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OPACE I, ET-CDMS

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Discussion Paper
Climatological needs for minimum Station Metadata in the frame of the WMO's Publication 9 Volume A

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1. Station Metadata WMO Reference

The question of Metadata is particularly highlighted nowadays and is pushed by the important worldwide exchange facilities. More and more data is shared around the world and increasingly data has to be described with a common language understandable by human and by computers. Metadata explains what represents this data and how to access and use it for the best.

A starting point to describe climatological data is to describe the origin of the data, the station, which means the location where sensors measure data or/and where meteorologists observe phenomenon. Station metadata elements are numerous and “ideally, a complete metadata should register all the changes a station has undergone during its lifetime, composing what is called the station history” (WMO 2003a).

At the international level, the WMO reference for operational station metadata is the WMO’s Publication 9 Volume A. After presenting briefly the Volume A publication, this paper gathers attempts and wishes of improvements of this publication made since the last decade, then it suggests implementation solution and finally proposes attributes to add for climatological purpose.

Historic : a world catalogue of operational stations

- **1873-1953**: International Meteorological Organization (IMO) maintained a catalogue of observing stations, called "Fascicule II".
- **1953**: WMO Executive Council (EC-III) decided to prepare a new edition of this catalogue as "Publication No. 9 "Synoptic Weather Messages" in accordance with the principle that "all stations (surface and upper air) actually in operation and used for synoptic purposes shall be included and no others".

What is Volume A?

May be considered as the current WMO standard for station metadata exchange:

WMO standard & "station metadata": Volume A is the official WMO catalogue that describe operational stations

Exchange: It exists an official process to exchange and update this catalogue
Information is coming from the WMO members (feedback form available from the WMO site)
And WMO maintains the full catalogue and makes it available on its web site

What is the contents of Volume A

Volume A contains a complete list of all the surface and upper-air stations, in operation, which are used for **synoptic purposes** i.e. real time application. The contents are arranged in the order of the WMO Regions and in index number order within each Region. More than 12 000 stations are listed.

Volume A contains the information on the station name and identification number, location, elevation/pressure, the types and times of observations carried out.

```
REGION I - AFRICA / AFRIQUE

OCEAN ISLANDS / ILES DANS L'OCEAN

INDEX   NAME                   LAT.    LONG.  ELEVATION PRESSURE  SURFACE OBSERVATIONS  OBS.H   UPPER-AIR   OTHER OBSERV. AND REMARKS
NUMBER                                         HP  H/HA  LEVEL   00 03 06 09 12 15 18 21 OBS.S  00 06 12 18

61901   ST. HELENA IS. 1) .. 15 56S  05 40W  436  435          X  X  X  X  X  X  X  X  H00-24* .  .  RW .  CLIMAT(CT);SEMI-AUT*;SUNDUR;WR
                                                                                                          2)
  902   WIDE AWAKE FIELD
         (ASCENSION IS.) 3)  07 58S  14 24W   79   86          X  X  X  X  X  X  X  X          .  .  RW .  A;CLIMAT(T);ROCOB IRREG.;WT
  931   S. TOME ............ 00 23N  06 43E   13    8          X  X  X  X  X  X  X  X  H06-18  W  .  W  .  CLIMAT(C);EVAP;SOILTEMP;SPECI;SUNDUR;WT
                                                                                              4)    4)
  934   PRINCIPE ........... 01 39N  07 25E    5    3          X  .  X  X  X  X  X  X          .  .  .  .  EVAP;SOILTEMP;SUNDUR
  967   DIEGO GARCIA 3) .... 07 18S  72 24E    3    1          X  X  X  X  X  X  X  .          RW .  W  .  C;CLIMAT(CT);NEPH;WR
  968   ILES GLORIEUSES 5) . 11 35S  47 17E    4    3          X+ X+ X+ X+ X+ X+ X+ X+ H00-24  .  .  .  .  A;AUT+;C;SEA;SOILTEMP;SUNDUR
  970   ILE JUAN DE NOVA 5)  17 03S  42 42E   10    9          X+ X+ X+ X+ X+ X+ X+ X+ H00-24  .  .  .  .  A;AUT+;C;SEA;SOILTEMP;SUNDUR
  972   ILE EUROPA 5) ...... 22 19S  40 20E   13   12          X+ X  X  X  X  X  X+ X+ H00-24  .  P  .  .  A;AUT+;C;EVAP;SEA;SOILTEMP;SUNDUR
  976   SERGE-FROLOW (ILE
         TROMELIN) 5) ...... 15 53S  54 31E   13    7          X  X  X  X  X  X  X  X+ H00-24  .  P  RW .  A;AUT+;C;CLIMAT(CT);SEA;SOILTEMP;SUNDUR
  979   LE COLORADO 5) ..... 20 54S  55 26E       743          .  .  .  .  .  .  .  .          .  .  .  .  RSD
  980   SAINT-DENIS/GILLOT
         (REUNION) 5) ...... 20 53S  55 31E   25   21          X  X  X  X  X  X  X  X  H00-24  .  P  P  .  A;AUT;METAR;RADSAMP;SEA;SOILTEMP;SUNDUR;TOTRA
  996   MARTIN DE VIVIES
         (ILE AMSTERDAM) 5)  37 48S  77 32E   29   45          X  X  X  X  X  X+ X+ X+ H00-24  .  .  RW .  AUT+;C;CLIMAT(CT);SEA;SOILTEMP;SUNDUR;WN
  997   ALFRED FAURE (ILES
         CROZET) 5) ........ 46 26S  51 52E  142  143          X+ X+ X+ X+ X+ X+ X+ X+ H00-24  .  .  .  .  AUT+;C;SOILTEMP;SUNDUR
  998   PORT-AUX-FRANCAIS
         (ILES KERGUELEN) 5) 49 21S  70 15E   30   29          X  X  X  X  X  X+ X+ X+ H00-24  .  .  RW .  AUT+;C;CLIMAT(CT);SEA;SOILTEMP;SUNDUR;WN
```

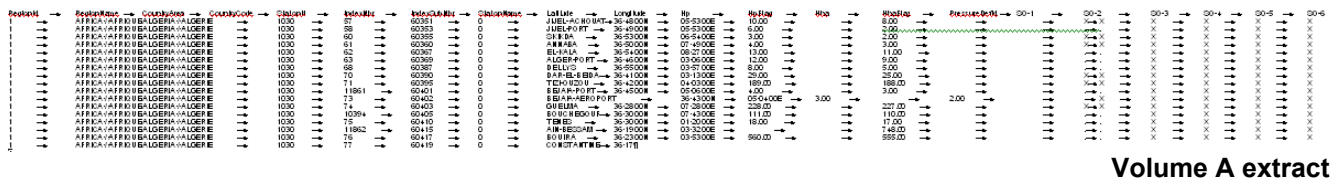
FootNotes

It also contains [illegible] station (radiation, seismological, phenological, river stage, etc.), special types of stations (airport, lightship, coastal station, etc.), special services (Hurricane forecast centre, etc.). It is known as the Code Table A Observation and Remarks.

Additional notes, known as Footnotes, contain useful information on the stations (Code Table B) as stations anomalies (station temporarily closed, etc.), instrument in used (CLASS A PAN, station without barometer, etc.), transmission status (RW DATA TRANSMITTED VIA GTS ONE DAY LATER, etc.).

