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| WEATHER CLIMATE WATER | **World Meteorological Organization**  **COMMISSION FOR OBSERVATION, INFRASTRUCTURE AND INFORMATION SYSTEMS**  **Second Session** 24 to 28 October 2022, Geneva | **INFCOM-2/Doc. 6.3(3)** |
| Submitted by: Secretary-General  21.IX.2022  **DRAFT 1** |

**AGENDA ITEM 6: TECHNICAL REGULATIONS AND OTHER TECHNICAL DECISIONS**

**AGENDA ITEM 6.3: Standing Committee on Information Management and Technology (SC-IMT)**

# update of the Manual on codes

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| **Summary** |
| **Document presented by:** the Secretary-General  **Strategic objective 2020–2023:** 2.2  **Financial and administrative implications:** within the parameters of the Strategic and Operational Plans 2020–2023, will be reflected in the Strategic and Operational Plans 2024–2027.  **Key implementers:** INFCOM and RAs  **Time frame:** 2023–2027  **Action expected:** Review the proposed draft Recommendation 6.3(3)/1 (INFCOM-2) |

# DRAFT RECOMMENDATION

## Draft Recommendation 6.3(3)/1 (INFCOM-2)

### Update of the Manual on Codes

THE COMMISSION FOR OBSERVATION, INFRASTRUCTURE AND INFORMATION SYSTEMS,

**Recalling**

(1) [Resolution 58 (Cg-18)](https://library.wmo.int/doc_num.php?explnum_id=9827" \l "page=193) - Future Integrated Seamless Global Data Processing and Forecasting System Collaborative Framework,

(2) [Resolution 2 (Cg-Ext-2021)](https://library.wmo.int/doc_num.php?explnum_id=11113#page=29) – Amendments to the Technical Regulations related to the establishment of the Global Basic Observing Network,

**Recognizing** the importance of providing clear guidance on how to report observations for international data exchange from stations of the Global Basic Observing Network (GBON),

**Taking note** of the successful completion of the experimental exchange of data with the Climate and Forecast Network Common Data Form (CF-NetCDF) profiles initiated with [Decision 21 INFCOM-1](https://library.wmo.int/doc_num.php?explnum_id=11197#page=251),

**Recommends** to the Executive Council the adoption of the Update of the Manual on Codes throughthe draft resolution provided in the [annex](#_Annex_to_draft) to the present recommendation.

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## Annex to draft Recommendation 6.3(3)/1 (INFCOM-2)

**Draft Resolution ##/1 (EC-76)**

THE EXECUTIVE COUNCIL,

**Recalling**

(1) [Resolution 58 (Cg-18)](https://library.wmo.int/doc_num.php?explnum_id=9827#page=193) - Future Integrated Seamless Global Data Processing and Forecasting System Collaborative Framework,

(2) [Resolution 2 (Cg-Ext-2021)](https://library.wmo.int/doc_num.php?explnum_id=11113#page=29) – Amendments to the Technical Regulations related to the establishment of the Global Basic Observing Network,

**Having considered** Recommendation 6.3(3)/1 (INFCOM-2),

**Welcomes** the successful experimental exchange of data in CF-NetCDF format established by INFCOM and performed by volunteer Members;

**Decides**

(1) To adopt the addition of a new section on Climate and Forecast (CF) profiles in the [*Manual on Codes Vol. I.2*](https://library.wmo.int/doc_num.php?explnum_id=11283) (WMO-No. 306) described in [Annex 1](#_Annex_1_to);

(2) To adopt the addition of a new Part in the [*Manual on Codes Vol. I.2*](https://library.wmo.int/doc_num.php?explnum_id=11283) (WMO No. 306) related to the GBON reporting practices for the data in Binary Universal Form for the Representation of meteorological data (BUFR) as described in [Annex 2](#_Annex_2_to);

(3) To adopt the amendments to the [*Manual on Codes Vol. I.2*](https://library.wmo.int/doc_num.php?explnum_id=11283) and [*Vol. I.3*](https://library.wmo.int/index.php?lvl=notice_display&id=19508#.Yxca43ZBw2w) (WMO-No. 306) due to the WMO reform as described in [Annex 3](#_Annex_3_to).

**Encourages** Members on exchanging data with the endorsed CF-NetCDF format;

[Annex 1](#_Annex_1_to): Climate and Forecast — Network Common Data Format (CF-NetCDF)

[Annex 2](#_Annex_2_to): Global Basic Observing Network reporting practices for BUFR

[Annex 3](#_Annex_3_to): Amendments due to the WMO reform

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## Annex 1 to draft Resolution X/X (EC-76)

**Climate and Forecast — Network Common Data Format (CF-NetCDF)**

Amend the Manual on Codes, Volume I.2 (WMO-No. 306). Add a new section, Part B.b. WMO-CF (to be inserted after section FM 94–XIV BUFR)

**WMO CF-Extensions**

**Definitions**

**CF Conventions**: The Climate and Forecast Conventions for netCDF (CF Conventions) define a minimum set of metadata required to ensure that conforming netCDF files meet a basic level of self-description and interoperability. The required (minimal) set of metadata ensures that all variables in a dataset have “an associated description of what it represents, including physical units if appropriate, and that each value can be located in space (relative to earth-based coordinates) and time”. Additional metadata are defined by the CF Conventions but are only recommended where they may not be needed or appropriate for all datasets.

Current and previous versions of the CF Conventions can be found at: https://cfconventions.org/

**WMO-CF Extensions:** The WMO-CF extensions build on the CF Conventions to provide the framework for standardizing semantics and metadata, further reducing the effort involved in specifying data products and increasing interoperability. The WMO-CF:

* + Define additional metadata requirements or recommendations that are not defined by the CF Conventions;
  + Specify the set of optional CF Conventions metadata that this extension requires, making those optional metadata mandatory.

**WMO-CF Profiles**: The WMO-CF profiles implement the WMO-CF extensions for different data types by, inter alia: defining the standardized metadata and semantics; specifying the names of dimension and coordinate variables; and specifying the ordering of dimensions. The WMO-CF Profiles reduce the degrees of freedom available when creating netCDF files, increasing the standardization of data from different publishers for the same type of data.

**FM SYSTEM OF WMO-CF PROFILES**

|  |  |
| --- | --- |
| FM 301-2022 WMO-CF Radial | Reports from operational weather radar |
| FM 302-2022 WMO-CF Marine Trajectory | Profile for the representation of meteorological/oceanographic observations along a trajectory within the ocean (or other body of water) or at/near the ocean surface.  Example observing platforms include, inter alia: crewed vessels making observations at the sea surface along a track; autonomous surface vehicles making similar measurements; and oceanographic gliders making measurements along a track. |

**WMO-CF GENERAL REGULATIONS:**

1. **NetCDF version and features**
   1. WMO-CF files should be encoded in version 4 of the NetCDF format.
   2. String data should be encoded using the string atomic data type.
2. **Representation of information in the WMO-CF NetCDF Extension and WMO-CF profiles.**
   1. Data shall conform with version 1.8 or higher of the netCDF conventions for CF (Climate and Forecast) metadata (CF hereafter). The version shall be specified in the *Conventions* global attribute (see Regulation WMO-CF.6).

Notes: may conform with version 1.3 or higher of the Attribute Convention for Data Discovery (ACDD) conventions. Where this is the case the version is recommended to be specified in the *Conventions* global attribute (see Regulation WMO-CF.6). The ACDD conventions can be found at: <https://wiki.esipfed.org/Attribute_Convention_for_Data_Discovery_1-3>

* 1. Data shall also conform with the regulations and the WMO-CF extensions defined within this document.
  2. Data conforming with the WMO-CF extensions shall be identified by the use of the label *WMO-CF n.n* in the *Conventions* global attribute (see Regulation WMO-CF.6) where *n.n* is the version number.
  3. Data shared on the WIS shall conform with one of the WMO-CF profiles defined within this document.
  4. Creators of WMO-CF files shall ensure that they validate against the specified CF conventions and the WMO-CF extensions.
  5. Attributes defined as part of the WMO-CF extension shall use the *wmo\_\_* namespace (double underscore).
  6. Any attribute using the *wmo\_\_* namespace but not defined as part of the WMO-CF extension shall be invalid.

1. **Dimensions and Coordinate Variables**
   1. Dimension names shall be specified within the WMO-CF Profiles defined below.
   2. The order of the dimensions within a variable shall be specified within the WMO-CF Profiles.
   3. The coordinate variable names shall be defined within the WMO-CF Profiles.
   4. The *standard\_name* attribute shall be used for all coordinate variables.
   5. The *units* attribute shall be used for all coordinate variables.
   6. The *axis* attribute shall be used to indicate the spatiotemporal coordinates (X, Y, Z, T) when present.
   7. When longitude and latitude are reported in units of degrees these shall be qualified with the direction, i.e. *degrees\_north* and *degrees\_east*.
   8. Time coordinate variables (T) shall include the *calendar* attribute.
2. **Station identifiers**
   1. Each station included in a data file shall be identifiable via:
      1. A WIGOS Station Identifier (WSI), or
      2. A traditional WMO Identifier (e.g. 5-digit or 7-digit code), if no WIGOS Station Identifier has been assigned, or
      3. An alternative station identifier, if no WIGOS Station Identifier or traditional WMO Identifier has been assigned. For example, ship ITU callsign.
   2. The *WIGOS Station Identifier* shall be stored as a string using the standard notation:
      1. <WIGOS station identifier series>-<issuer of identifier>-<issue number>-<local identifier>
   3. The form of the traditional WMO Identifier to be used shall be specified within the WMO-CF profile definitions below.
   4. The form of the alternative station identifier, if required, shall be specified within the WMO-CF profile definitions below.
   5. Data files containing data from a single station shall store the WIGOS Station Identifier and traditional WMO identifier using the *wmo\_\_wsi* and *wmo\_\_id* global attributes respectively. See WMO-CF.6.10.6 and WMO-CF.6.10.7.
   6. The rules specified in the WMO Manual on the WMO Integrated Global Observing System (WMO-No. 1160) shall be followed for WMO observing stations.
   7. Data files containing data from multiple stations shall store station identifiers according to the WMO-CF profile definitions below.
3. **General regulations for variables and variable attributes**
   1. A distinction is made between those variables that contain observed, measured or simulated data (hereafter data variables, see Regulation WMO-CF.5.2), those containing metadata or ancillary information (ancillary data, see Regulation WMO-CF.5.3) and those containing information defining the dimensions and coordinates (dimension and coordinate variables, see Regulation WMO-CF.3).
   2. *Data variables*
      1. Table WMO-CF-1 below lists the variable attributes that are defined for observed data and for use with the WMO-CF extensions.
      2. Attributes marked mandatory (M) shall be included for all variables.
      3. Attributes marked conditional (C) shall be included when the conditions described below are met.
      4. Attributes marked optional (O) are optional.
      5. Additional attributes may be defined as part of the WMO-CF Profiles listed in this volume.
      6. Other attributes not defined, either in the general regulations or in the profiles, may be used but have no meaning within the context of the WMO-CF Extensions.
      7. The *standard\_name* attribute shall be used when there is an existing definition in the CF conventions.
      8. The *long\_name* attribute should be used to describe the content of the variable.
      9. The *wmo\_\_parameter\_uri* and *wmo\_\_parameter\_name* attributes shall be used to unambiguously identify the observed/measured parameter being reported.
      10. The *wmo\_\_parameter\_uri* shall point to an entry in a codes registry authorized for use within the profile of the data product. The use of codes.wmo.int is authorized for all profiles; individual WMO-CF profiles may additionally define their own list of authorized registries.
      11. The *units* attribute shall be reported for all variables that represent dimensional quantities.
      12. When reported, the *units* shall be selected from those in WMO Common Code Table C-6 and represented using a string recognisable by the UDUnits package.
      13. If a variable is packed into an integer value the *scale\_factor* and *add\_offset* shall be used as defined in the NetCDF User Guide (NUG) and in the CF Conventions.

