



Interoperability, Through OGC web Services

ECMWF workshop

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Interoperability, what does it mean?

- Interoperability is concerned with the exchange of data through a common interface.
- Most metadata is only concerned with describing a resource (e.g. iso19115).
- This does not work well with truly dynamic metadata. This would include the detailed description of a model run at any point in its lifetime.
- The OGC “describe services” are designed to express the details of an offering”.



Interoperability, what does it mean?

- Must be able to understand the data exchanged.
 - Need metadata to describe the data in detail,
 - But,
- Need metadata to describe the:-
 - Service type i.e. allowed operations, permissions, supported profiles etc.
 - The contents of the “accessible data” (levels, fields, times etc)



Interoperability, what does it mean?

- Up to now the OGC community has been centered around a 2D world, but MetOcean has at least 5 dimensions (X,Y,Z,T, ensemble)
- Need to create a profile that specifically addresses the multi-dimensional data of the MetOcean community.
- The encoding (e.g.. GML, JSON) of this metadata needs to be based on a common model.
- In this talk we have called this model the “NWP Observation” and will use the O&M model.



COVERAGES:

- In order to understand data structures we need to define one!
- The TC211 (A high level technical committee) does this for us.
- The TC211 concept of a “feature” is well described and allows data models to be based on a core model.
- For gridded data such a model is known as a coverage and allows a number of “encodings” may be based on this conceptual model.

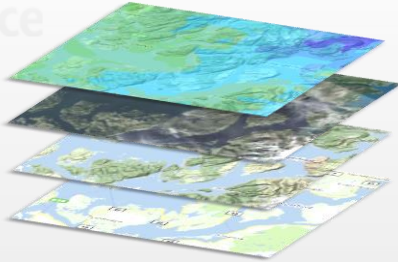


COVERAGES:

- A “coverage” is a special kind of geographic feature, with the distinguishing characteristics that whilst other features have one particular value associated a coverage typically conveys different values at different locations.
- A “coverage” is represented by its "domain" (the universe of extent) and a range of values representing the Coverage's value at each defined location.
- A “coverage” can be multi-dimensional, such as a 4-D x/y/z/t for climate, weather and ocean data.

What kind of coverages?

1. Assess foundation data



MetOc
imagery
DEM
topography/
bathymetry

2. UAV Mission Planning



deterministic &
probabilistic
weather f/c with
'confidence'
quality mask

3. Data capture (UAV & sensors) – integrate with predictive models



temp/pressure/ wind/precip time-series (deployed met-sensors)
temp soundings (deployed sono-bouys)
geo-rectified hi-res imagery / hi-res TIN coverage DEM

4. Assess overland trafficability for route plan



DEM
land-usage
terrain type
soil moisture
precipitation

5. Assess optimal coastal landing point and time



bathymetry
SCAT-winds
ocean-currents
sea-state
Tideline variation



Why WCS and Why OGC?:

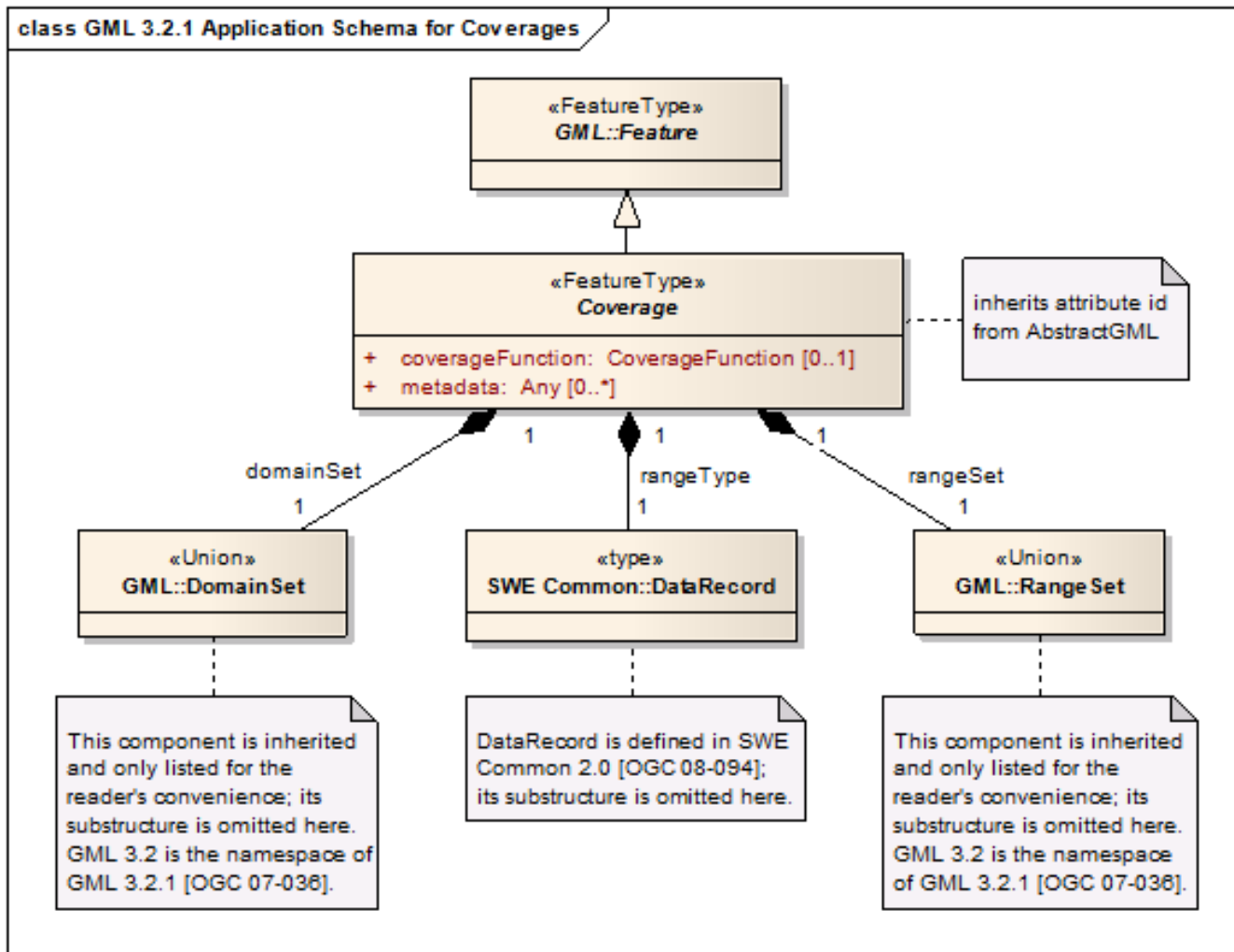
- *“The OGC Web Coverage Service (WCS) supports **electronic retrieval of geospatial data** as “coverages” – that is, digital geospatial information **representing space/time-varying phenomena.**”*
- *“A GetCoverage request prompts a WCS service to process a particular coverage selected from the service’s offering and **return a derived coverage.***
- *The WCS Core standard defines the domain sub-setting operation which delivers all data from a coverage inside a **specified request envelope** (“bounding box”), relative to the coverage’s envelope – more precisely, the intersection of the request envelope with the coverage envelope. “*



