World Meteorological Organization

Working together in weather, climate and water

Modelling of WMO data products based on BUFR/CREX tables

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WMO Secretariat

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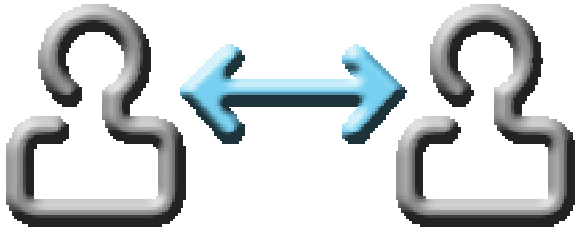
Data representation for interchange

WMO has a long history in the development and operational use of data representation systems for the interchange of data products related to weather, climate and water.



Data representation for interchange

WMO data representation systems:

- Traditional Alphanumerical Codes (TAC)
  SYNOP, TEMP, METAR, etc.
- Table Driven Code Forms (TDCF)
  BUFR, CREX, GRIB

See:
http://www.wmo.int/pages/prog/www/WMOCodes/ManualCodes.html

Data representation for interchange

There are other data representation systems (e.g. NetCDF, HDF) or XML-derived systems used to present data products related to weather, climate and water.

Issue: how to ensure the highest level of interoperability between applications based on different data representation systems?

Data representation for interchange

For the WMO Commission for Basic Systems (CBS):

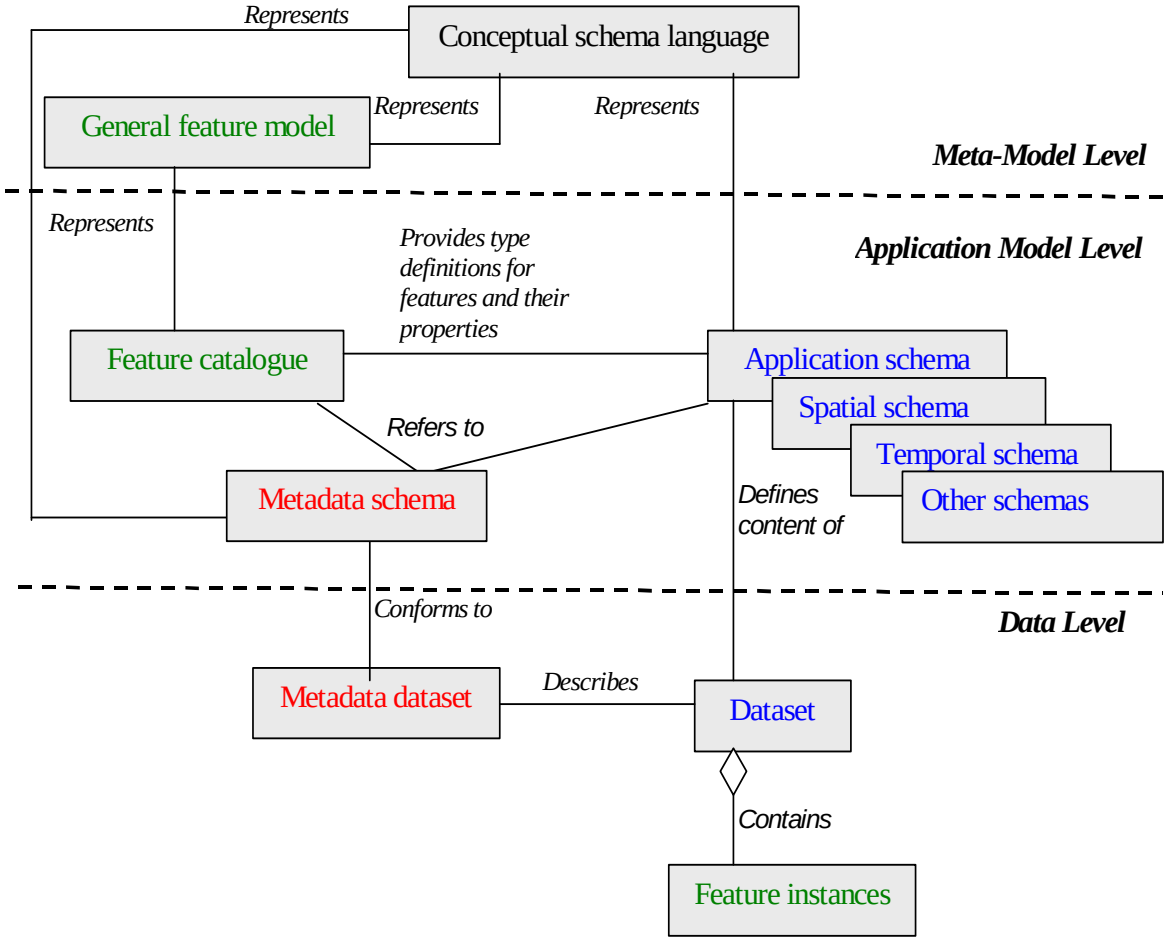
The application of the ISO 19100 series of geographic information standards to the development of a WMO conceptual model of data representation should be considered as a fundamental element of a CBS policy on data representation systems.