Note: The current version of the NetCDF User Guide can be found at: https://www.unidata.ucar.edu/software/netcdf/docs/user\_guide.html

* + 1. Variables that contain missing data shall include the *\_FillValue* attribute and use this to indicate the default fill value and value of missing data.
    2. Variables that contain missing data shall also include the *valid\_range* attribute to indicate the range of valid values expected.
    3. The *valid\_range* attribute shall indicate the full range of values that are valid and not just the range of values reported in the file.
    4. For observed variables where metadata or other information is available in an ancillary variable the link shall be made using the *ancillary\_variables* attribute.
    5. Where there is a requirement for metadata to be reported this shall be included in the profile definitions below.
  1. *Ancillary data*
     1. Ancillary variables contain metadata or information about one or more observed variables.
     2. Ancillary variables shall be referenced from the associated data variables with CF *ancillary\_variables* attributes as described in CF Section 3.4 “Ancillary Variables”.
     3. Where the ancillary variable has a physical meaning, for example observation height above a reference surface, then the rules for observed data shall also apply.
     4. For efficiency the ancillary data may be encoded using either flags or masks following the CF conventions, see example 1.
     5. When ancillary data are encoded the *flag\_meanings* and either *flag\_values* or *flag\_masks* shall be included in the file following the CF conventions.
     6. Where a code list or controlled vocabulary is specified in the WMO-CF profile definition then only values from that code list shall be valid for the *flag\_meanings*.
     7. The relevant code list or controlled vocabulary shall be indicated via the *wmo\_\_parameter\_name* and *wmo\_\_parameter\_uri* attribute, see example 1.
     8. Attributes containing Boolean values shall be encoded as either the string ‘true’ or ‘false’.
     9. No meaning or default value should be inferred by the absence of an ancillary variable.
     10. No meaning shall be inferred by data set to the missing value.

1. **Global attributes**
   1. Table WMO-CF-2 lists the global attributes defined for use with WMO CF-1.0. This includes attributes defined in other conventions, such as the Attribute Convention for Data Discovery 1-3 (ACDD 1-3) and the CF conventions, and the netCDF user guide (NUG).
   2. Attributes marked mandatory (M) shall be included for all variables.
   3. Attributes marked conditional (C) shall be included when the conditions described below are met.
   4. Attributes marked optional (O) are optional.
   5. Additional attributes may be defined as part of the WMO-CF Profiles listed in this volume.
   6. Other attributes not defined in the general regulations, the profiles or the CF conventions may be used but have no meaning within the context of the WMO-CF Extensions.
   7. The *Conventions* attribute shall be used to indicate the conventions followed by a dataset. Where multiple conventions are followed these shall be comma separated.
   8. The *featureType* attribute shall be used for files containing discrete sampling geometries to indicate the type of geometry.
   9. The *standard\_name\_vocabulary* attribute shall be used to indicate the version of the *standard\_name* table used.
   10. The following global attributes are defined as part of the WMO-CF extension and shall be included:
       1. *wmo\_\_cf\_profile*. The *wmo\_\_cf\_profile* attribute shall indicate the specific profile included within a file and shall reference one of the profiles defined within this volume.
       2. *wmo\_\_originating\_centre*. The *wmo\_\_originating\_centre* attribute shall be used to identify the originator of the files. Valid values are defined in Common Code Table C-11. Where data originate from outside of the WMO system the *wmo\_\_originating\_centre* attribute may be omitted.
       3. *wmo\_\_originating\_sub\_centre*. The *wmo\_\_originating\_sub\_centre* attribute shall be used to identify the originating sub centre where different from the originating centre. Valid values are defined in Common Code Table C-12. Where data originate from outside of the WMO system the *wmo\_\_originating\_sub\_centre* attribute may be omitted.
       4. *wmo\_\_data\_category*. The *wmo\_\_data\_category* attribute shall be included to identify the type of data contained within the file. Valid values are given in Common Code Table C-13.
       5. *wmo\_\_update\_sequence\_number*. The *wmo\_\_update\_sequence\_number* attribute shall be included and used to indicate whether the data are original or updated. The rules shall follow those defined for BUFR (zero for original messages and for messages containing only delayed reports; incremented for the other updates).
       6. *wmo\_\_wsi*. The *wmo\_\_wsi* attribute shall be used to indicate a WIGOS Station Identifier of the observing station or platform to which the file relates. The *wmo\_\_wsi* attribute shall be omitted if the file contains data related to multiple stations, or if no WIGOS station identifier has been assigned.
       7. *wmo\_\_id*. The *wmo\_\_id* attribute shall be used to indicate the traditional WMO identifier of the observing station or platform to which the file relates. The *wmo\_\_id* attribute shall be omitted if the file contains data related to multiple stations.
2. **Compression and chunking**
   1. Compression, or chunking, may be used on variables within a NetCDF file.
   2. Data can furthermore be compressed or chunked using HDF filters. If this is the case however the data producer must use a method that has been agreed upon by ET-Data. In that case the filter in question would be described in this volume. The following minimum requirements shall apply:
      1. Decompression algorithm is open;
      2. Software implementing this is freely available;
      3. Filter number is registered with HDF Group to avoid name clashes.

**WMO-CF General Regulations: Tables**

**Table WMO-CF-1: List of defined variable attributes for ancillary and data variables.**

|  |  |  |
| --- | --- | --- |
| Attribute name | Description | Mandatory (M), Conditional (C) or Optional (O) |
| standard\_name | A standard name that references a description of a variables content in the standard name table. | C - see Regulations WMO-CF.3.4 and WMO-CF.5.2.7. See also profile definitions. |
| long\_name | A descriptive name that indicates a variables content. This name is not standardized. | O |
| wmo\_\_parameter\_uri | Link to external code registry to unambiguously identify the parameter or variable reported. This may be one from the codes.wmo.int registry or from another registry specified in the profile definitions. | M |
| wmo\_\_parameter\_name | Parameter name used to unambiguously identify the parameter or variable reported. Analogous to standard\_name. | M |
| \_FillValue | A value used to represent missing or undefined data. Allowed for auxiliary coordinate variables but not allowed for coordinate variables. | C - see Regulation WMO-CF.5.2.14 |
| valid\_range | Smallest and largest valid values of a variable. | M |
| scale\_factor | If present for a variable, the data are to be multiplied by this factor after the data are read by an application. See also the add\_offset attribute. | O |
| add\_offset | If present for a variable, this number is to be added to the data after it is read by an application. If both scale\_factor and add\_offset attributes are present, the data are first scaled before the offset is added. | O |
| units | Units of a variable’s content. | C - see Regulations WMO-CF.5.2.11 and WMO-CF.5.2.12 |
| coordinates | Identifies auxiliary coordinate variables, label variables, and alternate coordinate variables. | C - see profile definitions |
| ancillary\_variables | Identifies a variable that contains closely associated data, e.g., the measurement uncertainties of instrument data. | C - see Regulation WMO-CF.5.2.17 |

**Table WMO-CF-2: List of defined global attributes.**

|  |  |  |
| --- | --- | --- |
| Attribute name | Description | Mandatory (M), Conditional (C) or Optional (O) |
| Conventions | A comma-separated list of the conventions that are followed by the dataset. e.g. NUG, ACDD-1.3, CF-1.8, WMO CF-1.0 | M |
| featureType | Specifies the type of discrete sampling geometry to which the data in the scope of this attribute belongs, and implies that all data variables in the scope of this attribute contain collections of features of that type. | C – see Regulation WMO-CF.6.8, mandatory for discrete sampling geometries. |
| title | Short description of the file contents. | M |
| wmo\_\_cf\_profile | The WMO CF profile used to represent the data contained within the file. | M |
| wmo\_\_data\_category | The type of data contained within the file according to Common Code Table C-13 | M |
| wmo\_\_data\_policy | Options are: core, recommended | M |
| wmo\_\_originating\_centre | The originator of the data according to Common Code Table C-11. | C - see Regulation WMO-CF.6.10.2. |
| wmo\_\_originating\_sub\_centre | The originating sub centre for the data if different from the *wmo\_\_originating\_centre*. See common code table C-12 | C - see Regulation WMO-CF.6.10.3. |
| wmo\_\_update\_sequence\_number | Indicator as to whether the data are original or updated. The rules shall follow those defined for BUFR in Volume I.2 (zero for original messages and for messages containing only delayed reports; incremented for other updates). | C - see Regulation WMO-CF.6.10.5. |
| wmo\_\_id | The traditional WMO identifier for the observing station/platform. | C - see Regulations WMO-CF.6.10.6 and WMO-CF.6.10.7. |
| wmo\_\_wsi | The WIGOS Station Identifier (WSI) for the observing station/platform. | C - see Regulations WMO-CF.6.10.6 and WMO-CF.6.10.7. |

