Climate Science Modelling Language: Overview and Roadmap

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Outline

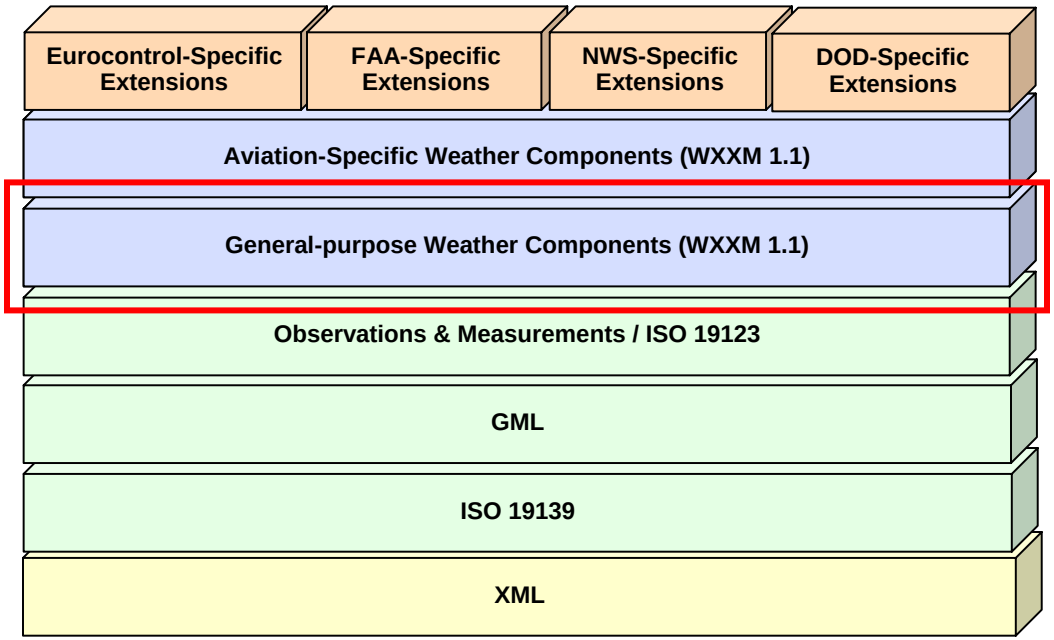
- CSML aims & design principles
- ISO/DIS 19156
- CSML v3
- CDM / CF
- Roadmap
- Issues

CSML aims

- To provide a simple standards-based application schema
  - Tuned to the requirements of the met/ocean community
  - Covering a majority of common information types
  - Integrating easily with existing technology
- Re-usable component for multiple met/ocean application domains

CSML/WXXM Context

- CSML 2 - Source of design principles for WXXM 1.1
- CSML 3 – Design principles + directly re-usable general-purpose data components for WXXM 2.X?

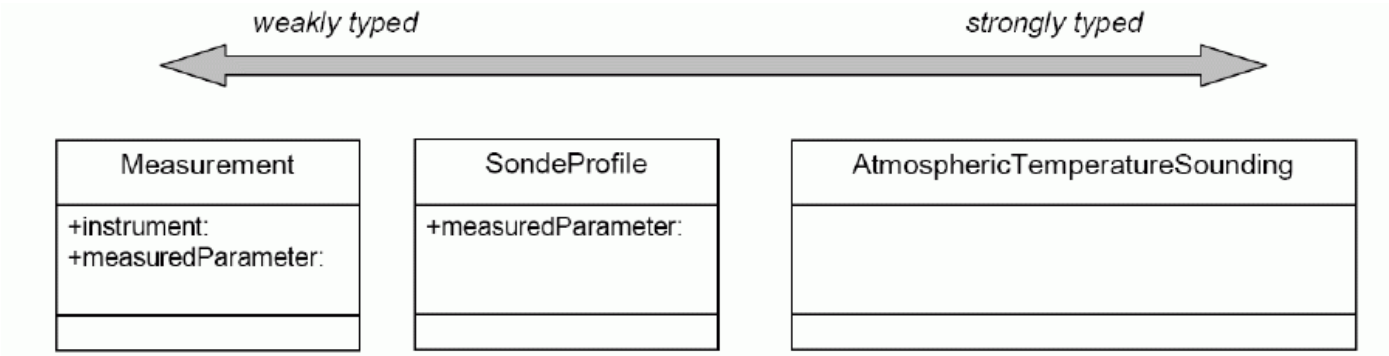


Layered WXXM 1.1 Data Model

CSML design principles

- ‘Soft-typing’ on observable phenomenon
- Geometry and topology of sampling is a crucial classifier
- Integration with existing technology (e.g. needs to co-exist with CF-netCDF)
- Leverage OGC / ISO TC211 models where possible

