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# Web Coverage Service Meeting with Reality

Visual   
Weather

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- Why should you be interested?
- OGC Web Coverage Service
  - WCS Core 2.0
- Meteorological Data Extraction Patterns
- MetOcean DWG WCS 2.0 Profile (Proposal)
  - Mapping NWP Models
  - Vertical level types
  - Trajectories and corridors

By courtesy of Peter Trevelyan, UK Met Office  
and Pavol Novotný, IBL

- Meteorological services all around the world **produce lots of gridded data**. There is more and more data available.
- There is increasing demand from end-users for the *raw* data (understandable by their computers) rather than for the data *visualisation* (what only humans can read).

## Is there a chance of rain within next 7 days?

If user's computers want to take decision, we can:

- push all data to the user and let him evaluate the answer or,
- provide user with “subset” of the data.

- Data volumes grow faster than the network links.

## Is there a chance of rain within next 7 days?

1M grid points x 24h x 7 days  $\approx$  hundreds MB of data

- *Wikipedia: “**Big data** is the term for a collection of data sets so large and complex that it becomes difficult to process using on-hand database management tools or traditional data processing applications. The challenges include capture, curation, storage, search, **sharing, transfer, analysis, and visualization.**”*
- **Sooner or later the data volumes needed for “some simple answers” will not be transferable over networks!**

# Why Should You Be Interested in WCS?

- If you just start reading the specification it seems like dream given a form and it has all what is needed:
  - *WCS 2.0 Spec: “The OGC Web Coverage Service (WCS) supports **electronic retrieval of geospatial data** as “coverages” – that is, digital geospatial information **representing space/time-varying phenomena.**”*
  - *WCS 2.0 Spec: “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 subsetting 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.”*
- WCS is a machine to machine protocol for gridded data extraction (subsetting).



- 49 pages, closely coupled with GML.
- 3 main types of requests (procedures):
  - GetCapabilities – lists all coverages.
  - DescribeCoverage – describes coverage metadata.
  - GetCoverage with “Slice” and “Trim” operations.
- Designed to be extensible:  
*WCS 2.0 Spec: “OGC Profile and Application Profile standards establish domain-targeted specializations of interface standards.”*
- By default the WCS requests are passed via HTTP XML POST requests with a complicated XML schema.

# WCS 2.0 Core GetCoverage Operation

Corn Density Coverage 1

Corn Density Coverage 2

GetCoverage Operation

New Coverage

Potentially different geospatial domain

Potentially different data format

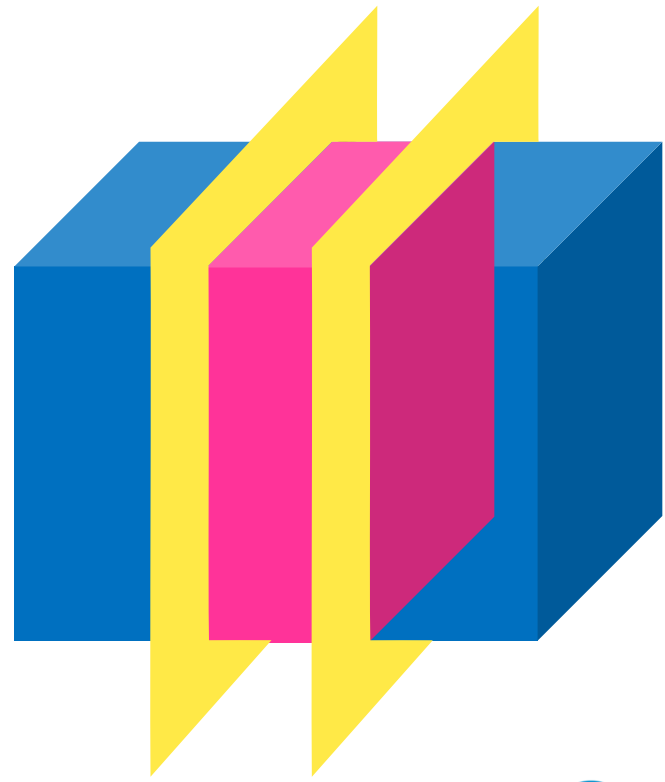


# WCS 2.0 Core GetCoverage Operation

Slice Operation  
(dimension reduction)

