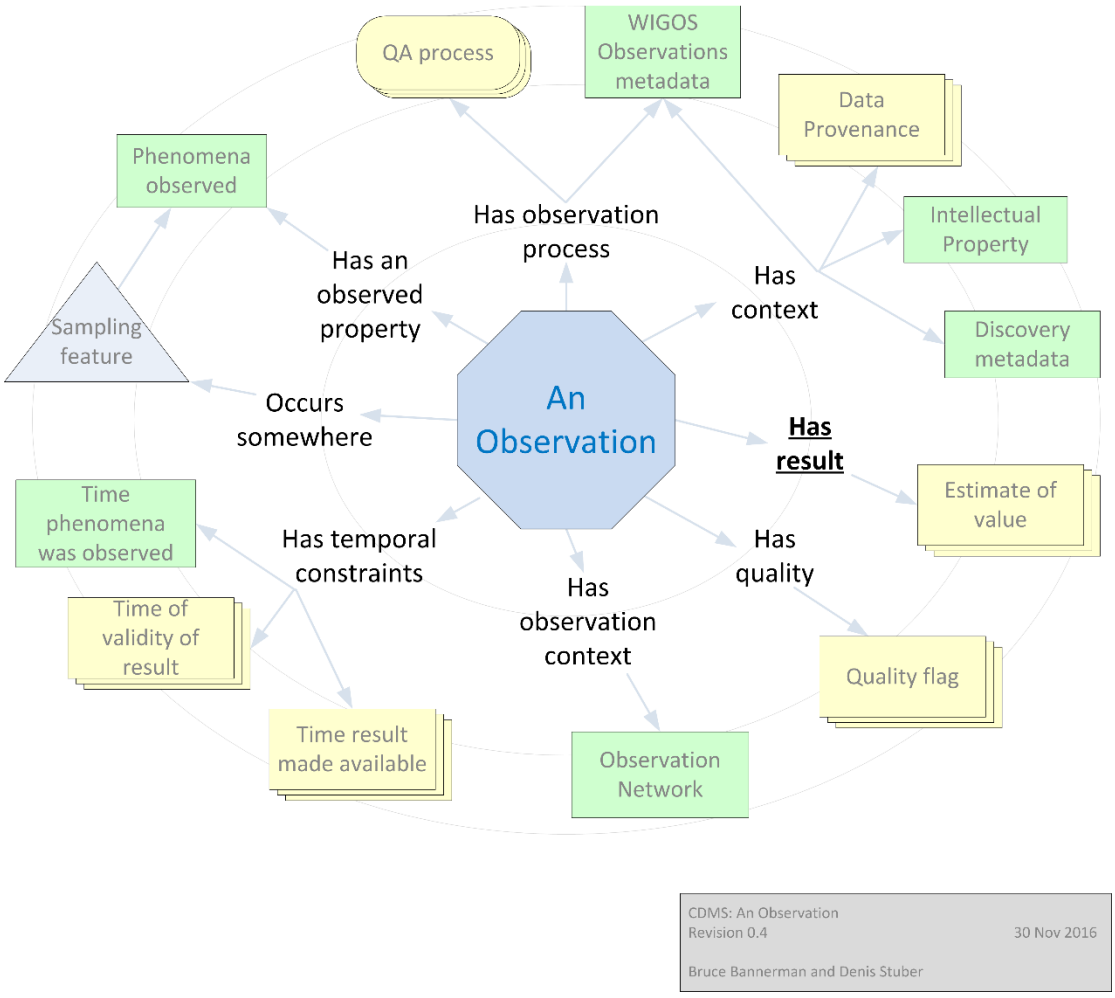


Climate Data Model

FOR A CLIMATE DATA MANAGEMENT SYSTEM

Contents

A way forward

Overview / Summary

Define “climate” (reference GCOS variables)

Mention alternative terminology including “earth systems”

Review of existing data models

DATA MODELS CONSIDERED

Survey results for hourly observations data models

#	Country	Name	Type	System Name
1.	AUSTRALIA	BoM	NMHS	CLIDE
2.	BRAZIL	INMET	NMHS	INMET
3.	CANADA	MSC	NMHS	ESC
4.	CZECH	CHMI	ATACO	CLIDATA
5.	DWD	DWD	NMHS	
6.	FRANCE	MF	NMHS	BDCLIM
7.	FRANCE	MFI	METEO FRANCE INTERNATIONAL	CLISYS
8.	NEW ZEALAND	METSERVICE	NMHS	CLIDB
9.	RUSSIA	HYDROMET	NMHS	CLIWARE
10.	SPAIN	AEMET	NMHS	SAEMET
11.	UK	UK Met Office	ORGANIZATION	CLIMSOFT
12.	UK	UK Met Office	NMHS	MIDAS
13.	WMO	WMO	ORGANIZATION	CLICOM
14.	WMO	WMO	ORGANIZATION	MCH
15.				
16.				
17.				

