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Swiss Confederation

Federal Department of Home Affairs FDHA
**Federal Office of Meteorology and Climatology MeteoSwiss**

# Application of WIGOS Metadata Standard

*… Supporting adequate use of observations & rational network evolution*

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TT-WIGOSMD

**Capacity Building on Hydrological Data Exchange, standardization, and Interoperability in Region VI**
**25–30 January 2024, Zagreb, Croatia**

| Physical Session (ISRBC, Zagreb Croatia) 29th January 2024 | | |
|---|---|---|
| 11:40–12:30 | Application of WIGOS Metadata Standard | Jörg Klausen, chair TT-WIGOS Metadata |
| | KPIs for WIGOS metadata | Jörg Klausen, chair TT-WIGOS Metadata<br>Anna Milan, WMO Secretariat |
| 12:30–12:40 | Questions: Application of WIGOS Metadata Standard | Jörg Klausen, chair TT-WIGOS Metadata<br>Lucia Cappelletti, MeteoSwiss |

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INTERNATIONAL SAVA RIVER BASIN COMMISSION

# Objectives of presentation

- Understand the importance of observational metadata
- Understand the concepts of the WIGOS metadata standard vs the WIS metadata
- Understand how WIGOS Metadata Standard (WMDS) is expressed in the WIGOS Metadata Representation (WMDR)
- Know where to find code lists and their governance
- Know how WMDR records can be assessed (KPIs)

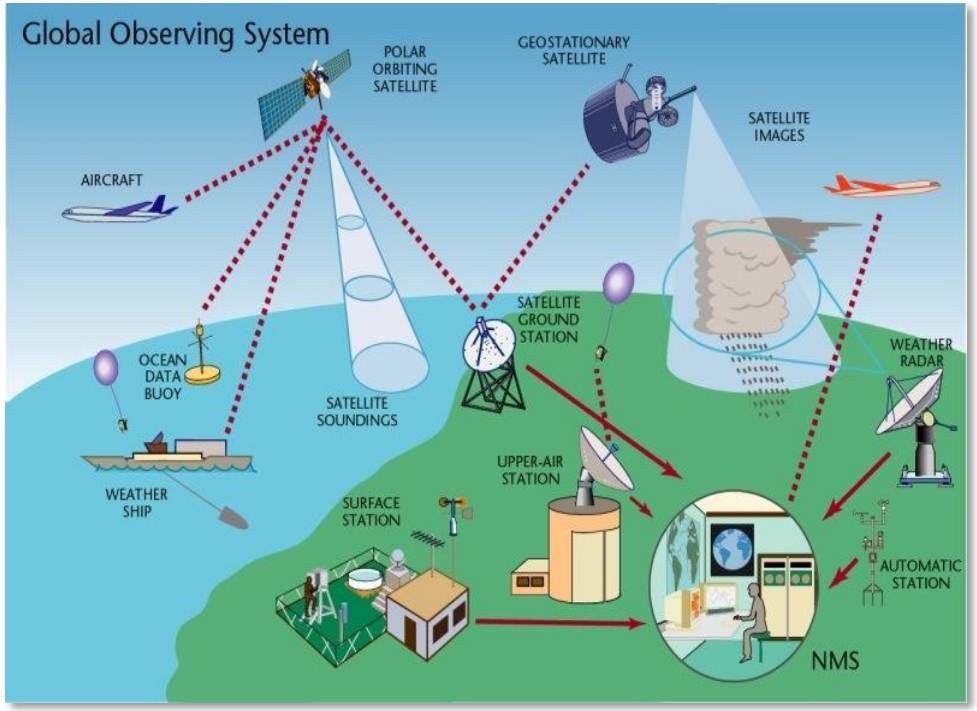
# Outline

- Introduction
- WIGOS Metadata Standard (WMDS )
- WIGOS Metadata Representation (WMDR)
- WMDR UML Model
- OSCAR/Surface API
- WMDR XML KPIs
- Q&A

# INTRODUCTION

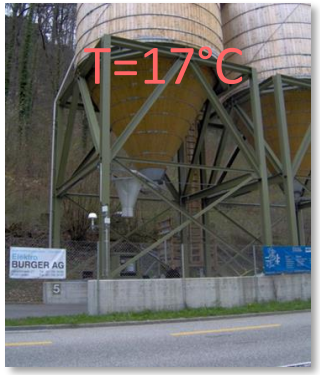
# WIGOS, WMDS, WMDR and OSCAR

- WIGOS: A framework for integrating all surface and space-based WMO observing systems and WMO contributions to co-sponsored observing systems under a common regulatory and management framework
  - Global Observing System (WWW/**GOS**)
  - Global Atmospheric Watch (**GAW**)
  - WMO Hydrological Observations (**WHOS**)
  - Global Cryosphere Watch (**GCW**)
  - …..
- Common observation framework → common language
  - WIGOS Metadata Standard (WMDS)
  - WIGOS Metadata Representation (WMDR)
  - OSCAR/Surface as global metadata repository



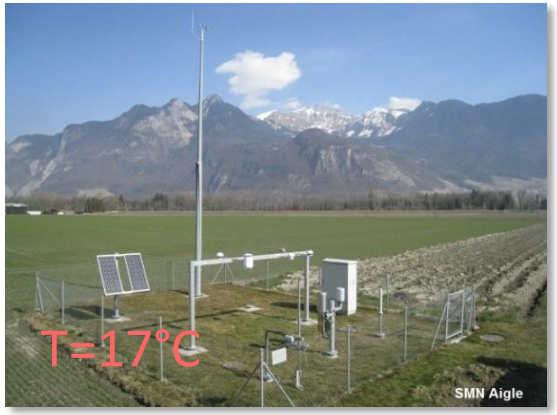
# What are metadata? Why are they essential?

- Metadata = documentation describing data, context of observations
  - → Observed variable
  - → Location
  - → Environment
  - → Intended use
  - → …



- Essential data are exchanged globally.
- Metadata are needed to make *adequate* use of observations, yet, they have not always been easily available to users.



# Metadata for climate applications

“The details and history of local conditions, instruments, operating procedures, data processing algorithms and other factors pertinent to interpreting data (i.e. metadata) should be documented and treated with the same care as the data themselves.”