Weak vs. Strong Typing




```
<Measurement>
  <instrument>RADIOSONDE</instrument>
  <measuredParameter>TEMPERATURE</measuredParameter>
</Measurement>
```

Weak-typing example. Schema has relatively few elements and can represent multiple types of measurements. External vocabularies required.

```
<SondeProfile>
  <measuredParameter>TEMPERATURE</measuredParameter>
</SondeProfile>
```

```
<AtmosphericTemperatureSounding/>
```

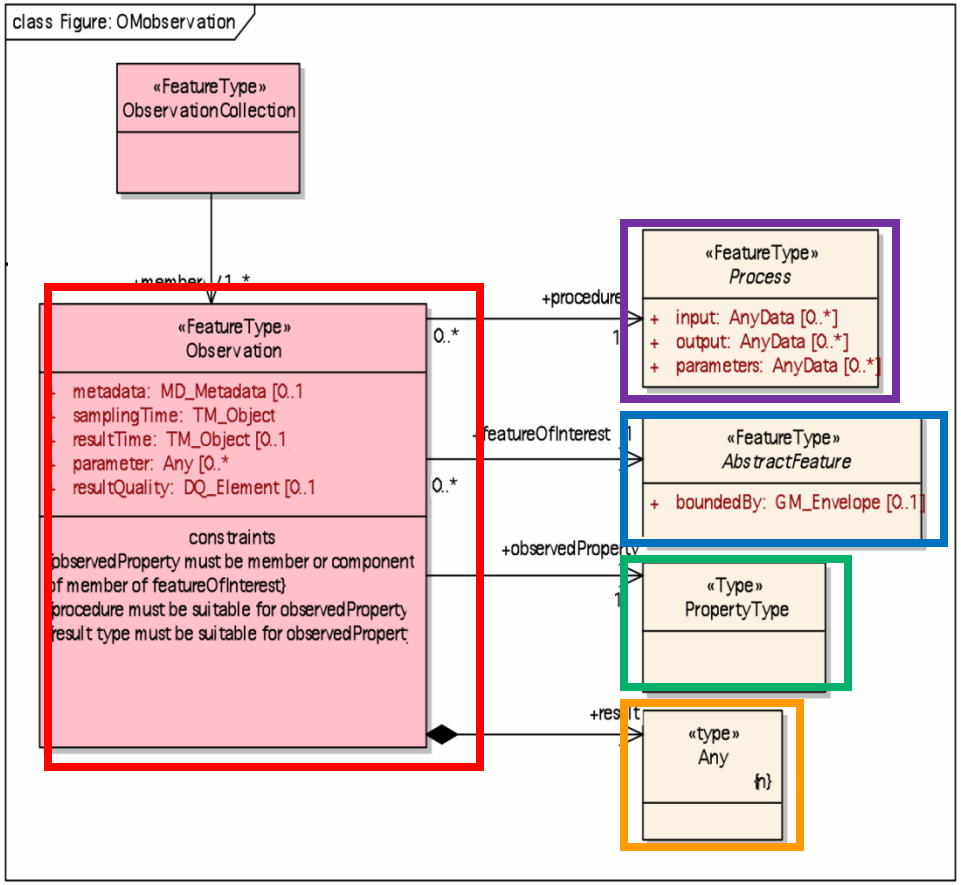
Strong-typing example. Schema fully defines a particular data type. One type required for each measurement type. External vocabularies not required.