Data representation for interchange

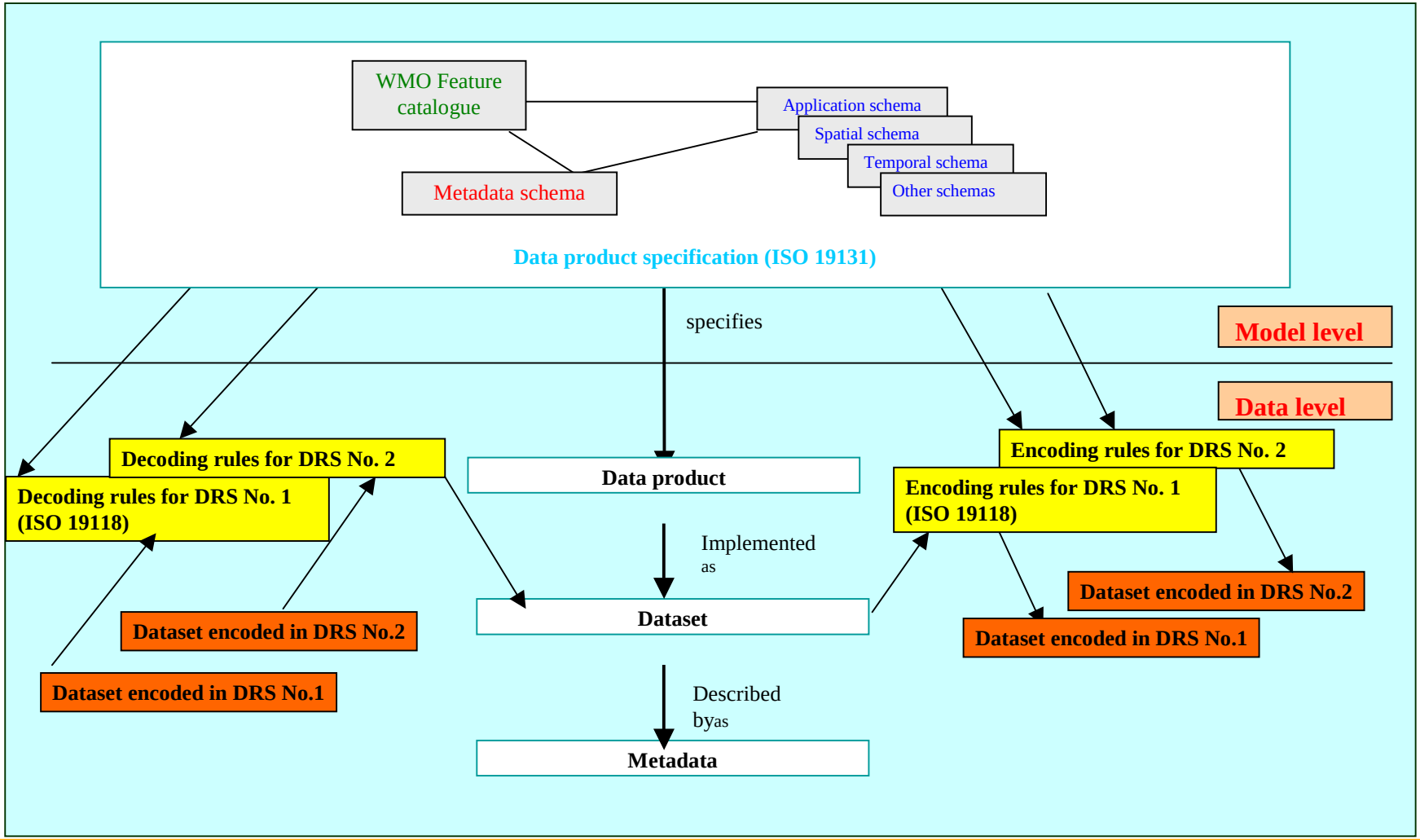
The CBS policy should lead to :

- The development of a WMO core profile of the ISO 19100 series for data and metadata
- A standard approach for data representation, facilitating the interoperability and data interchange between applications based on data representations systems associated to BUFR, CREX, GRIB, XML, NetCDF and HDF