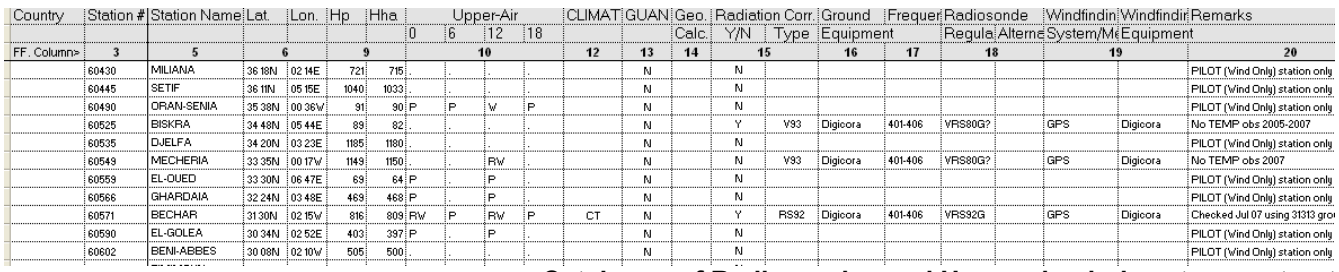
Format of the Volume A

In the past, the Volume A was printed, but nowadays it is deliver as a flat data file, in ASCII format, that is divided into 29 columns. If the 28 first columns are well structured and consist on specific and precise data, the 29th column is reserved for a large range of information.



Volume A extract

As well, a second file gives information for upper-air stations on the type of radiosonde, windfinding equipment, ground systems, radiation corrections applied to temperature observations and other local practices for the radiosondes and upper-air systems in use by Members (WMO Catalogue of Radiosondes and Upper-air wind Systems).



Country	Station #	Station Name	Lat.	Lon.	Hp	Hha	Upper-Air				CLIMAT	GUAN	Geo.	Radiation Corr.		Ground	Frequer	Radiosonde		Windfindin	Windfindir	Remarks
							0	6	12	18			Calc	Y/N	Type	Equipment		Regula	Alterne	System/Me	Equipment	
FF. Column>	3	5	6		9		10				12	13	14	15		16	17	18		19		20
	60430	MILIANA	36 18N	02 14E	721	715	.	.	.	.		N		N								PILOT (Wind Only) station only
	60445	SETIF	36 11N	05 15E	1040	1033	.	.	.	.		N		N								PILOT (Wind Only) station only
	60490	ORAN-SENIA	35 38N	00 36W	91	90	P	P	W	P		N		N								PILOT (Wind Only) station only
	60525	BISKRA	34 48N	05 44E	89	82	.	.	.	.		N		Y	V93	Digicora	401-406	VRS80G?		GPS	Digicora	No TEMP obs 2005-2007
	60535	DJELFA	34 20N	03 23E	1185	1180	.	.	.	.		N		N								PILOT (Wind Only) station only
	60549	MECHERIA	33 35N	00 17W	1149	1150	.	.	RW	.		N		N	V93	Digicora	401-406	VRS80G?		GPS	Digicora	No TEMP obs 2007
	60559	EL-OUED	33 30N	06 47E	69	64	P	.	P	.		N		N								PILOT (Wind Only) station only
	60566	GHARDAIA	32 24N	03 48E	469	468	P		P			N		N								PILOT (Wind Only) station only
	60571	BECHAR	31 30N	02 15W	816	809	RW	P	RW	P	CT	N		Y	RS92	Digicora	401-406	VRS92G		GPS	Digicora	Checked Jul 07 using 31313 gro
	60590	EL-GOLEA	30 34N	02 52E	403	397	P	.	P	.		N		N								PILOT (Wind Only) station only
	60602	BENI-ABBES	30 08N	02 10W	505	500	.					N		N								PILOT (Wind Only) station only

Catalogue of Radiosondes and Upper-air wind systems extract

Version

The last revision of the Volume A is very recent: April 2010. And the latest edition of the flatfile of data Observing Stations is from 19 March 2012. The main modifications concern:

- Higher precision of horizontal coordinates: degrees-minutes-seconds (accuracy of +- 31 meters at the Equator versus 1852 meters for the previous version);
- Higher precision in vertical coordinates in meters rounded up to 2 decimals (centimetres versus meters for the previous version).

2. History of Volume A improvement attempts and Metadata station needs

Despite the latest modifications, the current Volume A, based on a flat file, suffers from several limitations:

- Difficulty to extend its capacity to describe the stations and so to answer to demands coming for example from the climatology community like the historical periods of station activities;
- Difficulty to extend the number of stations listed due to the WMO index number structure;
- Difficulty to manage and to access the data of Volume A as the volume A is not implemented with modern tools e.g. a database with its advantages and Web possibilities and services.

Those limitations are well known and several attempts were conducted in order to overpass them. In parallel, needs on Stations Metadata raised especially for exchange purpose.

2002

Volume A improvement

In January, Mr Harald Daan, the CBS rapporteur of Volume A, wrote a report on possible improvements of WMO Publication No 9 – Volume A (WMO 2002).

Mr Harald Daan noted that:

- If “real-time exchange has certainly been the primary purpose of VolA” other domains as **climatology**, agrometeorology, meteorological research, atmospheric chemistry, hydrology and geophysics (including seismology) are also interested.
- For **climatology**, the preservation of information on station changes and on obsolete stations would be very supportive.
- The index numbering system is limited and “in several areas, it is impossible to assign new numbers to stations.

Mr Harald Daan proposed a very detailed solution for a new structure of the Volume A that includes to:

- Enlarge the purpose of Volume A from "surface and upper air stations" to "all stations at fixed locations providing real-time meteorological observations;
- **Add historical periods**: “It should be recognised that the climatological community has very close links with the WWW, as both use the same observations, albeit in different frameworks of time. The only difference is that the data in VolA are of permanent importance for climatology, and remain so after stations are changed or deleted in VolA. This issue has been discussed above (para 5.1.1). **In addition, dates of start and closure should be added to the information.**
- Give rules for the allocation of a index number when a station moves.
- Prepare the Volume A to be “processable by computer”.

2003

Volume A prototype

WMO drew up a revised version of Volume A into a comprehensive database application (written in Access 2000) that takes into account Mr Harald Daan recommendations. In 2005 an expert was hired to develop the solution with an Oracle database, but in 2006, the design phase of the Oracle prototype eventually failed acceptance testing (WMO 2004 page 2).

2006

Volume A prototype

WMO enlisted the services of an expert from the Russian Federation, Alexander Besprozvannykh, to provide a revised version of Volume A as a standalone Oracle application (WMO 2008 page 2).

Standard to exchange Metadata

One of the terms of reference of the Expert team on "Climate Data Management including Metadata" (OPAG 1) of the Commission for Climatology is "**to establish standards for the exchange of metadata** and/or deposition in major data centres, with particular reference to the needs of the WMO Information System (WIS)" (WMO 2005)

2007

Volume A prototype

The prototype, CATREP from Mr Alexander Besprozvannykh, is ready and "it was concluded that the Application at its current mode has great potential and can completely replace the present operational version of Volume A.

But "during the same period due to re-structuring and a new strategic cost cutting approach by the IT division of the Secretariat, the Oracle servers within the Secretariat were closed down at the end of 2007 and relevant services outsourced to the United Nations International Computing Centre (UNICC). For this reason, implementation of redesigned Volume A within the Secretariat was not possible" (WMO 2008 page 2).

2009

Volume A improvement

The CCI expert team on WCP requirements for metadata (WMO 2009a) reports: “while extensive work has been accomplished to define content and format enhancements to the WMO’s Publication 9 Volume A, formal action has not been taken to refine and implement the proposed changes. **The team recommends that the proposed changes be refined and clarified as needed, then submitted for review and adoption by the WMO**.”

