



Met Office

Observations and
Measurements as a basis for
semantic reconciliation
between GRIB and netCDF
... and some other ideas.

Jeremy Tandy

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OGI

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Problem statement: interoperability

interoperable

Pronunciation: /ɪntər'ɒp(ə)rəb(ə)l/

adjective

(of computer systems or software) able to
exchange and make use of information

... requires both structure (syntax) and meaning (semantics)

GRIB (WMO No. 306 Vol I.2 FM92-XIV GRIB) is ...

- a message format for regulated products ...
- comprised of **sections**:
 - data payload
 - serialization details (data-type, precision, packing, compression & 'bitmap' masks) ... **syntax**
 - content description (grid and product definitions) and fixed metadata (originating centre, reference time etc.)
... **semantics**
- table driven – governed sets of code-tables and templates; the GRIB '*vocabulary*' (more **semantics**)

did anyone mention local tables?

- (section 2)
- designed for local use; bilateral exchange etc.
- often inaccessible beyond the original participants
- renders the GRIB message useless ...
- no tables: no decode!



World
Meteorological
Organization

Weather • Climate • Water

WMO-No. 306

Weather • Climate • Water

aside: publishing code-tables for reuse

WMO Codes Registry Check URI Datasets Admin Sparql About Search Not logged in

[http://codes.wmo.int / grib2 / codeflag / 4.2](http://codes.wmo.int/grib2/codeflag/4.2)

Register: Parameter number Stable

Parameter number by product discipline and parameter category

List **Table** Properties Metadata

Prev 0 Next page

Members

Item: 0-0-0 - Temperature <i>Temperature</i>	Type: Concept , Parameter	Stable
Item: 0-0-1 - Virtual temperature <i>Virtual temperature</i>		Stable
Item: 0-0-10 - Latent heat net flux <i>Latent heat net flux</i>	Type: Parameter , Concept	Stable
Item: 0-0-11 - Sensible heat net flux <i>Sensible heat net flux</i>	Type: Concept , Parameter	Stable
Item: 0-0-12 - Heat index <i>Heat index</i>	Type: Parameter , Concept	Stable

<http://codes.wmo.int/grib2/codeflag/4.2/0-0-0>

plain: ttl | rdf/xml

with metadata: ttl | rdf/xml

About the Register

owned by wmo
managed by www-dm
submitted on 3 Sep 2014 09:53:24.525
submitted by marqh (admin)

NetCDF (Network Common Data Form) is ...

- an API for storing and retrieving data in form of arrays
- described with a syntax of **dimensions**, **variables** and **attributes**
- (plus **groups** in the NetCDF-enhanced model)
- HDF5 “under the hood” ... but those details are abstracted away by the API

NetCDF is ... just a 'container'?

- out of the box, NetCDF can describe *any* array data ...
- data publishers are unconstrained in their choice of **dimensions, variables, attributes** and **groups**
- need *conventions* to supply semantics – so that consumers can understand the data too!