GCOS Climate Monitoring Principle #3

# Flavours of Metadata in WMO context

- Describe products
- Support discovery, access, retrieval

→ Formalized using *WCMP2*,
conforms to *OGC API - Records - Part 1: Core*


- Describe observations, stations
- Enable adequate use of observations
- Support rational evolution of observing systems

→Formalized using ISO19156
(includes ISO19115) metadata standard

# WIGOS METADATA STANDARD (WMDS)

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# Reference




https://wis.wmo.int/WIGOS-MD

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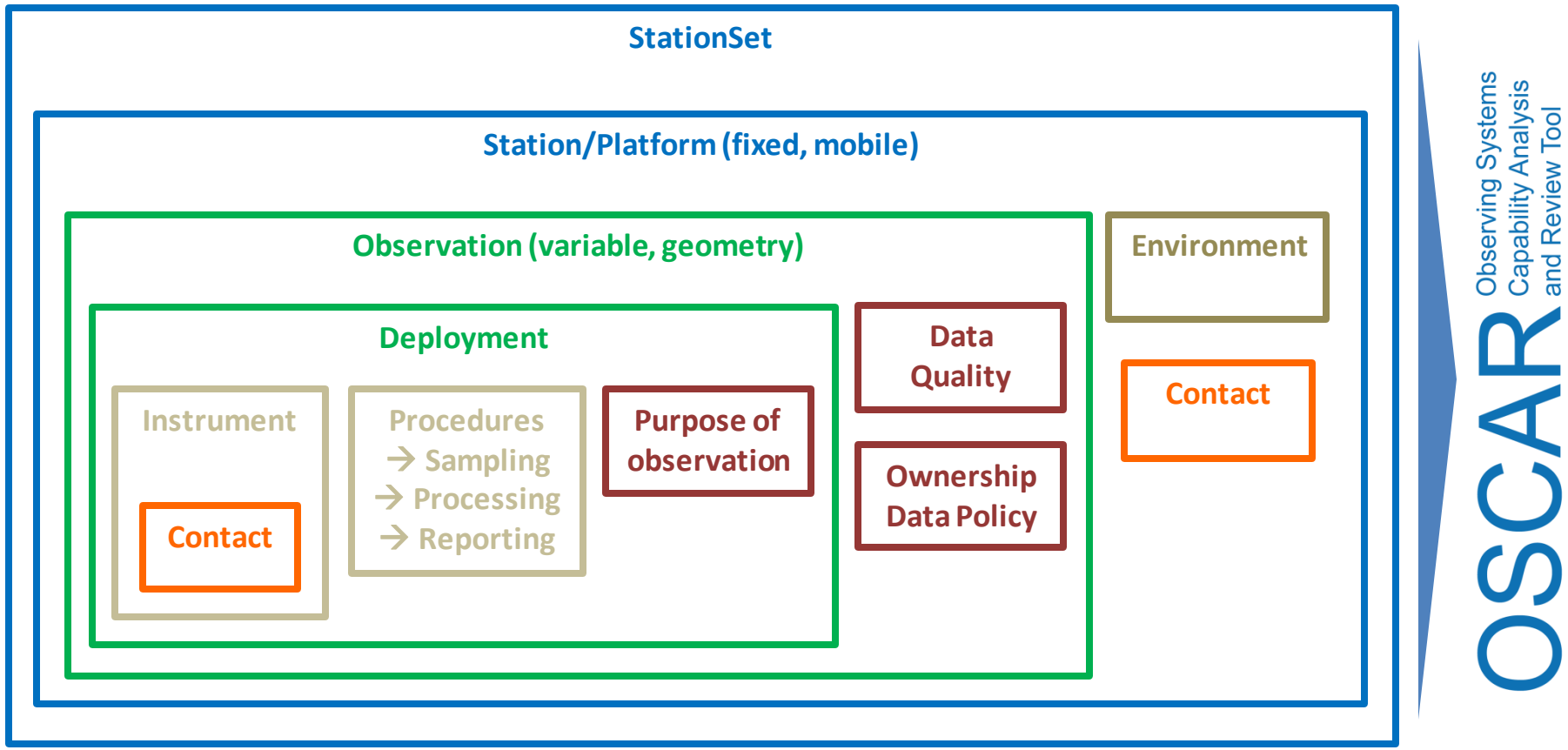
# 10 WIGOS metadata categories

| |
|---|
| **1. Observed variable** |
| **2. Purpose of observation** |
| **3. Station/ platform** |
| **4. Environment** |
| **5. Instruments & methods of observation** |
| **6. Sampling** |
| **7. Data processing and reporting** |
| **8. Data Quality** |
| **9. Ownership and Data Policy** |
| **10. Contact** |

- More than 90 elements
- More than 40 elements with controlled contents (code lists), most of which managed within the WMDS

# Hierarchy of WMD categories




OSCAR Observing Systems Capability Analysis and Review Tool

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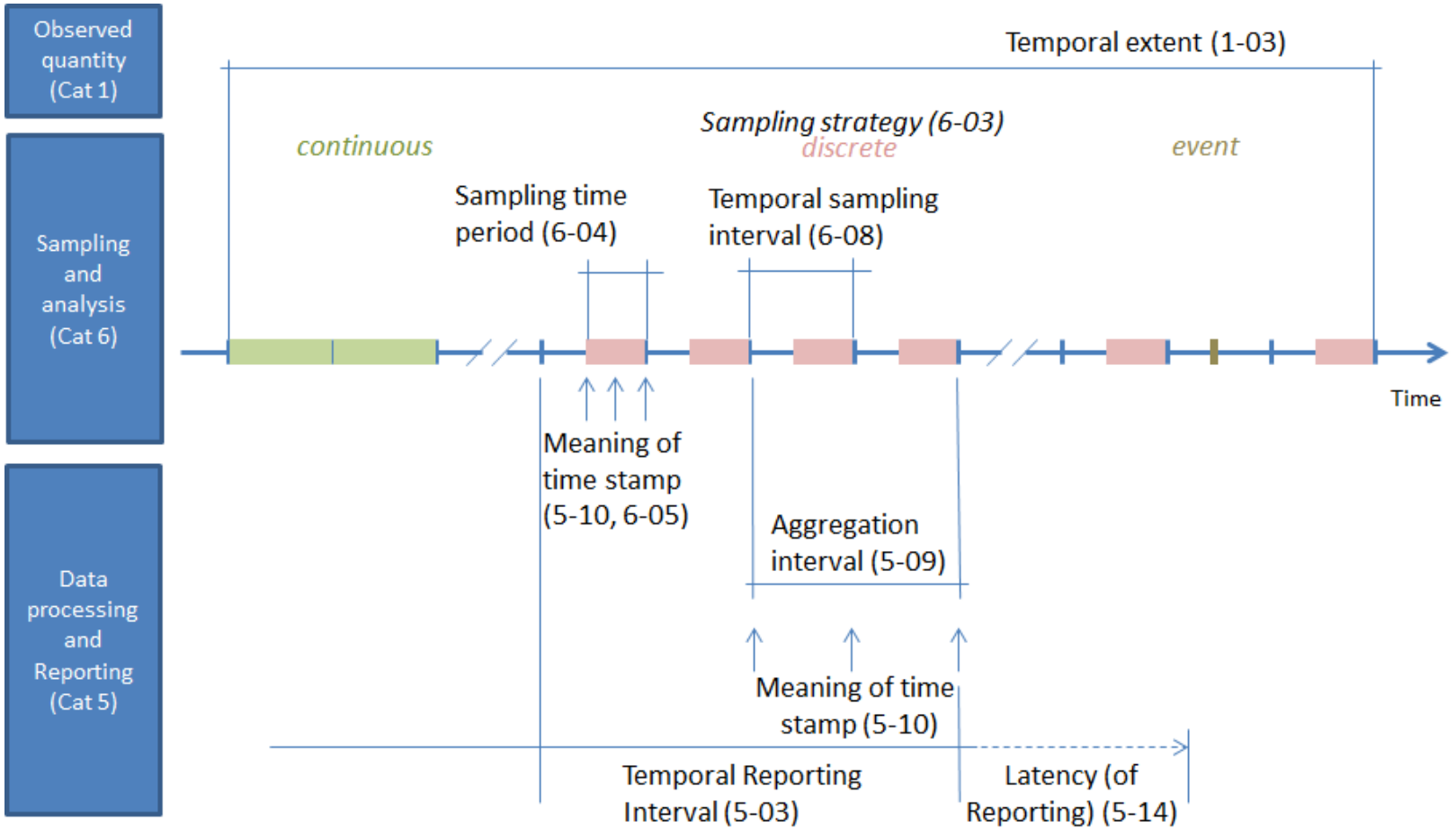
# WMDS is a descriptive standard