Standard to exchange Metadata

The group [CCI expert team on WCP] agreed that a first step would bet to develop a specific list of station metadata parameters, designating each as mandatory for climate, desirable, optional or unnecessary. This will provide immediate, tangible output and a basis for evaluation of various methods of representation and transfer (WMO 20099).

“CCL working group recommend that “an XML schema for station metadata exchange be defined. The CDMS developers present affirmed the need for a standard XML exchange schema definition” (WMO 2009b).
And also the same working group rules that “Today, no unique station metadata requirements for the climatological community have been identified. It appears that a manageable subset of possible station metadata might be adequate for discovering data and stations of interest. Principal components of such a subset include identifiers, name, locational coordinates, observing environment, parameters observed, observing frequency and period of record. Summary quality information about a station, such as scores for goodness of siting, consistency of operation and continuity of data provided, would also be valuable for climatological work.”

2010

Volume A improvement

The Expert Team on Requirements and Implementation of AWS Platforms (ET-AWS) from the Commission for Basic Systems (CBS) review the necessity of WMO Publication No. 9, Volume A be adapted to include National Station Identifiers (WMO 2010b).

Standard to exchange Metadata

Part of the work plan of the Expert Team on Climate Data Base Management Systems (ET-CDMS) of the Commission for Climatology is to “Develop an open-standards based data exchange model that allows full data provenance to be distributed with the data**, particularly stations data**”.

3. Summary and analysis

(1) For **international data exchange** Volume A appears to be the standard set of information on surface and upper air stations metadata. As the main contributors on Volume A are WMO members themselves, working on the improvement of Volume A for a climatological point of view will have a direct impact on all the community.

There are demands on Improvements of Volume A, from different meteorological and non-meteorological domains with for example addition of time periods, and addition of stations.

A complete solution for a revised Volume A has been designed in 2002 by Mr Harald Daan, the CBS rapporteur of Volume A but, despite several attempts, was never implemented. Nevertheless, coming from these attempts, the Russian Federation (Alexander Besprozvannykh) has developed the CATREP prototype which is a web application based on OGC[1] standard, which has been approved but never implemented by WMO.

(2) In parallel, needs to dispose of standard Stations Metadata are constant **for international exchange**.

Succeeding in the implementation of a revised Publication 9 Volume A will merge our 2 requirements : (1) enlarge Volume A to the desired panel of information on station metadata and (2) give to Volume A, with both syntactic and semantic design, the status of standard that we need for international exchange.

[1]Open Geospatial Consortium : to serve as a global forum for the collaboration of developers and users of spatial data products and services, and to advance the development of international standards for geospatial interoperability.

4. Suggestion on Volume A Implementation

- Volume A as a database, and not a flat file, appears as a necessity in terms of nowadays data exchange. The Ocean Data Acquisition Systems (ODAS) metadata could be a good example of where to go. ODAS metadata is part of a database that is easily accessible and that contains beginning and end dates of activities of the stations. Metadata is questionable through the web (http://www.argo.gov.cn/odas/access.aspx, 28 March 2012) and could be directly updated by the owners of the stations.

- A specification phase including climatologists and IT professional team appears necessary. This phase would have to take into account:
  - all the work done so far (Mr Harald Daan report, CATREP development, etc.)
  - the implementations that already exist like the database implementation of Volume A by the DWD[2] (DWD_Web Map Service), the Russian Federation with its WIS_DCPC_WFS (POSGIS database), also the demonstration on stations discovery in WIS (WMO 2009a page 7), etc.
  - requirements coming from WMO and its different Programmes and Commissions.

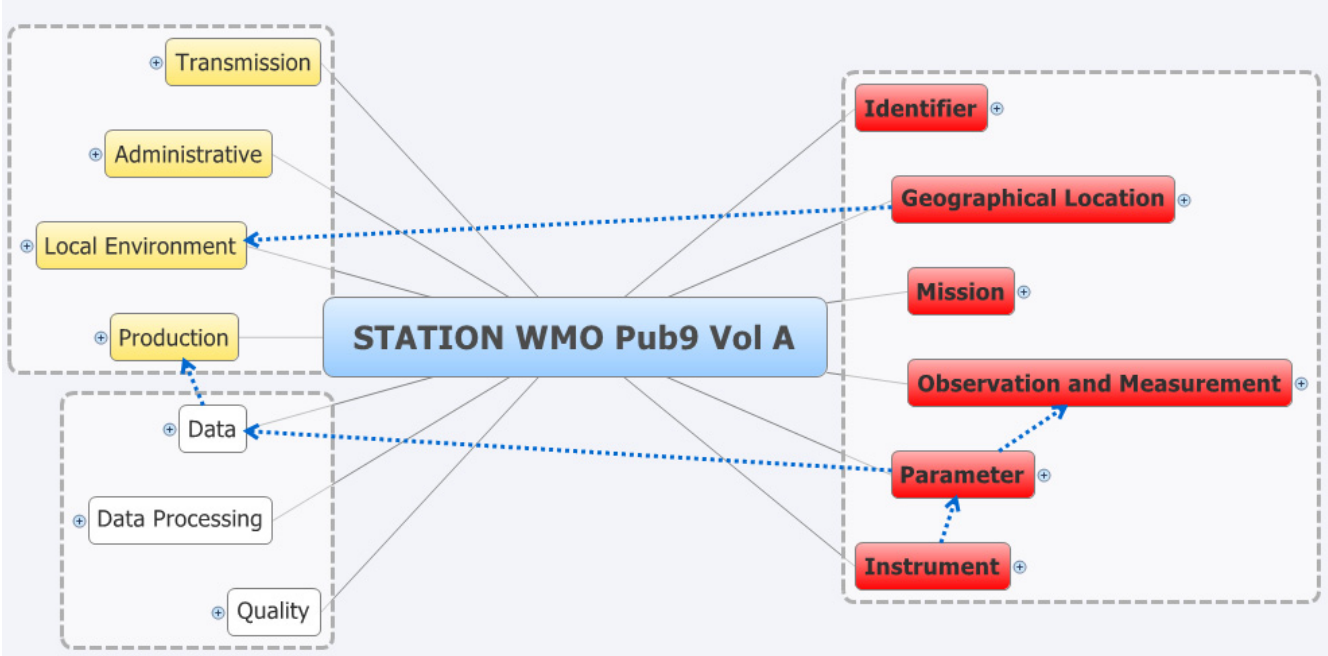
- Maintaining such database application with web facilities may prove to be expensive in budget and/or human resource (development, maintenance, etc.). This task, if not handle directly by WMO in its premises, could be given to a World Centre mandated by WMO.