18.	
19.	

Awaiting answer from

Country	Name	Type	System Name
AUSTRALIA	BoM	NMHS	ADAM
CHINA	CMA	NMHS	
JAPAN	JMA	NMHS	
SLOVAKIA	Private	IMS	CLDB

List of full schemas shared on the OpenCDMS GitHub

Country	Name	System Name
AUSTRALIA	BoM	CLIDE
FRANCE	MF	BDCLIM
UK	UK Met Office	CLIMSOFT
UK	UK Met Office	MIDAS
ORGANIZATIO N	WMO	CLICOM
ORGANIZATIO	WMO	MCH

Assessment of existing data models

STRUCTURE OF THE HOURLY DATA TABLE

Following the terms used by WMO-TD No. 60 (2007) where 3 data model types have been presented (Element Model, Observation Model, Value Model)

Element model (EM)	An Element Model represents data in tables, having, in each row, different values of one variable observed at one station at different times. For example, hourly data could be stored in an **Houly** table. Each row would correspond to a specific station, a specific day, and a specific variable. The attributes, i.e. each cell of a specific row, store the different values of that variable and of that station for a given hour (e.g. 24 values for 1 day).
Observation model (OM)	An Observation Model represents data in tables having, in each row, the values of different variables observed at one station at a given time. For example, hourly data could be stored in an **Hourly** table. Each row would correspond to a specific station at a specific hour. Each column of a specific row would store the values of the different hourly variables observed at the specific hour, e.g. hourly max temperature, hourly mean temperature and precipitation.
Value model (VM)	A Value Model will represent the data values in tables having, in each row, only one value of one variable observed at one station at a specific time. For example, hourly data could be stored in an Hourly. Each row would correspond to a specific station at a specific time, for a specific variable and contains only 1 value

Country	Data Model Name	Data Model Type
AUSTRALIA	CLIDE	OM
BRAZIL	INMET	?
CANADA	ESC	VM
CZECH	CLIDATA	EM
DWD		VM
FRANCE	BDCLIM	OM
FRANCE	CLISYS	OM
NEW ZEALAND	CLIDB	
RUSSIA	CLIWARE	OM
SPAIN	SAEMET	EM
UK	CLIMSOFT	VM
UK	MIDAS	OM
WMO	CLICOM	EM
WMO	MCH	VM

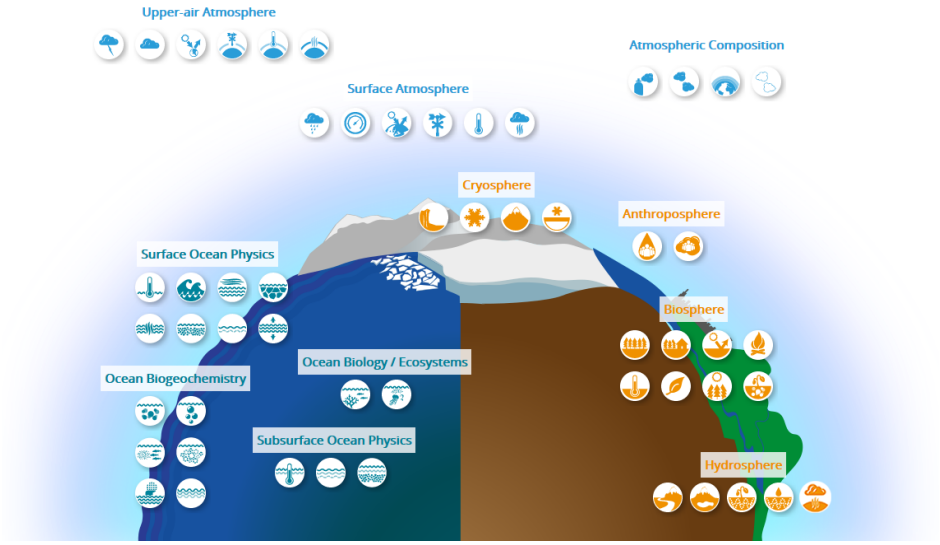
DATA QUALITY CODES

Assessment on existing Climatological Practices

COMPUTATION PRACTICES AND RULES WITH MISSING DATA

Main Principles

ABLE TO MANAGE ESSENTIAL CLIMATE VARIABLES (ECV)