- WMDS describes concepts and principles
- 10 categories
- Mix of general and specific metadata items
- Ambiguous without further specification
- Need formal specification of metadata items
- Need cardinalities
- Need «best practice» guidance material

# Concepts of Time in WMDS

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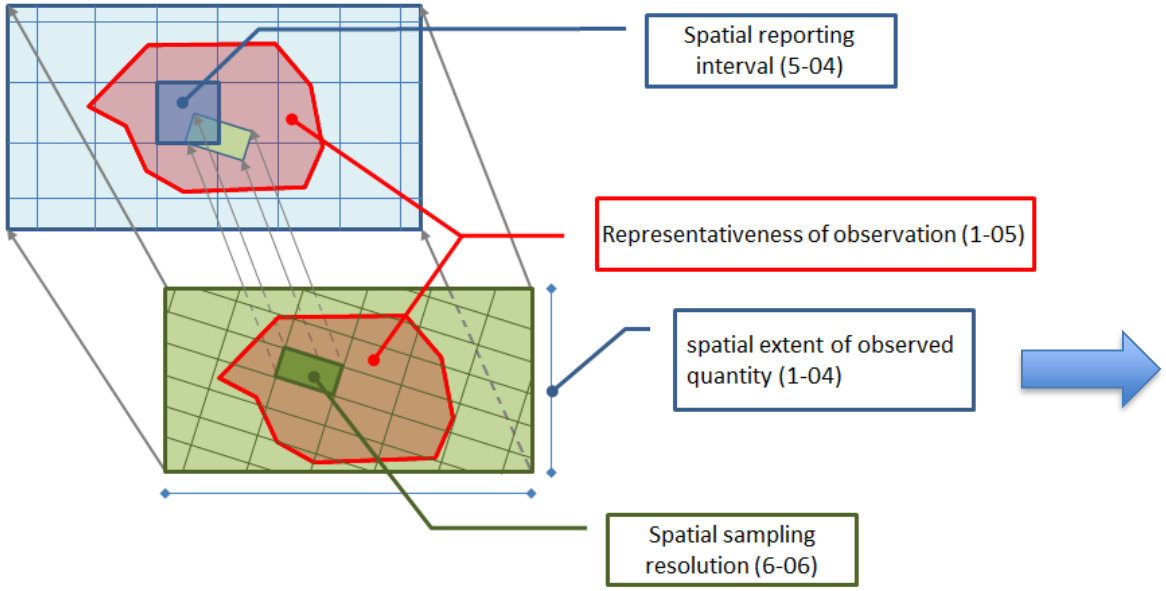
# Concepts of space in WMDS




## Geometry of observation (1-04)

Show 20 entries  Filter entries:

| Name | Notation | Description | Types | Status |
|---|---|---|---|---|
| Area | area | a two-dimensional feature, either a plane, or some other surf... | Concept | stable |
| inapplicable | inapplicable | observing geometry inapplicable | Concept | stable |
| Line | line | a one-dimensional feature, either a straight line, or a curve... | Concept | stable |
| Point | point | a zero-dimensional feature | Concept | stable |
| Total column | totalColumn | the integral of the vertical distribution of a feature | Concept | stable |
| unknown | unknown | observing geometry unknown | Concept | stable |
| Vertical profile | verticalProfile | synonymous to vertical distribution of a feature | Concept | stable |
| Volume | volume | a three-dimensional feature | Concept | stable |

Showing 1 to 8 of 8 entries  Previous 1 Next

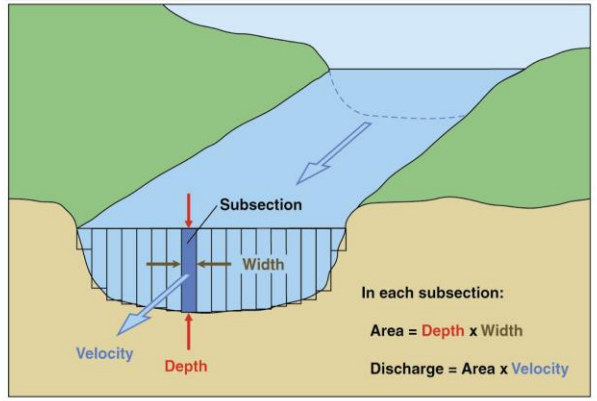
## Entry: Stream discharge

stable

**URI:** http://codes.wmo.int/wmdr/ObservedVariableTerrestrial/171

Volume of water flowing through a stream (or channel) cross-section per unit time. [Based on 'discharge' in International Glossary of Hydrology (WMO-No. 385). 2012 edition.]

Q: geometry?  A: point




USGS

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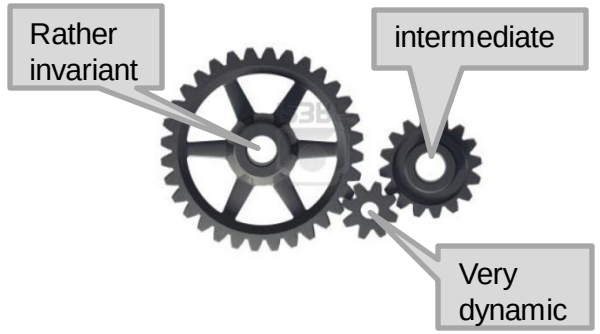
# Characteristics of WIGOS Metadata

- Generation
  - Various levels of granularity


- Transmission
  - Various intervals for (incremental) update




- Access and use
  - By humans (researchers, managers, the public)
  - By machines (services)

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# WIGOS METADATA REPRESENTATION (WMDR)