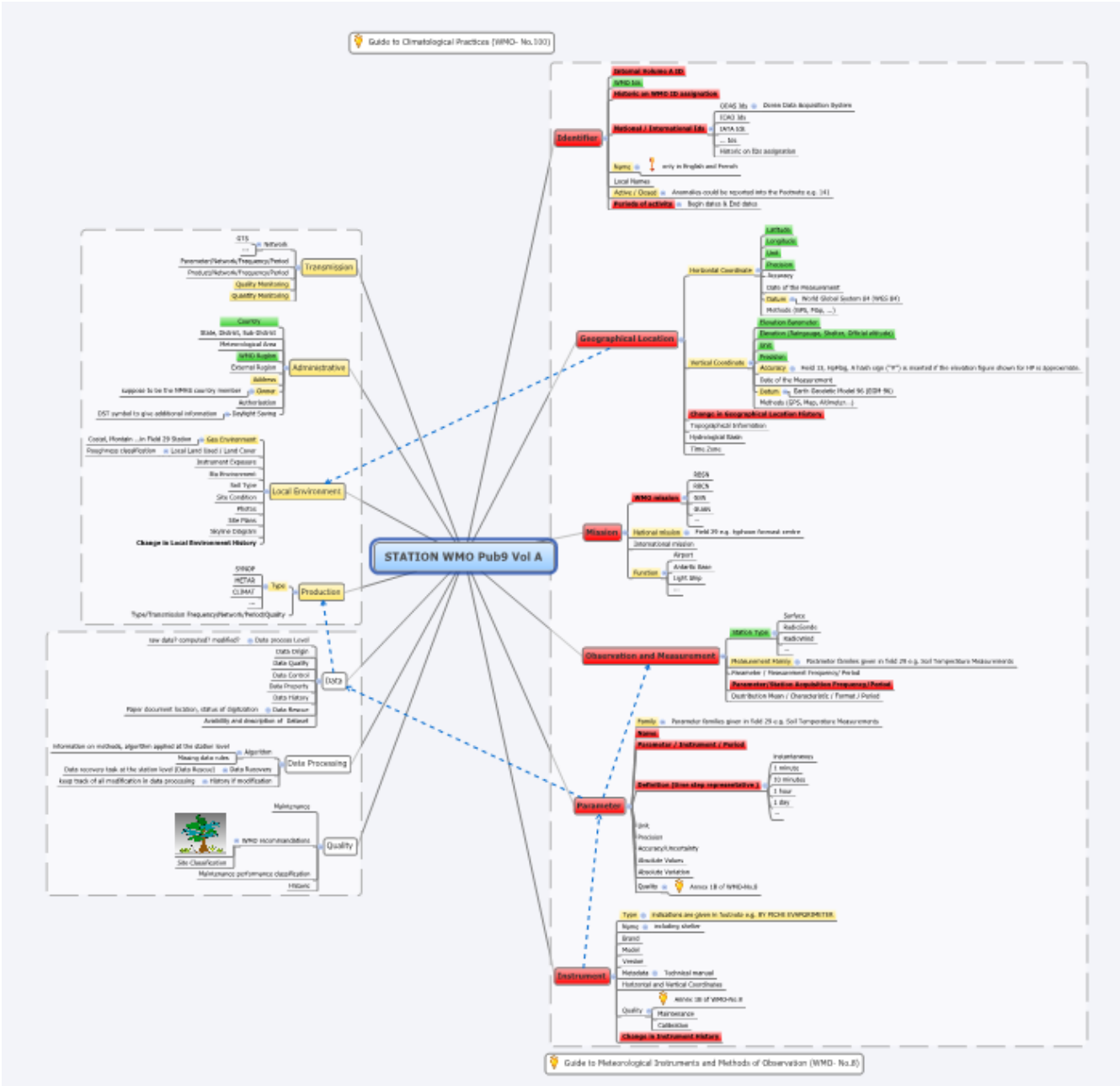
2 Deutscher Wetterdienst

5. Proposal for climatological needs on Volume A

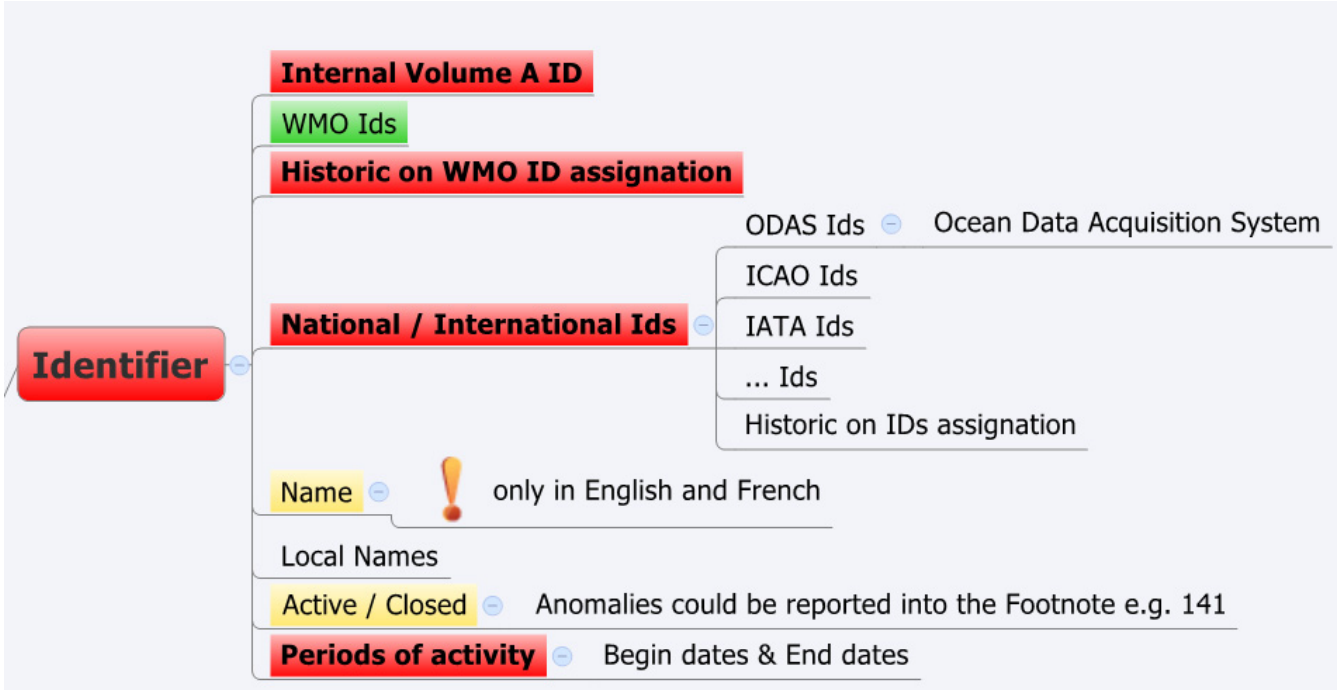
Here below is a synthetic representation of a station divided into 12 characteristic boxes. The meaning of the box colour is as follow:

In bold red	At least one element essential for climatological purpose is not present
No color	The Volume A does not give information on this characteristic; if this characteristic is recommended for climatological purpose it does not represent the "essential minimum"
In yellow	The Volume A gives partial information on this characteristic and more detailed information is needed for climatological purpose
In green	The information given by Volume A is sufficient for climatological purpose




Guide to Climatological Practices (WMO- No.100)
STATION WMO Pub9 Vol A
Identifier
Geographical Location
Mission
Observation and Measurement
Parameter
Instrument
Transmission
Administrative
Local Environment
Production
Data
Data Processing
Quality
Guide to Meteorological Instruments and Methods of Observation (WMO- No.8)

Identifier



Periods of activity

Gives all the periods of activities for each station. It allows to keep in the Volume A not only the stations operational but also all the ones which were operational in the past. It keeps equally the periods where possibly a stations was not operational. (WMO 2002 section D)

Historic on WMO ID assignation

In Volume A each station is given a WMO Id. It could happen that this WMO Id has been assigned to different operational stations during the history of Volume A. e.g. the WMO Id given to station B in 2012 could be assigned to station C in 1965 which was located far away from station B. There is here a risk for a user to combine data with different origins. Keeping the temporal change in WMO id assignation is a solution to prevent such problem.

National /International Ids

National and international Ids are very useful for data access (WMO 2002 section A). The historic on Ids assignation, as the WMO Id, should be present.

Name

Volume A offers only French and English language. This should be extend to allow internationalisation capacity to the future system.