- CSML resides nearer the weakly-typed end of the spectrum
- CSML types can support all JMBL parameters, as a result

ISO/DIS 19156

- ‘Geographic information — Observations and measurements’
- Draft ISO version of OGC's Observations & Measurements 1.0
- Submitted as ISO DIS by editor (Simon Cox) 18 March
  - Only non-technical amendments allowed now
- Schemas being finalised within OGC (O&M SWG): OGC document 10-025

Observation & Measurements Model



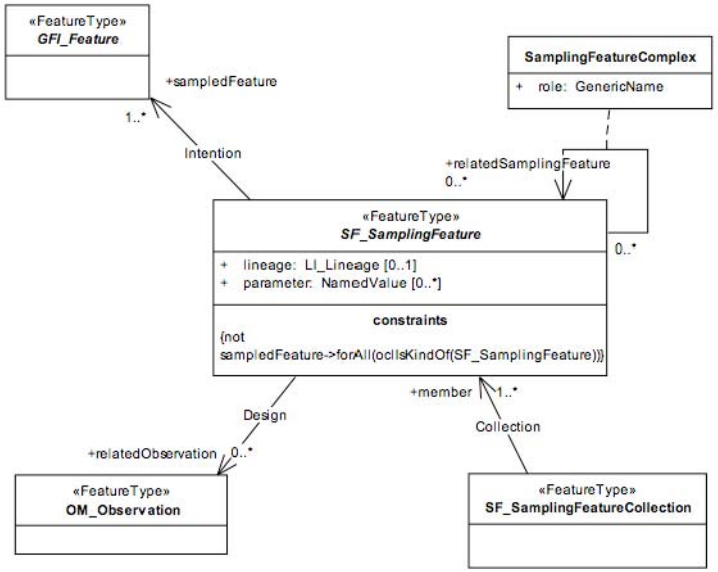
- An ***observation*** is an event that estimates an ***observed property*** of some ***feature of interest*** using a specified ***procedure*** and generates a ***result***.

- *Ok, I sorta get that, but how do I use O&M for weather data?*

- The ISO version of O&M refines the model to better support earth science needs, and codifies some best practices

O&M Sampling Features

- Often, the feature-of-interest is not a (whole) domain feature – rather it is a ***sampling feature***
  - "Sampling features are artefacts of an observational strategy, and have no significant function outside of their role in the observation process. ... A sampling feature is intended to sample some feature of interest in an application domain." (ISO/DIS 19156 §8.1.2)



Example

Radar Scan Volume = *Sampling Feature*

Microburst Detection(s) for scan = *Result Feature(s)*

Coverage Observations

- Observation of a set of properties that vary over the (spatiotemporal) extent of a feature
  - Result is a *coverage*
  - A GRIB or NetCDF file containing observational data for the CONUS is an example of a *grid coverage*

Bringing it together: ***Sampling Coverage Observation***

- Described in ISO/DIS 19156 – Best practices in use of observation and sampling models
- This is the basic CSML v3 pattern
- *CSML v3 leverages ISO version of O&M directly, unlike CSML v2 which was **aligned** with O&M*
- There are still some gaps for CSML to fill in, particularly w/respect to sampling time axes