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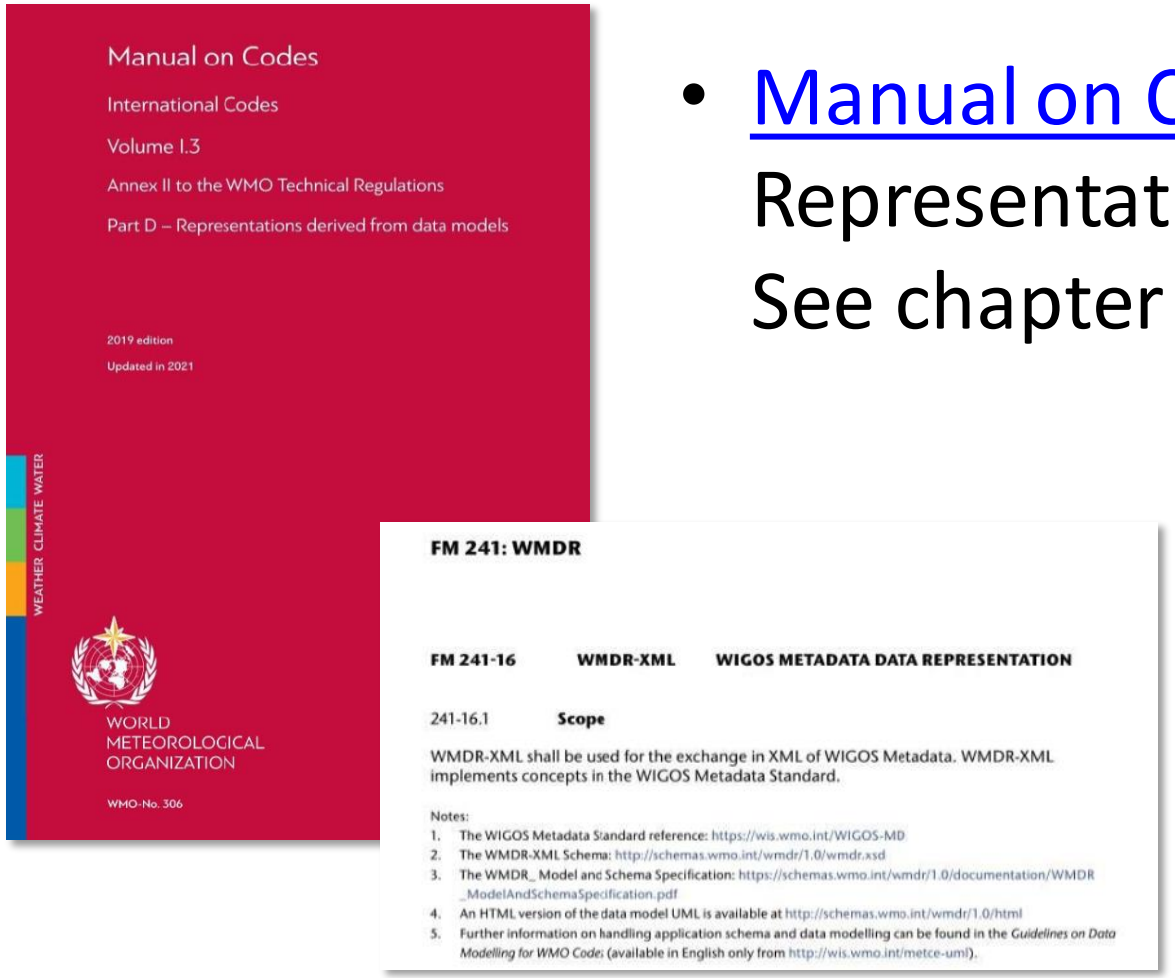
# What is a formal specification?

- Allowed elements
- Normative definition of elements
- Cardinalities
  - 0..1 (optional, at most one)
  - 0..* (optional, many allowed)
  - 1 (mandatory, exactly one)
  - 1..* (mandatory, at least one)
- Specify hierarchy between elements
  - «A» depends on «B»
- Specifies an exchange format

# Reference




- [Manual on Codes, Volume I.3](#) Part D – Representations derived from data models
  See chapter FM 241: WMDR

# THE WIGOS METADATA MODEL

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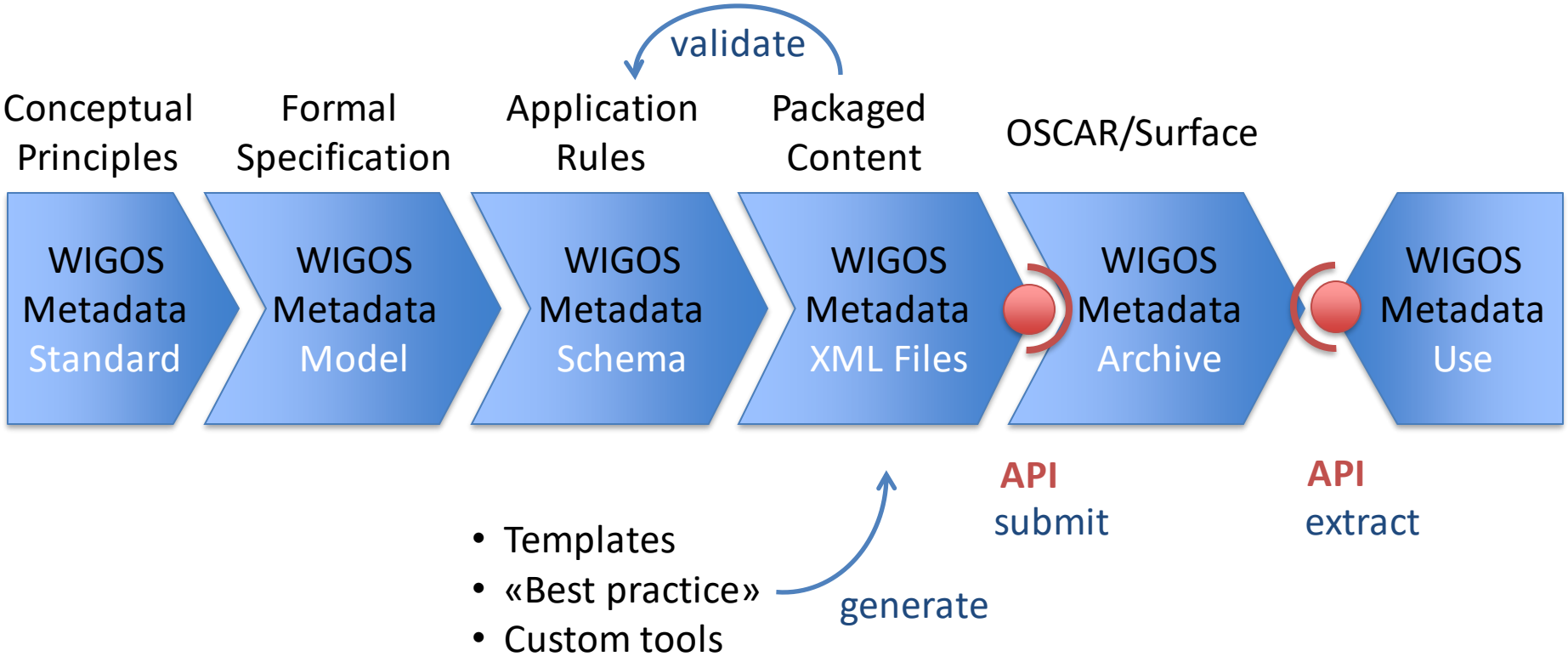
# WIGOS Metadata
## From Standard to Use

