



# Development of a GML Application Schema for data exchange supporting Meteorological Services for International Air Navigation

(WMO METCE & ~~ICAO IWXM~~)

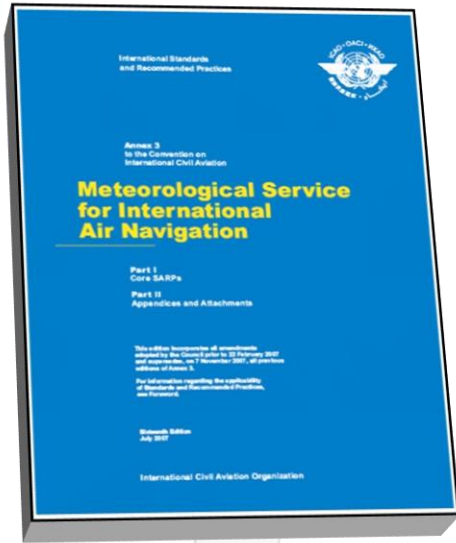
*see next talk from Aaron!*

Jeremy Tandy

(on behalf of TT-AvXML)



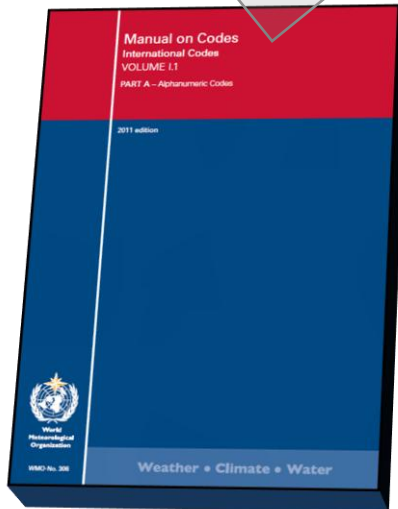
# Context: Meteorological Services for International Air Navigation (Technical Regulation)



***ICAO Annex 3 / WMO No. 49 II***

***Meteorological Service for International Air Navigation***

***Management of data exchange standards in support of meteorological services for international air navigation (OPMET) are delegated by ICAO to WMO***



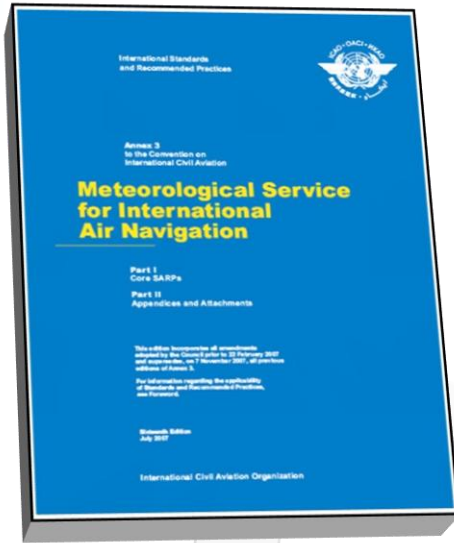
***WMO No. 306 Vol I.1***

***Manual on Codes***

***Part A – Alphanumeric Codes***



# Amendment 76 to ICAO Annex 3 (Nov 2013)



**ICAO Annex 3 / WMO No. 49 II**

**Meteorological Service for International Air Navigation**

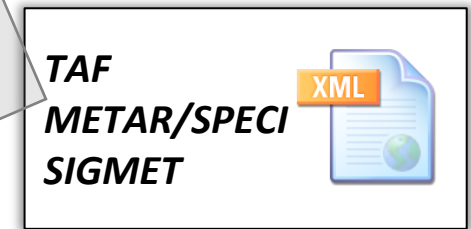
*Amendment 76 (2013) to ICAO Annex 3 shall, for states in a position to do so to, permit bilateral exchange of OPMET data via XML*



**WMO No. 306 Vol I.1**

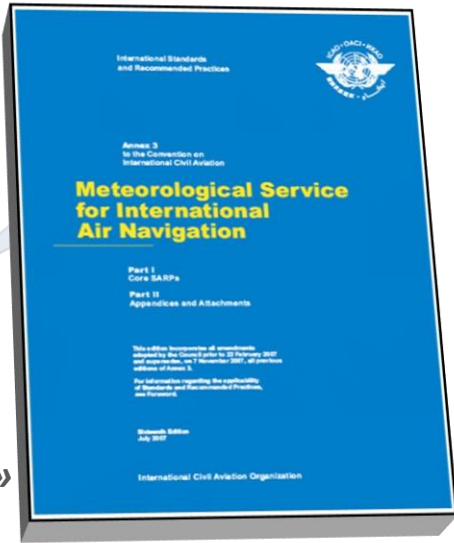
**Manual on Codes**

**Part A – Alphanumeric Codes**





# Model-driven data exchange standards



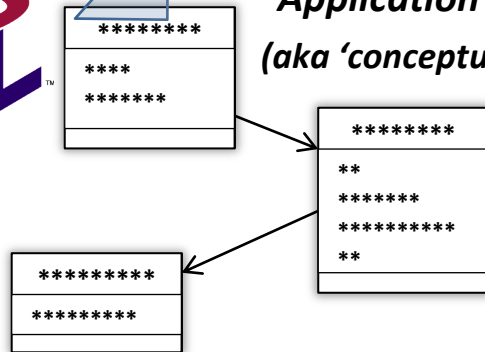
*ICAO Annex 3 / WMO No. 49 II*

*Meteorological Service for International Air Navigation*

« formalised as »



**Application Schema**  
(aka 'conceptual model')



*Technology independent description of content and structure of information to be exchanged for a given application*

**FullMoon**

« derive from »

**XML Schema 1.0**  
**Schematron**



*Validation schema and rules*

« conforms to »

**TAF**  
**METAR/SPECI**  
**SIGMET**



*Validatable data products*



# Standards-based approach: GML Application Schema

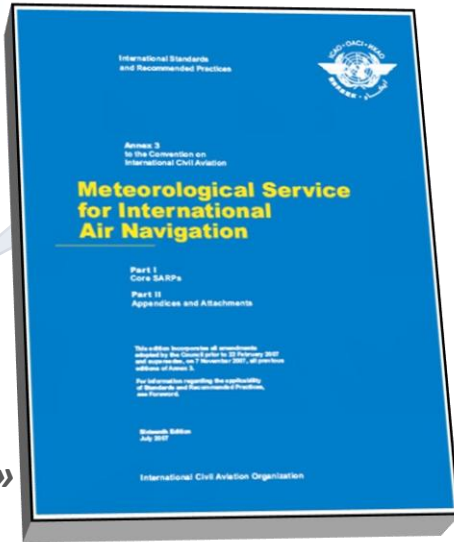
*IWXXM (ICAO Weather Information Exchange Model): formal representation of ICAO Annex 3 reports (TAF, METAR/SPECI and SIGMET)*