What is a coverage?

- A coverage has a domain,
- A set of parameters
- A set of results for each parameter
- Last, but not least it has “metadata”,
- The normal way to extract the information about any coverage is to use the “Describe Coverage” operation.
- The key question is: I have to know where I am in time and space for a result to have meaning.

Definition of Coverage





Is this enough information to adequately describe a coverage?

Name	Definition	Data type	Multiplicity
coverageId	Identifier of the coverage described	NCName	one (mandatory)
coverage-Function	GML 3.2.1 coverage function to describe how range values at coverage locations can be obtained	GML::CoverageFunction	zero or one (optional)
metadata	Application specific metadata	Any	zero or more (optional)
domainSet	Domain description of this coverage	GML::DomainSet	one (mandatory)
rangeType	Range structure description of this coverage	SWE Common::DataRecord	one (mandatory)
service-Parameters	Service-specific parameters of this coverage	ServiceParameters	one (mandatory)



Some key issues specific to MetOcean

- The methodology is to use the extension points already part of the WCS2.0 core profile.
- Some key issues to address:-
 - The data coverage may well be sparse, i.e. not all the data are available for every time and level. For example; air temperature may not be present for every output time-step at every specified level. It is therefore a challenge to present the output as a 4D coverage given the often sparsity of the data.
 - The time and level axes need to be enumerated as they are not regular. Solved by the time-height mask.



What is the relationship between Coverages and NWP data-sets?

- A coverage has axes just like NWP data
- A coverage has parameters and coordinate reference definitions
- It is easy to think of a coverage as a 2D field, but that would mean thousands of coverages per model run.
- A NWP model run is essentially a 4D cube of data so the trick is to create a coverage that has all four axes.
- This is the heart of the MetOcean work on coverages and of course WCS.



The New Met-Ocean Profile:-

- The purpose of this Met Ocean profile of WCS2.0 is to define the metadata returned in the response documents resulting from the WCS2.0 operations, for use within the meteorological and oceanographic communities
 - GetCapabilities,
 - DescribeCoverage
 - DescribeCoverageCollection
- We need a MetOcean profile for each of these operations.



WCS GetCapabilities MetOcean Profile

- There is a requirement to create clusters that organise the coverage collections into meaningful groups.
- Coverage collections are covered in a separate presentation, but they are very useful in limiting the size GetCapabilities response that might contain thousands of coverages as it can be limited to just listing the collections.
- Each collection has a unique identifier and the group names can be meaningful, for example: “Aviation Models”,
- Whereas a collection identifier could be “AVN_2015-05-15-00Z”



WCS DescribeCoverage MetOcean Profile

- Based on the observations and measure pattern (O&M)
- This is an iso standard (iso 19156)
- This pattern is used by the WXXM aviation community



A Multi-Dimensional Coverage

- Built over WCS 2.0 Core. Targeted on exposing NWP data, but applies to all multi-dimensional data.
- A challenge; how do you create a 3D/4D grid from an irregular grid with missing data?
- For actual coverage listing available forecast offsets and vertical levels using the “availability mask” (data mask). This is similar to masks in GRIB fields.