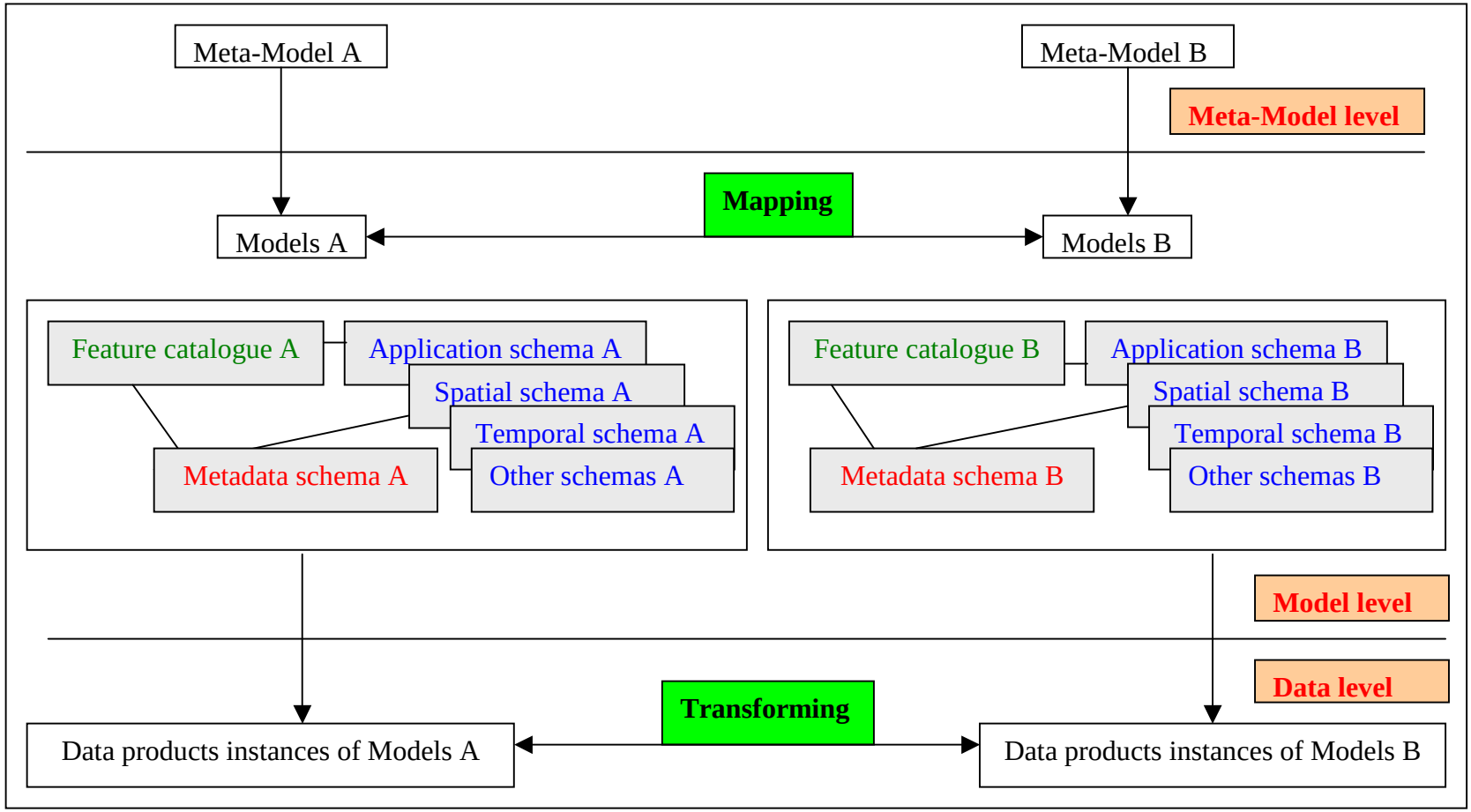
Relationship between features, metadata and data within the ISO Conceptual Schema Modelling Facilities (CSMF).