CF MetaData

Conformance

Discussion

Documents

Governance

CF Conventions and Metadata

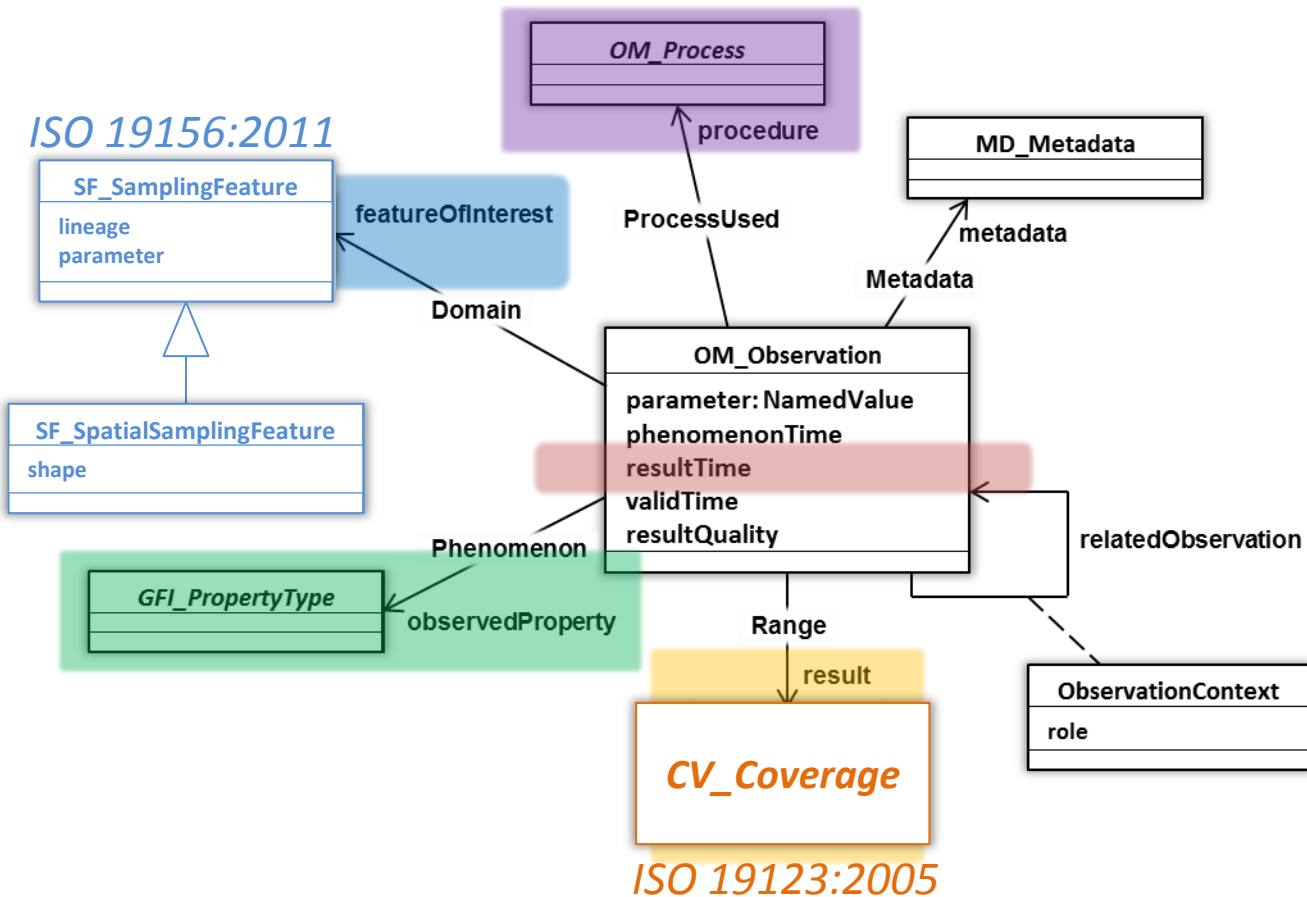
View the latest Conventions Documents

source: <http://cfconventions.org/>

Closing the gap #1

Publish data using well governed,
publically accessible semantics.