Met Office

The NWP Observation

- The key concept that underlies the metadata is the description of the NWP observation.
 - So what do we mean?
 - Meteorological observations or forecasts clearly relate to the real world. For example, we may observe the weather for Denver or provide a weather forecast for the North Atlantic European, however, there is a level of abstraction to resolve:
 - An observation of the weather for the town of Exeter happens at some representative location within the town or some representative locale nearby. The forecast domain for the North Atlantic European area is specified so that it covers the areas for which a forecast is required.
 - In each case, the observation event relates to some sampling regime that is a proxy for the real entity of interest (e.g. the site of the weather station, or the extent of the forecast domain). The observation or forecast is not directly related to real-world entities. ISO 19156 Observations and Measurements provides a conceptual model for describing this layer of indirection; Sampling Features.

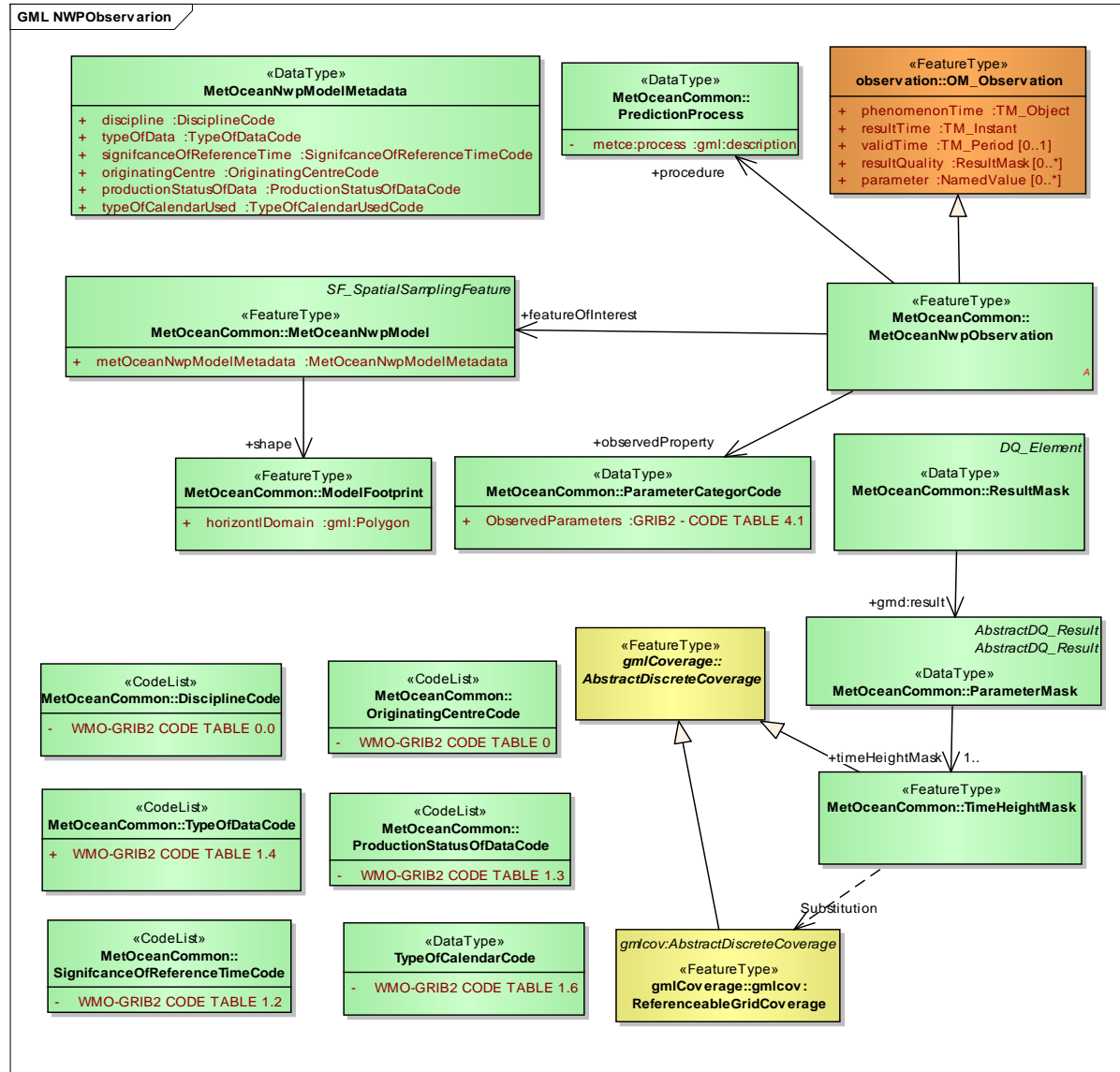


The New Met-Ocean Profile:-

- A MetOcean coverage is multi-dimensional, so height is not a attribute, but a true axis
- The metadata must support this multi-dimensionality i.e. The time and vertical axes need to be enumerated.
- A “MetOcean Coverage” is a coverage, but it we have to cope with “missing data”, i.e. it is often a “sparse coverage”.
- A mask is used to describe the “result quality”



The NWP Observation





The Requirements class

Requirements Class

<http://www.opengis.net/spec/metocean/1.0/req/uml-MetOceanNwpObservation>

Requirement

/observed-property

The observed property of the OM_Observation type shall be a link the WMO code definitions as described in the GRIB tables.

Requirement

/result-quality

The MetOceanNwpObservation shall have a resultQuality property (from OM_Observation) that points to a ResultMask.

Requirement

/feature-of-interest

The 'featureOfInterest' property of the OM_Observation element shall reference a MetOceanNWPMModel that is an instance of SF_SpatialSamplingPoint (from ISO 19156:2011 Spatial Sampling Features).