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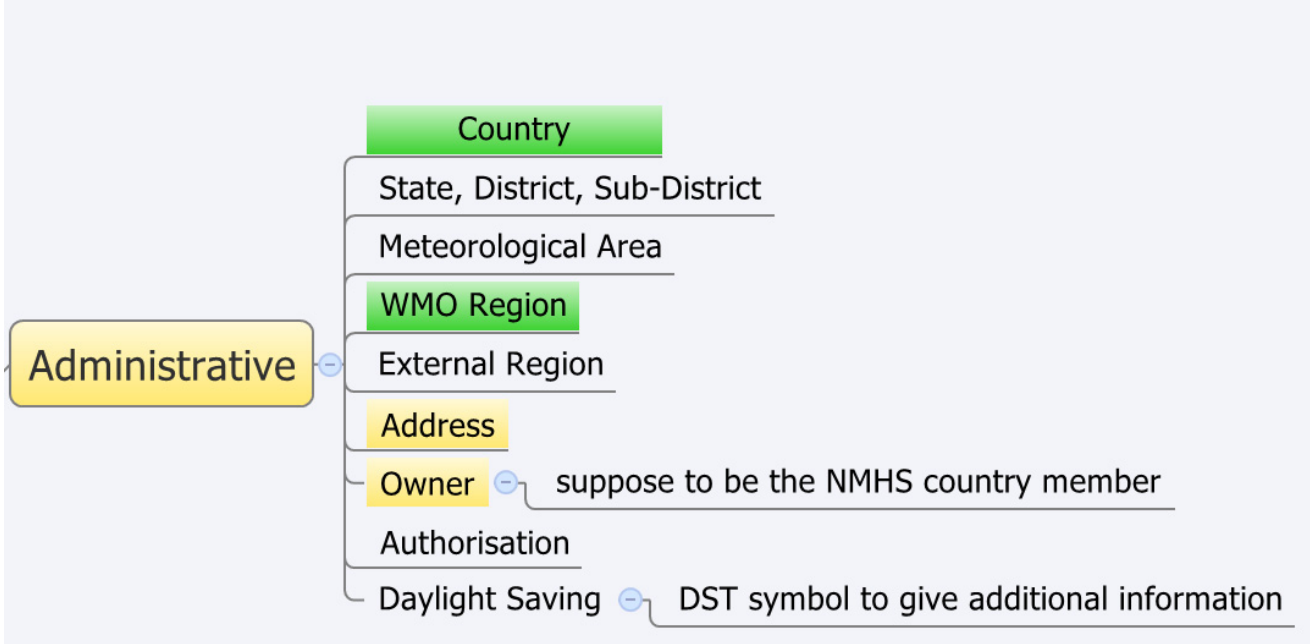
Administrative



Address and Owner

That information is not explicitly given in Volume A.

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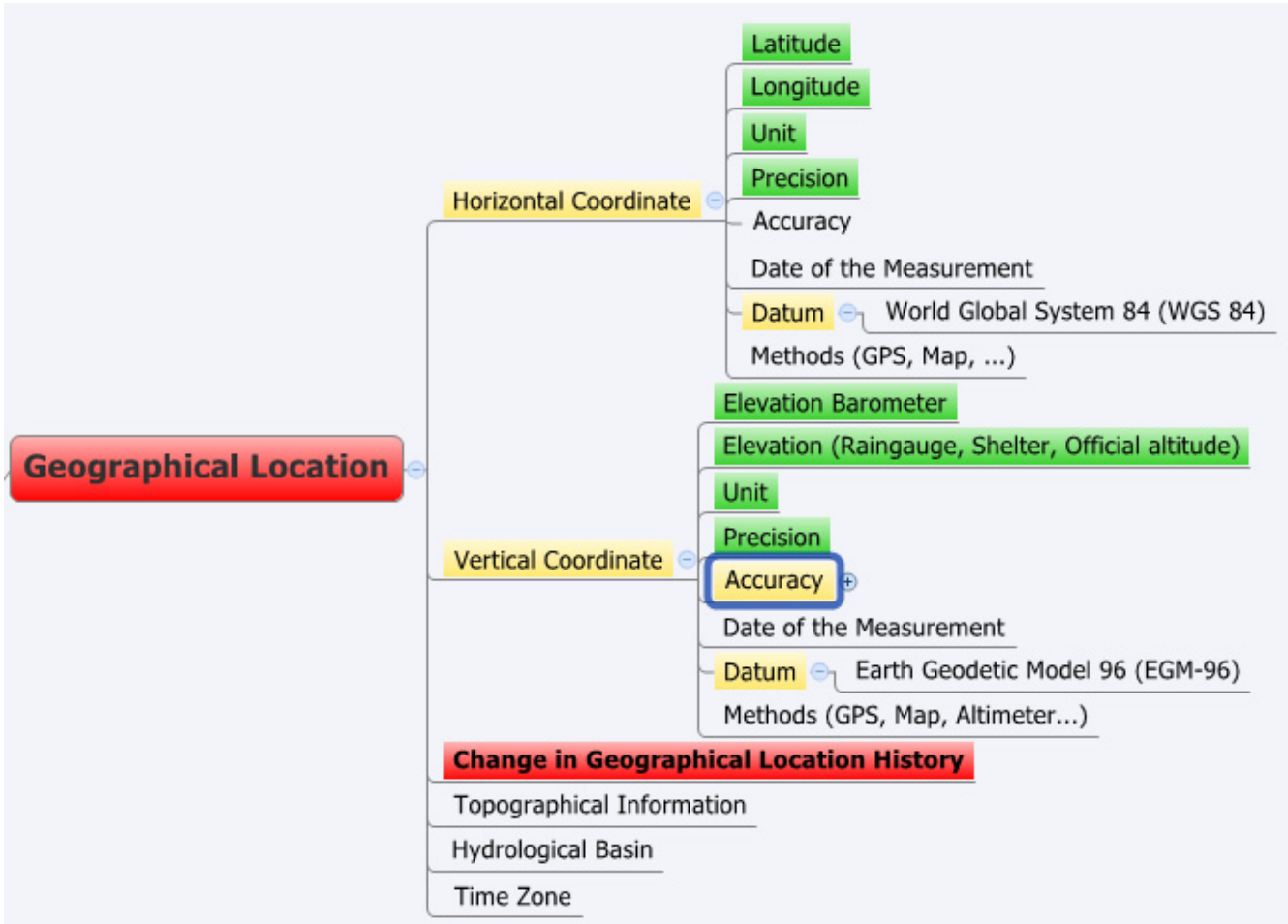
Geographical Location



Change in geographical Location History

Allow keeping the different locations a station has had during its history.

Precision & Accuracy

If the precision is known (second for horizontal coordinate and millimetre for the vertical coordinate) the accuracy of the measure, which belongs to the method used, is unknown in Volume A.