Facilitating the conversion between DRS



Facilitating the transformation of datasets instances of different models



BUFR/CREX Tables

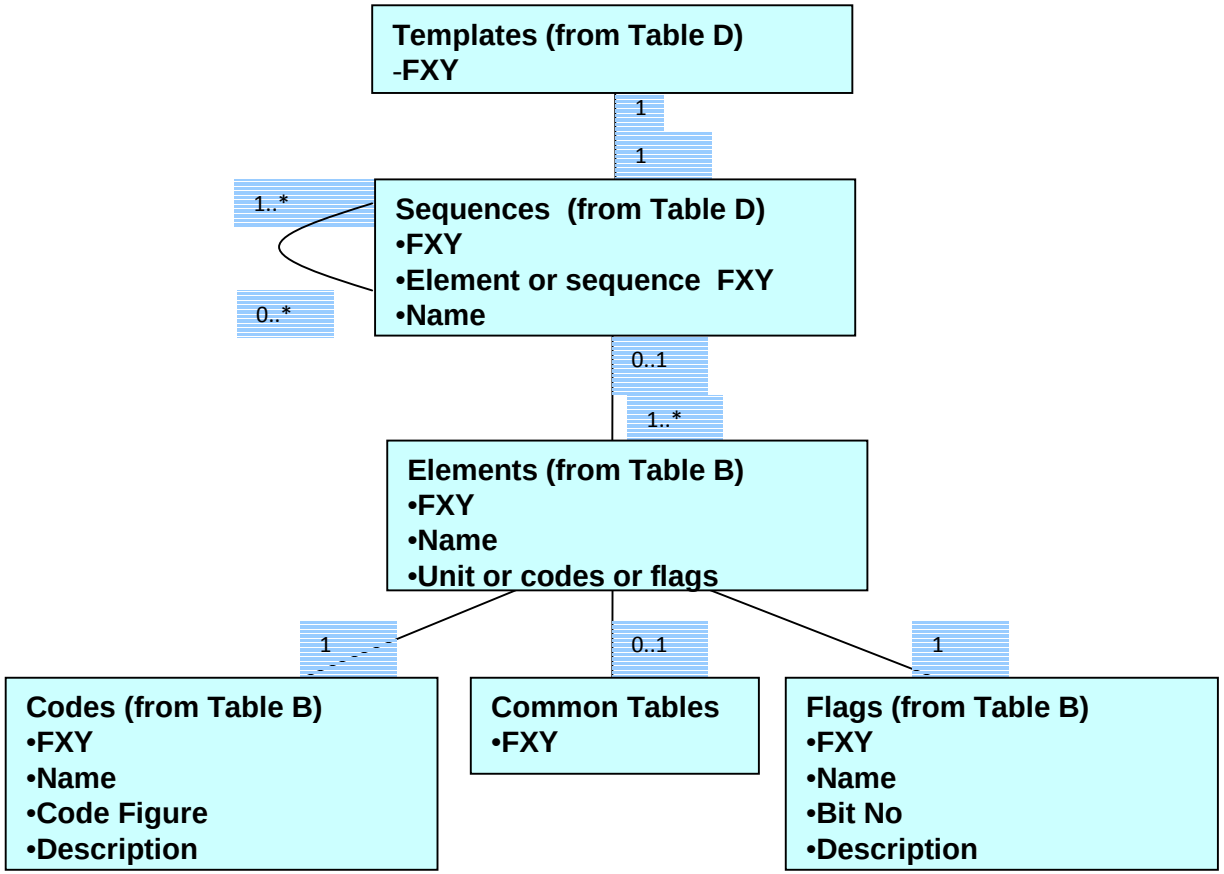
The parts of Volume I.2 of the WMO Manual on Codes related to BUFR/CREX mix the aspects related to:

- The modelling of the data
- The data representation for interchange

BUFR/CREX Tables

- Table B of elements
  - Element descriptors (FXY=0XY)
  - Replication descriptors (FXY=1XY)
- Table D of sequences (FXY=3XY)
- Code/flag tables

Relationship between BUFR/CREX Tables



Three-level modelling based on BUFR/CREX tables

The methodology for creating a model of a WMO data product is based on a sequential reading of the table of sequences:

A table is created for each sequence or replication found.

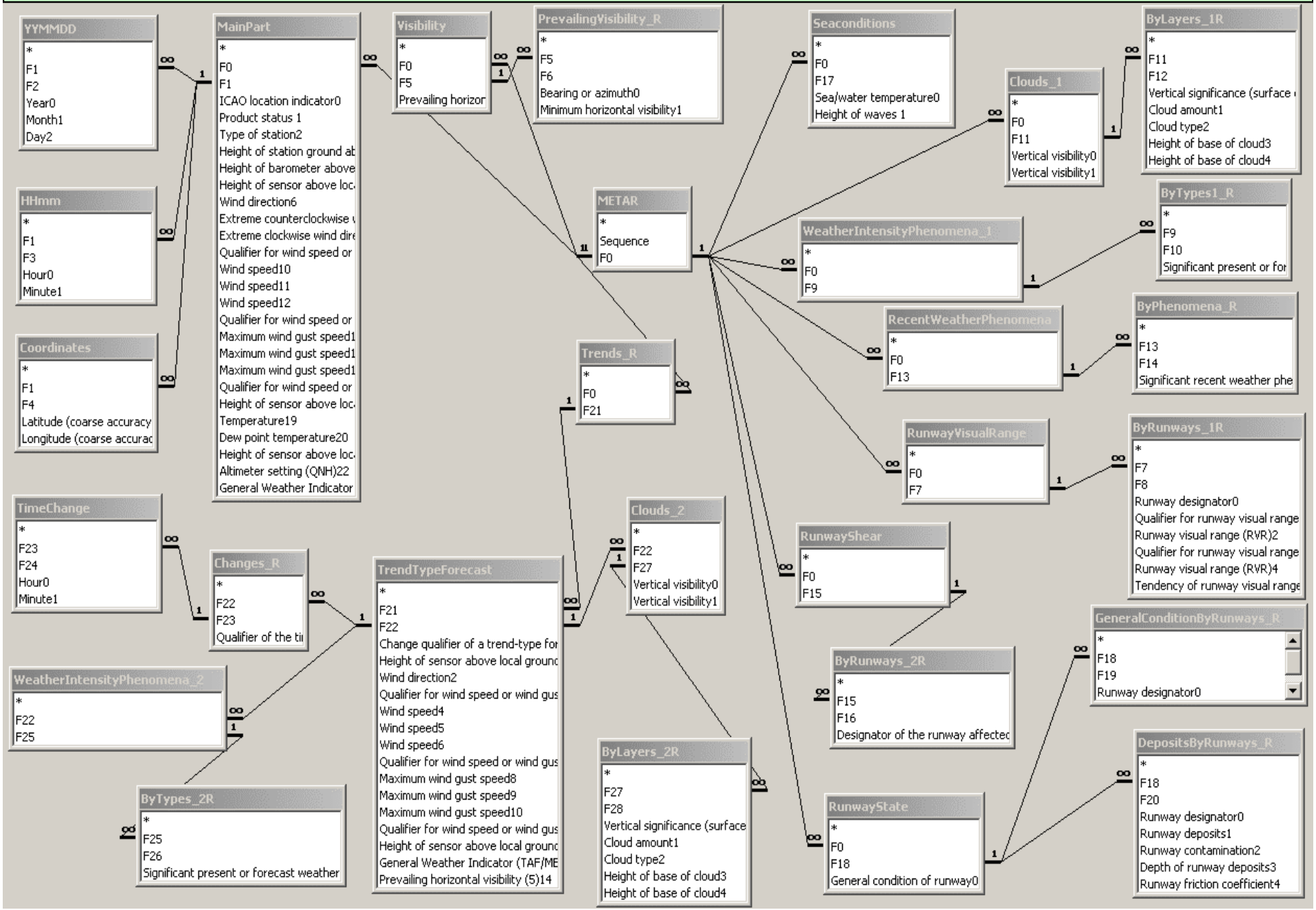
Results: a tree of tables with their relationship