**Examples**

**Example 1** Minimal example showing the use of flag values and flag meanings attribute to record the anemometer type.

int anemometer\_type( obs );  
 anemometer\_type:long\_name="type of anemometer";  
 anemometer\_type:flag\_values= 0, 1, 2, 3, 15;  
 anemometer\_type:flag\_meanings="Cup\_rotor Propeller\_rotor Sonic Wind\_observation\_through\_ambient\_noise Missing\_value";  
 anemometer\_type:wmo\_\_parameter\_name="Anemometer type";  
 anemometer\_type:wmo\_\_parameter\_uri="http://codes.wmo.int/bufr4/codeflag/\_0-02-169";

**FM 301-2022 WMO-CF RADIAL**

**REGULATIONS**

1. **Scope**
   1. This profile is for the representation of weather radar and lidar data in the native instrument-centric polar coordinates. Such data is the primary output of the radar/lidar signal processor known as "Level 2" data. This is the lowest level output commonly available from operational instruments and is well suited to data exchange.
   2. The structure of this profile conforms to the WMO Information and Data Models for Radial Radar and Lidar Data. Effort has also been made to maximize compatibility with the CfRadial 2 format from which this profile has been derived
2. **Overview**
   1. Level 2 radar/lidar data may be conceptualized as a simple hierarchy of data objects where each object contains a collection of objects from the level below. These objects are:
      1. Volume – The top-level object for the profile. A Volume is a collection of logically associated sweeps. Typically, these sweeps will represent a continuous or near-continuous series of observations acquired by the instrument during a single cycle of the scan schedule.
      2. Sweep – Represents a subset of the data in the volume over which certain fundamental conditions remain constant. A common example is for a sweep to contain the data observed during a single 360-degree scan at a fixed elevation angle.
      3. Ray – Represents a collection of data along a single direction of pointing from the instrument.
      4. Range Bin – Represents a collection of data within a ray that are related to the same short window of range along the beam propagation path.
      5. Dataset – A measured or calculated quantity that is associated with a range bin. Each Dataset will typically represent one of the measured radar moments such as reflectivity or Doppler velocity, but may also be used to store derived information such as quality control metrics.
   2. Within a Sweep all Range Bins contain the same collection of Datasets, and all Rays contain the same collection of Range Bins. This allows the lower three levels of the hierarchy to be collapsed into a collection of 2D variables. Each variable stores a single Dataset, with dimensions for Ray and Range Bin.
   3. To facilitate the hierarchical nature of the data to be represented, NetCDF groups are used. The global scope is used to store the Volume object, a group is used for each Sweep object, and a variable within each Sweep group is used for each Dataset. Coordinate variables and ancillary variables within the Sweep groups provide metadata related to the Ray and Range Bin objects.
3. **Global scope/root group**
   1. The global scope of the profile contains data and metadata which are relevant to the entire volume.
   2. *Attributes*
      1. Table 301-1 lists the global attributes that shall be included in addition to those defined under General Regulation WMO-CF.6.
      2. Table 301-2 lists the mandatory values that shall be used for the global attributes where defined.
      3. Table 301-3 lists additionally defined global attributes that are optional.
   3. *Ancillary variables*
      1. Table 301-4 lists the global variables that shall be included in the global root group.
      2. Table 301-5 lists the global variables that should be included in the global/root group.
4. **Sweep groups**
   1. A sweep group contains all of the data and metadata related to Sweep object. This includes the dimensions and coordinates which define the basic geometry of the sweep (Rays and Range Bins), the measured radar/lidar quantities (Datasets), as well as many supporting ancillary variables. Each sweep group may also contain subgroups to cater for specialized metadata such as monitoring information.
   2. Sweep groups shall be named *sweep\_<n>* where *<n>* is the sweep number starting at 0 for the first sweep acquired during the volume and increasing sequentially in acquisition order.
   3. *Dimensions*
      1. The *time* dimension shall define the number of Rays in the sweep. It shall be used as the primary dimension for Dataset variables.
      2. The *range* dimension shall define the number of Range Bins in the sweep. It shall be used as the secondary dimension for Dataset variables.
      3. The *frequency* dimension shall define the number of operating frequencies. Where a single frequency is present this dimension shall have length 1.
      4. The *prt* dimension may define the number of pulse repetition times used in a pulsing scheme. This dimension is optional for fixed, staggered and dual PRT schemes but required for more complex schemes.
   4. *Coordinate variables*
      1. Table 301-6 lists the coordinate variables that shall be used in the sweep groups.
   5. *Ancillary variables*
      1. Table 301-7 lists the ancillary variables that shall be included in the sweep groups.
      2. Table 301-8 lists the ancillary variables that may be included in the sweep groups.
   6. *Dataset variables (observed and quality data)*
      1. Dataset variables shall have dimensions *(time, range)*.
      2. Dataset variables for well-known radar moments shall be named according to Table 301-9.
      3. The General Regulations for variables (WMO-CF.5) shall apply, including the regulations on mandatory and optional attributes.
      4. The *coordinates* attribute shall be set to *"elevation azimuth range"*
      5. Additional attributes for field/geophysical variables are defined in Table 301-10.
   7. *Monitoring subgroup*
      1. If monitoring data is available, a monitoring subgroup will be included in each relevant sweep group, to store the monitoring variables.
      2. The group shall be named *monitoring*.
      3. Table 301-11 lists the variables that may be included in this subgroup when present.
5. **Radar parameters group**
   1. The radar parameters group holds optional ancillary variables that are specific to the radar instrument.
   2. This group shall be located at the global scope and named *radar\_parameters*.
   3. Table 301-12 lists the variables which may be included in this group.
   4. This group may be omitted from the file if no radar parameters are to be stored.
6. **Lidar parameters group**
   1. The lidar group holds optional ancillary variables that are specific to the lidar instrument.
   2. This group shall be located at the global scope and named *lidar\_parameters*.
   3. Table 301-13 lists the variables which may be included in this group.
   4. This group may be omitted from the file if no lidar parameters are to be stored.
7. **Radar calibration group**
   1. The radar calibration group holds optional ancillary variables that are related to calibrations of the radar instrument. Several calibrations may be stored, typically one per pulse width.
   2. This group shall be located at the global scope and named *radar\_calibration*.
   3. *Dimensions*
      1. The *calib* dimension shall define the number of calibrations stored.
   4. Table 301-14 lists the ancillary variables which may be included in this group.
   5. This group may be omitted from the file if no radar calibrations are to be stored.
8. **Lidar calibration group**
   1. The lidar calibration group holds optional ancillary variables that are related to calibrations of the lidar instrument.
   2. This group shall be located at the global scope and named *lidar\_calibration*.
   3. No ancillary variables have been defined for this group. It is reserved for future use.
   4. This group may be omitted from the file if no lidar calibration variables are to be stored.

**FM 301-2022 Tables**

**Table 301-1: Global attributes for the global scope/root group that shall be reported in addition to those defined in General Regulation WMO-CF.6.**

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Convention | Value or description |
| instrument\_name | string | CF/Radial | Name of radar or lidar |
| institution | String | CF | See CF Conventions Appendix A |
| references | String | CF | See CF Conventions Appendix A |
| source | String | CF | See CF Conventions Appendix A |
| history | String | CF | See CF Conventions Appendix A |
| comment | String | CF | See CF Conventions Appendix A |
| platform\_is\_mobile | string | CF/Radial | "false" (mobile platforms are not supported by this profile) |

**Table 301-2: Mandatory values defined for the global attributes.**

|  |  |  |
| --- | --- | --- |
| Attribute name | Type | Value |
| Conventions | string | "CF-1.8, WMO CF-1.0" |
| wmo\_\_cf\_profile | string | "FM 301-2022" |

**Table 301-3: Global attributes defined for this profile that are conditional or optional.**

|  |  |  |  |
| --- | --- | --- | --- |
| Attribute name | Type | Convention | Value or description |
| site\_name | string | CF/Radial | Name of site where data were gathered |
| scan\_name | string | CF/Radial | Name of scan strategy used, if applicable |
| scan\_id | int | CF/Radial | Scan strategy id, if applicable. Assumed 0 if missing. |
| ray\_times\_increase | Boolean | CF/Radial | "true" or "false". Set to true if ray times increase monotonically throughout all of the sweeps in the volume. |
| simulated | Boolean | ODIM | "true" or "false". Set to true if data in this file are simulated. |

**Table 301-4a: Metadata variables with global scope that shall be included in WMO-CF Radial files. Units and other attributes are defined in Table 301-4b.**

|  |  |  |  |
| --- | --- | --- | --- |
| variable path/name | Dimensions | Type | Comment |
| /volume\_number |  | int | Volume numbers are sequential, relative to some arbitrary start time, and may wrap. |
| /time\_coverage\_start |  | string | UTC time of first ray in file. |
| /time\_coverage\_end |  | string | UTC time of the last ray in the file. |
| /latitude |  | double | Latitude of instrument using WGS84. For a mobile platform this is the latitude of the instrument at the start of the volume |
| /longitude |  | double | Longitude of instrument using WGS84. For a mobile platform this is the longitude of the instrument at the start of the volume |
| /altitude |  | double | Altitude of instrument above mean sea level, using WGS84 and EGM2008 geoid corrections. For a scanning radar this is the centre of rotation of the antenna. For a mobile platform this is the altitude at the start of the volume. |
| /platform\_type |  | string | Type of platform upon which the radar system is mounted. Allowed values are listed in Table 15 |
| /instrument\_type |  | string | Type of instrument. Allowed values are listed in Table 15. |