Observations and measurements

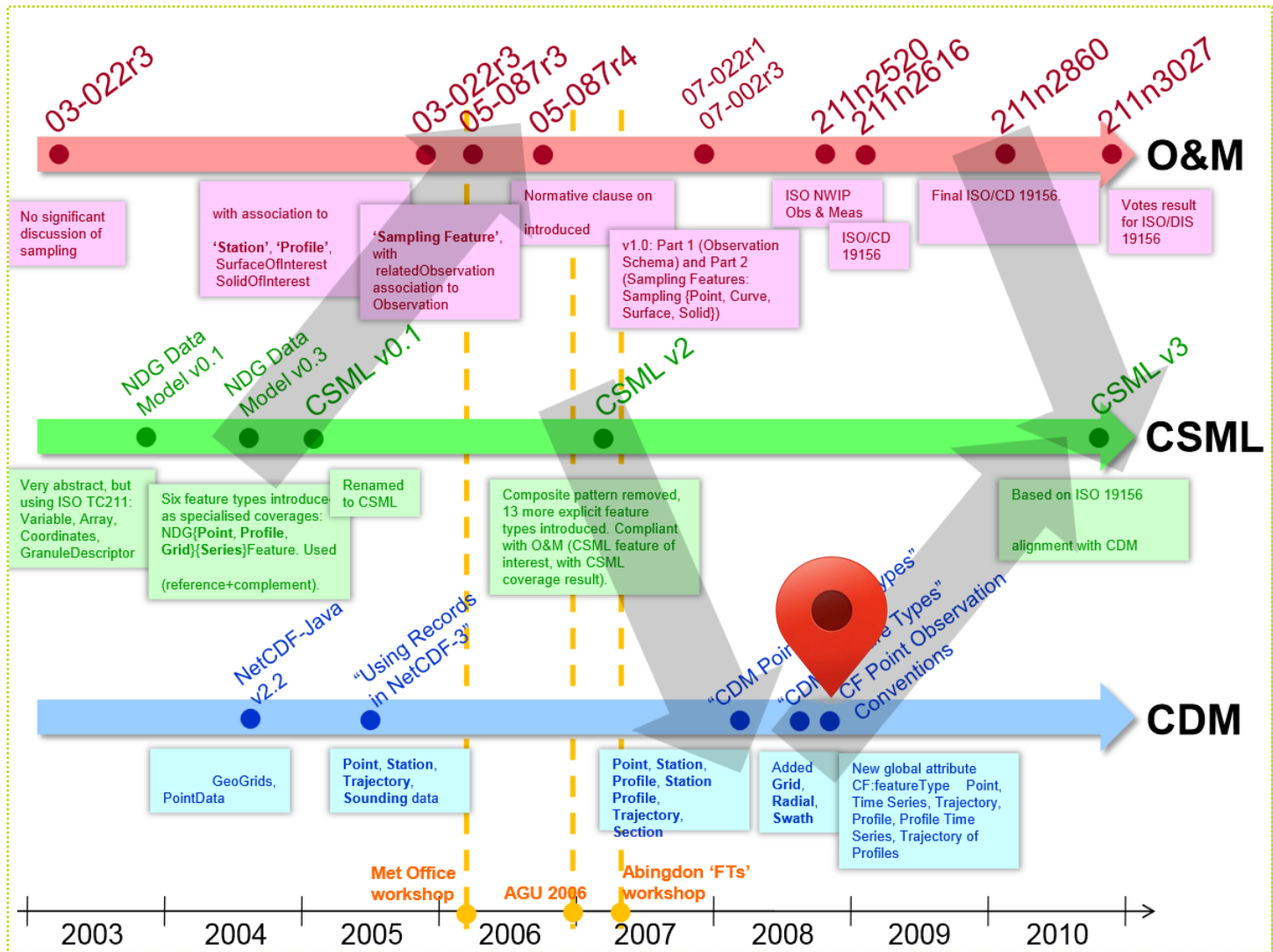


OM_Observation:

- an **EVENT** whose
- **RESULT** is an estimate of a value of some
- **PROPERTY** of some
- **THING** obtained using a specified
- **PROCEDURE** ...

ISO 19156:2011 'Geographic information – Observations and measurements' provides a metamodel for describing the context required to interpret the results of an observation.