Requirement

/phenomenon-time

The MetOceanNwpObservation shall have a phenomenon time that is a time period denoting the validity period of the forecast.

Requirement

/resultmask

The ResultMask shall through the specialisation of gmd:result reference a TimeHeight Mask of type "ReferenceableGridCoverage".



The Requirements class

Name	Definition	Data types and values	Multiplicity
discipline	This table is used to indicate the discipline of the processed data contained within a specified Coverage. (this will reference WMO GRIB2 table 0.0)	DisciplineCode	1
typeOfData	A code to indicate if the what of kind of NWP product, e.g. analysis, forecast, analysis and forecast etc.(this will reference WMO GRIB2 table 1.4)	TypeOfDataCode	1
significanceOfReference Time	This defines the meaning of "Reference Time (this will reference WMO GRIB2 table 1.2)	SignificanceOfReferenceTime Code	1
originatingCentre	NATIONAL/INTERNATIONAL ORIGINATING CENTERS (this will reference WMO GRIB2 table 0)	OriginatingCentreCode	1
productionStatusOfData	The code used to indicate the production status, e.g. operational, research etc(this will reference WMO GRIB2 table 1.3)	ProductionStatusOfDataCode	1
TypeOfCalendar	The code used to indicate the type of calendar being used e.g. Gregorian, 360 day (often used by climate models), (this will reference WMO GRIB2 table 1.6)	TypeOfCalendarCode	1

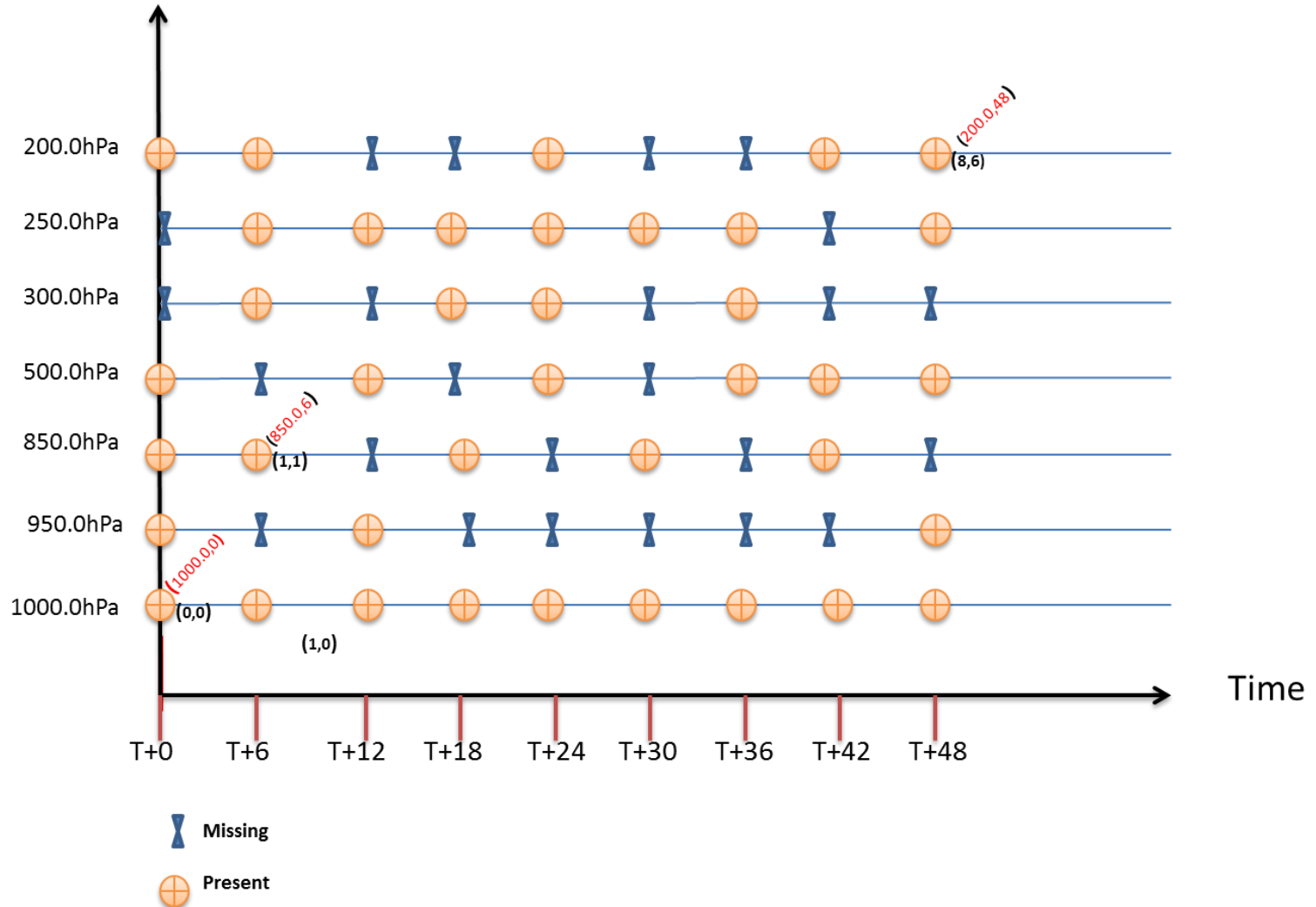


The Result mask

- The use of O&M property resultQuality
 - A reference to a pertaining TimeHeight mask is stored, together with the name of the physical parameter to which it corresponds. A Time-Height Mask is a 2-D ReferenceableGridCoverage with height/time axes and Boolean range values.
 - Such a mask serves to indicate areas where all range values, across the whole horizontal extent, contain only nil values This serves as a hint to applications as to which regions contain “interesting” (i.e., non-nil) values.
 - This is specialised using gmd:result that references the parameter mask that in turn references the timeHeightMask.