Datum

Not explicitly given in Volume A

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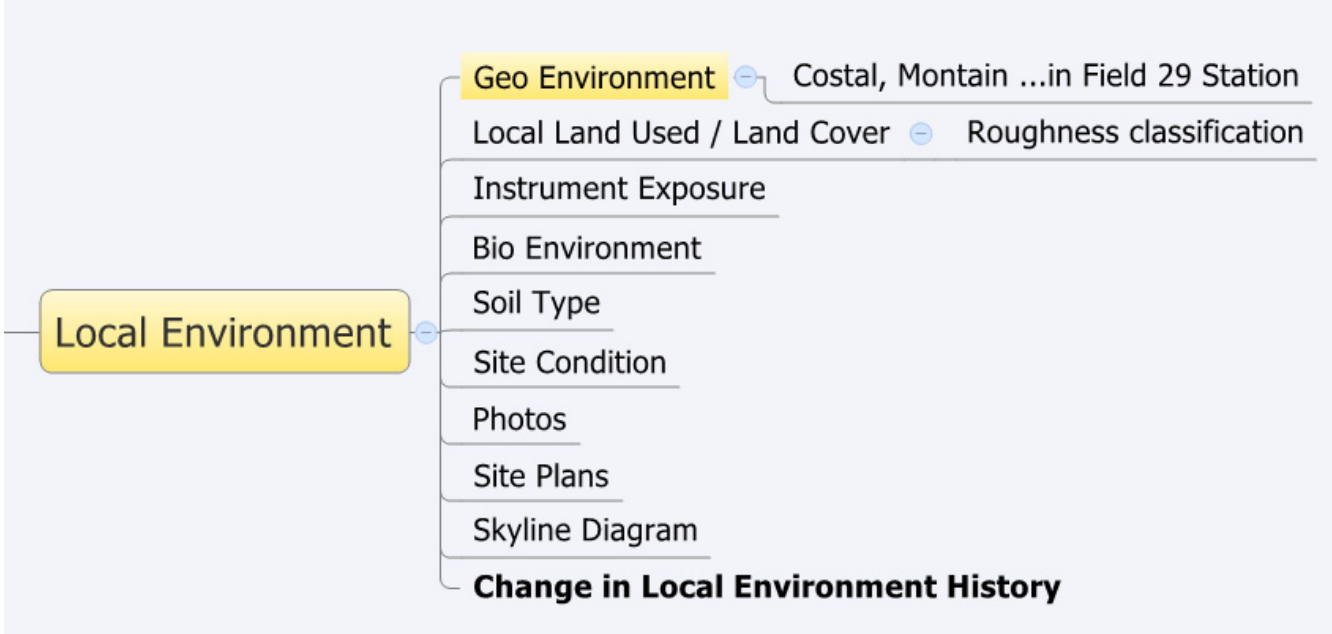
Local Environment



Change in Local Environment History

Important to add.

Geo Environment

See WMO 2002 section C.

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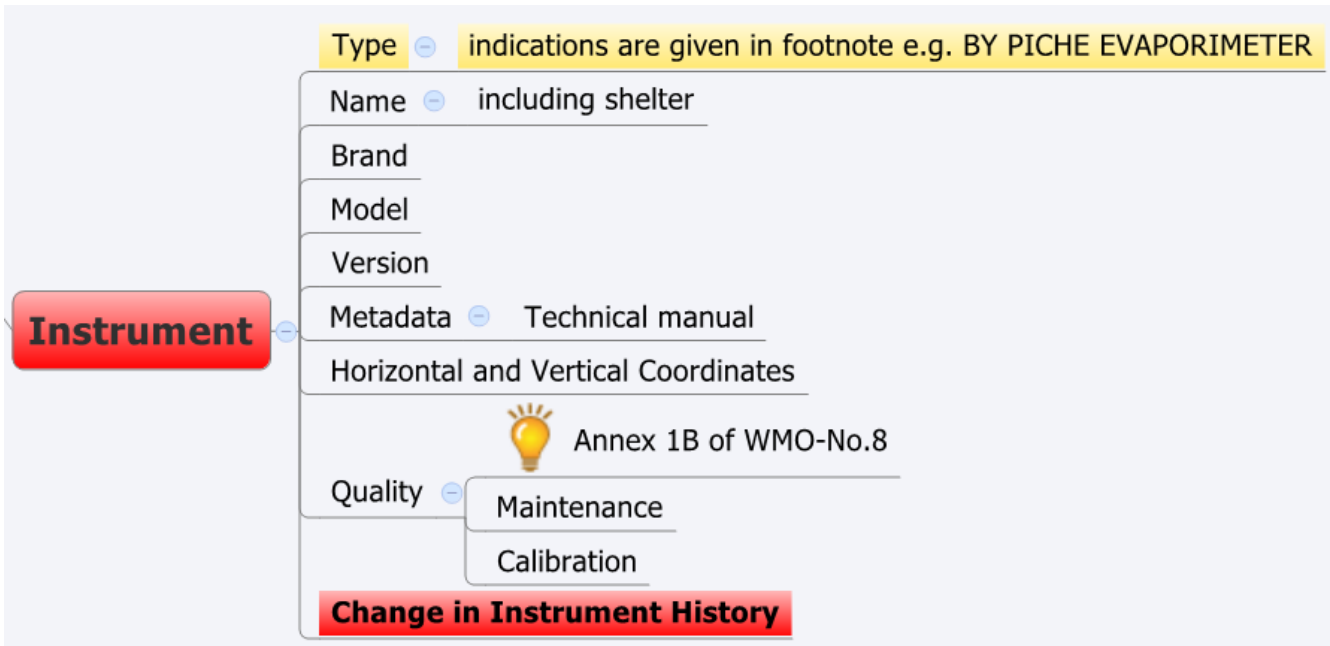
Instrument



Change in Instrument History

Allow keeping track on instrument changes

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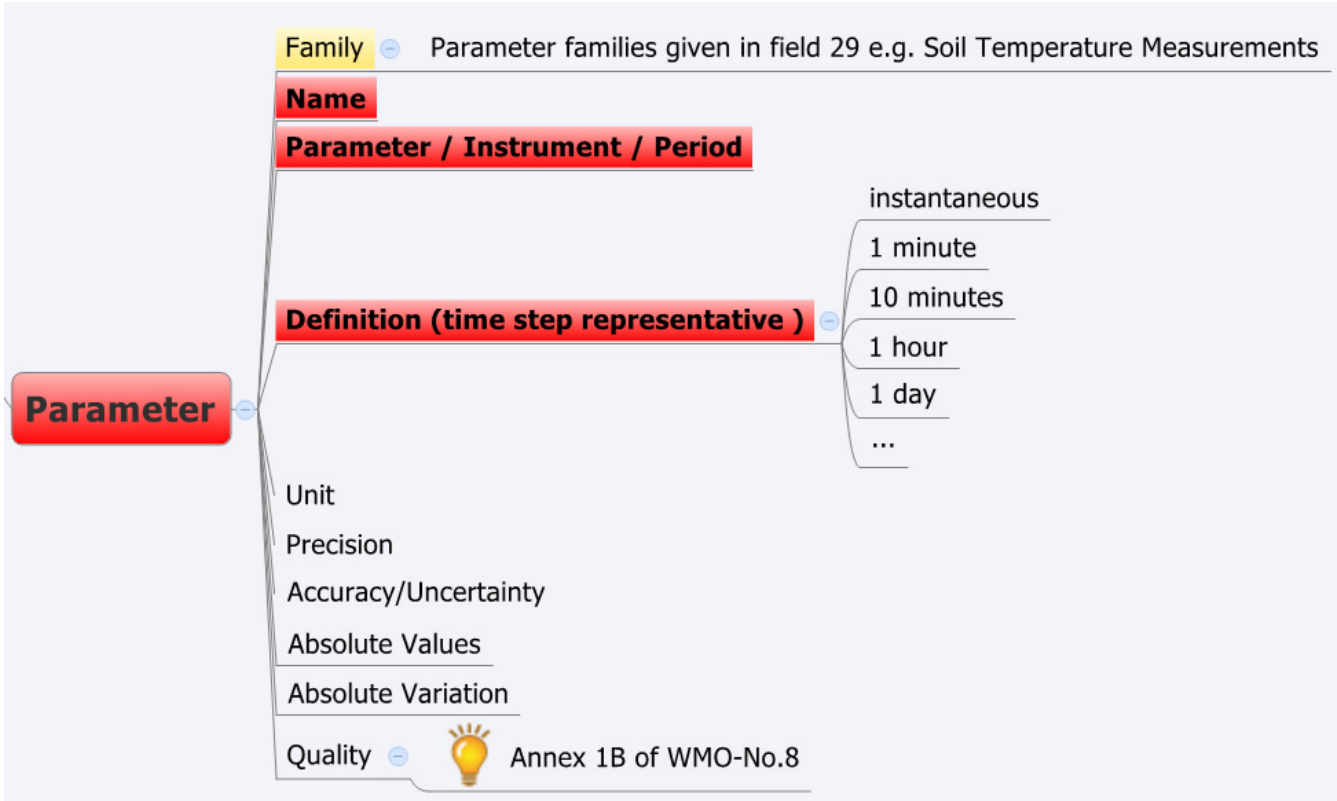
Parameter