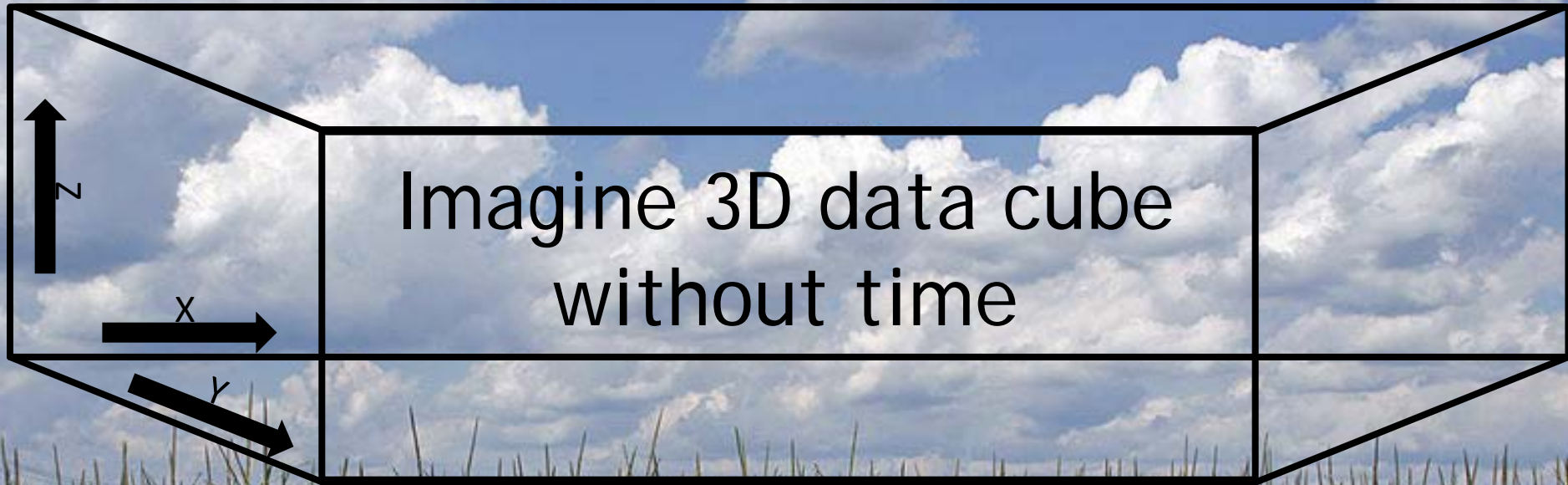


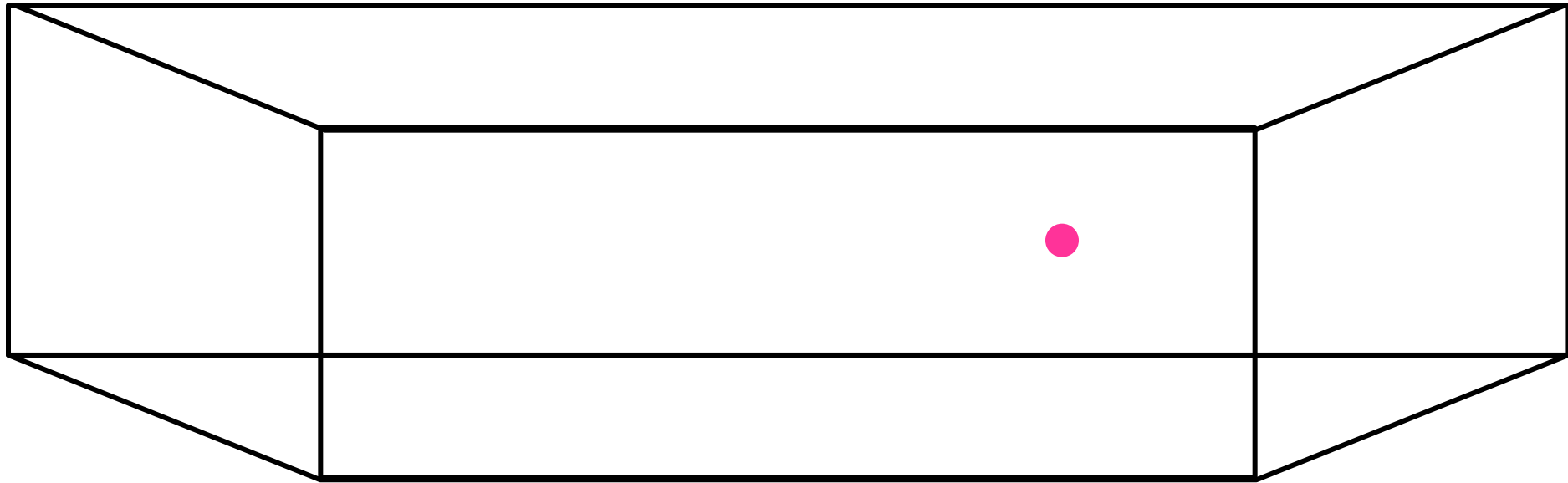
Trim Operation  
(extent reduction)



- Source coverage data is potentially N dimensional – just like variables in NetCDF.
  - Can have X, Y, Z (vertical level), Time.
- “Slice” operation reduces dimensions e.g.  
from 3D  $\rightarrow$  2D or/then 2D  $\rightarrow$  1D.
- “Trim” operation implements dimension range subsetting e.g.  
if applied to both X and Y we create a BBOX subsetting.
- “Slice” and “Trim” can be requested in other coordinate reference systems (CRS) than the CRS of the source data (in this case reprojection is needed).

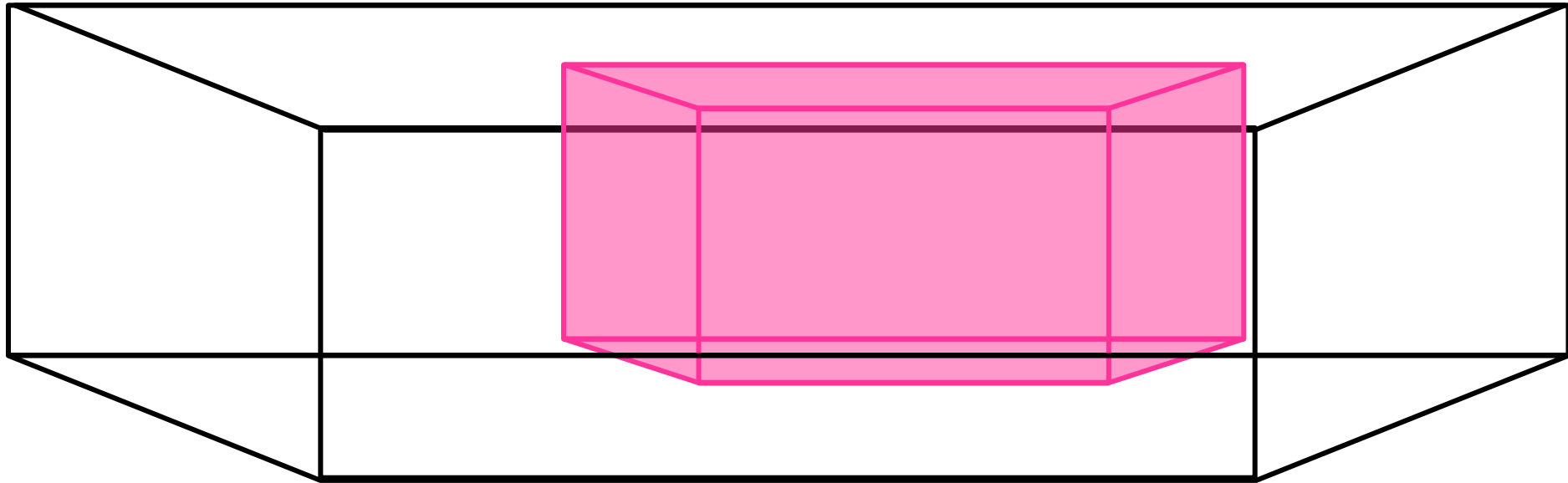
# Meteorological Data Extraction Patterns