**Table 301-4b: Mandatory attributes for the global variables defined in Table 301-4a.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Attribute | Type | Value |
| /time\_coverage\_start | units | string | "seconds since <reftime>" where <reftime> is an ISO8601 time string of the form YYYY-MM-DDThh:mm:ssZ |
|  | calendar | string | See CF Conventions Appendix A |
|  | standard\_name | string | "time" |
| /time\_coverage\_end | units | string | "seconds since <reftime>" where <reftime> is an ISO8601 time string of the form YYYY-MM-DDThh:mm:ssZ |
|  | calendar | string | See CF Conventions Appendix A |
|  | standard\_name | string | "time" |
| /latitude | units | string | "degrees\_north" |
|  | standard\_name | string | "latitude" |
| /longitude | units | string | "degrees\_east" |
|  | standard\_name | string | "longitude" |
| /altitude | units | string | "meters" |
|  | standard\_name | string | "height\_above\_reference\_elliposid" |

**Table 301-5a: Metadata variables with global scope that are conditional or optional. Attributes are listed in Table 301-5b.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Dimensions | Type | Comment |
| /altitude\_agl |  | double | Altitude of instrument above ground level. This is the centre of rotation of the antenna |
| /primary\_axis |  | string | Principle axis of rotation. Allowed values are specified in Table 301-15. |
| /status\_str |  | string | General-purpose string for storing any information that is not included in other parts of the data structure. Any text-based encoding may be used including simple text, XML, JSON etc |

**Table 301-5b: Attributes for those variables listed in Table 301-5a.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Attribute | Type | Value |
| /altitude\_agl | units | string | "meters" |
|  | standard\_name | string | "height" |

**Table 301-6a: Coordinate variables for the sweep groups. Attributes are defined in Table 301-6b.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Dimensions | Type | Comment |
| /sweep\_<n>/time | (time) | double | Coordinate variable for the time dimension. Each value is the time at centre of each ray |
| /sweep\_<n>/range | (range) | float | Coordinate variable for the range dimension. Each value is range along beam propagation path to the centre of each range bin |
| /sweep\_<n>/frequency | (frequency) | float | List of operating frequencies in Hertz. In most cases only a single frequency is used. |

**Table 301-6b: Mandatory attributes for the sweep group coordinate variables listed in Table 301-6a.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | attribute | kind | value |
| /sweep\_<n>/time | units | string | "seconds since <reftime>" where <reftime> is an ISO8601 time string of the form YYYY-MM-DDThh:mm:ssZ |
|  | calendar | string | See CF Conventions Appendix A. |
|  | standard\_name | string | "time" |
| /sweep\_<n>/range | units | string | "meters" |
|  | standard\_name | string | "projection\_range\_coordinate" |
|  | long\_name | string | "range\_to\_measurement\_volume" |
|  | axis | string | "radial\_range\_coordinate" |
|  | spacing\_is\_constant | Boolean/ string | "true" if range bins are evenly spaced |
|  | meters\_to\_center\_of\_first\_gate | float | Range to start of first gate in meters |
|  | meters\_between\_gates | float | Range between consecutive gates in meters. Required if *spacing\_is\_constant* is true |
| /frequency | units | string | "s -1" |
|  | standard\_name | string |  |

**Table 301-7a: Mandatory metadata variables that shall be included in the sweep groups. Table 301-7b lists the attributes for these variables where defined.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Dimensions | Kind | Comment |
| /sweep\_<n>/sweep\_number | (range) | int | The index of the sweep within the volume, 0-based. |
| /sweep\_<n>/sweep\_mode | none | string | Type of sweep that was performed. Allowed values are listed in Table 301-15 |
| /sweep\_<n>/follow\_mode | none | string | Target following mode used to control antenna pointing. Allowed value are listed in Table 301-15. |
| /sweep\_<n>/prt\_mode | none | string | Pulsing mode used for sweep. Standard allowed values are listed in Table 301-15. More complicated pulsing schemes may also be represented using a sequence of "H" and "V" characters. For example "HHVVH" |
| /sweep\_<n>/fixed\_angle | none | float | Target angle for the sweep. In most sweep modes this is the elevation angle, for RHI mode this is the azimuth angle |
| /sweep\_<n>/azimuth | (time) | float | Azimuth of the antenna relative to true north at the centre of dwell for each ray of the sweep. |
| /sweep\_<n>/elevation | (time) | float | Elevation of the antenna relative to true north at the centre of dwell for each ray of the sweep. |

**Table 301-7b: Mandatory attributes defined for the sweep group metadata variables listed in Table 301-7a.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | attribute | kind | value |
| /sweep\_<n>/fixed\_angle | units | string | "degrees" |
| /sweep\_<n>/azimuth | units | string | "degrees" |
|  | standard\_name | string | "sensor\_to\_target\_azimuth\_angle" |
|  | long\_name | string | "Azimuth angle from true north" |
|  | axis | string | "radial\_azimuth\_coordinate" |
| /sweep\_<n>/elevation | units | string | "degrees" |
|  | standard\_name | string | "sensor\_to\_target\_elevation\_angle" |
|  | long\_name | string | "Elevation angle from horizontal plane" |
|  | axis | string | "radial\_elevation\_coordinate" |

**Table 301-8a: Optional/conditional metadata variables that may be reported in the sweep groups. Attributes are defined in Table 301-8b.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Dimensions | Kind | Comment |
| /sweep\_<n>/polarization\_mode | none | string | Polarization mode used during sweep. Allowed values are listed in Table 301-15. |
| /sweep\_<n>/polarization\_sequence | (prt) | string | Polarization sequence for each PRT that is used. Only applicable if *prt\_mode* is "hybrid". As an example, the form of it would be ['H','H','V','V','H'] for HHVVH pulsing |
| /sweep\_<n>/rays\_are\_indexed | none | Boolean/ string | Indicates whether or not the ray angles (elevation in RHI sweep mode, azimuth in other modes) are indexed to a regular grid. |
| /sweep\_<n>/rays\_angle\_resolution | none | float | If *rays\_are\_indexed* is true, this is the resolution of the angular grid – i.e. the delta angle between successive ray |
| /sweep\_<n>/qc\_procedures | none | string | General-purpose string for storing any information that describes the QC procedures performed on this sweep. Any text-based encoding may be used including simple text, XML, JSON etc |
| /sweep\_<n>/target\_scan\_rate | none | float | Intended scan rate for this sweep. The actual scan rate is stored in scan\_rate. This variable is optional. Omit if not available. |
| /sweep\_<n>/scan\_rate | (time) | float | Actual antenna scan rate. Set to negative if counter- clockwise in azimuth or decreasing in elevation. Positive otherwise. |
| /sweep\_<n>/antenna\_transition | (time) | byte | 1 if antenna is in transition, i.e. between sweeps, 0 if not. If transition rays are not included in the file this variable may be omitted. |
| /sweep\_<n>/pulse\_width | (time) | float | Length of transmitted pulse. |
| /sweep\_<n>/calib\_index | (time) | int | Index for the radar calibration that applies to this pulse width. The value must match one of the calibration indexes listed by */radar\_calibration/calib\_index*. |
| /sweep\_<n>/rx\_range\_resolution | (time) | float | Resolution of the raw receiver samples if different to ‘meters\_between\_gates’. Raw data may be resampled before data storage. |
| /sweep\_<n>/prt | (time) | float | Pulse repetition time. For staggered prt, also see *prt\_ratio*. |
| /sweep\_<n>/prt\_ratio | (time) | float | Ratio of prt/prt2. For dual/staggered prt mode. |
| /sweep\_<n>/prt\_sequence | (time, prt) | float | Sequence of prts used. Optional for fixed, staggered and dual, which can make use of *prt* and *prt\_ratio*. Required for more complicated pulsing schemes. |
| /sweep\_<n>/nyquist\_velocity | (time) | float | Unambiguous velocity. This is the effective Nyquist velocity after unfolding. See also the field-specific attributes *fold\_limit\_lower* and *fold\_limit\_upper*. |
| /sweep\_<n>/unambiguous\_range | (time) | float | Unambiguous range |
| /sweep\_<n>/n\_samples | (time) | int | Maximum number of samples used to compute moments. The actual number of samples used may vary from field to field. This value refers to the maximum number of samples used for any field. The Dataset attribute *sampling\_ratio* is the actual number of samples used for a given field, divided by *n\_samples*. It will generally be 1.0, the default. |

**Table 301-8b: Attributes for the optional sweep group metadata variables defined in Table 301-8a.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Attribute | Kind | Value |
| /sweep\_<n>/rays\_angle\_resolution | units | string | "degrees" |
| /sweep\_<n>/target\_scan\_rate | units | string | "degrees/s" |
| /sweep\_<n>/scan\_rate | units | string | "degrees/s" |
| /sweep\_<n>/pulse\_width | units | string | "seconds" |
| /sweep\_<n>/rx\_range\_resolution | units | string | "meters" |
| /sweep\_<n>/prt | units | string | "seconds" |
| /sweep\_<n>/prt\_sequence | units | string | "seconds" |
| /sweep\_<n>/nyquist\_velocity | units | string | "meters/s" |
| /sweep\_<n>/unambiguous\_range | units | string | "meters" |