The data mask for a sparse coverage.





WCS DescribeCoverage A MetOcean Profile data

- The NWP Observation metadata links to a GRIB2 description, wherever possible
- This ensures a controlled set of vocabularies.
- This is based on the GRIB2 tables and referenced to a WMO based registry.
- The metadata is not restricted to WMO, but all the references must be links to a controlled registry.



But what about the real world?

- For example:-
 - The status of any NWP “Model Run” should be available using an OGC Web Service.
 - Thus the progress of any model run could be monitored.



Collections:-

- The concept of collections is very powerful as it allows coverages to be grouped together.
- An individual model run is, in its own right, a collection of coverages, each with a different vertical coordinate reference system.
- There is often a requirement to compare values from different simulations. The “reference times” (aka model run times) are considered to be a property of the coverage collection.



Describe coverage collection

- A *DescribeCoverageCollection* request submits a list of identifiers for Coveragecollection resources and returns, for each identified Coveragecollection resource, a description of the coveragecollection.
 - A *GetCapabilities* request allows retrieval of the identifiers of all coveragecollection resources currently offered by the WCS service.
 - A client application is not required to retrieve identifiers via a *GetCapabilities* request and may use alternative means

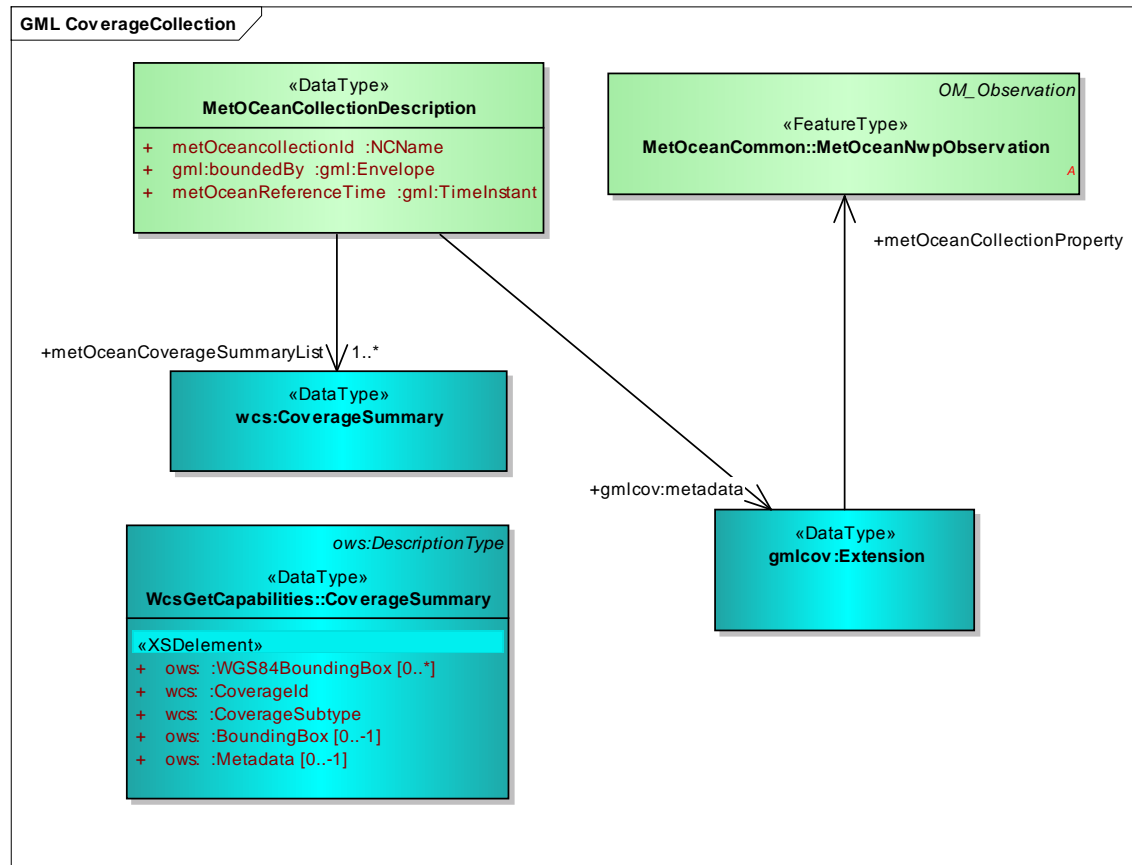


MetOceanDescribeCoverageCollection

- MetOceanCollectionId:-
 - The identifier of the MetOceanCollection. ,
- The bounding box'
 - that contains the coverageCollection
- MetOceanReferenceTime,
 - The reference time of the collection if needed.
- gmlcov:metadata,
 - The extension point for metadata in point for Metadata. 1