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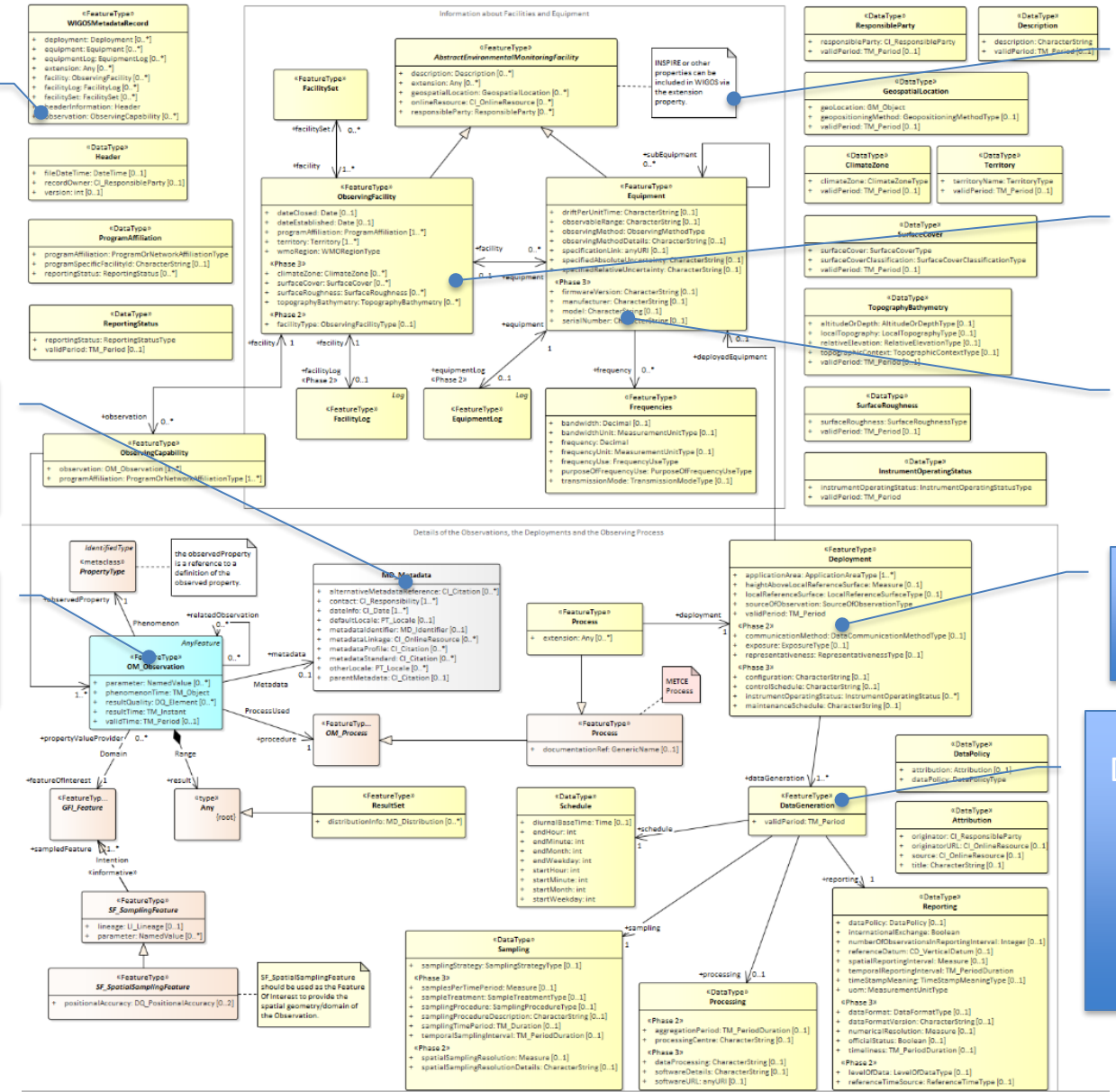
# WIGOS Metadata Representation: UML Model

WMD Record

«WIS»-type metadata

Observation




Extensions

Observing facility

Equipment

Deployment

DataGeneration
- Schedule
- Sampling
- Processing
- Reporting

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# WMDS/WMDR Code Tables

- http://wmo.codes.int/wmdr/
- working space for development: https://github.com/wmo-im/wmds

- TT-WIGOSMD is governing the evolution of these tables
- Process driven by user requirements
  - change requests, github issues
  - WMO Fast Track (FT) process

# OSCAR/SURFACE API

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# OSCAR/Surface API

- WMDR very comprehensive, (dauntingly) flexible
- OSCAR/Surface management console is intended to support editing of single stations
- If metadata are maintained in a digital archive, it makes sense to automate WIGOS metadata production and delivery
- OSCAR/Surface API* allows machine-to-machine interaction, intended to support bulk operations or repeated updates.
- OSCAR/Surface API accepts valid WMDR XML records only.

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*API=Application Programming Interface

# How to generate WMDR XML* Files

- Get familiar with the WMDR (reference material) and OSCAR/Surface
- Define scope of delivery (station type, network, historical metadata, …)
- Map WMDR and your DB elements
- identify WMDR entities/classes in DB (at first mandatory elements)
- Provide more content within the defined scope
  - hierarchy
  - optional elements
- Map code lists entries
- Define default values/ include missing metadata (i.e. code lists) in DB

  → generate valid WMDR XMLs

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*XML=eXtensible Markup Language

# How to validate WMDR XML

- XSD*
  - Formal validation rules
  - Expressed in XML
- On-line validators exist for XSD
  - https://www.freeformatter.com/xml-validator-xsd.html
  - http://www.xmlvalidation.com/
  - Notepad++ XML extension
  - OSCAR/Surface (!)
- Stand-alone tools
  - XMLSpy