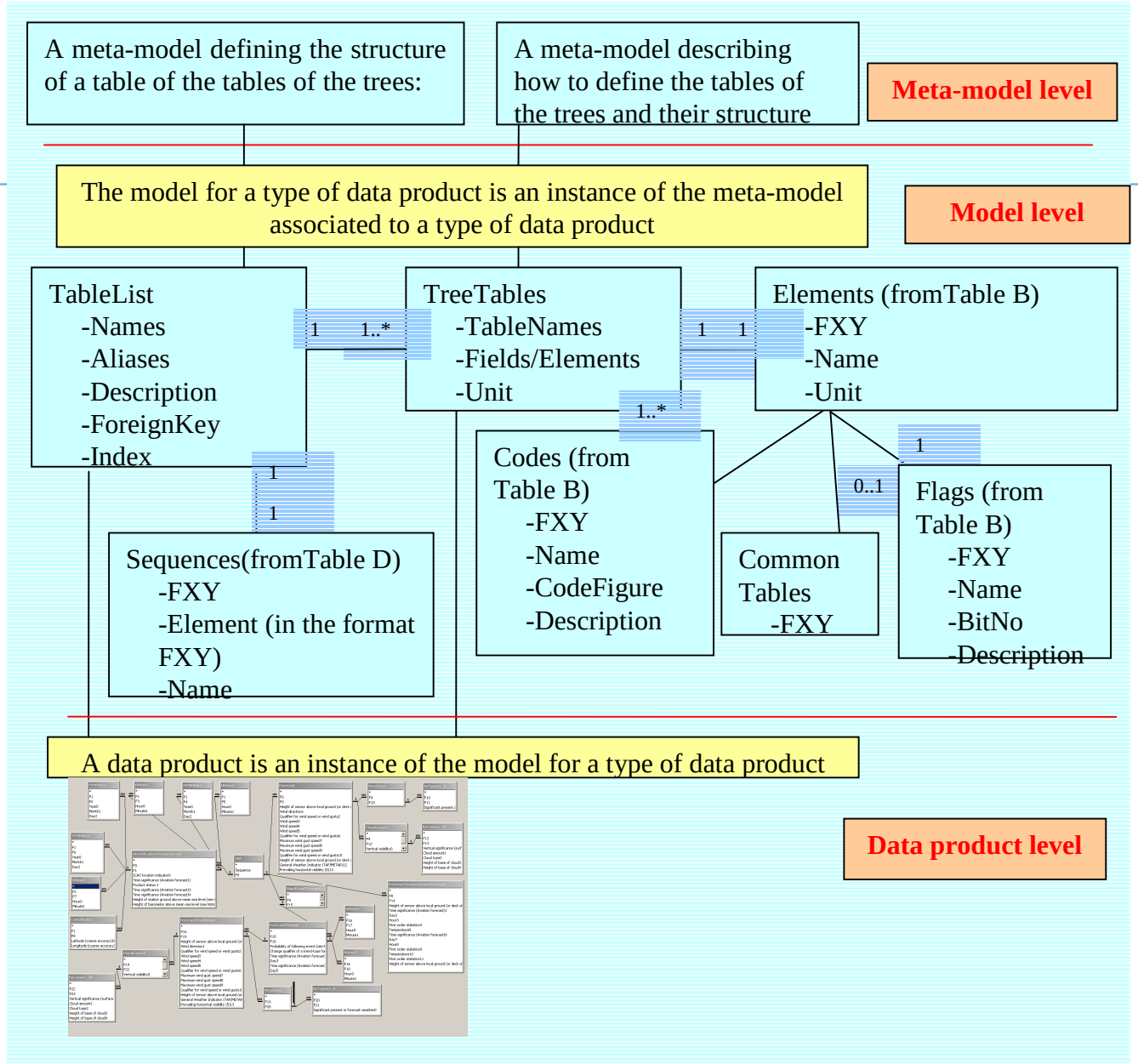
Three-level modelling based on BUFR/CREX tables