*SAF (Simple Aeronautical Features)*

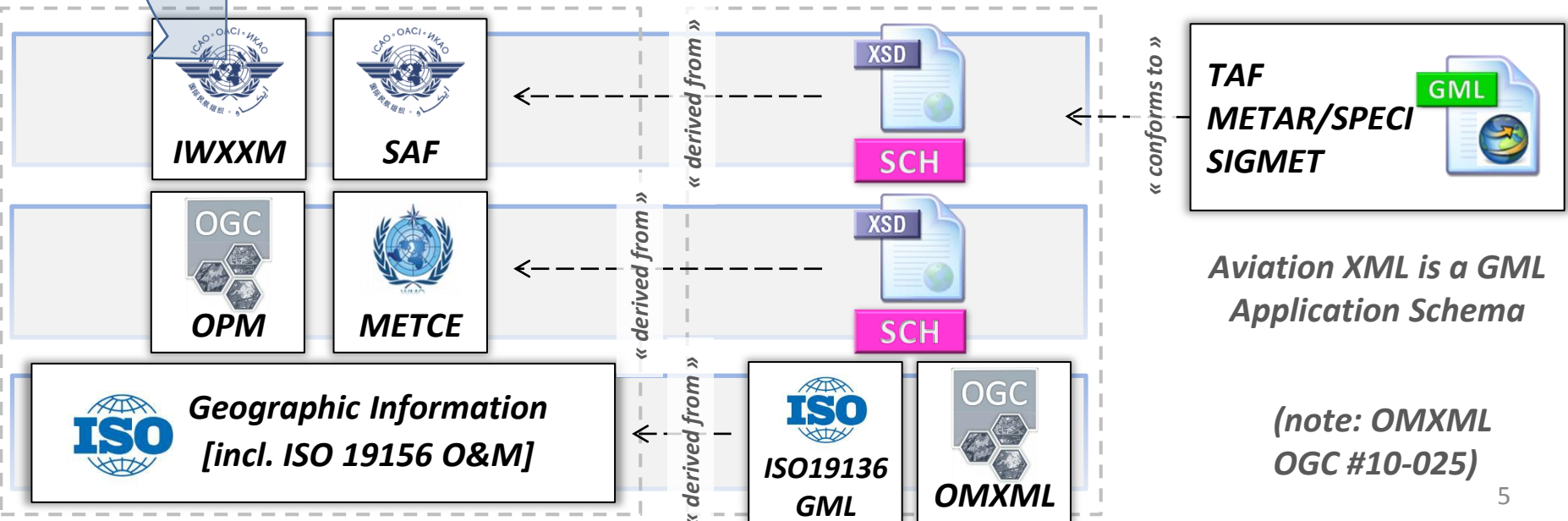
*OPM (Observable Property Model)*

*METCE (Modèle pour l'Échange des informations sur le Temps, le Climate et l'Éau)*

*ISO 19100-series of International Standards*



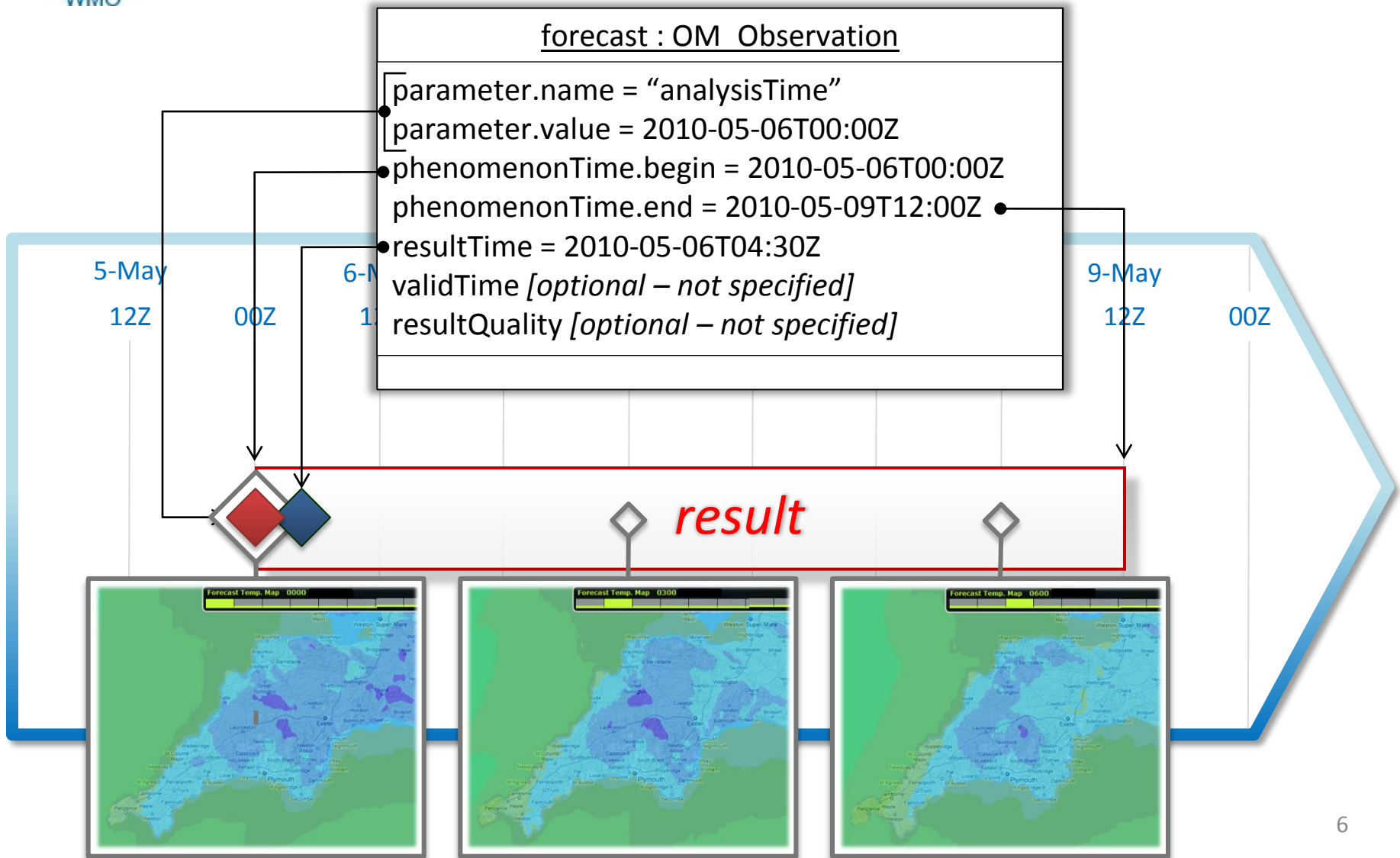
« formalised as »



(note: OMXML OGC #10-025)



# ISO19156 Observations and measurements: also suitable for numerical simulations – including forecasts







# WMO Logical Data Model: Application Schemas under WMO governance

**RC2 change!**

«<http://def.wmo.int/2013/opm>»

«<http://def.wmo.int/2013/metce>»

**OPM**

**Observable Property Model**



*Enables one to describe how abstract physical quantities are qualified or constrained (e.g. explicitly state the averaging period for wind-speed, or the height of measurement above local ground for a screen temperature)*

*Developed within the OGC 'Sensor Web Enablement' Standards Working Group & INSPIRE Thematic Working Group*

*Tentative agreement with OGC that a stable version of OPM is managed under the governance of WMO*



**METCE**

*(Modèle pour l'Échange des informations sur le Temps, le Climate et l'Éau)*

*Provides a foundation of generic meteorological concepts, phenomena and entities upon which domain- industry- or community-specific Application Schema can be built:*

- *specialised observation classes*
- ***simple observation procedure*** \*
- *meteorological features (e.g. volcano, tropical cyclone)*
- *plus "miscellaneous" stuff*