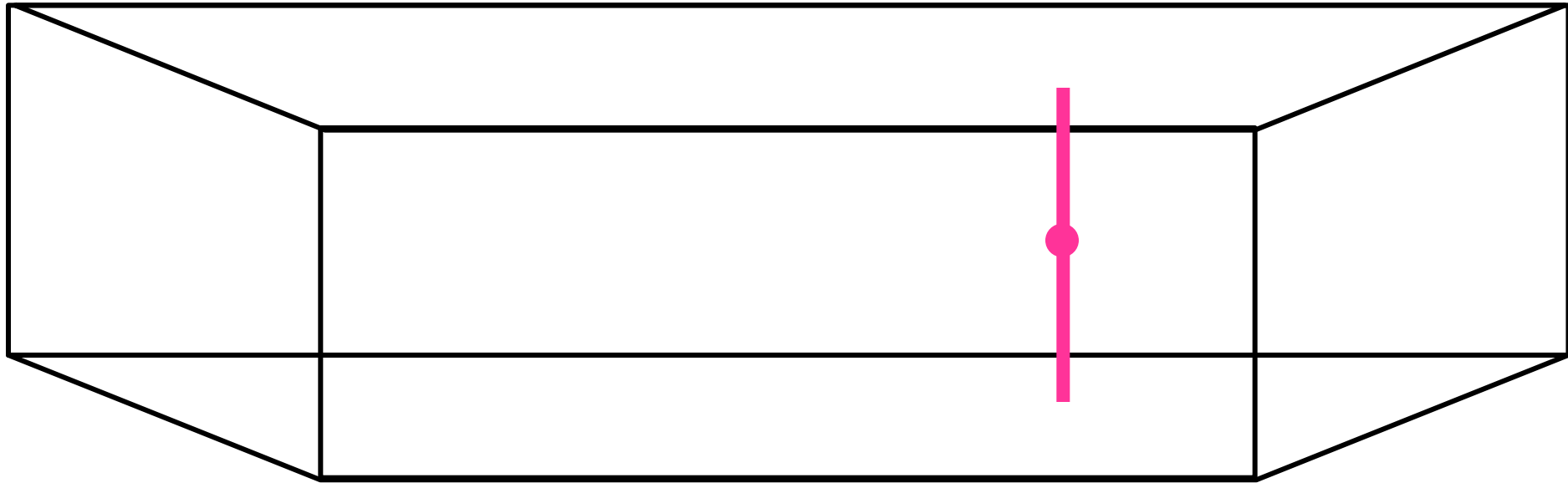


- Extracting data for a point = Slice X, Slice Y, Slice Z

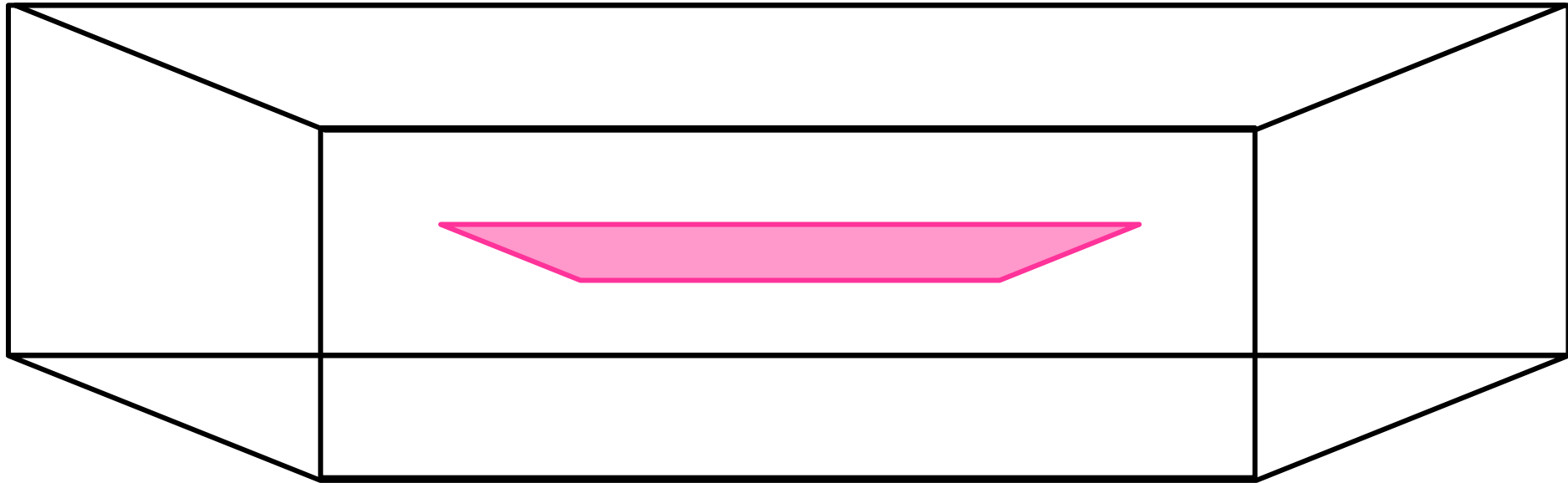




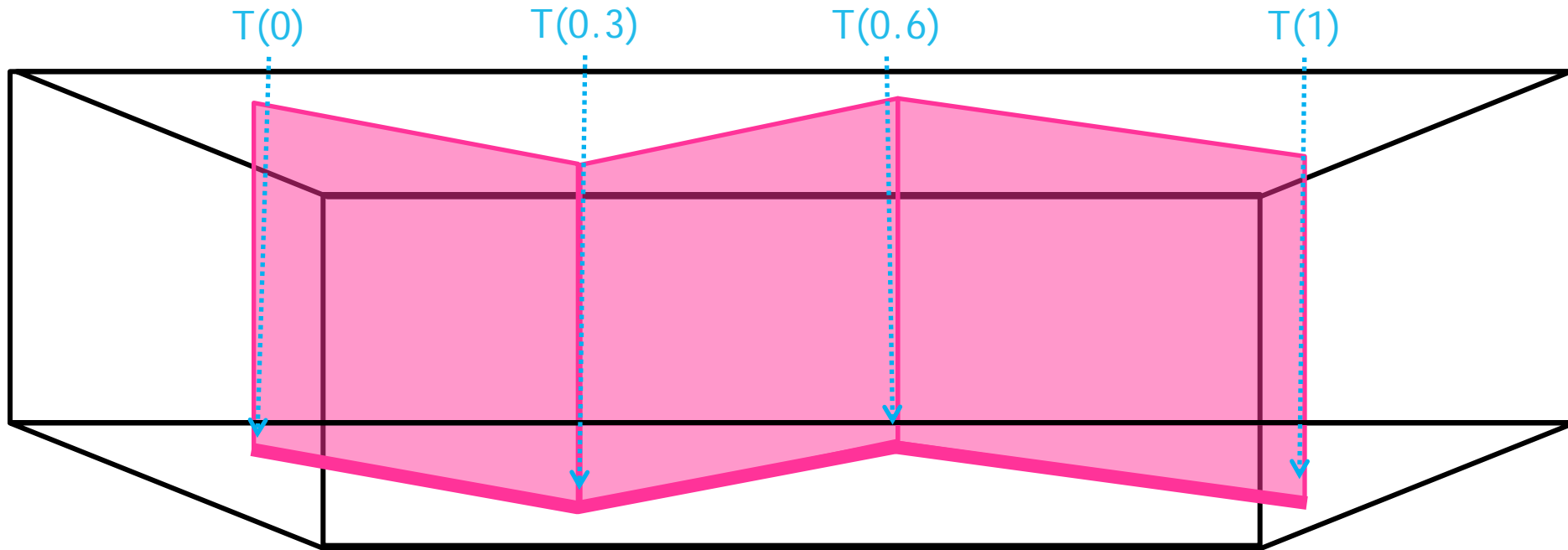
- Extracting vertical profile data for 2D geospatial domain = Trim X, Trim Y, Trim Z