**Table 301-9: Dataset variable names, standard\_name and long\_name attributes for well-known radar moments.**

|  |  |  |
| --- | --- | --- |
| Variable path/name | Quantity (standard\_name) | Description (long\_name) |
| /sweep\_<n>/DBZH | radar\_equivalent\_reflectivity\_factor\_h | Equivalent reflectivity factor H |
| /sweep\_<n>/DBZV | radar\_equivalent\_reflectivity\_factor\_v | Equivalent reflectivity factor V |
| /sweep\_<n>/ZH | radar\_linear\_equivalent\_reflectivity\_factor\_h | Linear equivalent reflectivity factor H |
| /sweep\_<n>/ZV | radar\_linear\_equivalent\_reflectivity\_factor\_v | Linear equivalent reflectivity factor V |
| /sweep\_<n>/DBTH | radar\_equivalent\_reflectivity\_factor\_h | Total power H (uncorrected reflectivity) |
| /sweep\_<n>/DBTV | radar\_equivalent\_reflectivity\_factor\_v | Total power V (uncorrected reflectivity) |
| /sweep\_<n>/TH | radar\_linear\_equivalent\_reflectivity\_factor\_h | Linear total power H (uncorrected reflectivity) |
| /sweep\_<n>/TV | radar\_linear\_equivalent\_reflectivity\_factor\_v | Linear total power V (uncorrected reflectivity) |
| /sweep\_<n>/VRADH | radial\_velocity\_of\_scatterers\_away\_from\_instrument\_h | Radial velocity of scatterers away from instrument H |
| /sweep\_<n>/VRADV | radial\_velocity\_of\_scatterers\_away\_from\_instrument\_v | Radial velocity of scatterers away from instrument V |
| /sweep\_<n>/WRADH | radar\_doppler\_spectrum\_width\_h | Doppler spectrum width H |
| /sweep\_<n>/WRADV | radar\_doppler\_spectrum\_width\_v | Doppler spectrum width V |
| /sweep\_<n>/ZDR | radar\_differential\_reflectivity\_hv | Log differential reflectivity H/V |
| /sweep\_<n>/LDR | radar\_linear\_depolarization\_ratio | Log-linear depolarization ratio HV |
| /sweep\_<n>/LDRH | radar\_linear\_depolarization\_ratio\_h | Log-linear depolarization ratio H |
| /sweep\_<n>/LDRV | radar\_linear\_depolarization\_ratio\_v | Log-linear depolarization ratio V |
| /sweep\_<n>/PHIDP | radar\_differential\_phase\_hv | Differential phase HV |
| /sweep\_<n>/KDP | radar\_specific\_differential\_phase\_hv | Specific differential phase HV |
| /sweep\_<n>/PHIHX | radar\_differential\_phase\_copolar\_h\_crosspolar\_v | Cross-polar differential phase |
| /sweep\_<n>/RHOHV | radar\_correlation\_coefficient\_hv | Correlation coefficient HV |
| /sweep\_<n>/RHOHX | radar\_correlation\_coefficient\_copolar\_h\_crosspolar\_v | Co-to-cross polar correlation coefficient H |
| /sweep\_<n>/RHOVX | radar\_correlation\_coefficient\_copolar\_v\_crosspolar\_h | Co-to-cross polar correlation coefficient V |
| /sweep\_<n>/DBM | radar\_received\_signal\_power | Log power |
| /sweep\_<n>/DBMHC | radar\_received\_signal\_power\_copolar\_h | Log power co-polar H |
| /sweep\_<n>/DBMHX | radar\_received\_signal\_power\_crosspolar\_h | Log power cross-polar H |
| /sweep\_<n>/DBMVC | radar\_received\_signal\_power\_copolar\_v | Log power co-polar V |
| /sweep\_<n>/DBMVX | radar\_received\_signal\_power\_crosspolar\_v | Log power cross-polar V |
| /sweep\_<n>/SNR | radar\_signal\_to\_noise\_ratio | Signal-to-noise ratio |
| /sweep\_<n>/SNRHC | radar\_signal\_to\_noise\_ratio\_copolar\_h | Signal-to-noise ratio co-polar H |
| /sweep\_<n>/SNRHX | radar\_signal\_to\_noise\_ratio\_crosspolar\_h | Signal-to-noise ratio cross-polar H |
| /sweep\_<n>/SNRVC | radar\_signal\_to\_noise\_ratio\_copolar\_v | Signal-to-noise ratio co-polar V |
| /sweep\_<n>/SNRVX | radar\_signal\_to\_noise\_ratio\_crosspolar\_v | Signal to noise ratio cross polar V |
| /sweep\_<n>/NCP | radar\_normalized\_coherent\_power | Normalized coherent power |
| /sweep\_<n>/NCPH | radar\_normalized\_coherent\_power\_h | Normalized coherent power co-polar H |
| /sweep\_<n>/NCPV | radar\_normalized\_coherent\_power\_v | Normalized coherent power co-polar V |
| /sweep\_<n>/RR | radar\_estimated\_precipitation\_rate | Rain rate |
| /sweep\_<n>/REC | radar\_scatterer\_classification | Radar echo classification |

**Table 301-10: List of optional/conditional attributes that   
may be reported for Dataset variables.**

|  |  |  |  |
| --- | --- | --- | --- |
| Attribute name | Type | Convention | Value or description |
| \_Undetect | same as field data | ODIM | Indicates an area (range bin) that has been radiated but has not produced a valid echo |
| sampling\_ratio | float | CF/Radial | Number of samples for this field divided by *n\_samples*. |
| is\_discrete | Boolean/ string | CF/Radial | "true" or "false". If "true", this indicates that the field takes on discrete values, rather than floating point values. For example, if a field is used to indicate the hydrometeor type, this would be a discrete field. |
| field\_folds | Boolean/ string | CF/Radial | "true" or "false". Used to indicate that a field is limited between a min and max value, and that it folds between the two extremes. This typically applies to such fields as radial velocity and PhiDP |
| fold\_limit\_lower | float | CF/Radial | If *field\_folds* is "true", this indicates the lower limit at which the field folds. |
| fold\_limit\_upper | float | CF/Radial | If *field\_folds* is "true", this indicates the upper limit at which the field folds. |
| is\_quality\_field | Boolean/ string | CF/Radial | Set to "true" if this Dataset stores a quality control field. |
| flag\_values | same as field data | CF | Array of flag values. These values have special meaning, as documented in *flag\_meanings*. |
| flag\_meanings | string | CF | Meaning of *flag\_values* or *flag\_masks*. |
| flag\_masks | same as field data | CF | Valid bit-wise masks used in a flag field that is comprised of bit-wise combinations of mask values. See *flag\_meanings*. |
| qualified\_variables | string | CF/Radial | Applicable if *is\_quality\_field* is "true". Array list of variables that this variable qualifies. Every field variable in this list should list this variable in its *ancillary\_variable* attribute. |
| ancillary\_variables | string | CF | Array list of variables to which this variable is related. In particular, this is intended to list the variables that contain quality information about this field. In that case, the quality field will list this field in its *qualified\_variable* attribute. |
| thresholding\_xml | string | CF/Radial | Thresholding details. Supplied if thresholding has been applied to the field. |
|  |  |  | This should be in self-descriptive XML. For example: |
|  |  |  | *<thresholding field="DBZ">* |
|  |  |  | *<field\_used>* |
|  |  |  | *<name>NCP</name>* |
|  |  |  | *<min\_val>0.15</min\_val>* |
|  |  |  | *</field\_used>* |
|  |  |  | *<field\_used>* |
|  |  |  | *<name>SNR</name>* |
|  |  |  | *<min\_val>-3.0</min\_val>* |
|  |  |  | *</field\_used>* |
|  |  |  | *</thresholding>* |

**Table 301-11a: Optional/conditional variables that may be included in the monitoring subgroup when present. Attributes are defined in Table 301-11b.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Dimensions | Kind | Comment |
| /sweep\_<n>/monitoring/radar\_measured\_transmit\_power\_h | (time) | float | Measured transmit power H polarization |
| /sweep\_<n>/monitoring/radar\_measured\_transmit\_power\_v | (time) | float | Measured transmit power V polarization |
| /sweep\_<n>/monitoring/radar\_measured\_sky\_noise | (time) | float | Noise measured at the receiver when connected to the antenna with no noise source connected. |
| /sweep\_<n>/monitoring/radar\_measured\_cold\_noise | (time) | float | Noise measured at the receiver when connected to the noise source, but it is not enabled. |
| /sweep\_<n>/monitoring/radar\_measured\_hot\_noise | (time) | float | Noise measured at the receiver when it is connected to the noise source and the noise source is on. |
| /sweep\_<n>/monitoring/phase\_difference\_transmit\_hv | (time) | float | Phase difference between transmitted horizontally and vertically-polarized signals as determined from the first valid range bins |
| /sweep\_<n>/monitoring/antenna\_pointing\_accuracy\_elev | (time) | float | Antenna-pointing accuracy in elevation |
| /sweep\_<n>/monitoring/antenna\_pointing\_accuracy\_az | (time) | float | Calibration offset for the horizontal channel |
| /sweep\_<n>/monitoring/calibration\_offset\_h | (time) | float | Calibration offset for the horizontal channel |
| /sweep\_<n>/monitoring/calibration\_offset\_v | (time) | float | Calibration offset for the vertical channel |
| /sweep\_<n>/monitoring/zdr\_offset | (time) | float | ZDR offset (bias) |

**Table 301-11b: Attributes defined for those variables listed in Table 301-11a.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Attribute | Kind | Value |
| /sweep\_<n>/monitoring/radar\_measured\_transmit\_power\_h | units | string | dBm |
| /sweep\_<n>/monitoring/radar\_measured\_transmit\_power\_v | units | string | dBm |
| /sweep\_<n>/monitoring/radar\_measured\_sky\_noise | units | string | dBm |
| /sweep\_<n>/monitoring/radar\_measured\_cold\_noise | units | string | dBm |
| /sweep\_<n>/monitoring/radar\_measured\_hot\_noise | units | string | dBm |
| /sweep\_<n>/monitoring/phase\_difference\_transmit\_hv | units | string | degrees |
| /sweep\_<n>/monitoring/antenna\_pointing\_accuracy\_elev | units | string | degrees |
| /sweep\_<n>/monitoring/antenna\_pointing\_accuracy\_az | units | string | degrees |
| /sweep\_<n>/monitoring/calibration\_offset\_h | units | string | dB |
| /sweep\_<n>/monitoring/calibration\_offset\_v | units | string | dB |
| /sweep\_<n>/monitoring/zdr\_offset | units | string | dB |

**Table 301-12a: List of optional/conditional metadata variables that may be reported for the radar parameters group. Attributes are defined in Table 301\_12b.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Dimensions | Kind | Comment |
| /radar\_parameters/antenna\_gain\_h | none | float | Nominal antenna gain, H polarization |
| /radar\_parameters/antenna\_gain\_v | none | float | Nominal antenna gain, V polarization |
| /radar\_parameters/beam\_width\_h | none | float | Antenna beam width, H polarization |
| /radar\_parameters/beam\_width\_v | none | float | Antenna beam width, V polarization |
| /radar\_parameters/receiver\_bandwidth | none | float | Bandwidth of radar receiver |