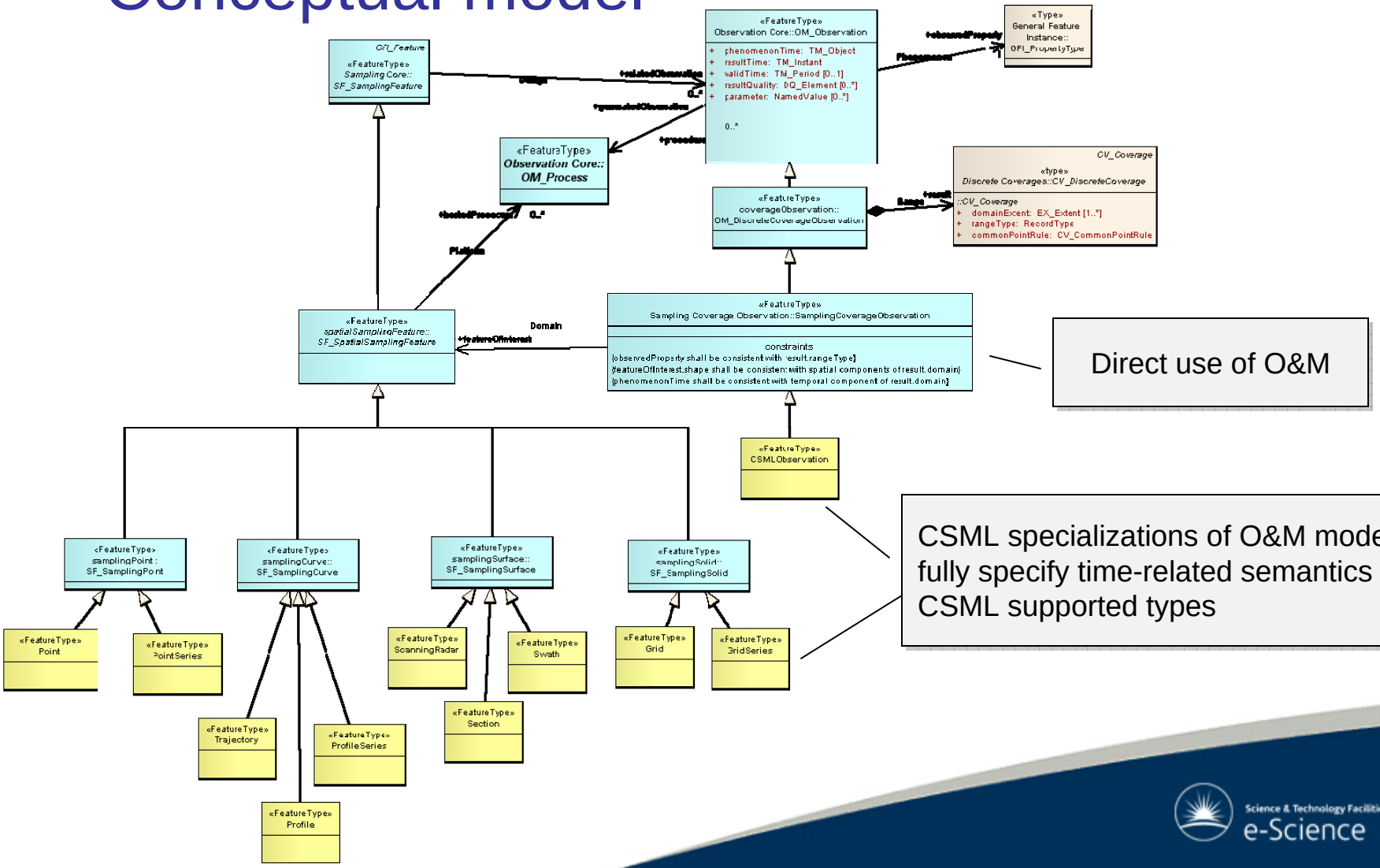
Sampling Coverage Observation

- Consistency constraints
  - *feature of interest* is a *spatial sampling feature*
  - *observed property* consistent with *range type* of coverage result
  - *shape* of sampling feature contains *spatial elements* of coverage domain
  - *phenomenon time* contains *temporal elements* of coverage domain

- Spatial sampling feature is spatial!
  - “Properties observed on sampling features may be time-dependent, but the temporal axis does not generally contribute to the classification of sampling feature classes” (ISO/DIS 19156 §9.1)

CSML v3

- Conceptual model



CSML v3 Feature Types

Point	
based on	*SF_SamplingPoint*
phenomenonTime	*TM_Instant*
coverage result	CV_DiscretePointCoverage

A single observation at a point. E.g. Raingauge measurement

PointSeries	
based on	*SF_SamplingPoint*
phenomenonTime	*TM_Period*
coverage result	CVT_DiscreteTimeInstantCoverage

A time-series of single datum observations at a fixed location. E.g. Tidegauge, buoy, weather station

Trajectory		
based on	*SF_SamplingCurve*	
phenomenonTime	*TM_Period*	
coverage result	CV_DiscreteGridPointCoverage	
	grid dimension	*one*
	external CRS	*four (x-y-z-t)*
	alignment	-

An observation along a discrete path in time and space e.g. aerosol measurements along an aircraft's flight path