What are Essential Climate Variables (ECVs)?

Atmosphere

Surface

- Precipitation
- Pressure
- Radiation budget
- Temperature
- Water vapour
- Wind speed and direction

Upper-air

- Earth radiation budget
- Lightning
- Temperature
- Water vapor
- Wind speed and direction

Atmospheric Composition

- Aerosols
- Carbon dioxide, methane and other greenhouse gases
- Clouds
- Ozone
- Precursors for aerosols and ozone

Land

Hydrosphere

- Groundwater
- Lakes
- River discharge

Cryosphere

- Glaciers
- Ice sheets and ice shelves
- Permafrost
- Snow

Biosphere

- Above-ground biomass
- Albedo
- Evaporation from land
- Fire
- Fraction of absorbed photosynthetically active radiation (FAPAR)
- Land cover
- Land surface temperature
- Leaf area index
- Soil carbon
- Soil moisture

Anthroposphere

- Anthropogenic Greenhouse gas fluxes
- Anthropogenic water use

Ocean

Physical

- Ocean surface heat flux
- Sea ice
- Sea level
- Sea state
- Sea surface currents
- Sea surface salinity
- Sea surface stress
- Sea surface temperature
- Subsurface currents
- Subsurface salinity
- Subsurface temperature

Biogeochemical

- Inorganic carbon
- Nitrous oxide
- Nutrients
- Ocean colour
- Oxygen
- Transient tracers

Biological/ecosystems

- Marine habitats
- Plankton

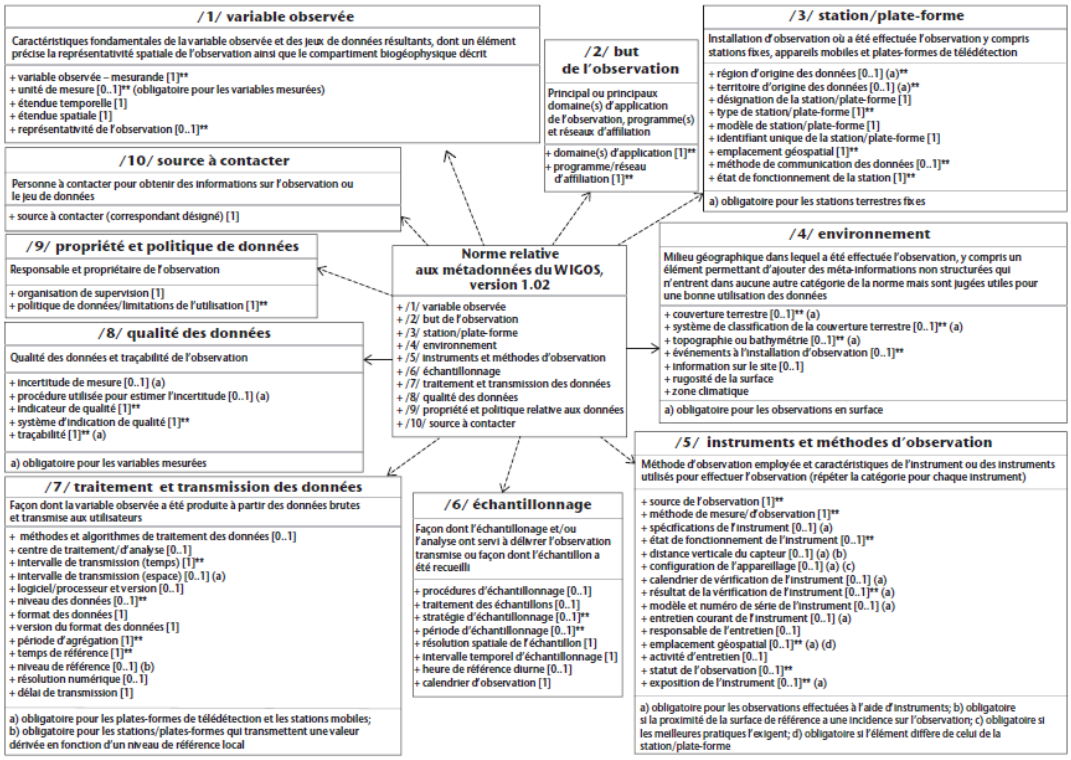
https://gcos.wmo.int/en/essential-climate-variables/table