*Intended to complement existing WMO Table-Driven Code Forms*

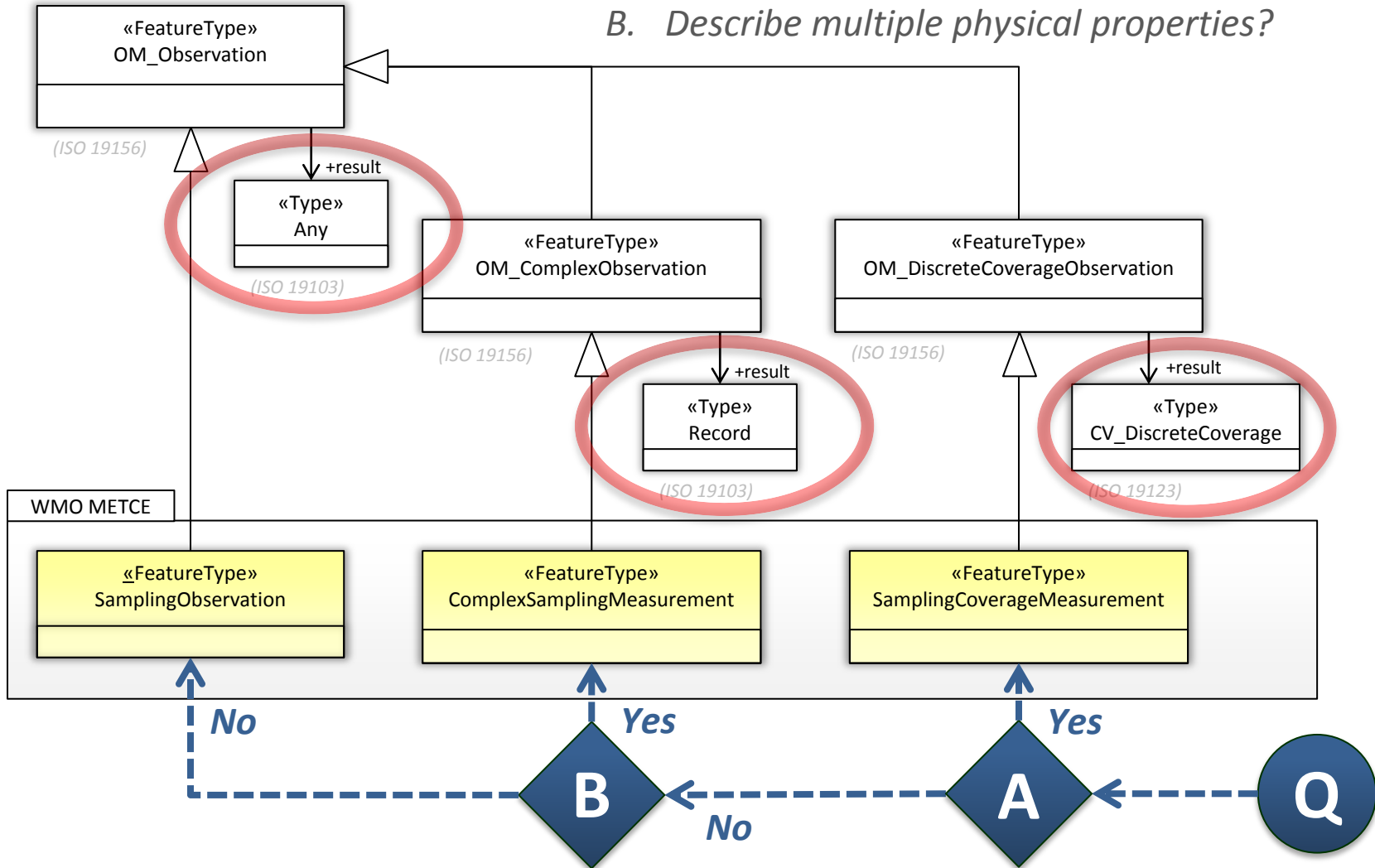


# METCE: specialisations of OM\_Observation

Does the data collected (e.g. the 'result') from the Observation event:

A. Vary in space and or time?

B. Describe multiple physical properties?



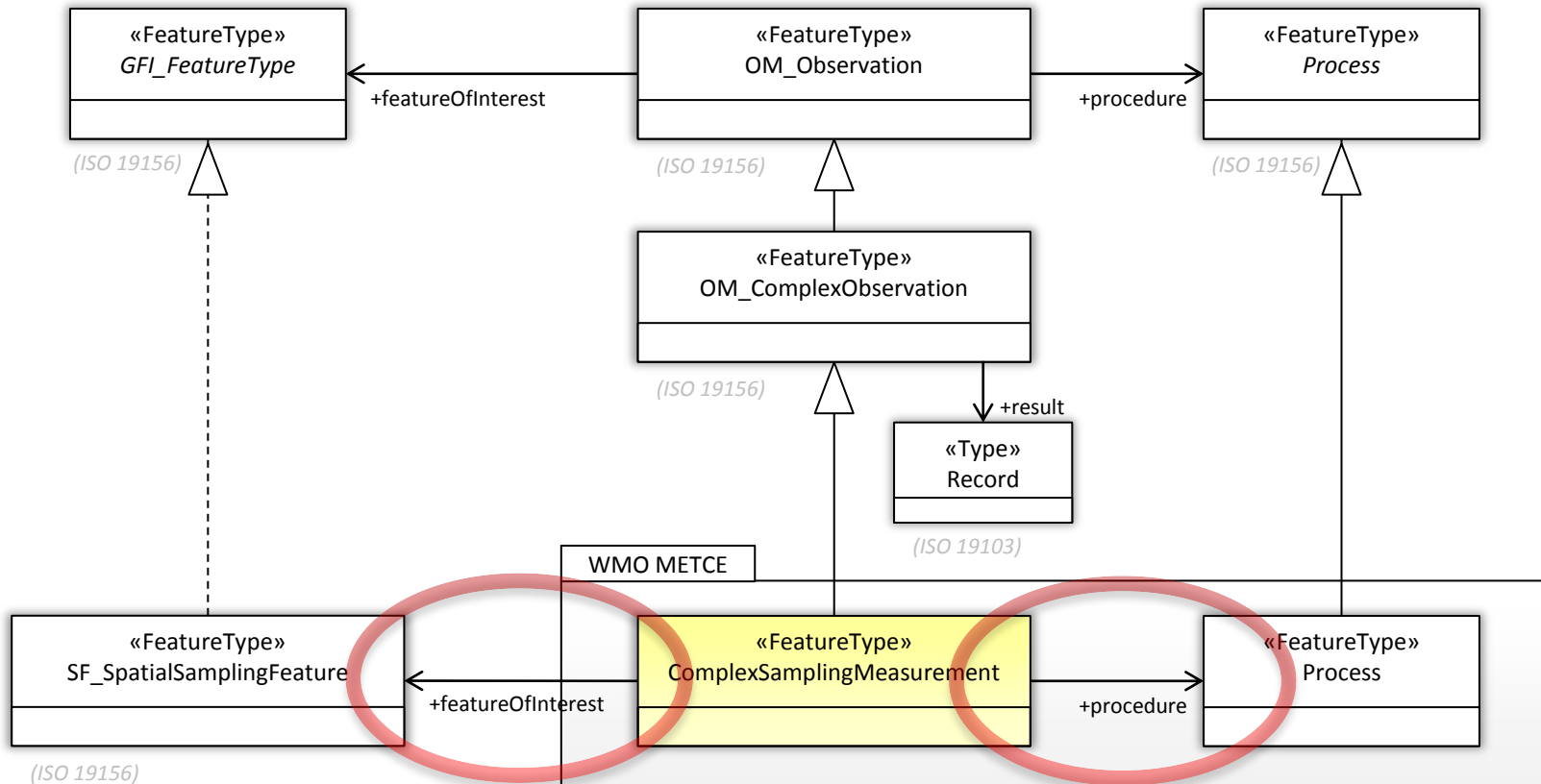




# Common constraints applicable to all WMO METCE Observation types

All specialisations of *OM\_Observation* defined in WMO METCE require:

- association role *'featureOfInterest'* shall be of type *SF\_SpatialSamplingFeature*
- association role *'procedure'* shall be of type *Process* (from WMO METCE)





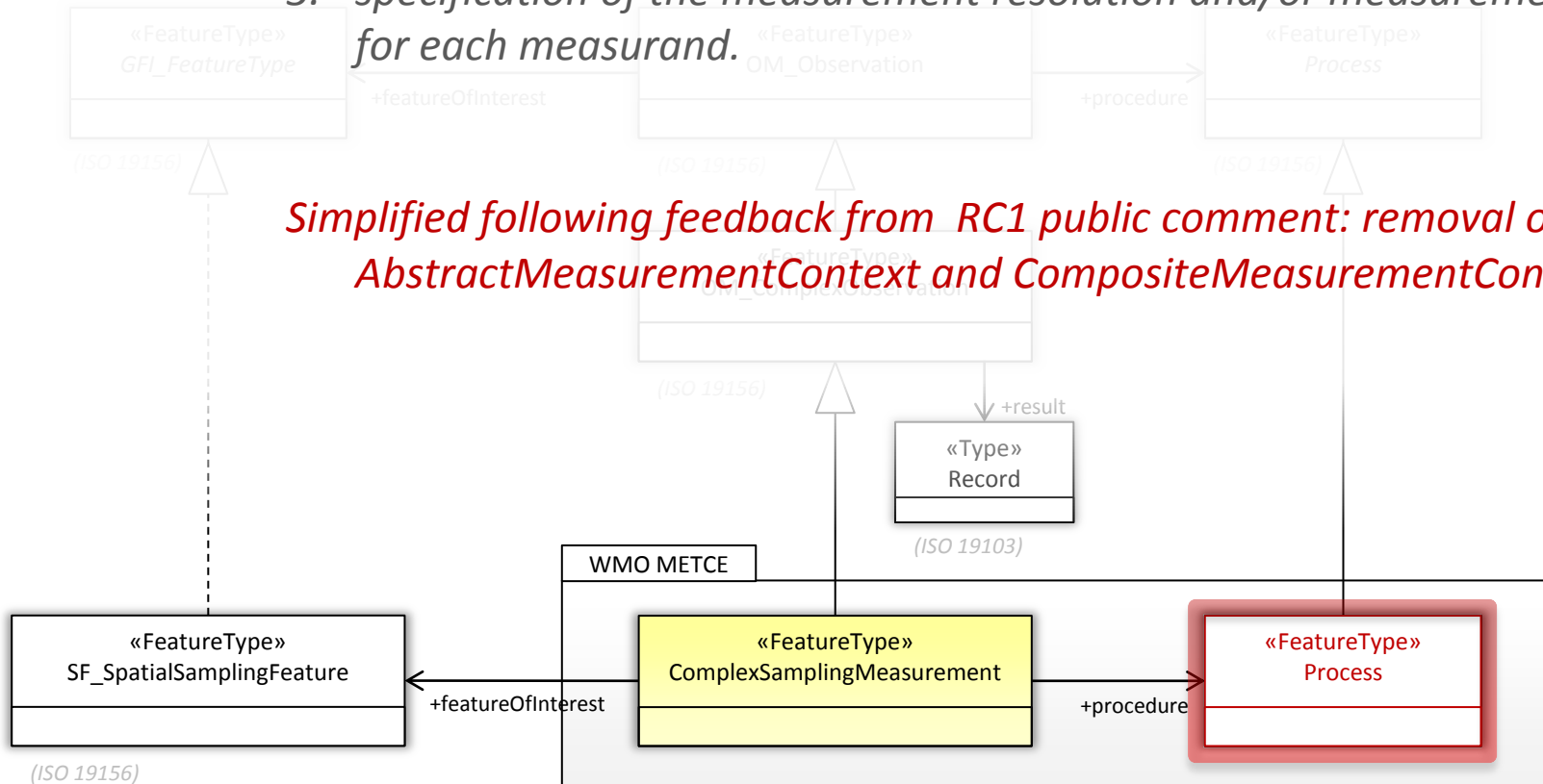
# METCE: Process

**RC2 change!**

Process (from WMO METCE) provides a concrete implementation of the abstract OM\_Process supporting the following requirements:

1. reference to supporting documentation,
2. specification of configuration parameters,
3. specification of the measurement resolution and/or measurement range for each measurand.

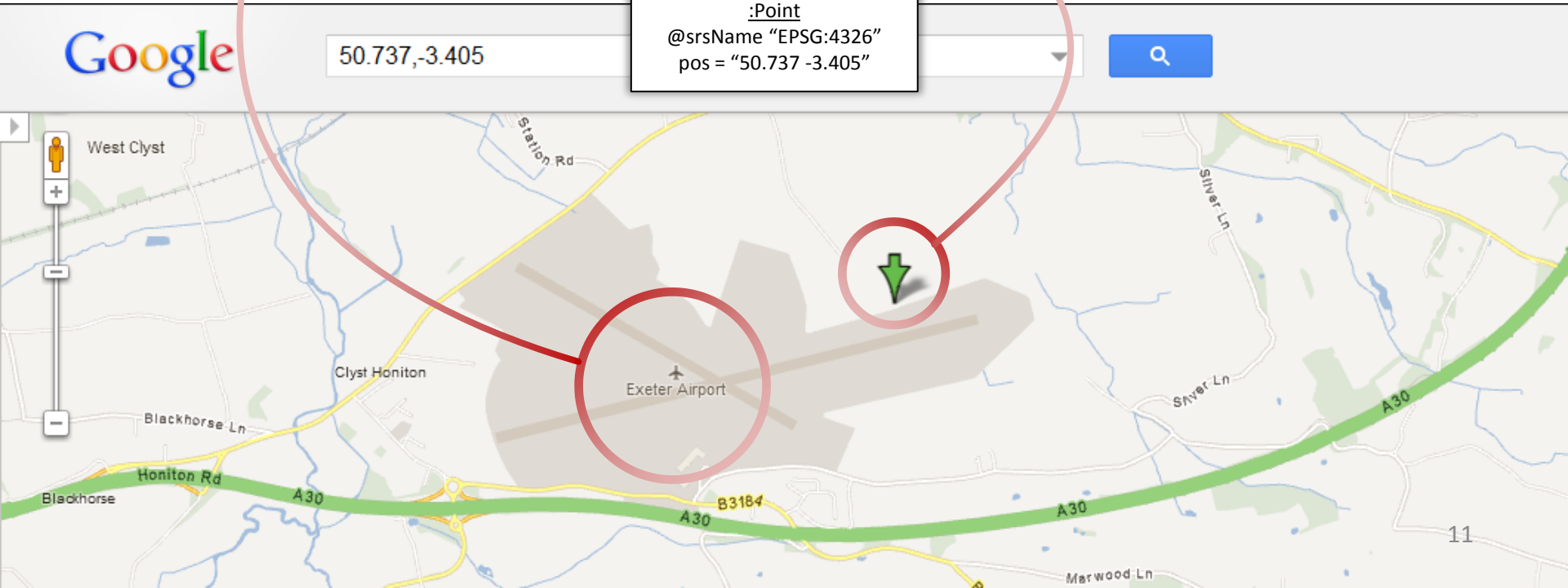
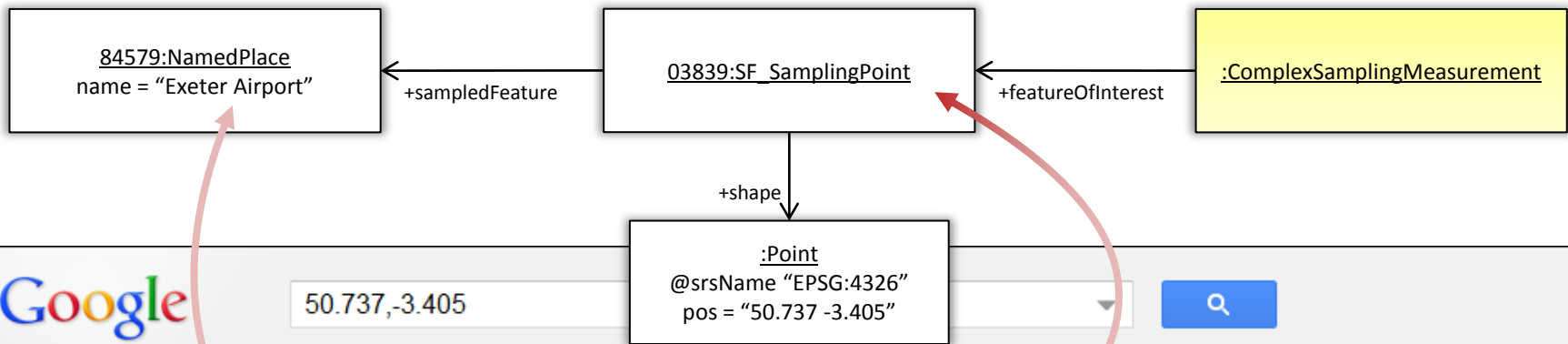
*Simplified following feedback from RC1 public comment: removal of AbstractMeasurementContext and CompositeMeasurementContext classes*