F X Y	Reference	Element/Sequence name
3 07 051	3 07 045	Main part of METAR/SPECI data
3 07 051	3 07 046	Visibility
3 07 051	3 07 013	Runway visual range
3 07 051	3 07 014	Weather intensity and phenomena
3 07 051	3 07 047	Clouds
3 07 051	3 07 016	Recent weather phenomena
3 07 051	3 07 017	Runway shear
3 07 051	3 07 049	Sea conditions
3 07 051	3 07 050	Runway state
3 07 051	1 01 000	Delayed replication of one descriptor
3 07 051	0 31 001	Replication count (0 to 3 normally)
3 07 051	3 07 048	Trend type forecast

F X Y	Reference	Element/Sequence name
3 07 045	0 01 063	ICAO location indicator
3 07 045	0 08 079	Aviation product status (routine, special, corrected, not available)
3 07 045	0 02 001	Type of station
3 07 045	3 01 011	Year, month, day
3 07 045	3 01 012	Hour, minute
3 07 045	3 01 023	Latitude-longitude (coarse accuracy)
3 07 045	0 07 030	Height of station ground above mean sea level
3 07 045	0 07 031	Height of barometer above mean sea level
3 07 045	0 07 032	Height of sensor above local ground = 10m (if the actual value is not available)
3 07 045	0 11 001	Wind direction
3 07 045	0 11 016	Extreme counterclockwise wind direction of a variable wind
3 07 045	0 11 017	Extreme clockwise wind direction of a variable wind
3 07 045	0 08 054	Qualifier for wind speed or wind gusts
3 07 045	0 11 083	Wind speed (km/h)
3 07 045	0 11 084	Wind speed (knots)
3 07 045	0 11 002	Wind speed (m/s)

Relationship between tables in the METAR model




A meta-model defining the structure of a table of the tables of the trees:
A meta-model describing how to define the tables of the trees and their structure
Meta-model level
The model for a type of data product is an instance of the meta-model associated to a type of data product
Model level
TableList
-Names
-Aliases
-Description
-ForeignKey
-Index
1
1..*
TreeTables
-TableNames
-Fields/Elements
-Unit
1
1
Elements (fromTable B)
-FXY
-Name
-Unit
1..*
1
1
Sequences(fromTable D)
-FXY
-Element (in the format FXY)
-Name
Codes (from Table B)
-FXY
-Name
-CodeFigure
-Description
Common Tables
-FXY
0..1
1
Flags (from Table B)
-FXY
-Name
-BitNo
-Description
A data product is an instance of the model for a type of data product
Data product level

Three-level modelling based on BUFR/CREX tables

- A meta-model defining the structure of a table of the tables of the trees
- A meta-model describing how to define the tables of the trees and their structure

Documents describing a model for a data product

- Table of the tables of the tree
- Tables of the tree

Meta-model level

Model level

Table of the tables of the tree for METAR/SPECI

name	alias	alias_2 (see footnote 2)	description	ForeighnKey	index
M307051	M1	METAR	-	-	F0
M307051M307045	M2	MainPart	Main part of METAR/SPECI data	F0	F1
M307051M307045M301011	M3	YYMMDD	Year, month, day	F1	F2
M307051M307045M301012	M4	HHmm	Hour, minute	F1	F3
M307051M307045M301023	M5	Coordinates	Latitude-longitude (coarse accuracy)	F1	F4
M307051M307046	M6	Visibility	Visibility	F0	F5
M307051M307046R1	M7	PrevailingVisibility_R	-	F5	F6
M307051M307013	M8	RunwayVisualRange	Runway visual range	F0	F7
M307051M307013R1	M9	ByRunways_1R	-	F7	F8
M307051M307014	M10	WeatherIntensityPhenomena_1	Weather intensity and phenomena	F0	F9
M307051M307014R1	M11	ByTypes1_R	-	F9	F10
M307051M307047	M12	Clouds_1	Clouds	F0	F11
M307051M307047R1	M13	ByLayers_1R	-	F11	F12
M307051M307016	M14	RecentWeatherPhenomena	Recent weather phenomena	F0	F13
M307051M307016R1	M15	ByPhenomena_R	-	F13	F14
M307051M307017	M16	RunwayShear	Runway shear	F0	F15
M307051M307017R1	M17	ByRunways_2R	-	F15	F16
M307051M307049	M18	Seaconditions	Sea conditions	F0	F17
M307051M307050	M19	RunwayState	Runway state	F0	F18
M307051M307050R1	M20	GeneralConditionByRunways_R	-	F18	F19
M307051M307050R2	M21	DepositsByRunways_R	-	F18	F20
M307051R1	M22	Trends_R	-	F0	F21
M307051R1M307048	M23	TrendTypeForecast	Trend type forecast	F21	F22
M307051R1M307048R1	M24	Changes_R	-	F22	F23
M307051R1M307048R1M301012	M25	TimeChange	Time of change	F23	F24
M307051R1M307048M307014	M26	WeatherIntensityPhenomena_2	Weather intensity and phenomena	F22	F25
M307051R1M307048M307014R1	M27	ByTypes_2R	-	F25	F26