**Table 301-12b: Attributes defined for those variables listed in Table 301-12a.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Attribute | Kind | Value |
| /radar\_parameters/antenna\_gain\_h | units | string | dBi |
| /radar\_parameters/antenna\_gain\_v | units | string | dBi |
| /radar\_parameters/beam\_width\_h | units | string | degrees |
| /radar\_parameters/beam\_width\_v | units | string | degrees |
| /radar\_parameters/receiver\_bandwidth | units | string | s-1 |

**Table 301-13a: List of optional/conditional metadata variables that may be reported for the lidar parameters group. Attributes are defined in Table 301-13b.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Dimensions | Kind | Comment |
| /lidar\_parameters/beam\_divergence | none | float | Transmit side |
| /lidar\_parameters/field\_of\_view | none | float | Receive side |
| /lidar\_parameters/aperture\_diameter | none | float |  |
| /lidar\_parameters/aperture\_efficency | none | float |  |
| /lidar\_parameters/peak\_power | none | float |  |
| /lidar\_parameters/pulse\_energy | none | float |  |

**Table 301-13b: Attributes defined for those variables listed in Table 301-13a.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Attribute | Kind | Value |
| /lidar\_parameters/beam\_divergence | units | string | milliradians |
| /lidar\_parameters/field\_of\_view | units | string | milliradians |
| /lidar\_parameters/aperture\_diameter | units | string | cm |
| /lidar\_parameters/aperture\_efficency | units | string | percent |
| /lidar\_parameters/peak\_power | units | string | watts |
| /lidar\_parameters/pulse\_energy | units | string | joules |

**Table 301-14a: List of optional/conditional metadata variables that may be reported for the radar calibration group. Attributes are defined in Table 301-14b.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Dimensions | Kind | Comment |
| /radar\_calibration/calib\_index | (calib) | byte | Calibration index for each ray |
| /radar\_calibration/time | (calib) | float | Time of calibration |
| /radar\_calibration/pulse\_width | (calib) | float | Pulse width for this calibration |
| /radar\_calibration/antenna\_gain\_h | (calib) | float | Derived antenna gain, H channel |
| /radar\_calibration/antenna\_gain\_v | (calib) | float | Derived antenna gain, V channel |
| /radar\_calibration/xmit\_power\_h | (calib) | float | Transmit power H channel |
| /radar\_calibration/xmit\_power\_v | (calib) | float | Transmit power V channel |
| /radar\_calibration/two\_way\_waveguide\_loss\_h | (calib) | float | 2-way waveguide loss measurement plan to feed horn, H channel |
| /radar\_calibration/two\_way\_waveguide\_loss\_v | (calib) | float | 2-way waveguide loss measurement plane to feed horn, V channel |
| /radar\_calibration/two\_way\_radome\_loss\_h | (calib) | float | 2-way radome loss, H channel |
| /radar\_calibration/two\_way\_radome\_loss\_v | (calib) | float | 2-way radome loss, V channel |
| /radar\_calibration/receiver\_mismatch\_loss | (calib) | float | Receiver filter bandwidth mismatch loss |
| /radar\_calibration/receiver\_mismatch\_loss\_h | (calib) | float | Receiver filter bandwidth mismatch loss, H channel |
| /radar\_calibration/receiver\_mismatch\_loss\_v | (calib) | float | Receiver filter bandwidth mismatch loss, V channel |
| /radar\_calibration/radar\_constant\_h | (calib) | float | Radar constant, H channel |
| /radar\_calibration/radar\_constant\_v | (calib) | float | Radar constant, V channel |
| /radar\_calibration/probert\_jones\_correction | (calib) | float | Probert Jones antenna correction factor |
| /radar\_calibration/dielectric\_factor\_used | (calib) | float | The |K2| in the radar equation |
| /radar\_calibration/noise\_hc | (calib) | float | Measured noise level, H co-pol channel |
| /radar\_calibration/noise\_vc | (calib) | float | Measured noise level, V co-pol channel |
| /radar\_calibration/noise\_hx | (calib) | float | Measured noise level, H cross-pol channel |
| /radar\_calibration/noise\_vx | (calib) | float | Measured noise level, V cross-pol channel |
| /radar\_calibration/receiver\_gain\_hc | (calib) | float | Measured receiver gain, H co-pol channel |
| /radar\_calibration/receiver\_gain\_vc | (calib) | float | Measured receiver gain, V co-pol channel |
| /radar\_calibration/receiver\_gain\_hx | (calib) | float | Measured receiver gain, H cross-pol channel |
| /radar\_calibration/receiver\_gain\_vx | (calib) | float | Measured receiver gain, V cross-pol channel |
| /radar\_calibration/base\_1km\_hc | (calib) | float | Reflectivity at 1km for SNR=0dB noise corrected, H co-pol channel |
| /radar\_calibration/base\_1km\_vc | (calib) | float | Reflectivity at 1km for SNR=0dB noise corrected, V co-pol channel |
| /radar\_calibration/base\_1km\_hx | (calib) | float | Reflectivity at 1km for SNR=0dB noise corrected, H cross-pol channel |
| /radar\_calibration/base\_1km\_vx | (calib) | float | Reflectivity at 1km for SNR=0dB noise corrected, V cross-pol channel |
| /radar\_calibration/sun\_power\_hc | (calib) | float | Calibrated sun power, H co-pol channel |
| /radar\_calibration/sun\_power\_vc | (calib) | float | Calibrated sun power, V co-pol channel |
| /radar\_calibration/sun\_power\_hx | (calib) | float | Calibrated sun power, H cross-pol channel |
| /radar\_calibration/sun\_power\_vx | (calib) | float | Calibrated sun power, V cross-pol channel |
| /radar\_calibration/noise\_source\_power\_h | (calib) | float | Noise source power, H channel |
| /radar\_calibration/noise\_source\_power\_v | (calib) | float | Noise source power, V channel |
| /radar\_calibration/power\_measure\_loss\_h | (calib) | float | Power measurement loss in coax and connectors, H channel |
| /radar\_calibration/power\_measure\_loss\_v | (calib) | float | Power measurement loss in coax and connectors, V channel |
| /radar\_calibration/coupler\_forward\_loss\_h | (calib) | float | Coupler loss into waveguide, H channel |
| /radar\_calibration/coupler\_forward\_loss\_v | (calib) | float | Coupler loss into waveguide, V channel |
| /radar\_calibration/zdr\_correction | (calib) | float | corrected = measured + correction |
| /radar\_calibration/ldr\_correction\_h | (calib) | float | corrected = measured + correction |
| /radar\_calibration/ldr\_correction\_v | (calib) | float | corrected = measured + correction |
| /radar\_calibration/system\_phidp | (calib) | float | System PhiDP, as seen in drizzle close to radar |
| /radar\_calibration/test\_power\_h | (calib) | float | Calibration test power, H channel |
| /radar\_calibration/test\_power\_v | (calib) | float | Calibration test power, V channel |
| /radar\_calibration/receiver\_slope\_hc | (calib) | float | Computed receiver slope, ideally 1.0, H co-pol channel |
| /radar\_calibration/receiver\_slope\_vc | (calib) | float | Computed receiver slope, ideally 1.0, V co-pol channel |
| /radar\_calibration/receiver\_slope\_hx | (calib) | float | Computed receiver slope, ideally 1.0, H cross-pol channel |
| /radar\_calibration/receiver\_slope\_vx | (calib) | float | Computed receiver slope, ideally 1.0, V cross-pol channel |

**Table 301-14b: Attributes defined for those variables listed in Table 301-14a.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Attribute | Kind | Value |
| /radar\_calibration/time | units | string | "seconds since <reftime>" where <reftime> is an ISO8601 time string of the form YYYY-MM-DDThh:mm:ssZ |
| /radar\_calibration/pulse\_width | units | string | seconds |
| /radar\_calibration/antenna\_gain\_h | units | string | dB |
| /radar\_calibration/antenna\_gain\_v | units | string | dB |
| /radar\_calibration/xmit\_power\_h | units | string | dBm |
| /radar\_calibration/xmit\_power\_v | units | string | dBm |
| /radar\_calibration/two\_way\_waveguide\_loss\_h | units | string | dB |
| /radar\_calibration/two\_way\_waveguide\_loss\_v | units | string | dB |
| /radar\_calibration/two\_way\_radome\_loss\_h | units | string | dB |
| /radar\_calibration/two\_way\_radome\_loss\_v | units | string | dB |
| /radar\_calibration/receiver\_mismatch\_loss | units | string | dB |
| /radar\_calibration/receiver\_mismatch\_loss\_h | units | string | dB |
| /radar\_calibration/receiver\_mismatch\_loss\_v | units | string | dB |
| /radar\_calibration/radar\_constant\_h | units | string | m/mW dB units |
| /radar\_calibration/radar\_constant\_v | units | string | m/mW dB units |
| /radar\_calibration/probert\_jones\_correction | units | string | dB |
| /radar\_calibration/noise\_hc | units | string | dBm |
| /radar\_calibration/noise\_vc | units | string | dBm |
| /radar\_calibration/noise\_hx | units | string | dBm |
| /radar\_calibration/noise\_vx | units | string | dBm |
| /radar\_calibration/receiver\_gain\_hc | units | string | dB |
| /radar\_calibration/receiver\_gain\_vc | units | string | dB |
| /radar\_calibration/receiver\_gain\_hx | units | string | dB |
| /radar\_calibration/receiver\_gain\_vx | units | string | dB |
| /radar\_calibration/base\_1km\_hc | units | string | dBZ |
| /radar\_calibration/base\_1km\_vc | units | string | dBZ |
| /radar\_calibration/base\_1km\_hx | units | string | dBZ |
| /radar\_calibration/base\_1km\_vx | units | string | dBZ |
| /radar\_calibration/sun\_power\_hc | units | string | dBm |
| /radar\_calibration/sun\_power\_vc | units | string | dBm |
| /radar\_calibration/sun\_power\_hx | units | string | dBm |
| /radar\_calibration/sun\_power\_vx | units | string | dBm |
| /radar\_calibration/noise\_source\_power\_h | units | string | dBm |
| /radar\_calibration/noise\_source\_power\_v | units | string | dBm |
| /radar\_calibration/power\_measure\_loss\_h | units | string | dB |
| /radar\_calibration/power\_measure\_loss\_v | units | string | dB |
| /radar\_calibration/coupler\_forward\_loss\_h | units | string | dB |
| /radar\_calibration/coupler\_forward\_loss\_v | units | string | dB |
| /radar\_calibration/zdr\_correction | units | string | dB |
| /radar\_calibration/ldr\_correction\_h | units | string | dB |
| /radar\_calibration/ldr\_correction\_v | units | string | dB |
| /radar\_calibration/system\_phidp | units | string | degrees |
| /radar\_calibration/test\_power\_h | units | string | dBm |
| /radar\_calibration/test\_power\_v | units | string | dBm |