Parameter / Instrument / Period

At the station level an instrument measures a parameter but the instrument is subject to change during the history of the station, e.g.:

- Minimum daily parameter measure in New York station with a Minimum thermometer (brand, model, version, etc.) from 1928 to 1998
- Minimum daily parameter measured in New York station with a Temperature Sensor (brand, model, version, etc.) from 1999 up to now

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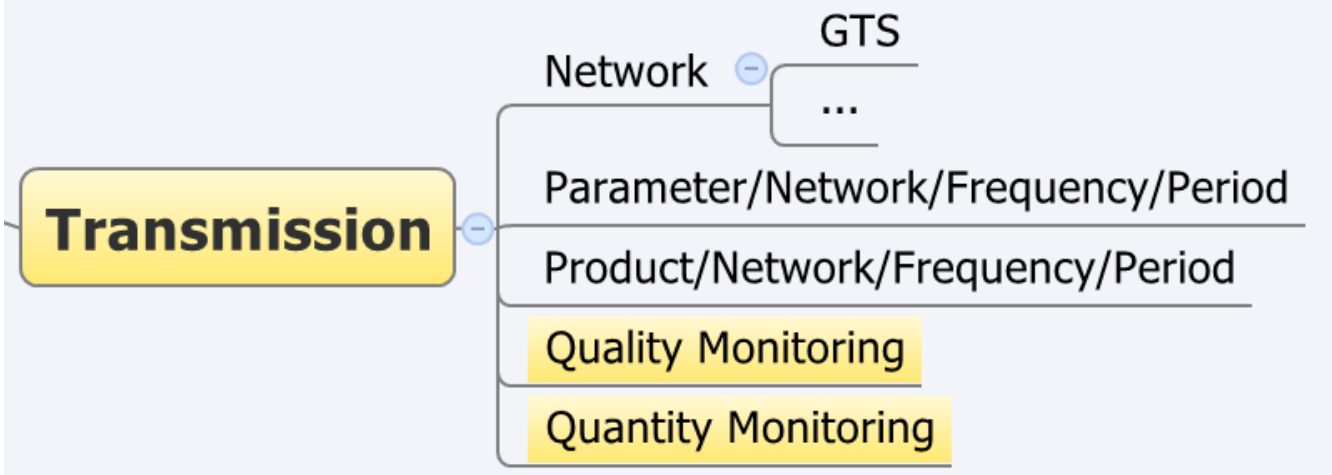
Transmission



Quality Monitoring and Quantity Monitoring

See WMO 2002 section M

Product/Network/Frequency/Period

See WMO 2002 section Ha

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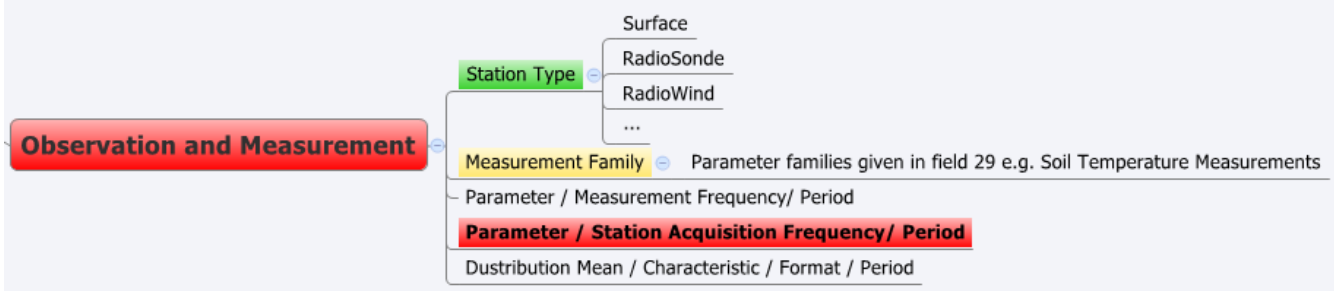
No color	The Volume A does not give information on this characteristic; if this characteristic is recommended for climatological purpose it does not represent the “essential minimum”
In yellow	The Volume A gives partial information on this characteristic and more detailed information is needed for climatological purpose
In green	The information given by Volume A is sufficient for climatological purpose

Observation and Measurement

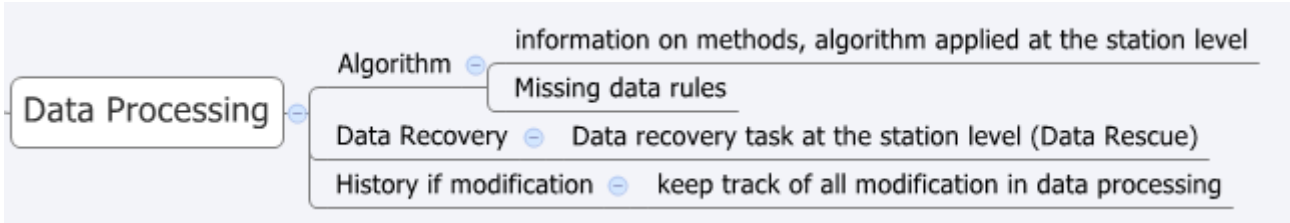


Parameter/Station Acquisition Frequency/Period

Allow to know the theoretical contents of the station database in term of parameter values.

In bold red	The Volume A does not give information on this characteristic which is consider as essential for climatological purpose
No color	The Volume A does not give information on this characteristic; if this characteristic is recommended for climatological purpose it does not represent the “essential minimum”
In yellow	The Volume A gives partial information on this characteristic and more detailed information is needed for climatological purpose
In green	The information given by Volume A is sufficient for climatological purpose

Data Processing



In bold red	The Volume A does not give information on this characteristic which is consider as essential for climatological purpose
No color	The Volume A does not give information on this characteristic; if this characteristic is recommended for climatological purpose it does not represent the “essential minimum”
In yellow	The Volume A gives partial information on this characteristic and more detailed information is needed for climatological purpose
In green	The information given by Volume A is sufficient for climatological purpose