- Extracting vertical profile data for a point = Slice X, Slice Y
- With vertical range = Slice X, Slice Y, Trim Z

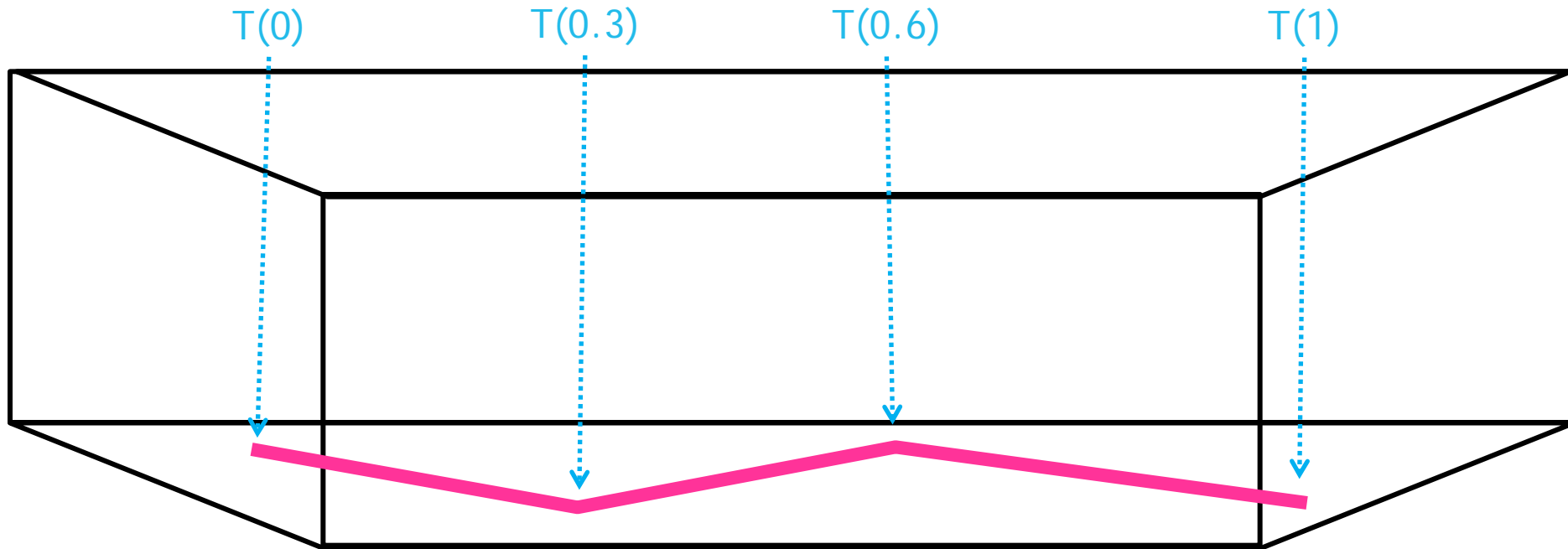


- Extracting data for 2D geospatial domain for a single vertical level = Trim X, Trim Y, Slice Z

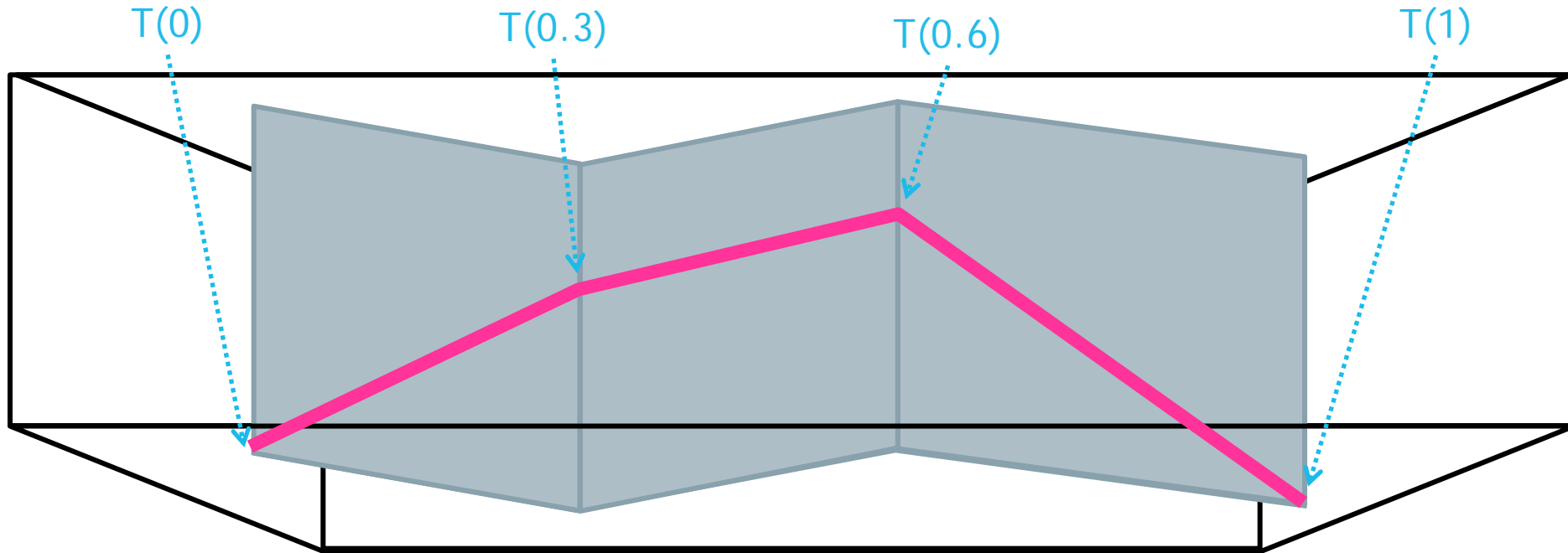


- Extracting **vertical profile** data “above” a trajectory =  
Trim in Trajectory CRS
- Trajectory CRS is 1 dimensional function  $T(q)$  for  $q$  in  $\langle 0;1 \rangle$   
mapping  $q$  to actual X, Y coordinates!