**Table 301-15: Allowed values for enumerated string variables.**

|  |  |
| --- | --- |
| variable path/name | valid values |
| /platform\_type | fixed |
|  | vehicle |
|  | ship |
|  | aircraft |
|  | aircraft\_fore |
|  | aircraft\_aft |
|  | aircraft\_tail |
|  | aircraft\_belly |
|  | aircraft\_roof |
|  | aircraft\_nose |
|  | satellite\_orbit |
|  | satellite\_geostat |
| /instrument\_type | radar |
|  | lidar |
| /primary\_axis | axis\_z |
|  | axis\_y |
|  | axis\_x |
|  | axis\_z\_prime |
|  | axis\_y\_prime |
|  | axis\_x\_prime |
| /sweep\_<n>/sweep\_mode | sector |
|  | coplane |
|  | rhi |
|  | vertical\_pointing |
|  | idle |
|  | azimuth\_surveillance |
|  | elevation\_surveillance |
|  | sunscan |
|  | pointing |
|  | manual\_ppi |
|  | manual\_rhi |
|  | doppler\_beam\_swinging |
|  | complex\_trajectory |
|  | electronic\_steering |
| /sweep\_<n>/follow\_mode | none |
|  | sun |
|  | vehicle |
|  | aircraft |
|  | target |
|  | manual |
| /sweep\_<n>/prt\_mode | fixed |
|  | staggered |
|  | dual |
|  | hybrid |
| /sweep\_<n>/polarization\_mode | horizontal |
|  | vertical |
|  | hv\_alt |
|  | hv\_sim |
|  | circular |

**FM 302-2022 WMO-CF MARINE TRAJECTORY**

**Regulations**

1. **Scope**
   1. This profile is intended for the reporting of meteorological and/or oceanographic observations along one or more trajectories, including both at or near the ocean surface and at depth, from a single platform. The trajectory may follow an undulating profile.
   2. A ragged array representation is used to allow multiple trajectories to be reported (e.g. see CF v1.8 conventions). This may be either a contiguous or indexed ragged array.
   3. Only data for a single platform shall be included in the file.
   4. Groups are not supported in this profile and groups other than the root group shall not be used.
2. **Global scope/root group**
   1. *Global attributes*
      1. The regulations defined in General Regulation WMO-CF.6 for global attributes shall apply.
      2. Table 302-1 lists the values to be used for the indicate attributes.
   2. *Station/platform identifier*
      1. The rules for station identifiers (WMO-CF.4.5, WMO-CF.4.6, WMO-CF.6.10.6 and WMO-CF.6.10.7) shall be observed,
   3. *Dimensions*
      1. Files containing marine profile trajectory data shall have the following dimensions:
         1. *obs*, the *obs* dimension shall be used to indicate the total number of observations within the file.
         2. *trajectory*, the *trajectory* dimension shall be used to indicate the number of trajectories contained in the file and to index the observations to a trajectory. When there is a single trajectory in the file this shall have dimension 1.
   4. *Coordinate Variables*
      1. Table 302-2 lists the coordinate variables that shall be used with this profile.
      2. For platforms located at the sea surface the depth shall be given as zero.
      3. The observation locations relative to the sea surface shall then be given by the sensor installation height (*/<measurand\_short\_name>\_<n>\_sensor\_installed\_height*) variable. See Regulation 302.2.7.4.
   5. *Trajectory identification*
      1. Table302-3 lists the variables that shall be used to identify the trajectory that an observation belongs to.
      2. *trajectory* provides the identifier for a trajectory.
      3. *trajectory\_index* provides the trajectory that an observation belongs to.
   6. *Data variables*
      1. The general regulations for data variables, including mandatory attributes, defined in General Regulation WMO-CF.5 shall apply.
      2. Only data variables with a valid *standard\_name* shall be included.
      3. Data variables shall have a single dimension *obs*.
      4. The NetCDF variable name shall be interpreted as the short name for the variable.
      5. Multiple variables sharing the same short name shall follow the following naming convention: *<measurand\_short\_name>\_<n>*, where *<n>* is incremented for each additional variable sharing the same short name. For example, *salinity\_1* and *salinity\_2* in the case of two salinity sensors on an observing platform.
      6. The *trajectory\_index* variable shall be used to indicate which trajectory an observation belongs to.
   7. *Ancillary variables*
      1. The naming of the ancillary variables shall take the form *<measurand\_short\_name>\_<n>\_<ancillary\_variable>*
      2. Table302-4 lists the mandatory ancillary variables that shall be reported for each observed/measured variable
      3. Table302-5 lists the conditional or optional ancillary variables defined for the observed/measured variables.
      4. The installed height of a sensor shall be included when the sensor is not at the same depth (or height) specified by the depth variable. In this case the sensor depth (or height) relative to the sea surface shall be given by the installed height added to the depth.

**FM 302-2022 Tables**

**Table 302-1: Values that shall be used for the indicated global attributes.**

|  |  |  |
| --- | --- | --- |
| Attribute name | Type | Value |
| Conventions | string | "CF-1.8, WMO CF-1.0" |
| wmo\_\_cf\_profile | string | "FM 302-2022" |
| featureType | string | "trajectory" |

**Table 302-2a: Coordinate variables that shall be used in the marine trajectory profile. Attributes are given in Table 302-2b.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Dimensions | Type | Comments |
| /lat | (obs) | float or double | Latitude of the observations |
| /lon | (obs) | float or double | Longitude of the observations |
| /depth | (obs) | float or double | Vertical position of the observing station or platform relative to sea level, for example glider depth. |
| /time | (obs) | float or double | Date and time of the observation |

**Table 302-2b: Attributes defined for the coordinate variables given in Table 302-2a.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Attribute | Type | Value |
| /lat | standard\_name | string | latitude |
|  | units | string | degrees\_north |
|  | axis | string | Y |
| /lon | standard\_name | string | longitude |
|  | units | string | degrees\_east |
|  | axis | string | X |
| /depth | standard\_name | string | depth |
|  | units | string | meters |
|  | axis | string | Z |
|  | positive | string | down |
|  | long\_name | string | depth\_below\_sea\_level |
| /time | standard\_name | string | time |
|  | units | string | "seconds since <reftime>" where <reftime> is an ISO8601 time string of the form YYYY-MM-DDThh:mm:ssZ |
|  | axis | string | T |
|  | calendar | string | standard |

**Table 302-3a: Variables defined to identify the trajectory an observation belongs to and that shall be included in marine trajectory files. Attributes are listed in Table 302-3b.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Dimensions | Type | Comments |
| /trajectory | (trajectory) | string | Identifier for trajectory |
| /trajectory\_index | (obs) | int | Index of the trajectory an observation belongs to. |

**Table 302-3b: Attributes defined for the trajectory variables listed in Table 302-3a.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Attribute | Type | Value |
| /trajectory | cf\_role | string | trajectory\_id |
| /trajectory\_index | long\_name | string | Index of the trajectory that this observation belongs to |
|  | instance\_dimension | string | trajectory |

**Table 302-4a: Ancillary variables defined and that shall be reported for each measured/observed variable. Attributes are given in Table 302-4b. <prefix> has been used to represent <measurand\_short\_name>\_<n>.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Dimensions | Type | Comments |
| /<prefix>\_sensor | (trajectory) | string | Name of sensor |
| /<prefix>\_sensor\_make | (trajectory) | string | Manufacturer of sensor |
| /<prefix>\_sensor\_model | (trajectory) | string | Model of sensor |
| /<prefix>\_sensor\_serial\_number | (trajectory) | string | Sensor serial number |
| /<prefix>\_sensor\_calibration\_date | (trajectory) | float | Last calibration data of sensor |

**Table 302-4b: Attributes for the ancillary variables defined in Table 302-4a .<prefix> has been used to represent <measurand\_short\_name>\_<n>.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Attribute | Type | Value |
| /<prefix>\_sensor\_calibration\_date | standard\_name | string | time |
|  | units | string | "seconds since <reftime>" where <reftime> is an ISO8601 time string of the form YYYY-MM-DDThh:mm:ssZ |
|  | axis | string | T |
|  | calendar | string | standard |

**Table 302-5a: Conditional/optional ancillary variables defined and that should be reported for each measured/observed variable when the described conditions are met. Attributes are given in Table 302-5b. <prefix> has been used to represent <measurand\_short\_name>\_<n>.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Dimensions | Type | Comments |
| /<prefix>\_sensor\_installed\_height | (trajectory) | float | Value to be added to sensor\_depth to get vertical position of sensor relative to sea surface. |
| </prefix>\_sensor\_measurement\_method | (trajectory) | string | The method used by the sensor to measure the parameter, e.g. capacitive humidity sensor. |

**Table 302-5b: Attributes for the ancillary variables defined in Table 302-5a. <prefix> has been used to represent <measurand\_short\_name>\_<n>.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable path/name | Attribute | Type | Value |
| /<prefix>\_sensor\_installed\_height | units | string | meters |
| </prefix>\_sensor\_measurement\_method | wmo\_\_parameter\_name | string |  |
|  | wmo\_\_parameter\_uri | string |  |

## Annex 2 to draft Resolution X/X (EC-76)

**GLOBAL BASIC OBSERVING NETWORK REPORTING PRACTISES**

**Add a new PART D in the Manual on Codes Vol. I.2 (WMO-No. 306) “Regulations for reporting GBON Parameters” as follows.**

**PART D**

**Regulations for reporting GBON parameters**

**GBON 1 REPORTING GBON OBSERVATIONS FROM SURFACE LAND FIXED STATIONS**

**GBON 1.1 BUFR sequences for surface land fixed stations**

The following BUFR sequences should be used for reporting GBON variables from surface land fixed stations. BUFR sequences different from the ones listed below may be used if the reporting practices for GBON variables in GBON 1.2 can be applied.