Inventory of ECV Inventory : https://climatemonitoring.info/wp-content/uploads/2020/07/ECV_Inventory_v3.0.xlsx

COMPLIANT WITH THE GCOS CLIMATE MONITORING PRINCIPLES

See : http://ane4bf-datap1.s3-eu-west-1.amazonaws.com/wmocms/s3fs-public/ckeditor/files/GCOS_Climate_Monitoring_Principles.pdf?1le4ALNYxVIStmm19we2SzoevxEFpHmT

COMPLIANT WITH THE WIGOS METADATA



See WMO- No. 1192

COMPLIANT WITH THE CIMO GUIDE

Guide to Instruments and Methods of Observation (WMO- No. 8°)

And especially the **Sitting Classification** (first common ISO/WMO standard published by ISO as ISO standard 19289:2014 (EN)).and the **Sustained Performance maintenance**

COMPLIANT WITH THE MANUAL ON THE HQ GDMF

High-quality Global Data Management Framework for Climate WMO- No. 1238. Especially with the International and National WMO Stewardship Maturity Matrix for Climate Data.

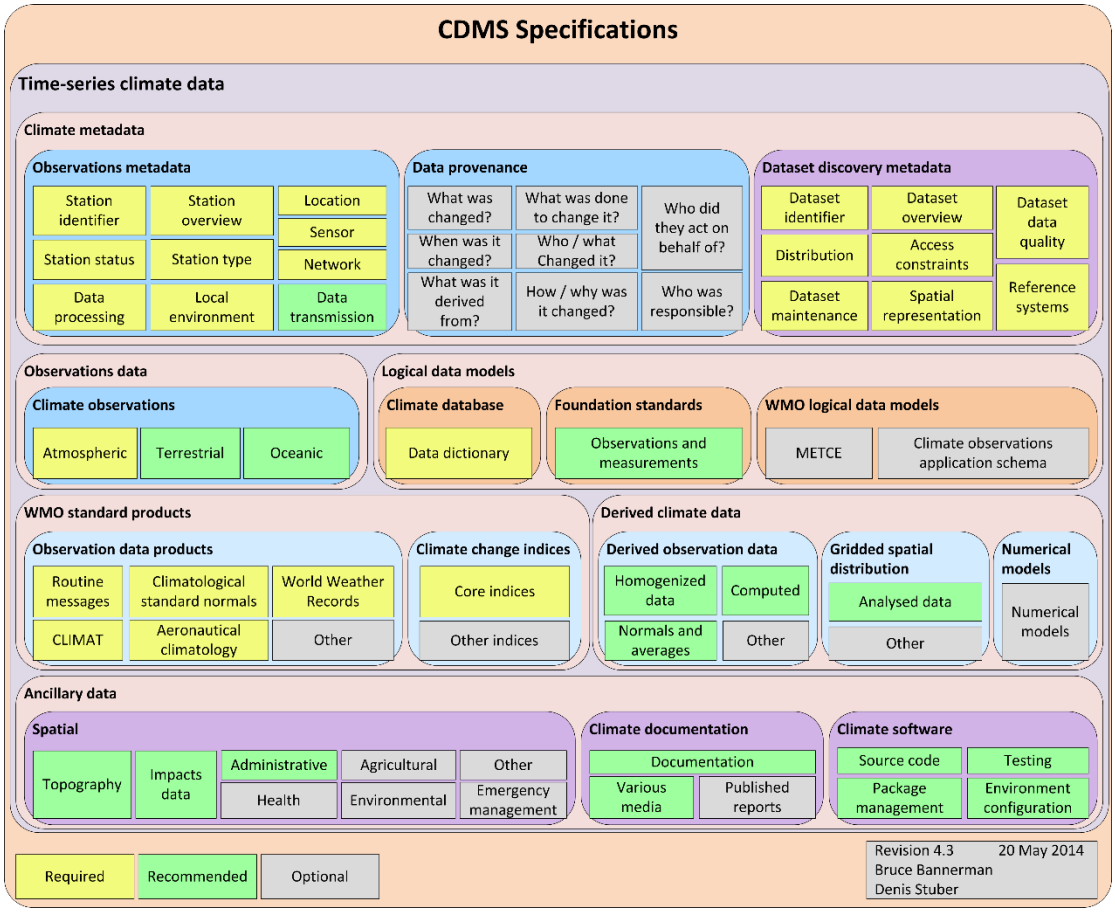
WMO Stewardship Maturity Matrix for Climate Data (SMM-CD)