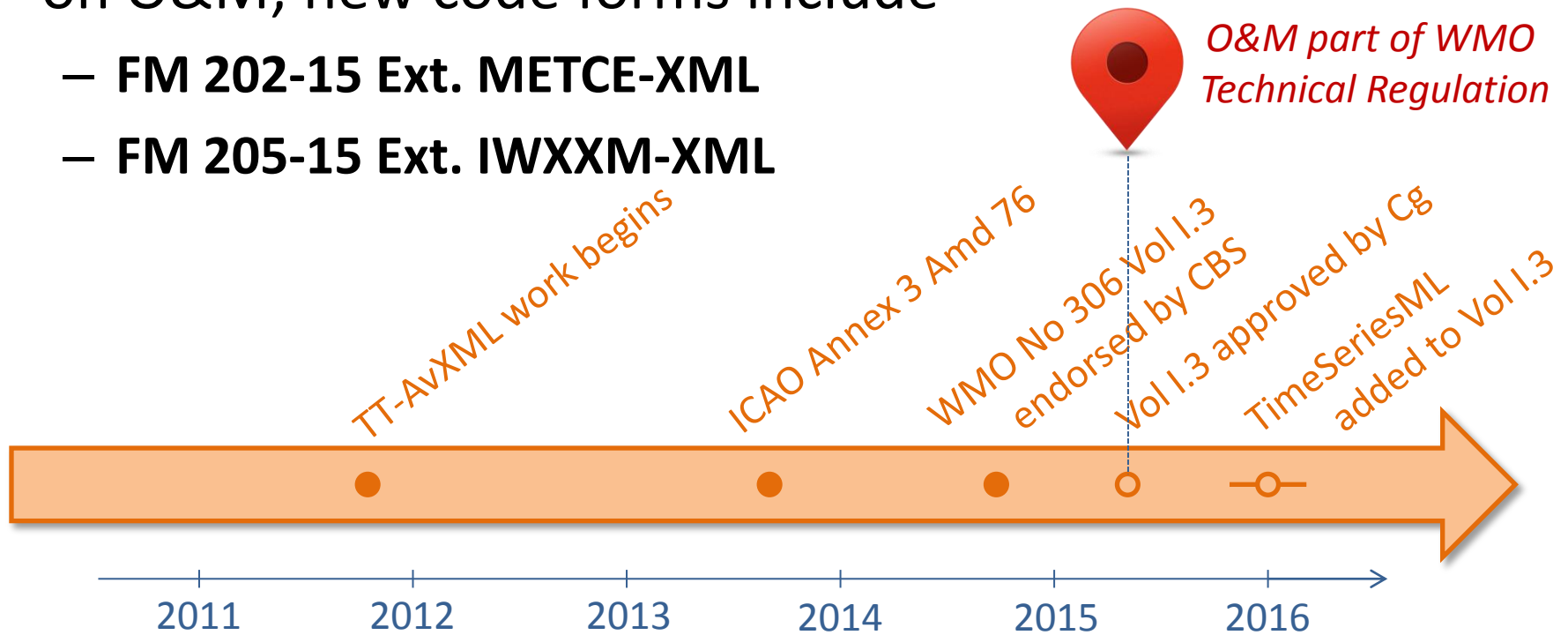
CF (CSML), CDM and O&M convergence



source: http://external.opengeospatial.org/twiki_public/pub/MetOceanDWG/MetOGCWorkshop3/Woolf-CSML-Exeter-Nov2010.pdf

WMO and O&M convergence

- WMO tasked by ICAO to deliver GML application schema for aeronautical meteorology data exchange
- WMO (TT-AvXML) adopt model-driven approach based on O&M; new code forms include
 - **FM 202-15 Ext. METCE-XML**
 - **FM 205-15 Ext. IWXXM-XML**



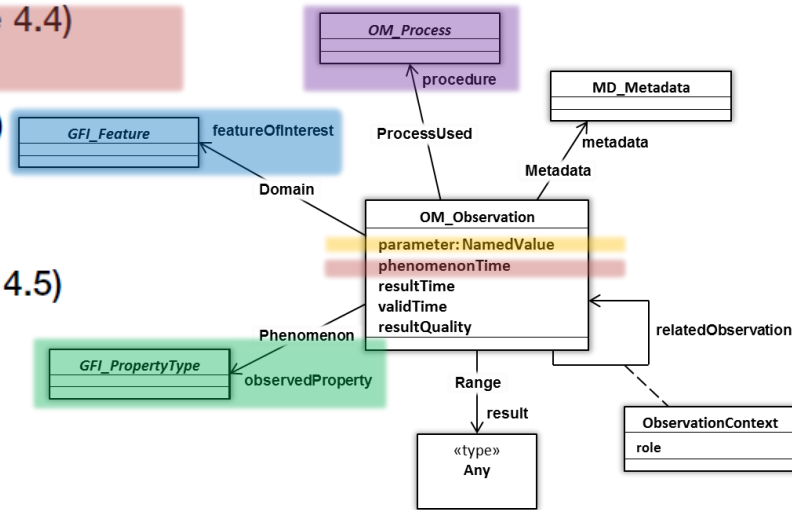
Closing the gap #2

Agree that O&M provides the common top-level semantics for our community and determine how to map to that model.

Heterogeneous GRIB templates

Product definition template 4.0 – analysis or forecast at a horizontal level or in a horizontal layer at a point in time

Octet No.	Contents
10	Parameter category (see Code table 4.1)
11	Parameter number (see Code table 4.2)
12	Type of generating process (see Code table 4.3)
13	Background generating process identifier (defined by originating centre)
14	Analysis or forecast generating process identifier (defined by originating centre)
15–16	Hours of observational data cutoff after reference time (see Note)
17	Minutes of observational data cutoff after reference time
18	Indicator of unit of time range (see Code table 4.4)
19–22	Forecast time in units defined by octet 18
23	Type of first fixed surface (see Code table 4.5)
24	Scale factor of first fixed surface
25–28	Scaled value of first fixed surface
29	Type of second fixed surface (see Code table 4.5)
30	Scale factor of second fixed surface
31–34	Scaled value of second fixed surface