# SamplingFeature as OM\_Observation.featureOfInterest

*In meteorology, we define a sampling regime that enables us to observe, measure or simulate the real-world. Sampling Features (from ISO 19156 'Observations and measurements') provide a way to characterise this sampling regime and the relationship to the real-world.*

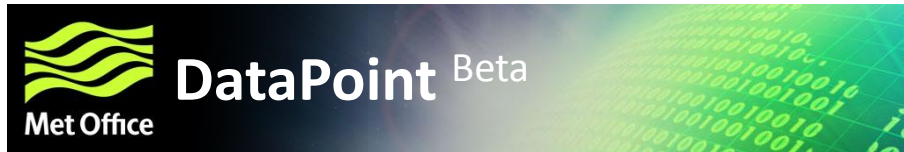




# Example use of METCE: Met Office DataPoint

*Illustrative example demonstrating how METCE provides a foundation to domain specific Application Schema ...*

A screenshot of a web browser displaying the Met Office DataPoint website. The browser's address bar shows 'www.metoffice.gov.uk/datapoint'. The website header includes the Met Office logo, 'DataPoint Beta', and navigation links like 'About us', 'Mobile', 'Help', and 'Site map'. A search bar is present. The main navigation menu includes 'Defence', 'Multi-media', 'Climate services', 'DataPoint', and 'A-Z'. The main content area features a large green background with binary code and two small images: a satellite view of a city and a close-up of a light fixture. A 'Read more &gt;' link is visible below the images. At the bottom right, there is a 'Register for Met Office DataPoint' section with a 'Sign up to get access to' link.



## UK hourly site-specific observations

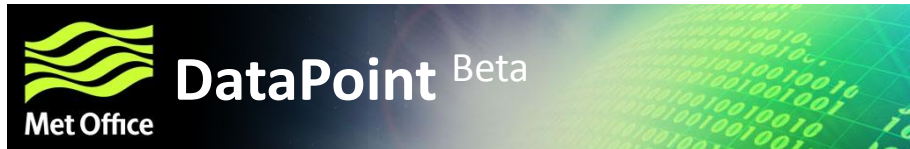
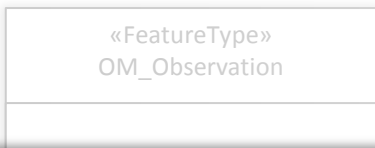
- Hourly observations for approximately 140 locations across the UK
- Parameters:
  - Air temperature
  - MSLP
  - Wind speed
  - Wind speed (gust)
  - Wind direction
  - Visibility
  - Weather type



# Which type of OM\_Observation?

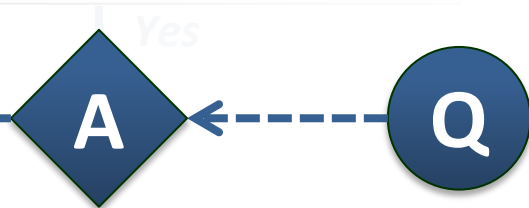
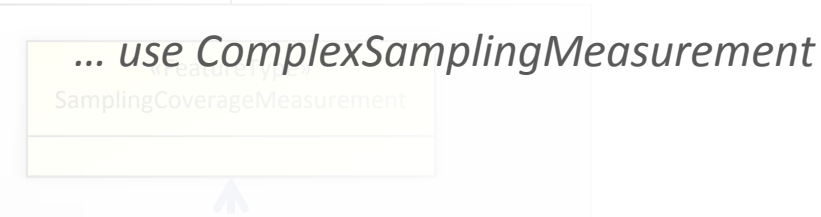
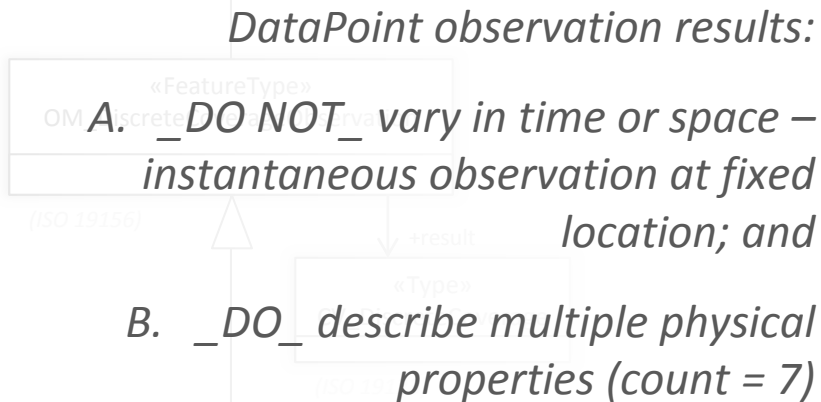
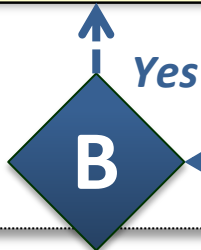
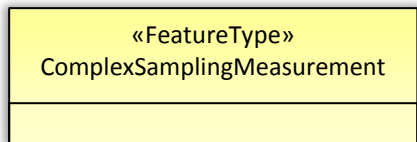
Does the data collected from the Observation event:

- A. Vary in space and or time?
- B. Describe multiple physical properties?