Section		
based on	*SF_SamplingSurface*	
phenomenonTime	*TM_Instant or TM_Period*	
coverage result	CV_DiscreteGridPointCoverage	
	grid dimension	*two*
	external CRS	*four (x-y-z-t)*
	alignment	*z- axis (at least)*

Series of profiles from a trajectory in time and space. E.g. marine CTD measurements along a ship's track

Profile		
based on	*SF_SamplingCurve*	
phenomenonTime	*TM_Instant*	
coverage result	CV_DiscreteGridPointCoverage	
	grid dimension	*one*
	external CRS	*four (x-y-z-t)*
	alignment	*z-axis*

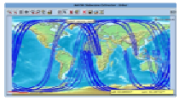
An observation of some parameter along a vertical line in space. E.g. Wind sounding or radiosonde.

ProfileSeries		
based on	*SF_SamplingCurve*	
phenomenonTime	*TM_Period*	
coverage result	CV_DiscreteGridPointCoverage	
	grid dimension	*two*
	external CRS	*four (x-y-z-t)*
	alignment	*z-, t- axes*

Time-series of profiles on fixed vertical levels at a fixed location. E.g. vertical radar timeseries

Swath		
based on	*SF_SamplingSurface*	
phenomenonTime	*TM_Instant or TM_Period*	
coverage result	CV_DiscreteGridPointCoverage	
	grid dimension	*two*
	external CRS	*three (x-y-t)*
	alignment	-

Two-dimensional grid of data along a satellite ground-path E.g. AVHRR satellite imagery

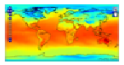


ScanningRadar		
based on	*SF_SamplingCurve*	
phenomenonTime	*TM_Instant*	
coverage result	CV_DiscreteGridPointCoverage	
	grid dimension	*Two*
		two (azimuth-range)
	external CRS	
	alignment	

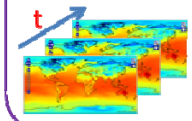
Backscatter profiles along a look direction at fixed elevation but rotating in azimuth. E.g. Weather radar

Grid		
based on	*SF_SamplingSolid*	
phenomenonTime	*TM_Instant or None*	
coverage result	CV_DiscreteGridPointCoverage	
	grid dimension	*three*
	external CRS	*three (x-y-z)*
	alignment	-

Single time-snapshot of a gridded field.



GridSeries		
based on	*SF_SamplingSolid*	
phenomenonTime	*TM_Period*	
coverage result	CV_DiscreteGridPointCoverage	
	grid dimension	*four*
	external CRS	*four (x-y-z-t)*
	alignment	-



Time-series of gridded parameter fields. E.g. Numerical weather prediction model

CSML v3

- XML schemas
  - Following model-driven approach based on GML encoding rules & ISO 19156
  - O&M schemas being finalised (OGC 10-025)
  - Nearly all coverages results based on constraining ISO 19123 CV_DiscreteGridPointCoverage in different ways
    - for encoding, use gml:ReferenceableGridCoverage (07-112r3 approved by GML SWG)
  - Available shortly!

netCDF Common Data Model / CF Point Observations

- Key objective of CSML v3: alignment with CDM / CF
  - [Feb 2007] CSML v2
  - [Jun 2008] CDM Feature Types
  - [Oct 2009] CF Point Observation conventions
  - [mid-2010] CSML v3:

CSML	CF/CDM
Point	Point
PointSeries	StationTimeSeries
Trajectory	Trajectory
Profile	Profile
ProfileSeries	StationProfile

CSML	CF/CDM
Swath	Swath
ScanningRadar	StationaryRadialSweep
Section	Collection of Profiles
Grid	Grid (single time)
GridSeries	Grid