MetOceanDescribeCoverageCollection UML





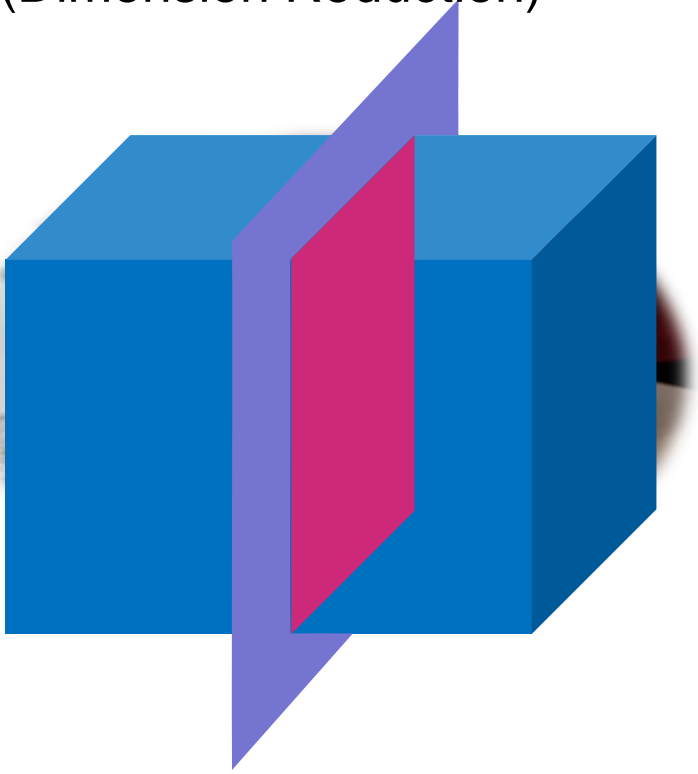
What kind of shapes:-

- A number of use cases have been examined and the following “data shapes” have been identified.
 - GRIDS:
 - Time Series:
 - Cross sections:
 - Point collections (e.g. observations):
 - Vertical profiles (e.g. ascents):
 - Trajectories:

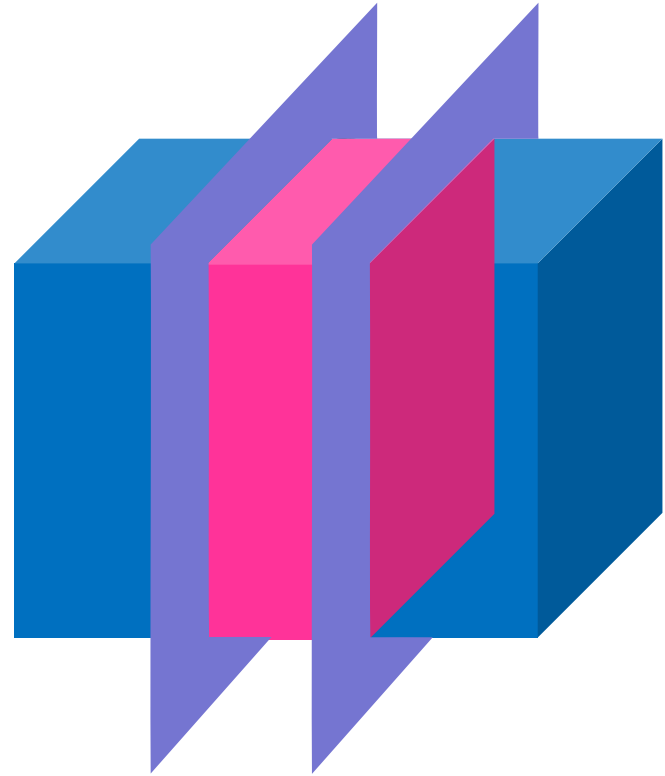


WCS 2.0 Core GetCoverage Operation

Slice Operation
(Dimension Reduction)



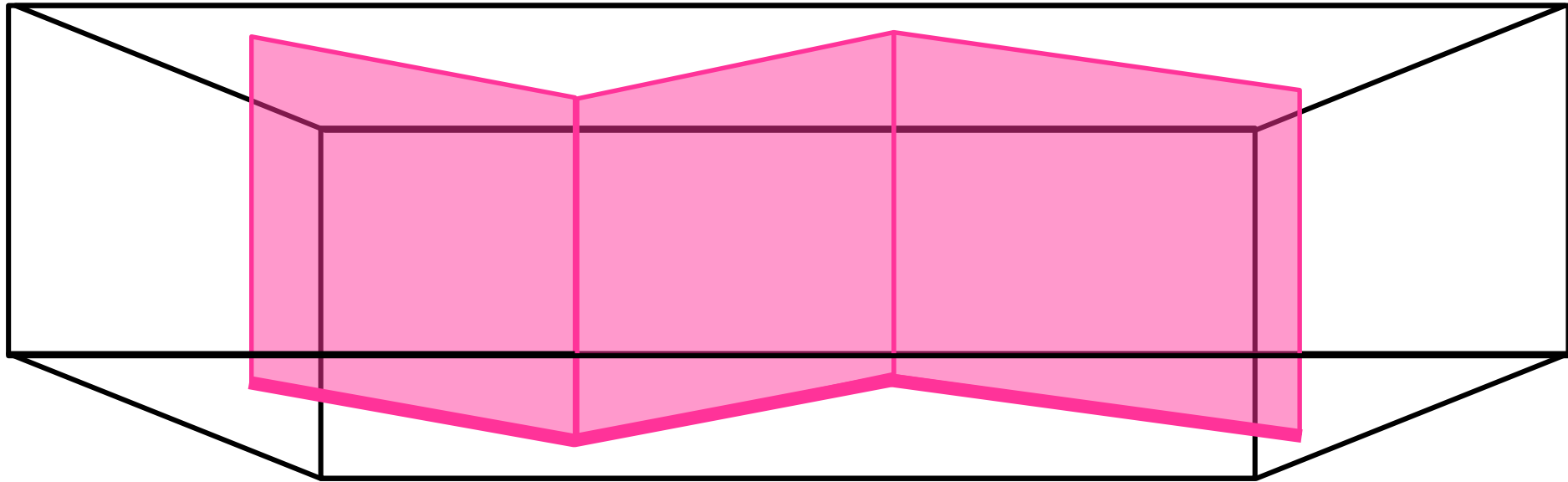
Trim Operation
(Extent Reduction)