Mission

WMO Mission

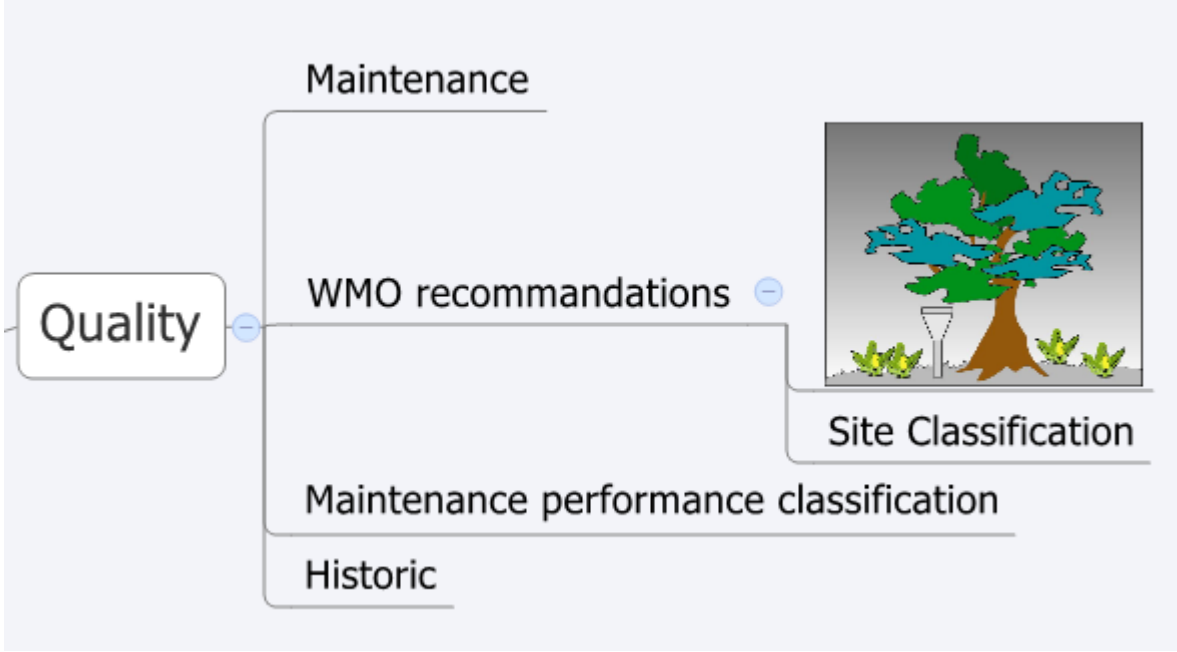
See WMO 2002 section E

Function

See WMO 2002 section B

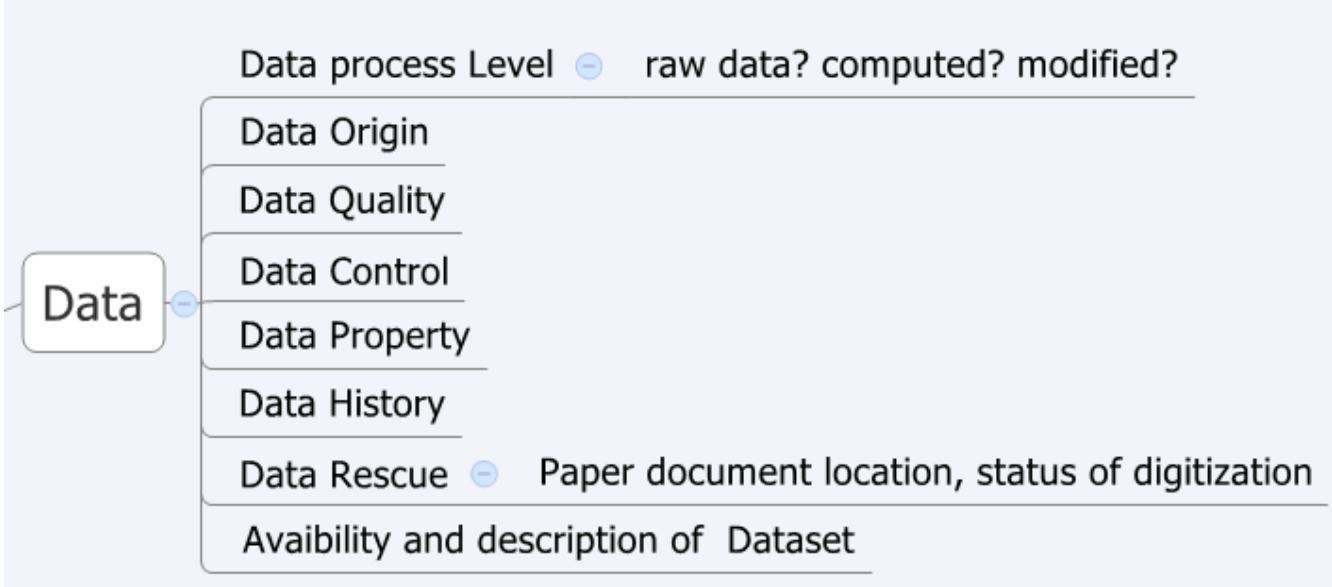
In bold red	The Volume A does not give information on this characteristic which is consider as essential for climatological purpose
No color	The Volume A does not give information on this characteristic; if this characteristic is recommended for climatological purpose it does not represent the “essential minimum”
In yellow	The Volume A gives partial information on this characteristic and more detailed information is needed for climatological purpose
In green	The information given by Volume A is sufficient for climatological purpose

Quality



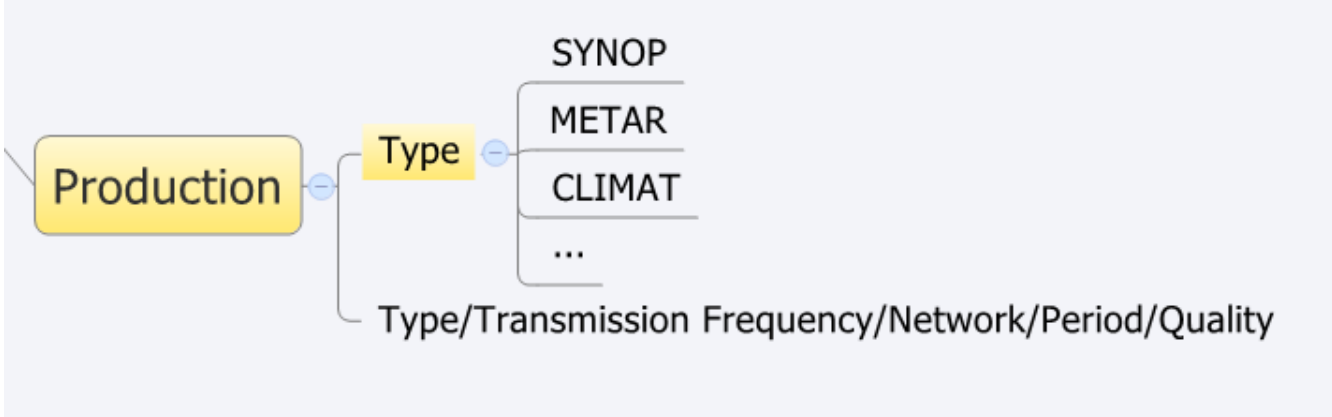
In bold red	The Volume A does not give information on this characteristic which is consider as essential for climatological purpose
No color	The Volume A does not give information on this characteristic; if this characteristic is recommended for climatological purpose it does not represent the “essential minimum”
In yellow	The Volume A gives partial information on this characteristic and more detailed information is needed for climatological purpose
In green	The information given by Volume A is sufficient for climatological purpose

Data information



In bold red	The Volume A does not give information on this characteristic which is consider as essential for climatological purpose
No color	The Volume A does not give information on this characteristic; if this characteristic is recommended for climatological purpose it does not represent the “essential minimum”
In yellow	The Volume A gives partial information on this characteristic and more detailed information is needed for climatological purpose
In green	The information given by Volume A is sufficient for climatological purpose

Production



In bold red	The Volume A does not give information on this characteristic which is consider as essential for climatological purpose
No color	The Volume A does not give information on this characteristic; if this characteristic is recommended for climatological purpose it does not represent the “essential minimum”
In yellow	The Volume A gives partial information on this characteristic and more detailed information is needed for climatological purpose
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