Extracts from the tables of the tree (METAR model)

table	alias	element	FXY	name	unit
M307051M307045	M2	E001063n0	001063	ICAO location indicator	Character
M307051M307045	M2	E008079n1	008079	Product status	Code table
M307051M307045	M2	E002001n2	002001	Type of station	Code table
M307051M307045M301011	M3	E004001n0	004001	Year	Year
M307051M307045M301011	M3	E004002n1	004002	Month	Month
M307051M307045M301011	M3	E004003n2	004003	Day	Day
M307051M307045M301012	M4	E004004n0	004004	Hour	Hour
M307051M307045M301012	M4	E004005n1	004005	Minute	Minute
M307051M307045M301023	M5	E005002n0	005002	Latitude (coarse accuracy)	Degree
M307051M307045M301023	M5	E006002n1	006002	Longitude (coarse accuracy)	Degree
M307051M307045	M2	E007030n3	007030	Height of station ground above mean sea level (see Note 3)	m
M307051M307045	M2	E007031n4	007031	Height of barometer above mean sea level (see Note 4)	m
M307051M307045	M2	E007032n5	007032	Height of sensor above local ground (or deck of marine platf	m
M307051M307045	M2	E011001n6	011001	Wind direction	Degree true
M307051M307045	M2	E011016n7	011016	Extreme counterclockwise wind direction of a variable wind	Degree true
M307051M307045	M2	E011017n8	011017	Extreme clockwise wind direction of a variable wind	Degree true
M307051M307045	M2	E008054n9	008054	Qualifier for wind speed or wind gusts	Code table
M307051M307045	M2	E011083n10	011083	Wind speed	km h-1
M307051M307045	M2	E011084n11	011084	Wind speed	knot
M307051M307045	M2	E011002n12	011002	Wind speed	m s-1
M307051M307045	M2	E008054n13	008054	Qualifier for wind speed or wind gusts	Code table
M307051M307045	M2	E011085n14	011085	Maximum wind gust speed	km h-1
M307051M307045	M2	E011086n15	011086	Maximum wind gust speed	knot
M307051M307045	M2	E011041n16	011041	Maximum wind gust speed	m s-1
M307051M307045	M2	E008054n17	008054	Qualifier for wind speed or wind gusts	Code table

Three-level modelling based on BUFR/CREX tables

Compliance with the ISO 19100 series of geographic information standards, in particular ISO 19131 (data product specification) at the model level:

BUFR tables  Feature Catalogue	Tables describing the tree of the tables and the tables of the trees  Application schemas	The WMO core profile of the ISO metadata standard  Metadata schema

Three-level modelling based on BUFR/CREX tables

- The application of the meta-model makes it possible to generate automatically the models for sets of data products from a database application.
- The models facilitate the implementation of the database applications at centres for the production, exportation, importation and storage of data products since the same type of applications or algorithms, based on these three levels, can be used to produce and receive the data products.

Three-level modelling based on BUFR/CREX tables

Application of the models to the presentation of data products for data interchange:

The encoding rules used to present the data products for their interchange in a DRS and the decoding rules used to import a data product received are defined by the model documentation and the reference documentation specific to the DRS.

Three-level modelling based on BUFR/CREX tables

Application to the presentation of OPMET data products in XML

A test of the transmission on the ICAO aeronautical fixed service (AFS) of a METAR instance of the three-level Modelling of WMO data products based on BUFR/CREX tables presented in XML was carried out in July 2009.