Courtesy Jozef Matula IBL



Meteorological Data Extraction Patterns



- Extracting vertical profile data for a trajectory =
Trim in Trajectory CRS



Specifying a Trajectory/Corridor

- Some definitions:-
 - **GetMetOCeanCorridor operation**
 - request to a WCS server for a corridor coverage based on a trajectory path with a lateral and vertical extent.
 - **path**
 - the route or course along which something travels or moves, for example the path of an aeroplane .
 - **corridor**
 - a corridor is defined as a passageway. The spatial extent is defined in one or more dimensions with reference to the path .

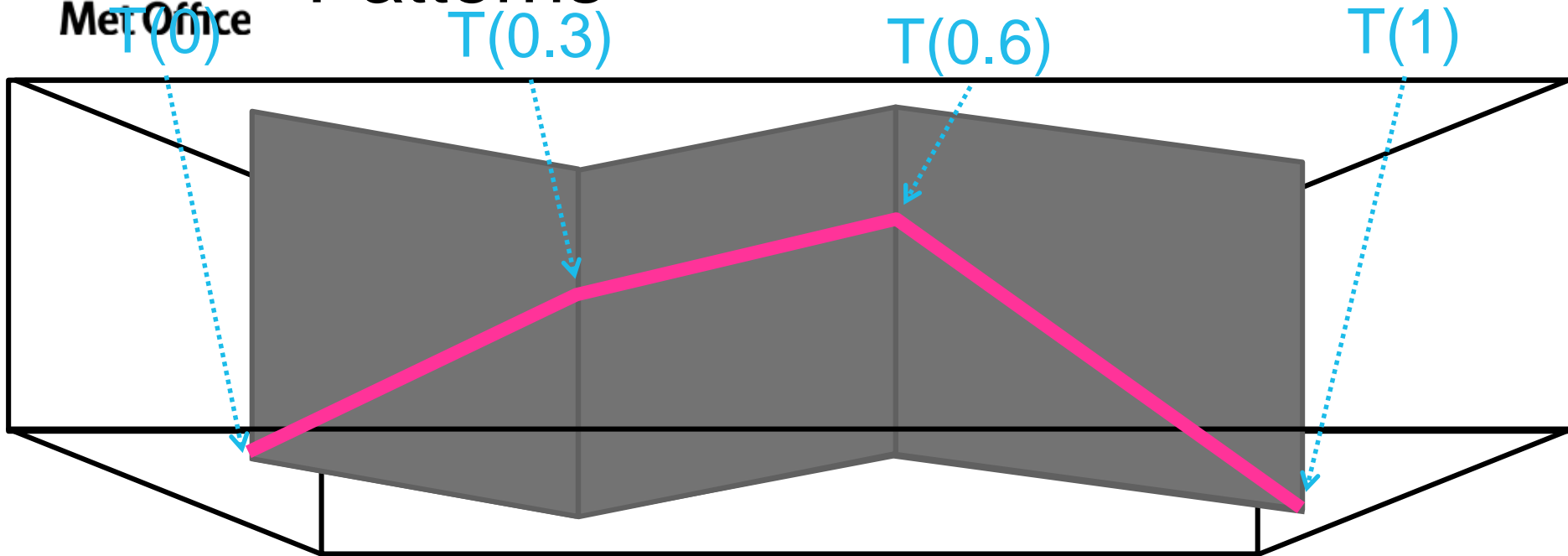


Specifying a Trajectory/Corridor

- **A trajectory/corridor may be specified in a number of ways.**
 - Need to identify the key parameters needed to meet the majority of use case:
 - Recognise that not all servers will support every variation.



Meteorological Data Extraction Patterns



- Extracting data for a 3D trajectory (airplane flight) = Trim in 3D Trajectory CRS
- 3D Trajectory CRS is 1 dimensional function $T(q)$ for q in $\langle 0;1 \rangle$ mapping q to real X, Y, Z coordinates.



Corridors

WCS 2 demo x

labs.metoffice.gov.uk/map/journey/journey.html

Apps For quick access, place your bookmarks here on the bookmarks bar. [Import bookmarks now...](#)

Pick options

.....