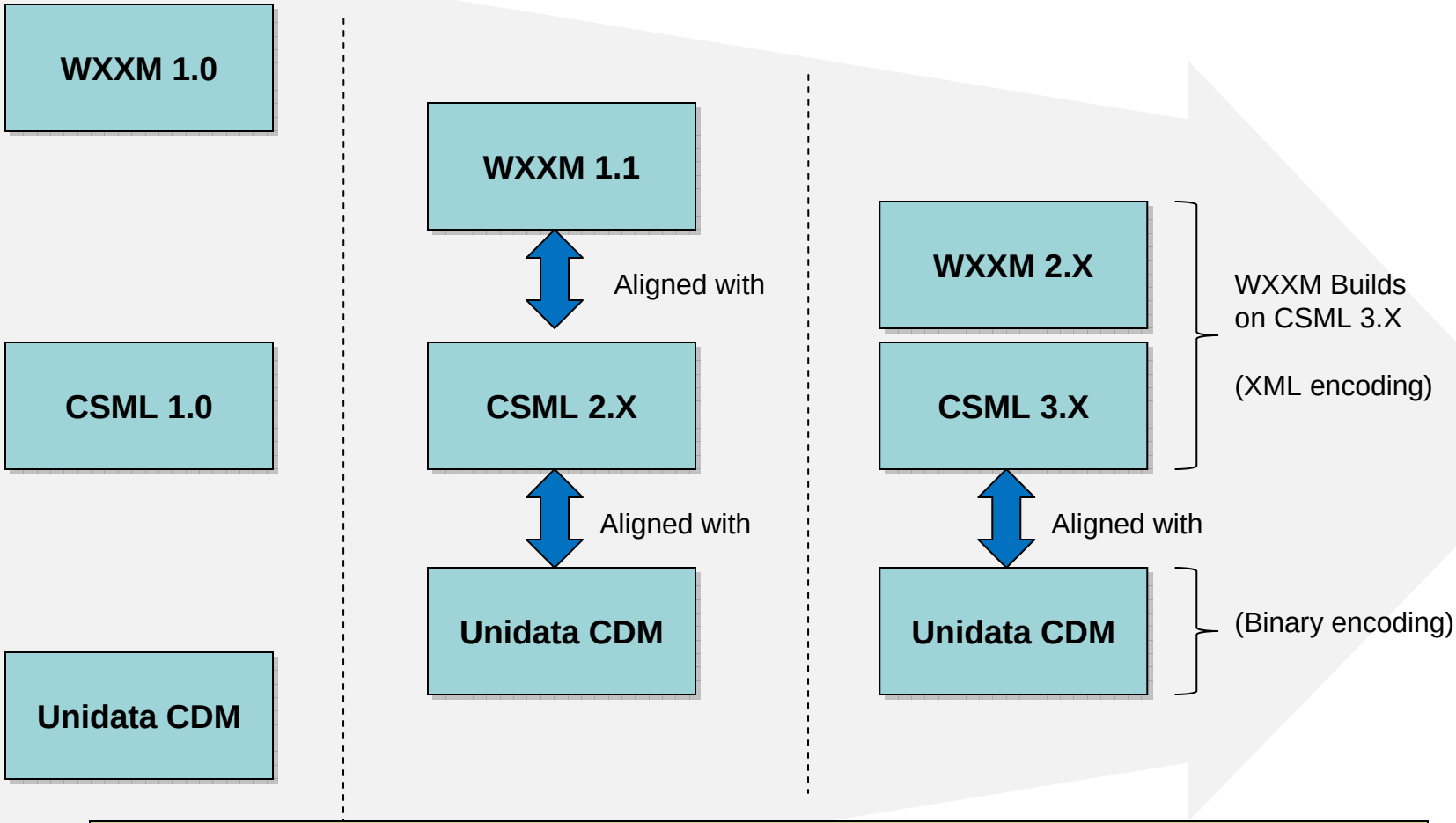
CSML roadmap

- Immediate
  - OGC Discussion Paper
- Next
  - Best Practice Paper ‘owned’ by OGC Met Ocean Domain Working Group?
    - neutral branding...
    - complete harmonisation (i.e. new names) with CF/CDM?

Issues

- Observed property
  - Ongoing discussion (SWE.SWG, GML.SWG) how best to represent semantic properties (SKOS, gml:ReferenceType, gml:CodeType, URIs vs. URNs etc.)
- Observation procedure (OM_Process)
  - Mandatory (can't have an observation without a procedure!) Can it be made nillable?
- Practical application
  - Code implementation
  - WFS, WCS, SOS, ...

Weather Model Convergence?



CSML work is proving to be of significant benefit to WXXM community!