Category	Data Access		Usability & Usage			Quality Management				Data Management		
Aspect	Discoverability	Accessibility	Portability	Documentation	Usage	Quality Assurance & Control	Quality Assessment	Uncertainty Analysis	Data Integrity	Preservation	Metadata	Governance
Level 1												
Level 2												
Level 3												
Level 4												
Level 5												

COMPLIANT WITH THE CDMS SPECIFICATIONS

Climate Data Management System Specifications WMO- No. 1131

See mainly the chapter 4 of the CDMS Specifications



- Handling observations from multiple sensors per station, per phenomenon, and recording the source of each observation.
- Managing multiple tiers of data quality, from raw records to homogenized data.
- **Managing spatial and time-series data**

- Using a robust data model that takes into account the requirements of open spatial standards, particularly the ISO 19156:2011 *Geographic information – Observations and measurements* standard, METCE and the WMO climate observations application schema (see component 4.2.3.2).
- Managing metadata related to data provenance. This entails ensuring that each change to an observation is recorded for future recovery, and recording the details of why a particular change was made, which includes:
  - Tracing the product lineage to the data source. For example, what observations and gridded data were used to underpin the analysis released in peer-reviewed paper X?
  - Ensuring that the reason for each observation change is recorded.
- Managing third-party and crowdsourced data.
- Managing intellectual property rights related to data.
- Enabling point-in-time recovery. For example, what data were present in the database for station X at time T?
- Storing a range of document formats, such as:
  - Photographs of observation stations and instruments, meteorological phenomena, etc.
  - Scanned paper observation forms
  - Scanned microfiche/microfilm

  - Relevant observations metadata documents, such as instrument calibration reports
  - Technical manuals
  - Site location plans and sections
  - Videos and other multimedia formats
- Handling data uncertainty (for more information, see Wikipedia articles on uncertain data and uncertainty).
- Managing multidimensional time-series gridded data and possibly numerical models.
- Providing support for the information management concepts of semantics and linked data.

COMPLIANT WITH CURRENT DATA STANDARDS

Not only station time series but able to manage **spatial** data. More and more data are created for climate services and should be available for NMHSs : models data, reanalysis, radars, etc.

WMO

WIS

METCE

WMO Register Codes

WMO AND OGC

Met Ocean DWG

WMO and Open Geospatial Consortium (OGC): The Meteorology and Oceanography Domain Working Group (Met Ocean DWG)

Hydrology Domain Working Group

WMO and Open Geospatial Consortium (OGC): The Hydrology Domain Working Group

OGC AND ISO

ISO 19156:2011 *Geographic information – Observations and measurements. E.g.* WaterML and the Meteorological Information Exchange Model of the International Civil Aviation Organization (ICAO).

ISO 19115 *Geographic Information - Metadata standard* (not for station metadata)

ISO 19131 *Geographic information – Data product specifications*

ISO 19157 *Geographic Information - Data Quality*

ISO 19158 *Geographic Information - Quality assurance of data supply*

ISO 19156 *Geographic information - Observations and measurements*

SensorML : *describing sensors and measurement processes*

References

#	Title	Edition
WMO-TD No. 60	Guidelines on Data Management	2007
WMO- No. 1192	WIGOS Metadata Standard	2019
WMO- No. 1238	High-quality Global Data Management Framework for Climate	2019
WMO- No. 1131	Climate Data Management System Specifications	2014
WMO- No. 8	Guide to Instruments and Methods of Observation	2018