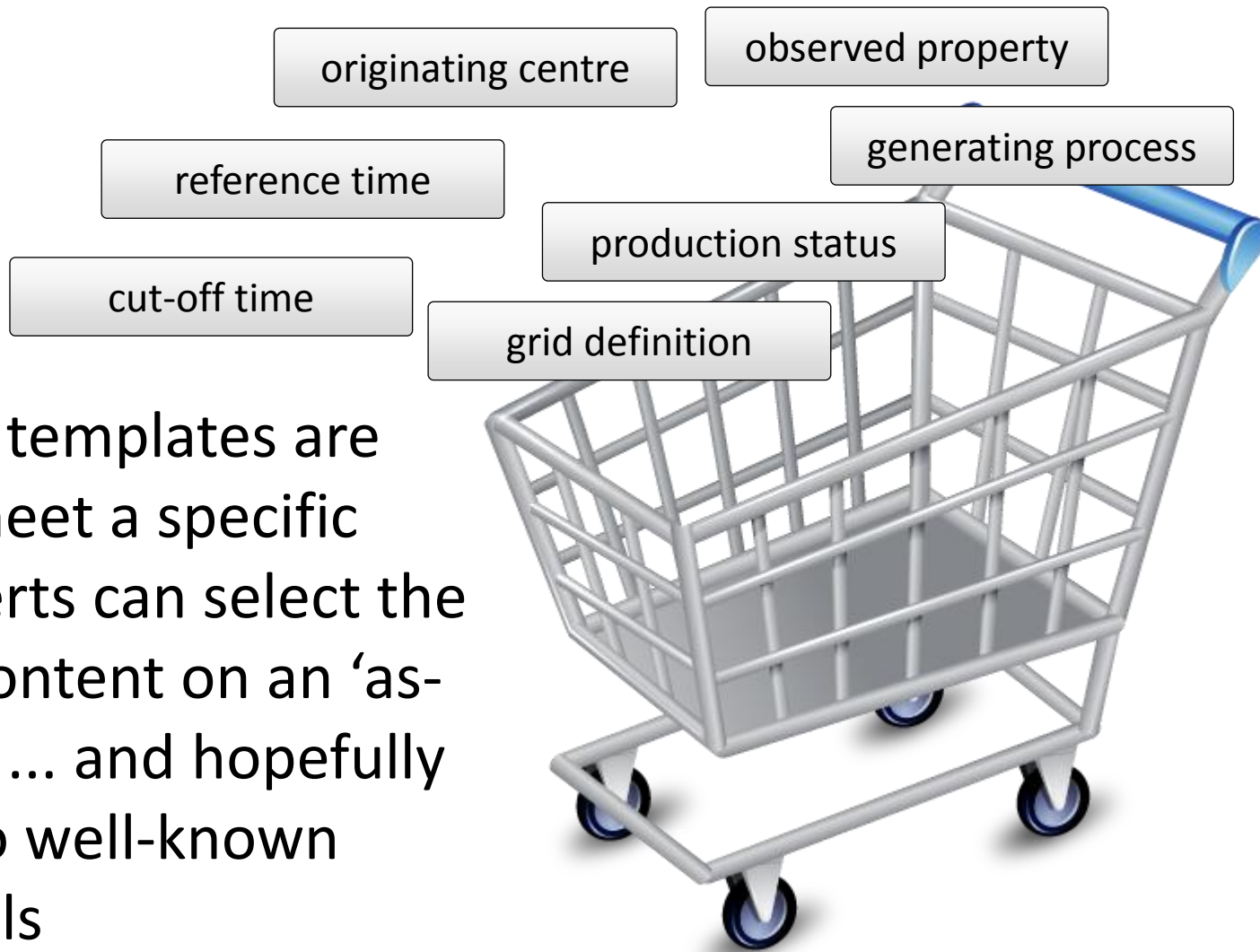
... there is no-size fits all mapping.

Closing the gap #3

Map GRIB templates to O&M on a case by case basis*.