- For road we need **Compound CRS** = Trajectory CRS + Z axis =  
Trim in Trajectory CRS + Slice in Z.



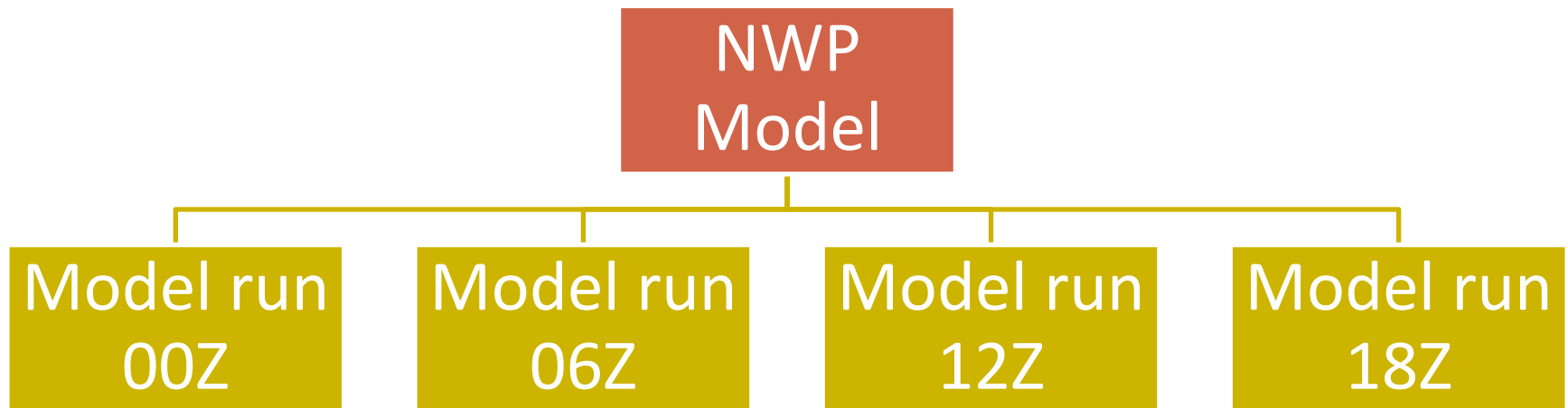
- Extracting data for a 3D trajectory (airplane flight) = Trim in 3D Trajectory CRS
- 3D Trajectory CRS is 1 dimensional function  $T(q)$  for  $q$  in  $<0;1>$  mapping  $q$  to real X,Y,Z coordinates.

- All mentioned patterns were purely geospatial and height related.
- Is the **time** is just yet another 4<sup>th</sup> dimension?
- We need to take into account:
  - Forecast validity time.
  - Model run reference time.
  - Ensemble member dimension.
- This potentially creates a 6D coverage?!
- Not to be forgotten too - “sampling” and “interpolation”.

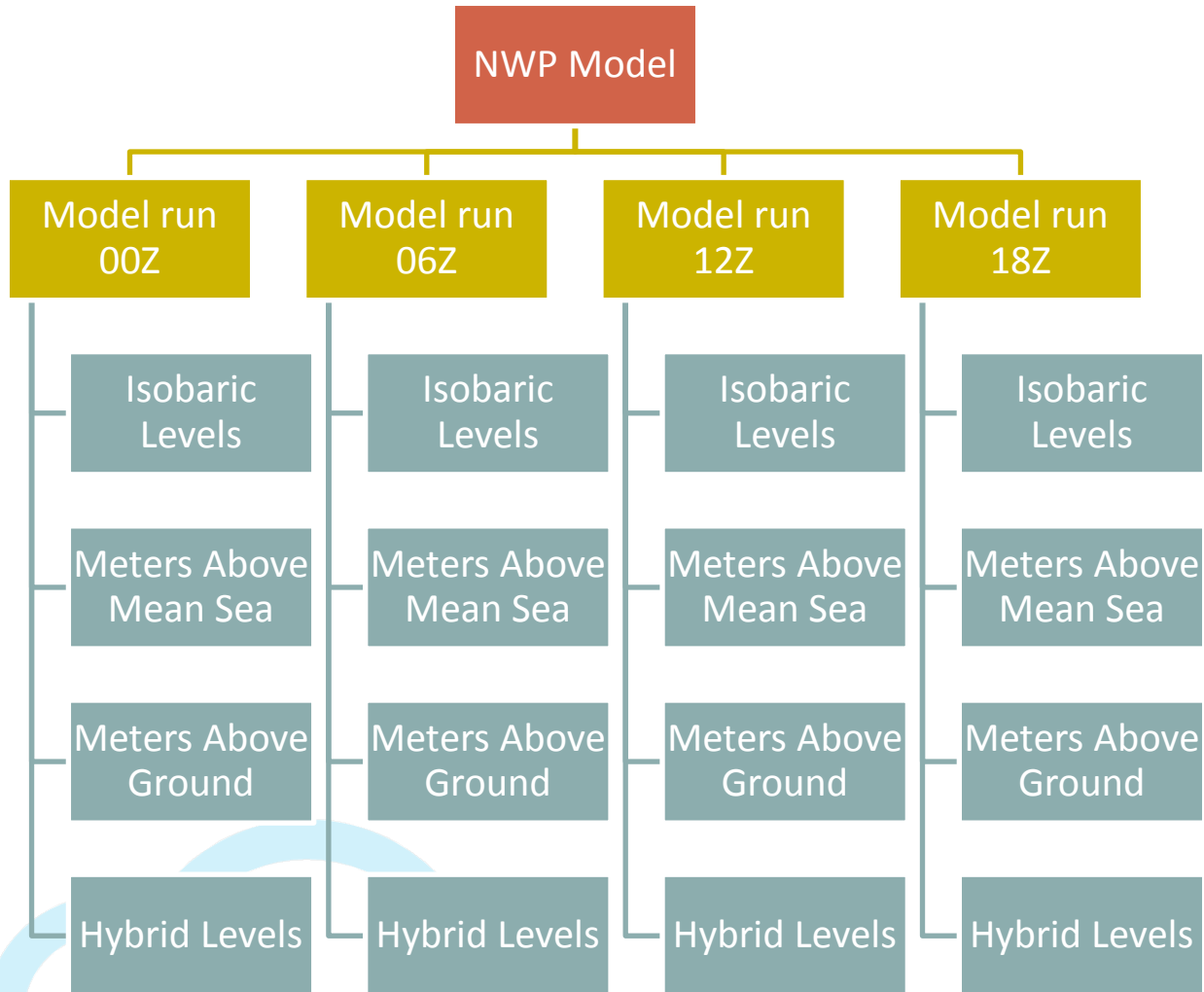
- *WCS 2.0 Spec: “The specification contained in this **WCS Core** is not sufficient for a fully functioning WCS implementation.”*
- No guidance on how to advertise validity times for which coverage data is available!
- Vertical level type of a coverage must be uniform (same as in WMS)
- Definition of “trajectory CRS” is strange quite hard to extend (time, corridor extents, interpolation types, etc).
- Unclear dimension name called “t” or “time”. Some CRSs use “lat”, “long”, some “x”, “y” coordinates.