## UK hourly site-specific observations

- Hourly observations for approximately 140 locations across the UK
- Parameters:
  - Air temperature
  - MSLP
  - Wind speed
  - Wind speed (gust)
  - Wind direction
  - Visibility
  - Weather type





## Validatable data products: bespoke Record class

*The Record class (from ISO 19103) provides a set of name-value pairs.*

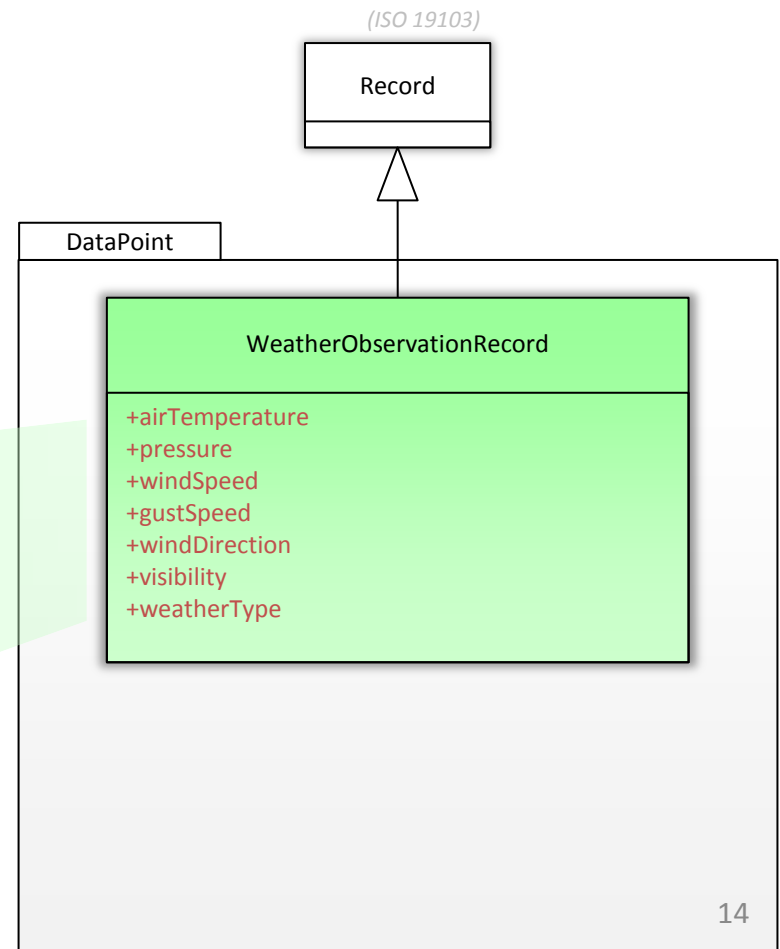
*In GML, this can be implemented using SWE DataRecord ...*

*However, in this example, we require validatable data products. Therefore, we need to generate an XML Type for the Record – which is derived from our Application Schema:*



### UK hourly site-specific observations

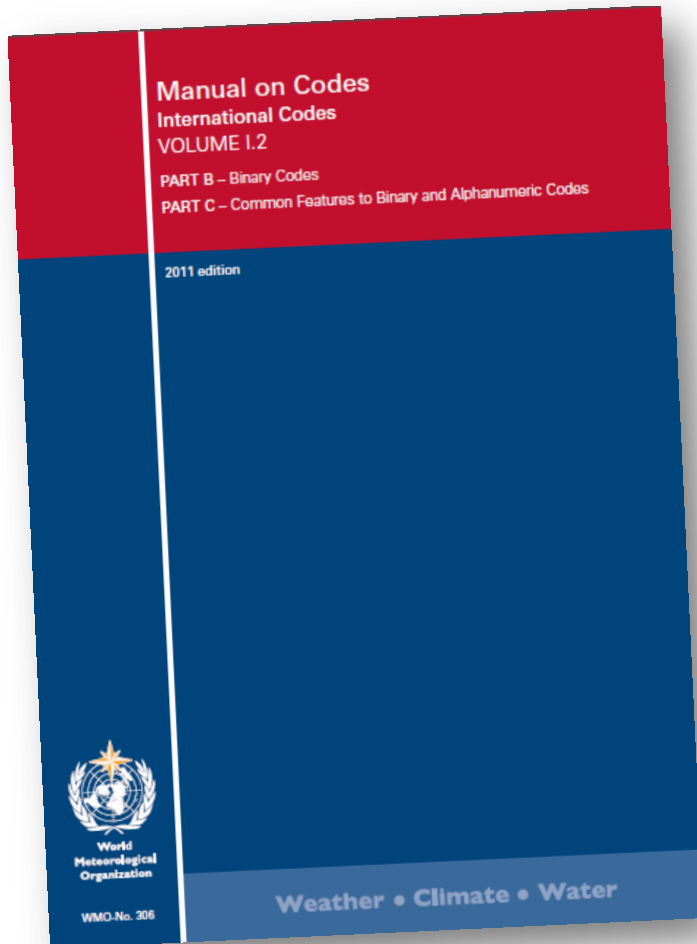
- Hourly observations for approximately 140 locations across the UK
- Parameters:
  - Air temperature
  - MSLP
  - Wind speed
  - Wind speed (gust)
  - Wind direction
  - Visibility
  - Weather type







## Aside: WMO No. 306 Manual on Codes and governance of authoritative definitions for meteorological properties



*The Code-Tables underpinning WMO Table-Driven Code Forms (GRIB and BUFR) are WMO's crown jewels ...*

*Decades of expert effort have gone into establishing authoritative terminologies to describe meteorological phenomena*

*WMO CBS stressed the importance of ensuring a strong linkage between the TDCF Code-tables and the WMO data models. [CBS-Ext.(10)]*

***'Strong linkage': a critical objective for TT-AvXML***



# Publication of web-accessible definitions for meteorology

*As the UN's authoritative voice on weather, water and climate it within WMO's mandate to publish authoritative on-line definitions of meteorological phenomena and properties*

*Each 'concept' will be assigned an HTTP URI identifier within the [codes.wmo.int](http://codes.wmo.int) domain based on existing codes and structures from the WMO code-tables*

*It is anticipated that in RC2 the definitions of those physical properties required to support International Air Navigation will resolve to useful information ...*

FM 92 GRIB - ver. 8.0.0

Code table 4.2 - Parameter number by product discipline and parameter category

Product discipline 0 - Meteorological products, parameter category 2: momentum

Number	Parameter	Units	Status
0	Wind direction (from which blowing)	degree true	Operational
1	Wind speed	$m s^{-1}$	Operational
2	u-component of wind	$m s^{-1}$	Operational
3	v-component of wind	$m s^{-1}$	Operational
4	Stream function	$m^2 s^{-2}$	Operational
5	Vertical velocity	$s^{-1}$	Operational
6	Montgomery stream function	$m^2 s^{-2}$	Operational

<http://codes.wmo.int/grib2/codeflag/4.2/0.2.1>

**RC2 change!**

Excerpt from GRIB2 Code- and Flag-tables

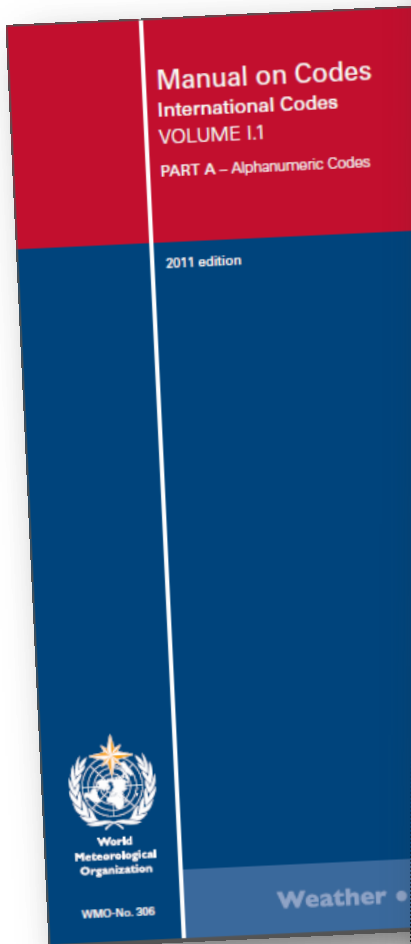


# WMO code-tables published as web-accessible resources

Code-tables (and code-table entries) from WMO No. 306 Vol I.1, BUFR4 and GRIB2 are also in the process of being published as web-accessible resources ...