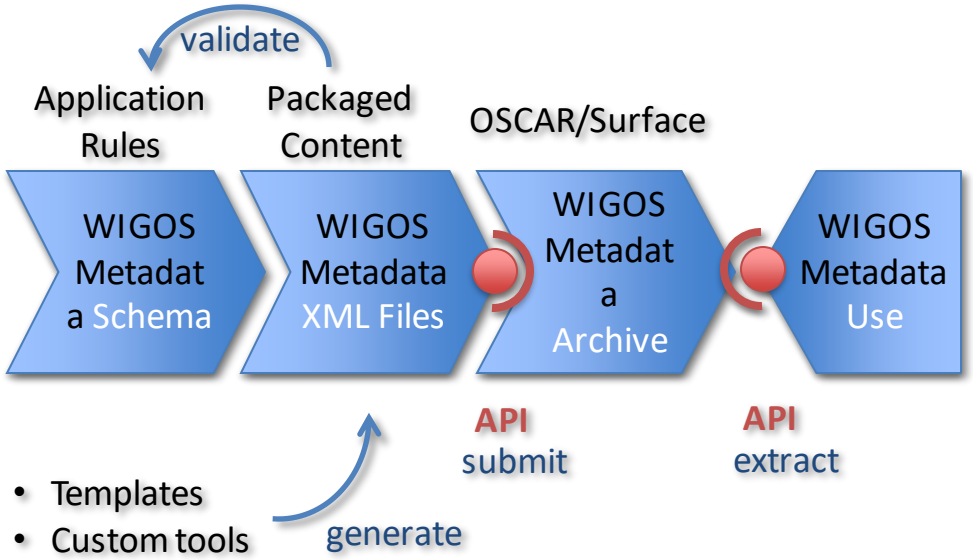
*XSD=XML Schema Definition

# OSCAR WMDR XML API

- WMDR API not transactional→ Business rules for inserting/ updating/ correcting metadata
  - identification of classes/entities
    - gml:identifier for stations (unique station name!)
    - Gml:id for «Deployment» and «Data generation»
    - Mandatory elements for «observation»
  - Identification of single elements with history
    - date
  - additional matching rules
  - Use and expand the OSCAR instrument catalogue and the contacts list
- Delete not supported
  - contact OSCAR/Surface support for help

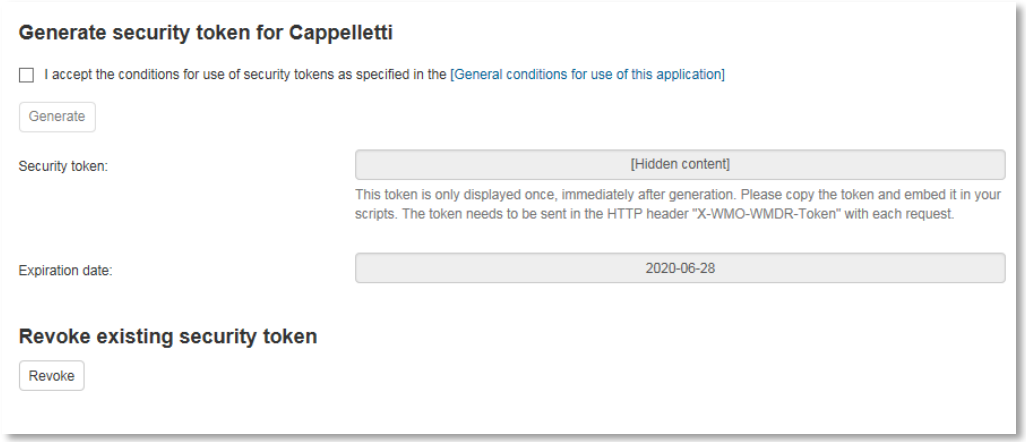
# How to upload WMDR XML to OSCAR/Surface

- Pre-requisites
  - Must have “machine user” role and token
  - Must have “NMHS” or “Data Center” role
- Collect your metadata
- Encode in WMDR XML
- Test upload using copy/paste in OSCAR/Surface DEPL
- Automate as desired
- NB: you must keep track of your gml:ids



# Authentication of machine users

- Machine user always linked to UI user (physical user)
  1. NFP login on UI
  2. Management tab → Manage machine access




  3. Generate token for machine user
- Submit XML (always use the test environment first!!)
  - POST request at https://oscar.wmo.int/surface/rest/api/wmd/upload with header «X-WMO-WMDR-Token:_____»
- Review logs

# Additional OSCAR/Surface API

- Available end points (mainly for internal use)
  - https://oscar.wmo.int/surface/rest/api?_wadl
- Example: List all approved stations
  - https://oscar.wmo.int/surface/rest/api/stations/approvedStations/wigosIds?pageSize=100&q=&page=1
  - https://oscar.wmo.int/surface/rest/api/stations/approvedStations/names?pageSize=100&q=&page=1

# Reference documents

- WIGOS Metadata Standard
  - https://library.wmo.int/opac/doc_num.php?explnum_id=3653
- WIGOS Metadata Schema
  - schemas.wmo.int/wmdr/ (official repository)
  - https://github.com/wmo-im/wmdr (working repository)
- WMDS Code Lists
  - https://codes.wmo.int/wmdr (official repository)
  - https://github.com/wmo-im/wmds/tree/master/tables_en (working repository)
- OSCAR/Surface user manual
  - https://www.wmo.int/pages/prog/www/wigos/documents/WIGOS-GM/OSCAR-Surface_user_manual.pdf
- WMO Moodle platform

# Additional OSCAR/Surface API (II)

**Search Stations**

- https://oscar.wmo.int/surface//rest/api/search/station?[facilityType=facilityType][&stationClass=stationClass][&programAffiliation=programAffiliation][&wmoRegion=wmoRegion][&territoryName=territoryName][&organization=organization][&variable=variable][&climateZone=climateZone][&latitudeMin=latitudeMin][&latitudeMax=latitudeMax] [&longitudeMin=longitudeMin] [&longitudeMax=longitudeMax][&elevationMin=elevationMin][&elevationMax=elevationMax]
  - Parameters: Parameter names must be evaluated as case-insensitive. All values of classifications must be drawn from one of the published codelists (http://codes.wmo.int/wmdr). Where multiple filters can be applied, values must be presented as comma-separated lists. {Notation} below refers to the entry in the code list and corresponds to the WMO_306_CD in OSCAR DB tables. If a value is not found or is empty, the corresponding parameter should be ignored.
    - facilityType = {from /FacilityType/{Notation}}
    - stationClass = {from //{Notation}} [not yet available]
    - programAffiliation = {from /ProgramAffiliation/{Notation}}
    - wmoRegion = {from /WMORegion/{Notation}}
    - territoryName = {from /TerritoryName/{Notation}}
    - organization = {internal OSCAR ID}
    - variable = {from /ObservedVariable/{Notation}}
    - climateZone = {from /ClimateZone/{Notation}}
    - latitudeMin = {decimal number}
    - latitudeMax = {decimal number}
    - longitudeMin = {decimal number}
    - longitudeMax = {decimal number}
    - elevationMin = {decimal number}
    - elevationMax = {decimal number}

    Returns: JSON file

Example

- https://oscar.wmo.int/surface//rest/api/search/station?programAffiliation=GBON&territoryName=HRV