- Protocol Extensions:
  - Key-Value Protocol Binding (using HTTP GET requests)
  - SOAP
- Format Extensions (GML, GeoTIFF, HDF-EOS, ...)
- Range Subsetting (extract only certain values)
- WCS Processing Extension (WCPS)
- “EO-WCS” Earth Observation WCS 2.0 Profile:
  - Defines metadata about times for which the coverage is available
  - Targeted on satellite imagery (EO)

- Built over WCS 2.0 Core. Targeted on exposing NWP data.
- Coverage =
  - Set of NWP Model Parameters,
  - from certain model run reference time (e.g. run from today 00Z),
  - using certain vertical level type (e.g. only hPa or only meters).
- Coverage Collection =
  - Logical set of coverages, possibly with mixed vertical levels types, various model runs etc.
  - Set of parameters for certain use case e.g. “Aviation Parameters Coverage” including Wind, Temperature, Icing and Turbulence coverages.
  - Whole NWP model e.g. “ECMWF Deterministic Global Model Coverage”.

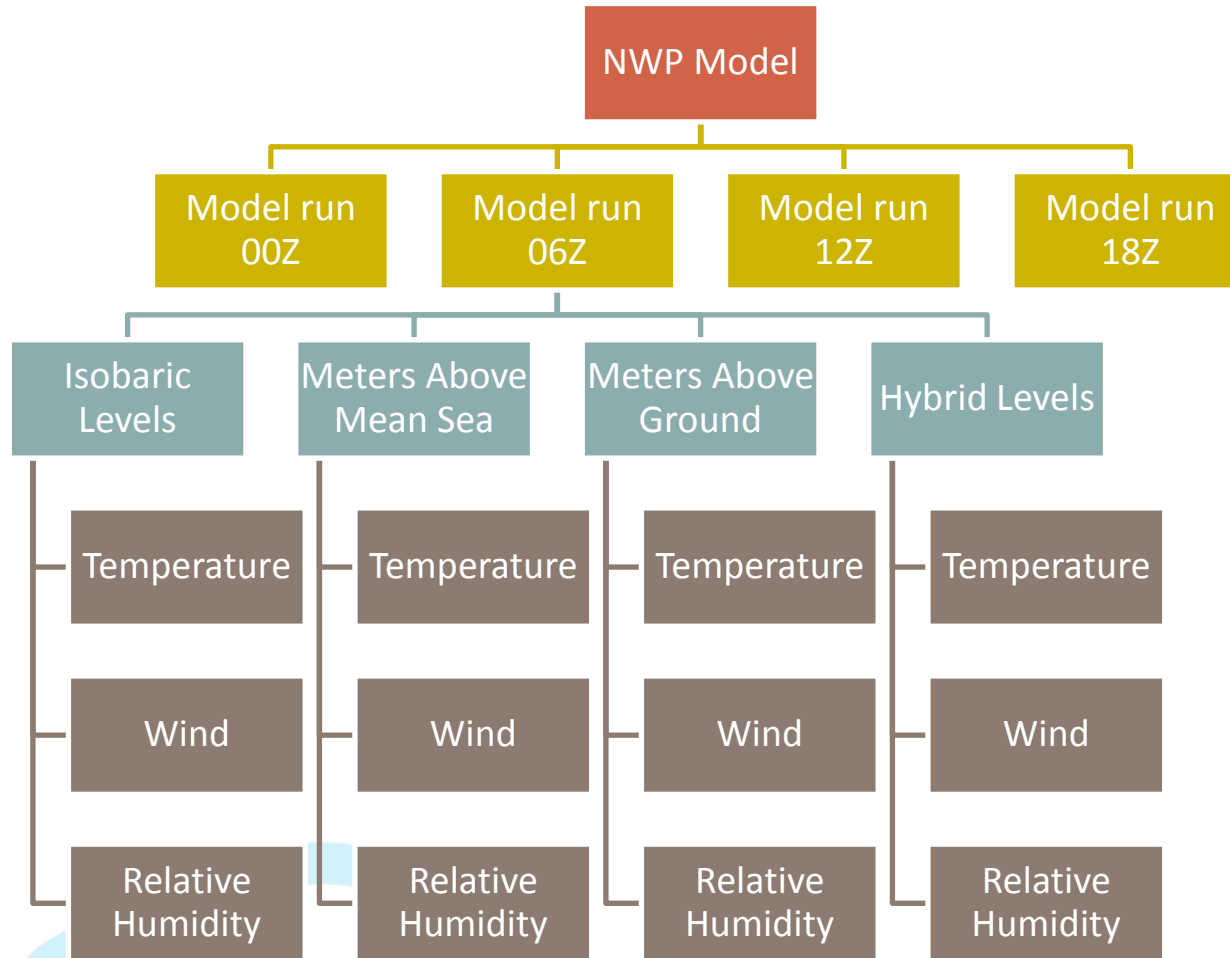


# MO Profile – NWP Metadata Hierarchy



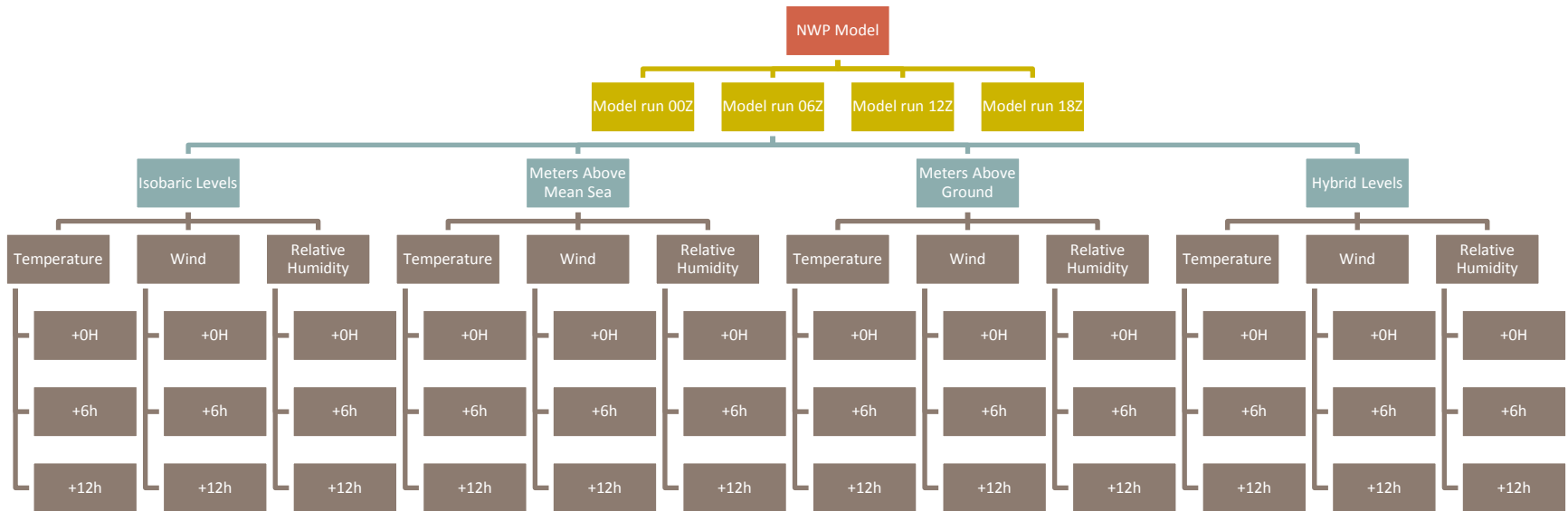


# MO Profile – NWP Metadata Hierarchy



# MO Profile – NWP Metadata Hierarchy

Metadata for one NWP model run assuming “only” 3 parameters, 3 forecast offset times.  
Intentionally unreadable!



# MO Profile – NWP Metadata Discovery

GetCapabilities()

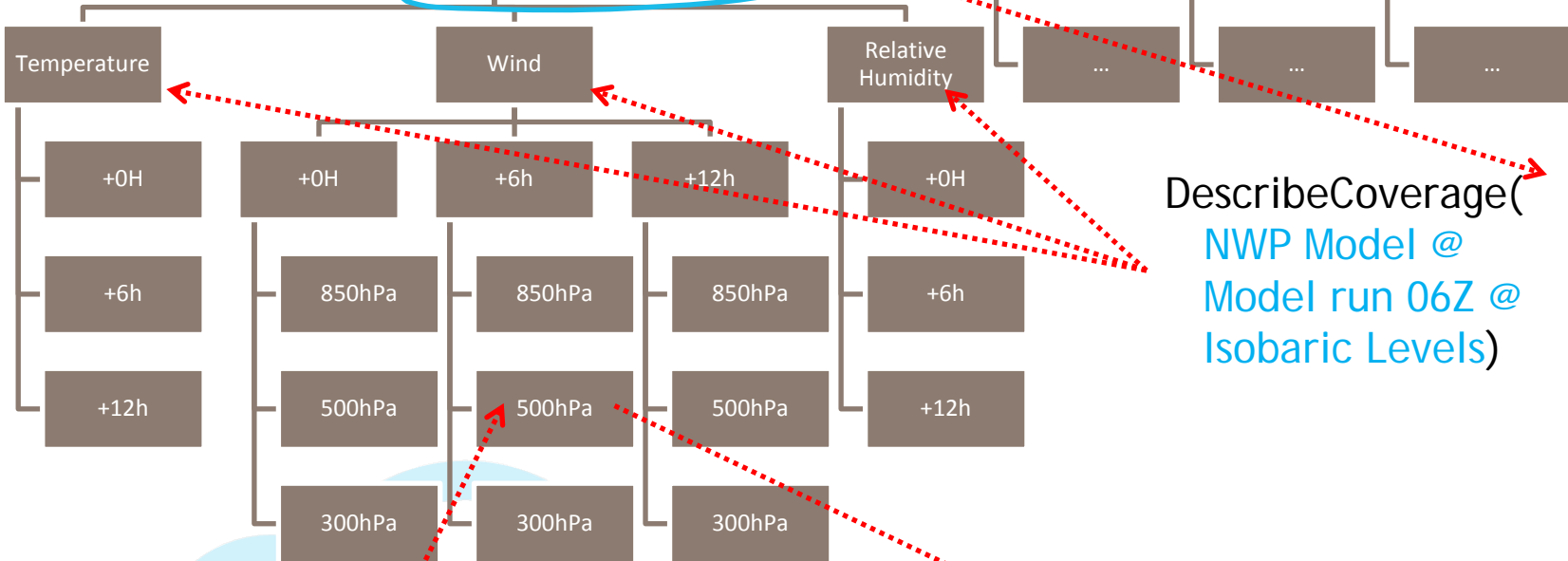
NWP Model  
CoverageCollection Identifier

DescribeCoverageCollection(NWP Model)

Model run 00Z Model run 06Z Model run 12Z Model run 18Z ...