<http://codes.wmo.int/306/4678>

4678



## w'w' Significant present and forecast weather

QUALIFIER		WEATHER PHENOMENA		
INTENSITY OR PROXIMITY	DESCRIPTOR	PRECIPITATION	OBSCURATION	OTHER
1	2	3	4	5
- Light	MI Shallow	DZ Drizzle	BR Mist	PO Dust/sand whirls (dust devils)
Moderate (no qualifier)	BC Patches	RA Rain	FG Fog	SQ Squalls
+ Heavy (well developed in the case of dust/sand whirls (dust devils) and funnel clouds)	PR Partial (covering part of the aerodrome)	SN Snow	FU Smoke	FC Funnel cloud(s) (tornado or water-spout)
	DR Low drifting	SG Snow grains	VA Volcanic ash	SS Sandstorm
VC In the vicinity	BL Blowing	IC Ice crystals (diamond dust)	DU Widespread dust	DS Duststorm
	SH Shower(s)	PL Ice pellets	SA Sand	
	TS Thunderstorm	GR Hail	HZ Haze	
	FZ Fre (su)	UP Unknown precipitation		

<http://codes.wmo.int/306/4678/+SHRA>

The w'w' groups shall be constructed by considering columns 1 to 5 in the table above in sequence, that is, intensity, followed by description, followed by weather phenomena. An example could be: +SHRA (heavy shower(s) of rain).

Excerpt from WMO No. 306 Vol I.1



## Met-Basic removed from WMO model

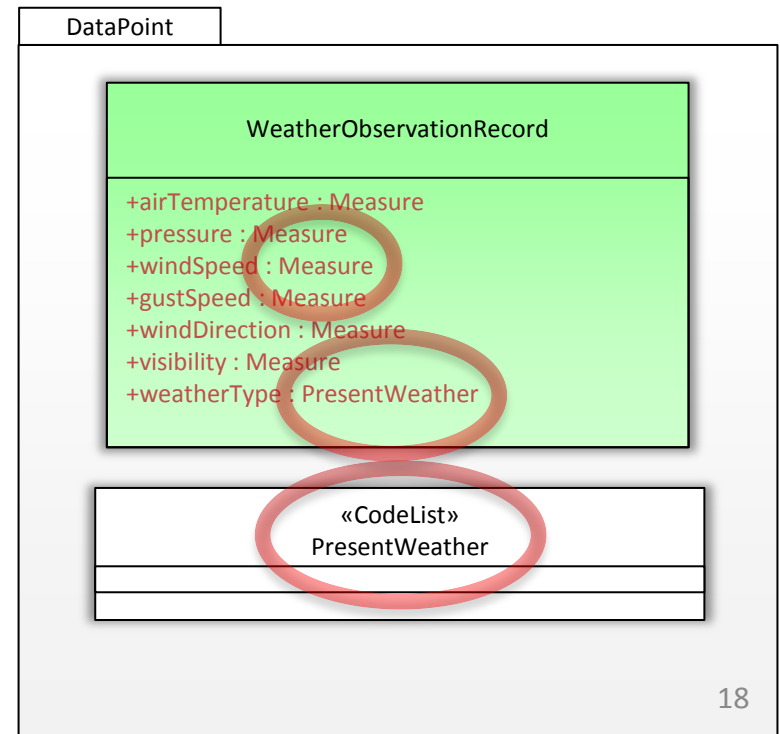
**RC2 change!**

*Met-Basic was intended to ensure that the semantics defined in the WMO code-tables was applied within Application Schemas using METCE; this \_was\_ achieved through provision of a palette of reusable “quantity value” and «CodeList» classes ...*

*However, in hindsight, coupling the model to the WMO code-tables was a poor design choice introducing unnecessary redundancy and inhibiting the flexibility of the model with respect to changes in the WMO code-tables.*

*For RC2, we propose that:*

- each quantity value property is specified with type “Measure” (from ISO 19103 Basic-types) or subclass thereof, and*
- a «CodeList» class is defined within the Application Schema for each nominal value property that shall be used as the specified type for that property.*





# Consistent application of semantics from WMO codes (1): *quantity values*

*Each quantity value property shall include the tagged value 'quantity' to refer to the appropriate concept from the WMO codes.*

*Tagged-values shall be visible within the XSD enabling information from the WMO codes to be used in data validation.*

```

<complexType name="WeatherObservationRecordType">
  <complexContent>
    <extension base="gml:AbstractGMLType">
      <sequence>
        ...
        <element name="windSpeed" type="gml:MeasureType">
          <annotation>
            <appinfo>
              <quantity>
                http://codes.wmo.int/grib2/codeflag/4.2/0.2.1
              </quantity>
            </appinfo>
          </annotation>
        </element>
        ...
      </sequence>
    </extension>
  </complexContent>
</complexType>

```



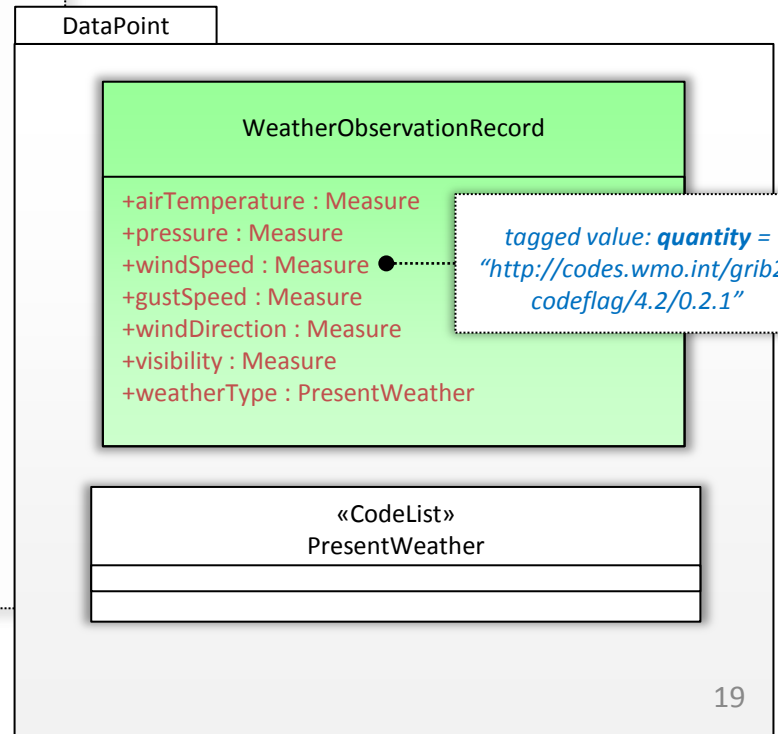
## RC2 change!