Three-level modelling based on BUFR/CREX tables

Application to the presentation of OPMET data products (e.g. METAR) in XML,

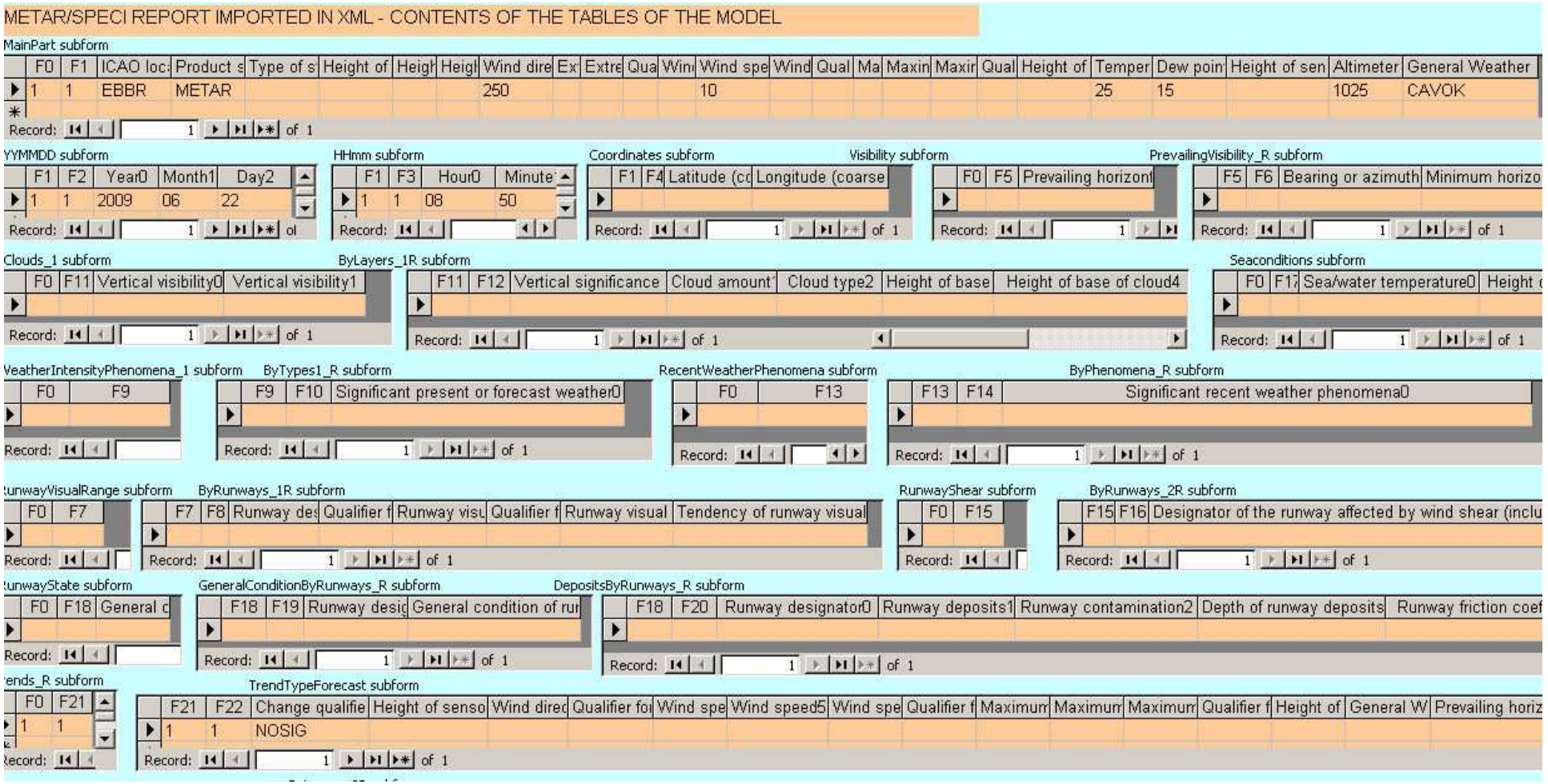
- To enter the values of the elements in the tables of the tree (instance of the METAR model)
- To export the tree of tables in XML producing .xsd and .xml files

Data level

METAR instance of the three-level Modelling of WMO data products based on BUFR/CREX tables

```
<?xml version="1.0" encoding="UTF-8"?>
<dataroot xmlns:od="urn:schemas-microsoft-com:officedata"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="test%202.xsd" generated="2009-06-22T11:03:38">
<M1>
<Sequence>307051</Sequence>
<F0>1</F0>
<M2>
<F0>1</F0>
<F1>1</F1>
<E0>EBBR</E0>
<E1>METAR</E1>
<E6>250</E6>
<E11>10</E11>
<E19>25</E19>
<E20>15</E20>
<E22>1025</E22>
<E23>CAVOK</E23>
<M3>
<F1>1</F1>
<F2>1</F2>
<E0>2009</E0>
<E1>06</E1>
<E2>22</E2>
</M3>
<M4>
<F1>1</F1>
<F3>1</F3>
<E0>08</E0>
<E1>50</E1>
</M4>
</M2>
<M22>
<F0>1</F0>
<F21>1</F21>
<M23>
<F21>1</F21>
<F22>1</F22>
<E0>NOSIG</E0>
</M23>
</M22>
</M1>
</dataroot>
```

METAR instance of the three-level Modelling of WMO data products based on BUFR/CREX tables



Three-level modelling based on BUFR/CREX tables

More information on the three-level Modelling of WMO data products based on BUFR/CREX tables is available from

http://www.wmo.int/pages/prog/www/WDM/modelling/ModelFromBUFR_V5.doc

Thank you