Isobaric Levels  
Coverage Identifier

Meters Above Mean Sea Meters Above Ground Hybrid Levels



DescribeCoverage(NWP Model @ Model run 06Z @ Isobaric Levels)

GetCoverage(Wind, SliceZ(500hPa), SliceT(+6h)...) →

Resulting Coverage Data

- Backward compatible with standard WCS GetCapabilities.
- Declares 2 custom operations:
  - DescribeCoverageCollection
  - GetCorridorCoverage
- Includes metadata about available Coverage Collections.
- Typically one NWP model is exposed as a single Coverage Collection.
- User has to use the DescribeCoverageCollection operation to discover further details/metadata.

- Request returns detailed metadata of Coverage Collection:
  - Listing “**actual coverages**” - NWP model runs and vertical levels types used in this collection – for example GFS Coverage Collection with 3 different vertical level types (ISBL, AGL, AMSL) can list following coverages:

GFS\_2013-11-07T00.00.00Z\_ISBL

GFS\_2013-11-07T00.00.00Z\_AGL

GFS\_2013-11-07T00.00.00Z\_AMSL

GFS\_2013-11-07T12.00.00Z\_ISBL

GFS\_2013-11-07T12.00.00Z\_AGL

GFS\_2013-11-07T12.00.00Z\_AMSL

- User has to use the DescribeCoverageCollection operation to discover further details/metadata.

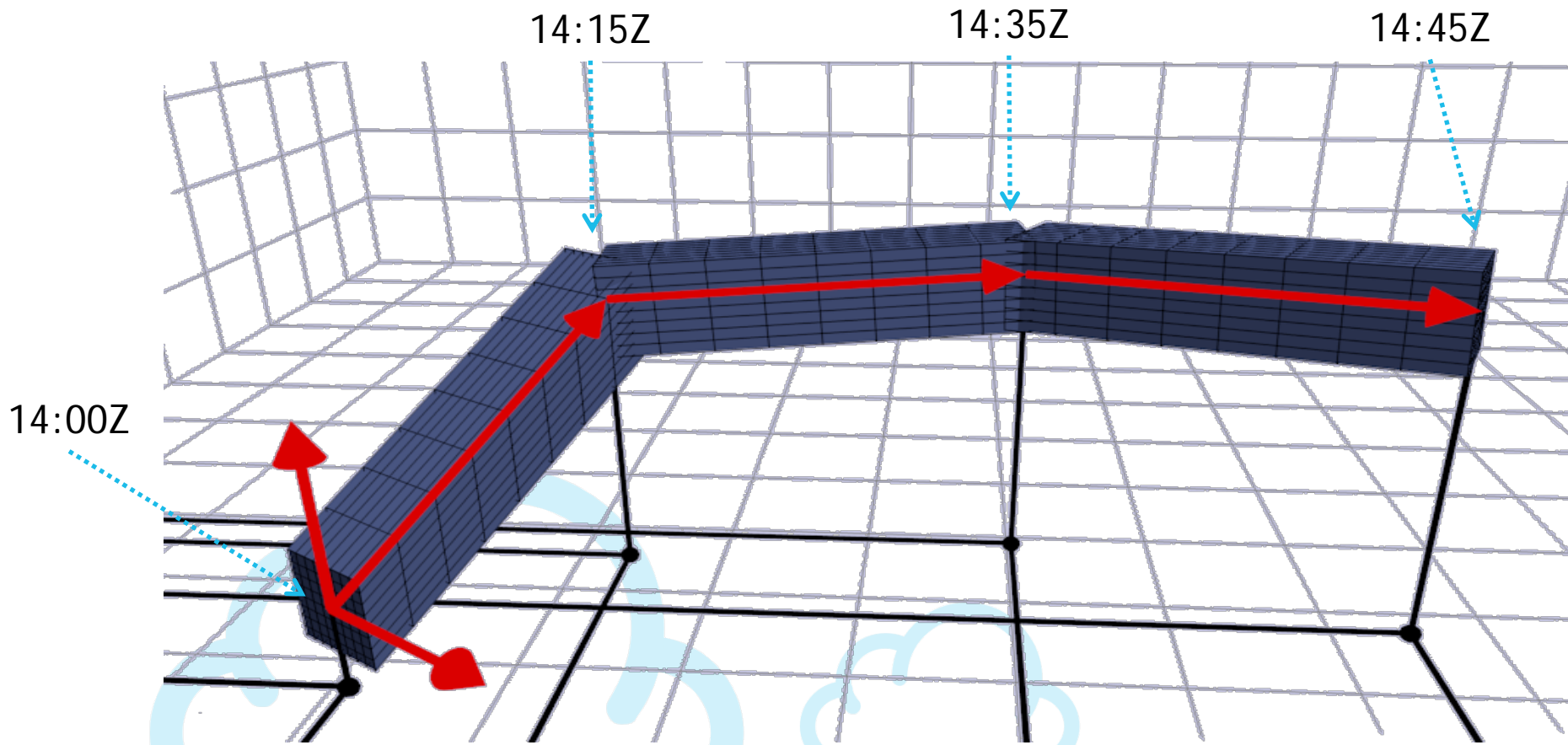
# MO Profile – DescribeCoverage

- Backward compatible DescribeCoverage.
- For actual coverage listing available forecast offsets and vertical levels using the “availability mask” (matrix).



# MO Profile – GetCorridorCoverage

- Native 2D+Time (fixed height) or 3D+Time trajectory concept.
- Trajectory depiction is part of request rather than part of CRS.
- Z extent is metric height in meters.



- In Visual Weather 3.6 we implement WCS 2.0 interface for:
  - accessing NWP data,
  - reprojection,
  - vertical interpolation,
  - horizontal interpolation.
- Support for trim and slice operations.
- Exposing metadata conforming to:
  - Earth Observation WCS Profile as well as
  - Met Ocean WCS Profile.
- Supported output formats are GRIB1, GRIB2, NetCDF and GeoTIFF, JSON, KML.



- Well, the WCS 2.0 MetOcean Profile is a work in progress.
- Future work and plans should/will address:
  - Key-Value-Pair HTTP GET Binding Profile to simplify usage.
  - GetPolygonCoverage (coverage over only polygonal geospatial area)
  - GetCrossSectionCoverage (coverage over only polygonal geospatial area)
  - GetCoverageStatistics / GetCorridorCoverageStatistics / GetPolygonCoverageStatistics –solve another a “big data” use case.
  - Ensemble models.
  - Merge with EO WCS 2.0 Profile.
  - Evaluate oceanography and climatology applications.



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**Questions?**

