - Advantages

- More Compact encoding
 - Domain: only description, not polygons
 - Range: compact encoding
- Various standardized result types
- Tools for processing & visualization
- Selective data access (subsetting)
- WCPS – server side processing

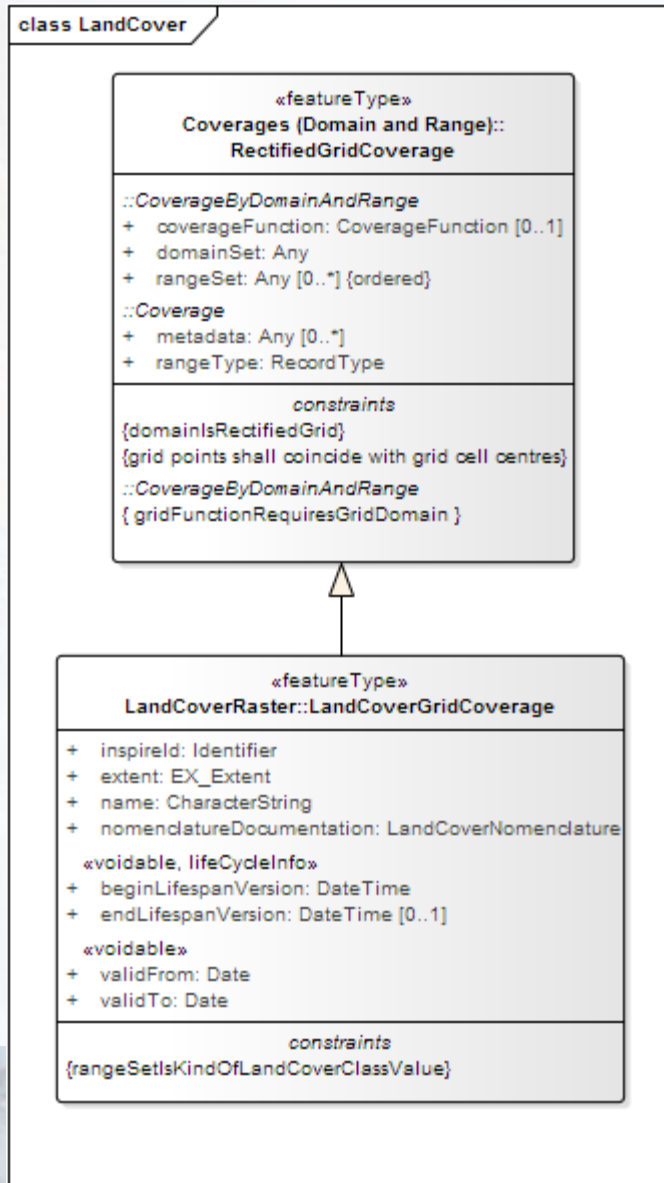
Thanks for your attention!

Kathi Schleidt

Kathi@DataCove.eu



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

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

A revised model for INSPIRE coverages

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«featureType»

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+ domainSet: Any
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::Coverage
+ metadata: Any [0..*]
+ rangeType: RecordType
«avoidable, lifecycleInfo»
+ beginLifespanVersion: DateTime
+ endLifespanVersion: DateTime [0..1]
«avoidable»
+ validFrom: Date
+ validTo: Date

constraints

{rangeSetIsKindOfLandCoverClassValue}

::RectifiedGridCoverage

{ domainsIsRectifiedGrid }

{ grid points shall coincide with grid cell centres }

::CoverageByDomainAndRange

{ gridFunctionRequiresGridDomain }

class Coverage

«featureType»

Coverages (Domain and Range)::

RectifiedGridCoverage

::CoverageByDomainAndRange

+ coverageFunction: CoverageFunction [0..1]

+ domainSet: Any

+ rangeSet: Any [0..*] {ordered}

::Coverage

+ metadata: Any [0..*]

+ rangeType: RecordType

constraints

{domainsIsRectifiedGrid}

{grid points shall coincide with grid cell centres}

::CoverageByDomainAndRange

{ gridFunctionRequiresGridDomain }

A revised model for INSPIRE coverages

class LandCoverExpanded

«featureType»

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+ inspireId: Identifier
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+ validTo: Date

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{ domainsIsRectifiedGrid }

{ grid points shall coincide with grid cell centres }

::CoverageByDomainAndRange

{ gridFunctionRequiresGridDomain }

class Coverage

«featureType»

Coverages (Domain and Range)::

RectifiedGridCoverage

::CoverageByDomainAndRange

+ coverageFunction: CoverageFunction [0..1]

+ domainSet: Any

+ rangeSet: Any [0..*] {ordered}

::Coverage

+ metadata: Any [0..*]