UKPPNOW ▾

List available data

Wind_Speed ▾

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48

exeter

Journey start time:

21/11/2014 08:00

wyton

Get Route

Map data ©2014 GeoBasis-DE/BKG (©2009), Google Terms of Use Report a map error

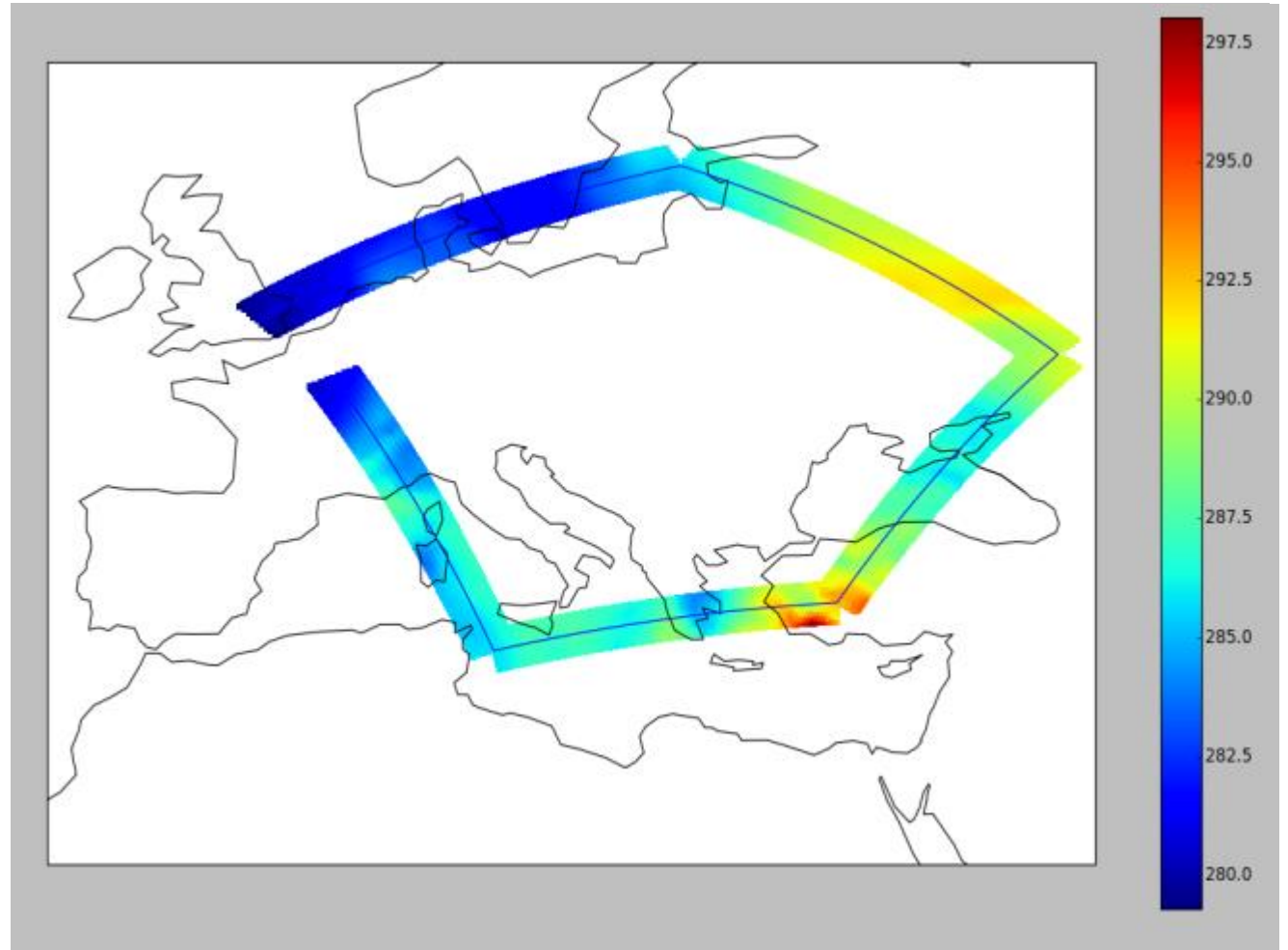
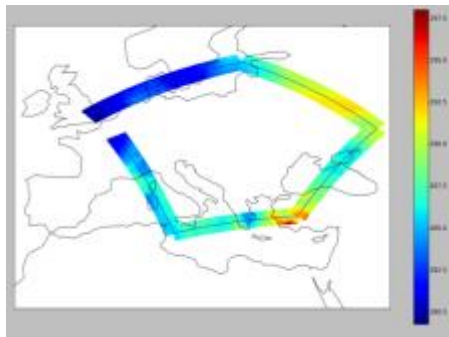
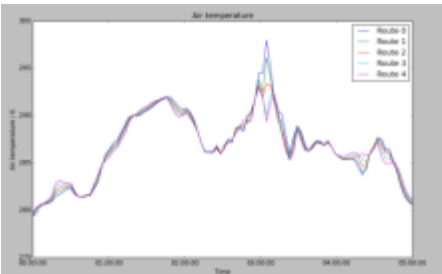
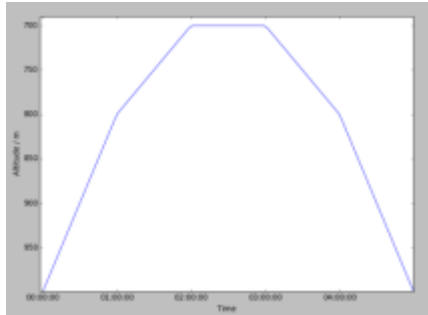


Planes, Trains and Automobiles





Visualisation





Questions & answers