# WMDR KPI

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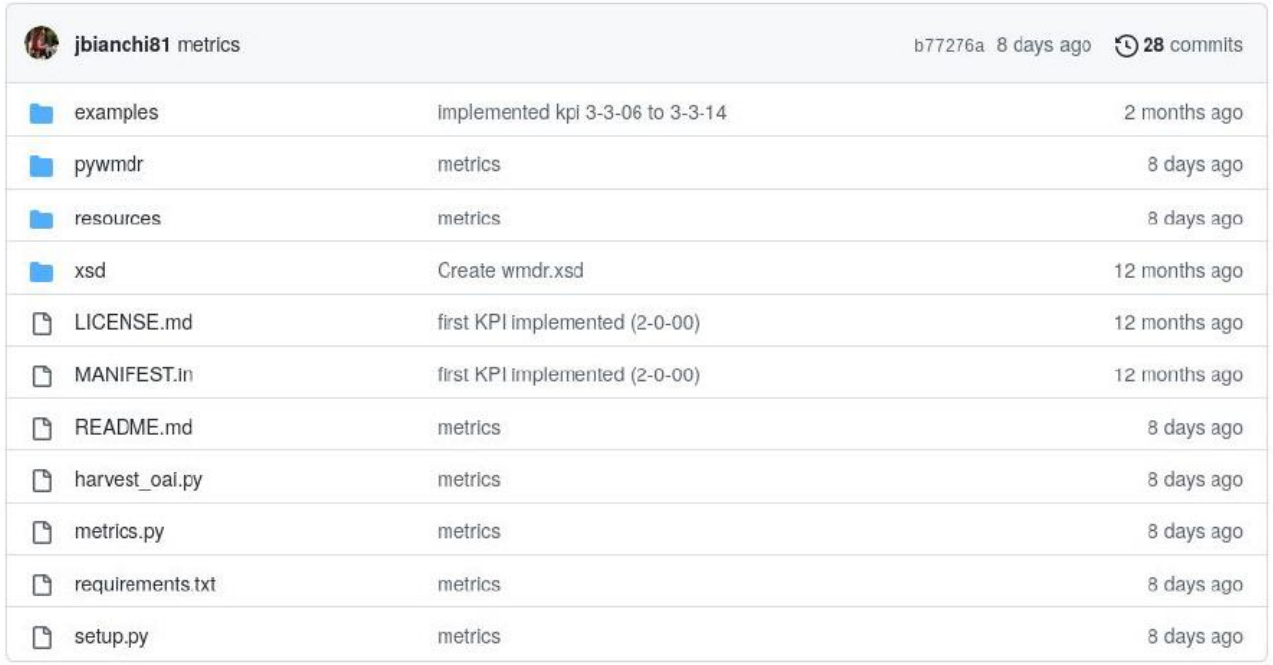
# Overview

- Developed by TT-WIGOSMD to characterize WMDR records
- Can help assess quality of documentation
- Can help assess observing networks
- Work in progress!!!
- Kudos to Juan Bianchi, Lara Ferrighi

| Category no. | Subcategory no. | Name | Criterium | Status |
|---|---|---|---|---|
| 1 | 0 | Schema compliance | Validity | To be expanded |
| 2 | 0 | Station characteristics | Completeness of a WMDR XML station record | Draft |
| 2 | 1 | Station characteristics (OSCAR/Surface) | Completeness of a station record (based on internal OSCAR/Surface elements) | Draft |
| 3 | 0 | Observations/measurements - Basic information | Completeness of a WMDR XML station record | Draft |
| 3 | 1 | Deployment | Completeness of a WMDR XML station record | Draft |
| 3 | 2 | Deployment (OSCAR/Surface) | Completeness of a station record (based on internal OSCAR/Surface elements) | Draft |
| 3 | 3 | Data generation | Completeness of a WMDR XML station record | Draft |
| 3 | 4 | Data generation (OSCAR/Surface) | Completeness of a station record (based on internal OSCAR/Surface elements) | Draft |
| 4 | 0 | Station contacts | Completeness of a WMDR XML station record | Draft |
| 4 | 1 | Station contact - individual | Completeness of a WMDR XML station record | Draft |
| 5 | 0 | Bibliographic references and Documents (OSCAR/Surface) | Completeness of a station record (based on internal OSCAR/Surface elements) | Draft |
| 6 | 0 | Value of a station for WIGOS | Importance of a station in a certain context/network | Collection of ideas (to be expanded) |
| 6 | 1 | Maintenance of a station record | Quality of a station record | Collection of ideas (to be expanded) |

# Git repo

- https://github.com/wmo-im/pywmdr/



jbianchi81 metrics — b77276a 8 days ago — 28 commits

| | | |
|---|---|---|
| examples | implemented kpi 3-3-06 to 3-3-14 | 2 months ago |
| pywmdr | metrics | 8 days ago |
| resources | metrics | 8 days ago |
| xsd | Create wmdr.xsd | 12 months ago |
| LICENSE.md | first KPI implemented (2-0-00) | 12 months ago |
| MANIFEST.in | first KPI implemented (2-0-00) | 12 months ago |
| README.md | metrics | 8 days ago |
| harvest_oai.py | metrics | 8 days ago |
| metrics.py | metrics | 8 days ago |
| requirements.txt | metrics | 8 days ago |
| setup.py | metrics | 8 days ago |

## Installation

### From source

Install latest development version.

```
python3 -m venv pywmdr
cd pywmdr
. bin/activate
git clone https://github.com/wmo-im/pywmdr.git
cd pywmdr
pip3 install -r requirements.txt
python3 setup.py build
python3 setup.py install
```

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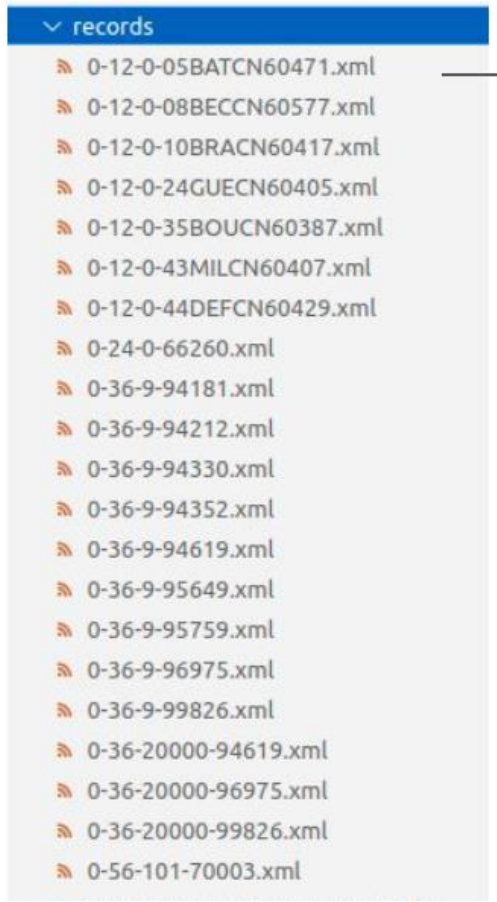
# Output example (0-22000-0-5FK29ZM.xml)

pywmdr kpi validate --kpi 20 -f examples/0-22000-0-5FK29ZM.xml


```
{
   "kpi_20": {
      "name": "KPI-2-0: station characteristics",
      “total": 32,
      "score": 7.0,
      "comments": [
          "geopositioning method is unknown or inapplicable",
          "time zone not found",
          "valid period of time zone not found",
          "Other links are missing",
          "Site description is shorter than required (300 chars)",
          "climate zone not found",
          "valid period of climate zone not found",
          "surface cover classification not found",
          "valid period of surface cover not found",
          "surface roughness not found",
          "valid period of surface roughness not found",
          "local topography not found",
          "relative elevation not found",
          "topographic context not found",
          "altitude or depth not found",
          "valid period of topography or bathymetry not found",
          "population10km not found",
          "population50km not found",
          "valid period of population not found",
          "logEntry not found"
      ],
      "percentage": 21.875
   }
}
```