+ rangeType: RecordType

constraints

{domainsIsRectifiedGrid}

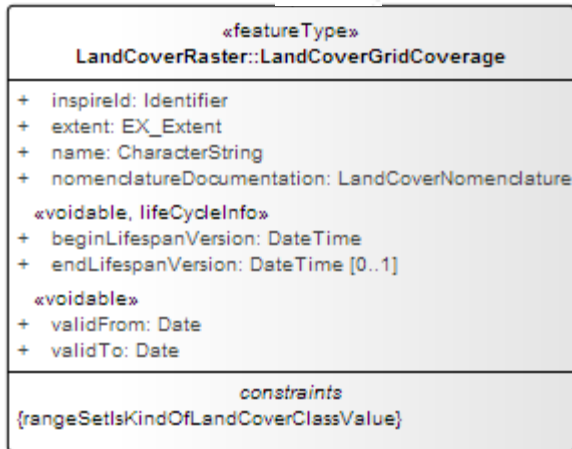
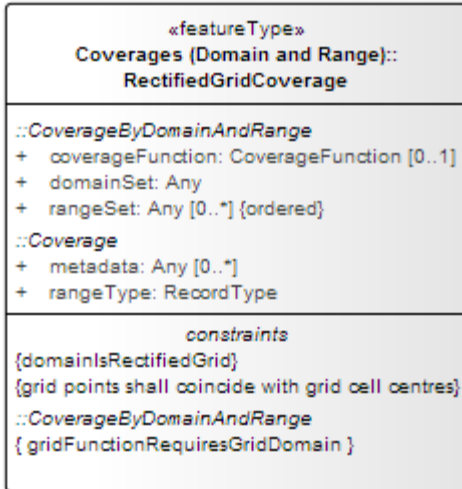
{grid points shall coincide with grid cell centres}

::CoverageByDomainAndRange

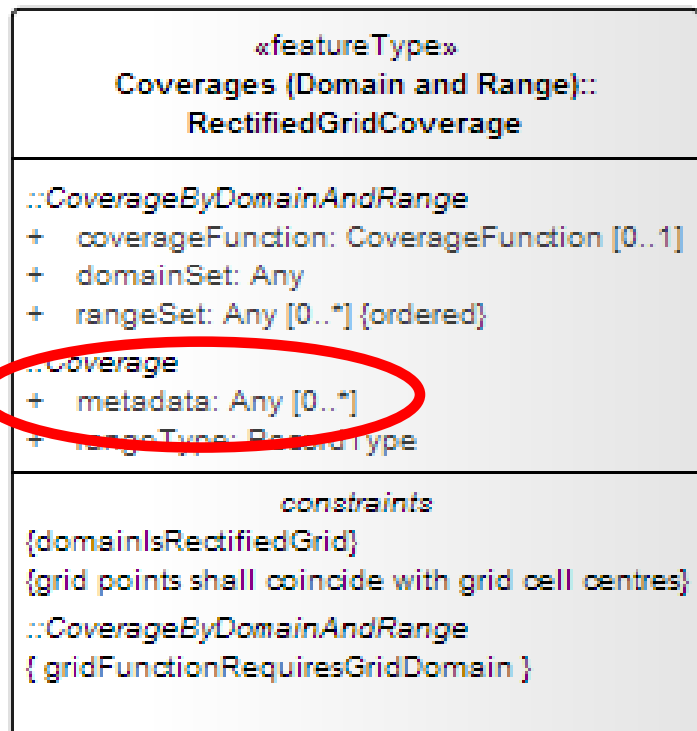
{ gridFunctionRequiresGridDomain }

A revised model for INSPIRE coverages

class LandCover



class Coverage



A revised model for INSPIRE coverages

class LandCoverMD

«featureType»
LandCoverGridCoverageMD

+ inspireId: Identifier
+ extent: EX_Extent
+ name: CharacterString
+ nomenclatureDocumentation: LandCoverNomenclature
«voidable, lifeCycleInfo»
+ beginLifespanVersion: DateTime
+ endLifespanVersion: DateTime [0..1]
«voidable»
+ validFrom: Date
+ validTo: Date

class Coverage

«featureType»
Coverages (Domain and Range)::
RectifiedGridCoverage

::CoverageByDomainAndRange
+ coverageFunction: CoverageFunction [0..1]
+ domainSet: Any
+ rangeSet: Any [0..*] {ordered}
+ Coverage
+ metadata: Any [0..*]
+ rangeType: RecordType

constraints

{domainsIsRectifiedGrid}
{grid points shall coincide with grid cell centres}
::CoverageByDomainAndRange
{ gridFunctionRequiresGridDomain }