**(and incorporate the O&M model into GRIB edition 3 to make the mapping easier)*

Supporting an ecosystem of conventions



Because GRIB templates are designed to meet a specific purpose, experts can select the information content on an 'as-needed' basis ... and hopefully map that onto well-known content models

Supporting an ecosystem of conventions

DCAT

ISO 19115-1

UncertML



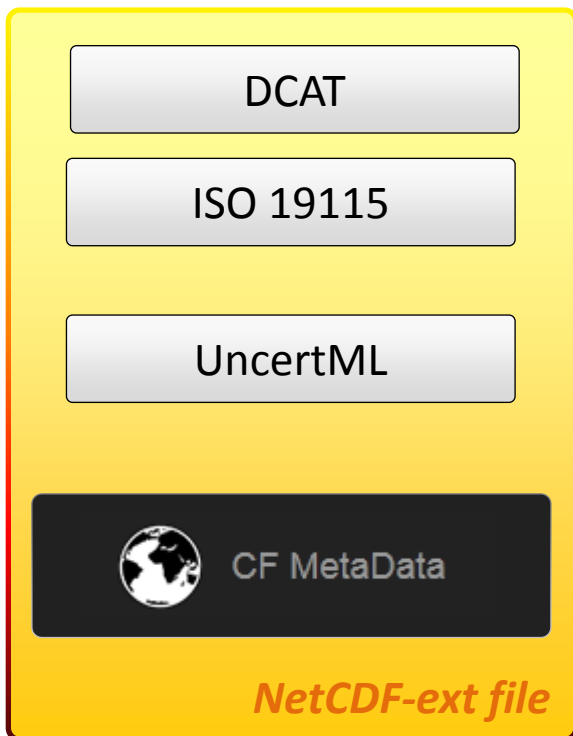
CF is great – but not the whole story ...

inclusion of elements from other standards and conventions in NetCDF alongside CF is difficult:

- validation tools throw exceptions
- reliance on NetCDF-classic model (NetCDF3) prevents use of **groups**

i) namespace awareness in NetCDF

Because **attributes** and **variables** are scoped to a **group**; names clashes can be avoided and software tools can ignore unrecognized properties ...



Discovery & usage metadata



Probability density function



Climate prediction model data

ii) including (complex) objects

Nesting of groups allows inclusion of complex objects ...

DCAT

ISO 19115

UncertML



CF Metadata

NetCDF-ext file

```
<group name="citation">
  <attribute name="uuid" value="UUID"/>
  <attribute name="objectType" value="acdd:CI_Citation"/>
  <attribute name="title" value="Title of cited item"/>
  <attribute name="identifier" value="Identifier of cited item"/>
  <attribute name="edition" value="Edition of cited item"/>
  <group name="date">
    <attribute name="date" value="Date associated with cited item"/>
    <attribute name="dateType" value="Type of date associated with cit
  </group>
  <group name="citedResponsibleParty">
    <attribute name="uuid" value="UUID"/>
    <attribute name="objectType" value="acdd:CI_ResponsibleParty"/>
    <attribute name="Name of responsible individual"/>
    <attribute name="organisationName" value="Name of responsible organ
    <attribute name="electronicMailAddress" value="Email of responsibl
    <group name="onlineResource">
      <attribute name="uuid" value="UUID"/>
      <attribute name="objectType" value="acdd:CI_OnlineResource"/>
      <attribute name="linkage" value="http://earthdata.nasa.gov"/>
      <attribute name="protocol" value="http"/>
      <attribute name="applicationProfile" value="Web Browser"/>
      <attribute name="name" value="EOSDIS - Earth Data Website"/>
      <attribute name="description" value="Access to data and inform
      <attribute name="function" value="information"/>
    </group>
  </group>
</group>
</group>
```

NcML illustration of CI_Citation from ISO 19115

source: <http://wiki.esipfed.org/index.php/NetCDF, HDF, and ISO Metadata>

Closing the gap #4

Update* the CF convention and related tools to support the NetCDF-enhanced model and namespace awareness using **groups**.

**(perhaps establishing “CF2” as a superset of CF is more appropriate than an update?)*

Note there is an active discussion thread [“CF Conventions and netCDF-4 enhanced model”](#)

Summary: gaps to close ...

1. Publish data using well governed, publically accessible semantics.
2. Agree that O&M provides the common top-level semantics for our community and determine how to map to that model.
3. Map GRIB templates to O&M on a case by case basis.
4. Update the CF convention and related tools to support the NetCDF-enhanced model and namespace awareness using groups.



Met Office

Thank you

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