# Bulk download (from https://oscar.wmo.int:443/oai/provider)

python3 harvest_oai.py records data/oscar/records




```
<wmdr:WIGOSMetadataRecord
xmlns:gml="http://www.opengis.net/
gml/3.2"
xmlns:xlink="http://www.w3.org/199
9/xlink" _
...
        </wmdr:ObservingCapability>
            </wmdr:observation>
        </wmdr:ObservingFacility>
    </wmdr:facility>
</wmdr:WIGOSMetadataRecord>
```

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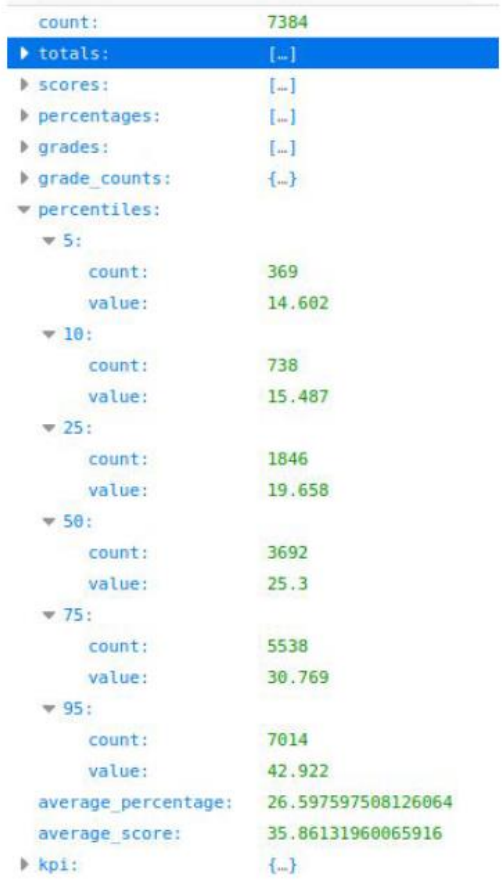
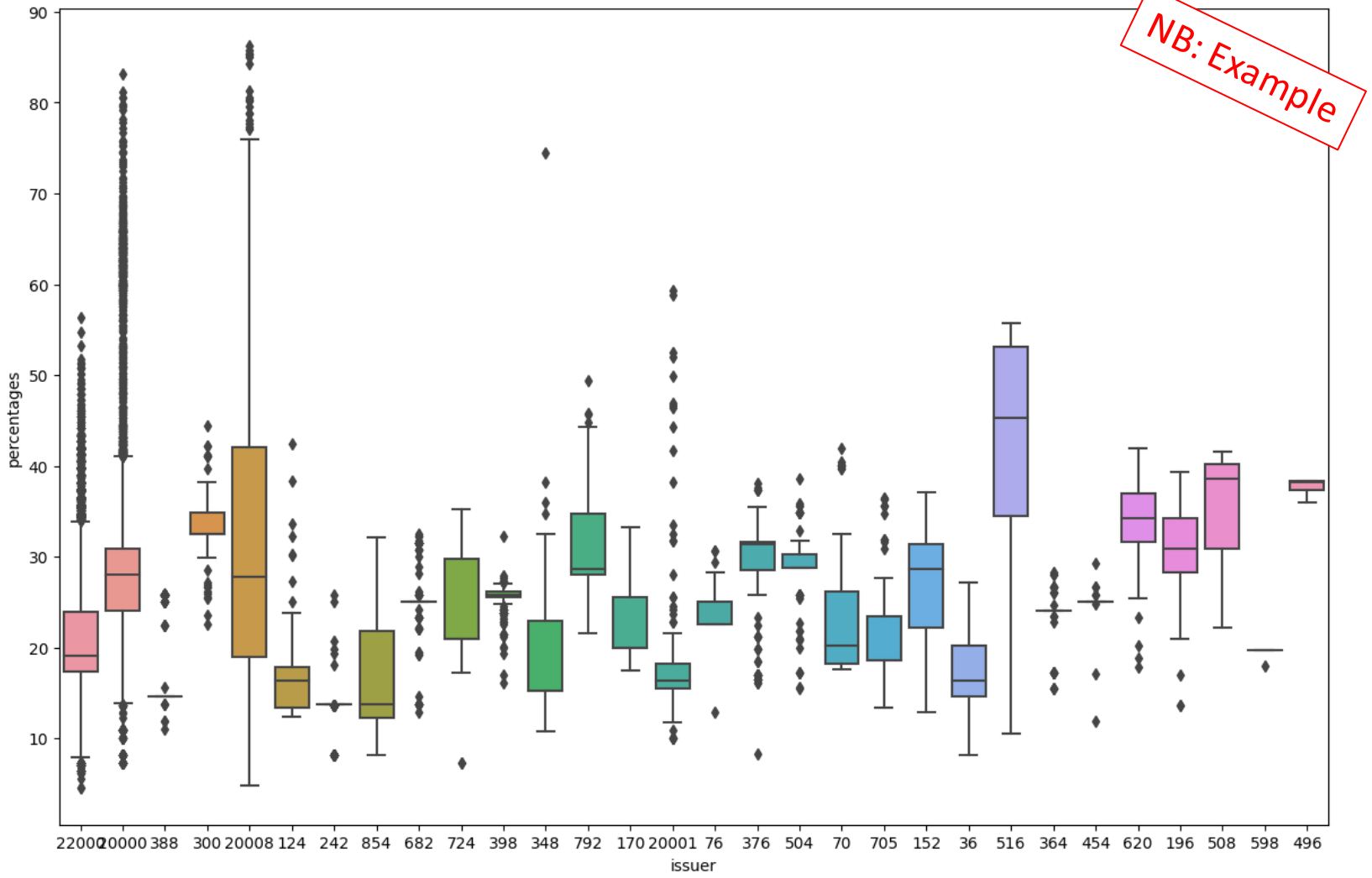
# Bulk evaluate and compute metrics

```
python3 metrics.py evaluate "data/oscar/records/*.xml" -o data/evaluations
python3 metrics.py metrics "data/evaluations/*.json" -m metrics.json
```





# Overall score by WSI Issuer

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# QUESTIONS?

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