*note change in guidance; where the unit of measure is defined within the Unified Code for the Units of Measure [<http://unitsofmeasure.org>] the symbol shall be used rather than a URI*

```

<dp:windSpeed uom="m/s">
  3.6
</dp:windSpeed>

```







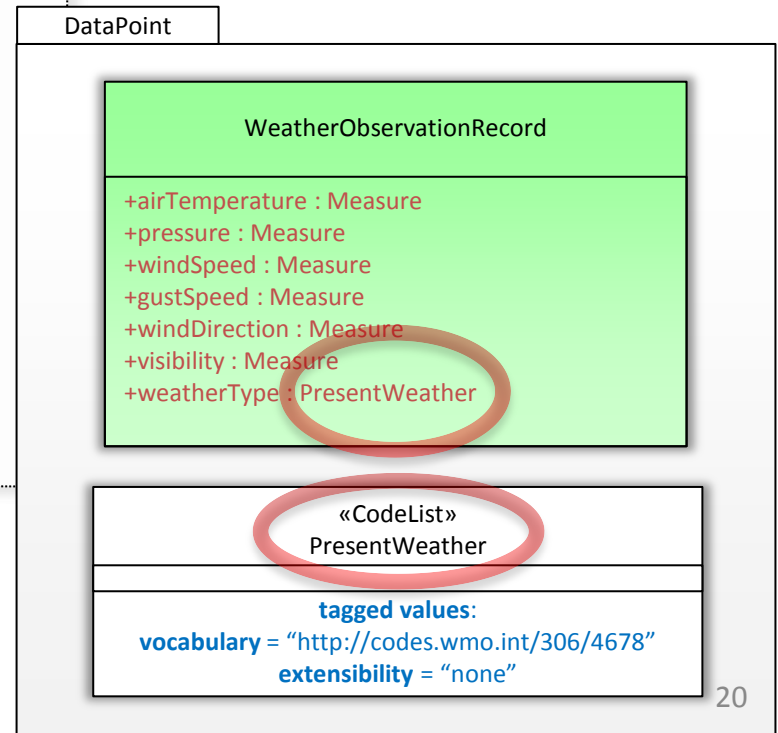
## Consistent application of semantics from WMO codes (2): *nominal values*

```
<complexType name="PresentWeatherType">
  <annotation>
    <appinfo>
      <vocabulary>
        http://codes.wmo.int/306/4678
      </vocabulary>
      <extensibility>
        none
      </extensibility>
    </appinfo>
  </annotation>
  <documentation>
    Significant present weather. See WMO No. 306 Vol I.1 code table 4678
  </documentation>
  </annotation>
  <complexContent>
    <extension base="gml:ReferenceType"/>
  </complexContent>
</complexType>
```



*Serialisation of «CodeList» classes follows practice from GML 3.3; gml:ReferenceType is used as extension base. Tagged values are included in schema documentation for developer reference.*

*Each «CodeList» class associated with a nominal value property shall include the tagged value ‘**vocabulary**’ to refer to the appropriate code-table from the WMO codes and the tagged value ‘**extensibility**’ to assert the validation regime to be used.*







# Consistent application of semantics from WMO codes (2): *nominal values*

*GML documents shall use XLINK to refer to the appropriate term.*

```

<complexType name="WeatherObservationRecordType">
  <complexContent>
    <extension base="gml:AbstractGMLType">
      <sequence>
        ...
        <element name="weatherType" type="dp:PresentWeatherType">
          <annotation>
            <documentation>
              Type of weather observed at the time of observation
            </documentation>
          </annotation>
        </element>
        ...
      </sequence>
    </extension>
  </complexContent>
</complexType>

```

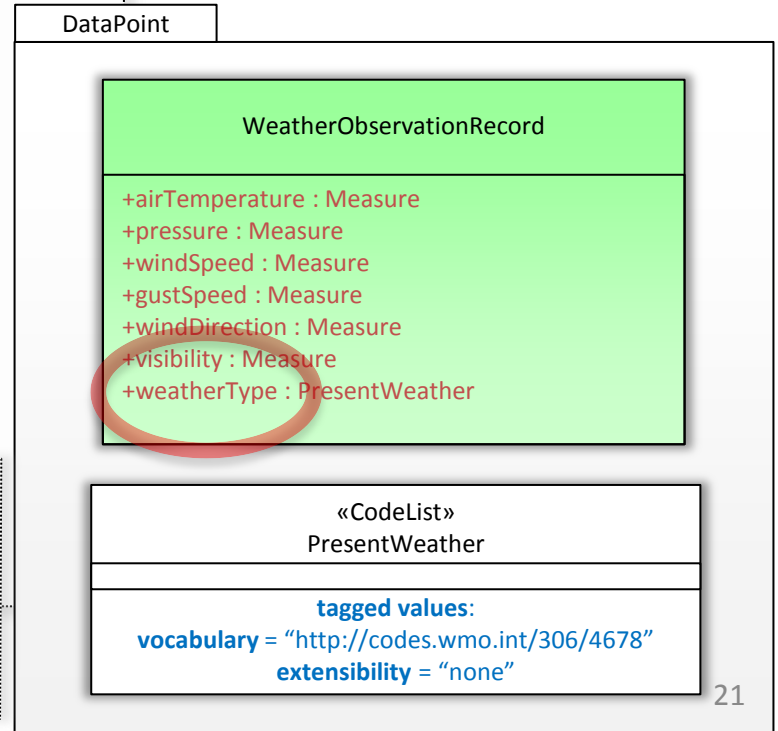


*Crucially, note that in line with best practice, «CodeList» resources are managed externally to the model; in this case using the existing WMO TDCF governance processes.*

```

<dp:weatherType
  xlink:href="http://codes.wmo.int/306/4678/+SHRA"
  xlink:title="Rain showers (heavy)"/>

```





## RC1 public comment feedback summary – *thanks!*

- *126 distinct issues (total)*
- *29 issues requiring either clarification with originator (8) or direct response with additional information (21); the latter group may be candidates for FAQ*
- *57 issues requiring amendments to the models (two-thirds of which relate to IWXXM)*
- *8 issues requiring amendments to guidance or provision of additional examples*
- *10 issues requiring amendments to associated material (e.g. registers)*
- *22 "other" issues ranging from amendments that may affect all models to non-technical policy issues*
- *Majority of issues citing minor modelling defects and documentation errors / ambiguities*
- *Small number of more significant changes (some of which indicated earlier)*



## Open issues for METCE / OPM ...

- *Publication of WMO code-tables as web-accessible registers; on-going work anticipated for partial completion for RC2.*
- *Ongoing harmonisation between WMO METCE and INSPIRE Annex 3 data specification 'Atmospheric Conditions / Meteorological Features'; similar but not quite ... engagement with INSPIRE maintenance process?*
- *Development of 'coverage-type' example products (e.g. high-fidelity gridded data for TRACON) to assess suitability of METCE for anticipated future products; pending resource availability.*
- *Resolution of policy concerns (mandated use of polygons for describing SIGMET boundaries, reporting missing values, strict enforcement of ICAO SARPs or enforcement of common usage, bulletin validation, anticipated life-cycle of changes to IWXXM etc.); to be discussed with ICAO MARIE-PT.*
- *Mapping METCE & IWXXM to TDCF; future work – out of current scope.*
- ...



# AvXML 1.0 standard development schedule

- [1<sup>st</sup> Feb 2013] *1.0RC1 review closes*
- [1-8 Feb 2013] *1.0RC1 feedback clarification*
- [Feb-Mar 2013] *Amendments incorporated for 1.0RC2*
- [Mar 2013] *1.0RC2 published for review* !
- [Apr/May 2013 (tbc)] *1.0RC2 review closes*
- [July 2013] *AvXML 1.0 published*



# *Any questions?*

*For more information regarding AvXML 1.0RC1 please refer to the release page:*

*<http://www.wmo.int/pages/prog/www/WIS/wiswiki/tiki-index.php?page=METCE-1.0RC1>*

*... including more detailed presentation for RC1:*

*<http://wis.wmo.int/doc=2125>*

*Please register with the [CBS-TT-AvXML Google Group](#) to be notified of developments and contribute to the RC2 public comment.*



Thank you