**GBON 1.1.1 BUFR Sequence for representation of SYNOP with supplementary information on one-hour observations <3 07 096>**

|  | | | |
| --- | --- | --- | --- |
| **Row**  **#** | **TABLE**  **REFERENCE** | **TABLE**  **REFERENCES** | **ELEMENT NAME** |
| **F X Y** |
| 1 | 3 07 096 | (Sequence for representation of SYNOP with supplementary information on one-hour observations) | |
| 2 |  | 3 01 090 | Surface station identification; time, horizontal and vertical coordinates |
| 3 |  | 3 01 089 | National station identification |
| 4 |  | 0 08 010 | Surface qualifier (temperature data) |
| 5 |  | 3 01 091 | Surface station instrumentation |
| 6 |  | 3 02 084 | “Instantaneous” data of sequence 3 07 096 |
| 7 |  | 3 02 085 | “Period” data of sequence 3 07 096 |
| 8 |  | 0 33 005 | Quality information (AWS data) |
| 9 |  | 0 33 006 | Internal measurement status information (AWS) |

GBON BUFR template 3 07 096 further expands as follows.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **#** | **FXY Expansion** | | | | **Element name** | **Description** | **Unit, Scale** | **GBON Regulation** |
| 1 | 3 01 090 | Surface station identification; time, horizontal and vertical co-ordinates | | | | |  |  |
| 2 | 3 01 090 | 3 01 004 | Surface station identification | | |  |  |  |
| 3 | 3 01 090 | 3 01 004 | 0 01 001 |  | WMO block number |  | Numeric, 0 | GBON 1.2.1.3 |
| 4 | 3 01 090 | 3 01 004 | 0 01 002 |  | WMO station number |  | Numeric, 0 | GBON 1.2.1.3 |
| 5 | 3 01 090 | 3 01 004 | 0 01 015 |  | Station or site name |  | CCITT IA5, 0 |  |
| 6 | 3 01 090 | 3 01 004 | 0 02 001 |  | Type of station |  | Code table, 0 | GBON 1.2.1.4 |
| 7 | 3 01 090 | 3 01 011 | Year, month, day | |  |  |  | GBON 1.2.1.5 |
| 8 | 3 01 090 | 3 01 011 | 0 04 001 |  | Year |  | a, 0 |  |
| 9 | 3 01 090 | 3 01 011 | 0 04 002 |  | Month |  | mon, 0 |  |
| 10 | 3 01 090 | 3 01 011 | 0 04 003 |  | Day |  | d, 0 |  |
| 11 | 3 01 090 | 3 01 012 | Hour, minute | |  |  |  | GBON 1.2.1.5 |
| 12 | 3 01 090 | 3 01 012 | 0 04 004 |  | Hour |  | h, 0 |  |
| 13 | 3 01 090 | 3 01 012 | 0 04 005 |  | Minute |  | min, 0 |  |
| 14 | 3 01 090 | 3 01 021 | Latitude/longitude (high accuracy) | | |  |  |  |
| 15 | 3 01 090 | 3 01 021 | 0 05 001 |  | Latitude (high accuracy) |  | deg, 5 | GBON 1.2.1.6 |
| 16 | 3 01 090 | 3 01 021 | 0 06 001 |  | Longitude (high accuracy) |  | deg, 5 | GBON 1.2.1.6 |
| 17 | 3 01 090 | 0 07 030 |  |  | Height of station ground above mean sea level |  | m, 1 | GBON 1.2.1.7 |
| 18 | 3 01 090 | 0 07 031 |  |  | Height of barometer above mean sea level |  | m, 1 | GBON 1.2.1.7 |
| 19 | 3 01 089 | National station identification | | |  |  |  |  |
| 20 | 3 01 089 | 0 01 101 |  |  | State identifier |  | Code table, 0 |  |
| 21 | 3 01 089 | 0 01 102 |  |  | National station number |  | Numeric, 0 |  |
| 22 | 0 08 010 |  |  |  | Surface qualifier (for temperature data) |  | Code table, 0 |  |
| 23 | 3 01 091 | Surface station instrumentation | | | |  |  |  |
| 24 | 3 01 091 | 0 02 180 |  |  | Main present weather detecting system |  | Code table, 0 |  |
| 25 | 3 01 091 | 0 02 181 |  |  | Supplementary present weather sensor |  | Flag table, 0 |  |
| 26 | 3 01 091 | 0 02 182 |  |  | Visibility measurement system |  | Code table, 0 |  |
| 27 | 3 01 091 | 0 02 183 |  |  | Cloud detection system |  | Code table, 0 |  |
| 28 | 3 01 091 | 0 02 184 |  |  | Type of lightning detection sensor |  | Code table, 0 |  |
| 29 | 3 01 091 | 0 02 179 |  |  | Type of sky condition algorithm |  | Code table, 0 |  |
| 30 | 3 01 091 | 0 02 186 |  |  | Capability to detect precipitation phenomena |  | Flag table, 0 |  |
| 31 | 3 01 091 | 0 02 187 |  |  | Capability to detect other weather phenomena |  | Flag table, 0 |  |
| 32 | 3 01 091 | 0 02 188 |  |  | Capability to detect obscuration |  | Flag table, 0 |  |
| 33 | 3 01 091 | 0 02 189 |  |  | Capability to discriminate lightning strikes |  | Flag table, 0 |  |
| 34 | 3 02 084 | “Instantaneous” data of sequence 307096 | | | |  |  |  |
| 35 | 3 02 084 | 3 02 031 | Pressure information | |  |  |  |  |
| 36 | 3 02 084 | 3 02 031 | 3 02 001 | Pressure and 3-hour pressure change | |  |  |  |
| 37 | 3 02 084 | 3 02 031 | 3 02 001 | 0 10 004 | Pressure | Station level | Pa, –1 | GBON 1.2.2.1, GBON 1.2.2.2 |
| 38 | 3 02 084 | 3 02 031 | 3 02 001 | 0 10 051 | Pressure reduced to mean sea level |  | Pa, –1 | GBON 1.2.2.2 |
| 39 | 3 02 084 | 3 02 031 | 3 02 001 | 0 10 061 | 3-hour pressure change |  | Pa, –1 |  |
| 40 | 3 02 084 | 3 02 031 | 3 02 001 | 0 10 063 | Characteristic of pressure tendency |  | Code table, 0 |  |
| 41 | 3 02 084 | 3 02 031 | 0 10 062 |  | 24-hour pressure change |  | Pa, –1 |  |
| 42 | 3 02 084 | 3 02 031 | 0 07 004 |  | Pressure | Standard level | Pa, –1 |  |
| 43 | 3 02 084 | 3 02 031 | 0 10 009 |  | Geopotential height |  | gpm, 0 | GBON 1.2.2.2 |
| 44 | 3 02 084 | 3 02 072 | Temperature and humidity data | | |  |  |  |
| 45 | 3 02 084 | 3 02 072 | 0 07 032 |  | Height of sensor above local ground (or deck of marine platform) |  | m, 2 | GBON 1.2.2.3 |
| 46 | 3 02 084 | 3 02 072 | 0 07 033 |  | Height of sensor above water surface |  | m, 1 |  |
| 47 | 3 02 084 | 3 02 072 | 0 12 101 |  | Temperature/air temperature | Scale: 2 | K, 2 | GBON 1.2.2.4 |
| 48 | 3 02 084 | 3 02 072 | 0 12 103 |  | Dewpoint temperature | Scale: 2 | K, 2 | GBON 1.2.2.5, GBON 1.2.2.7 |
| 49 | 3 02 084 | 3 02 072 | 0 13 003 |  | Relative humidity |  | %, 0 | GBON 1.2.2.6, GBON 1.2.2.7 |
| 50 | 3 02 084 | 1 03 000 |  |  | Delayed replication of 3 descriptors |  |  |  |
| 51 | 3 02 084 | 0 31 000 |  |  | Short delayed descriptor replication factor |  | Numeric, 0 |  |
| 52 | 3 02 084 | 1 01 005 |  |  | Replicate one descriptor five times |  |  |  |
| 53 | 3 02 084 | 3 07 063 | Depth below land surface and soil temperature | | |  |  |  |
| 54 | 3 02 084 | 3 07 063 | 0 07 061 |  | Depth below land surface |  | m, 2 |  |
| 55 | 3 02 084 | 3 07 063 | 0 12 130 |  | Soil temperature | Scale: 2 | K, 2 |  |
| 56 | 3 02 084 | 0 07 061 |  |  | Depth below land surface | Set to missing (cancel) |  |  |
| 57 | 3 02 084 |  |  |  | *Visibility data* |  |  |  |
| 58 | 3 02 084 | 1 01 000 |  |  | Delayed replication of 1 descriptor |  |  |  |
| 59 | 3 02 084 | 0 31 000 |  |  | Short delayed descriptor replication factor |  | Numeric, 0 |  |
| 60 | 3 02 084 | 3 02 069 | Visibility data | |  |  |  |  |
| 61 | 3 02 084 | 3 02 069 | 0 07 032 |  | Height of sensor above local ground (or deck of marine platform) |  | m, 2 |  |
| 62 | 3 02 084 | 3 02 069 | 0 07 033 |  | Height of sensor above water surface |  | m, 1 |  |
| 63 | 3 02 084 | 3 02 069 | 0 33 041 |  | Attribute of following value |  | Code table, 0 |  |
| 64 | 3 02 084 | 3 02 069 | 0 20 001 |  | Horizontal visibility |  | m, –1 |  |
| 65 | 3 02 084 | 0 07 032 |  |  | Height of sensor above local ground (or deck of marine platform) | Set to missing (cancel) |  |  |
| 66 | 3 02 084 | 0 07 033 |  |  | Height of sensor above water surface | Set to missing (cancel) |  |  |
| 67 | 3 02 084 |  |  |  | *Marine data* |  |  |  |
| 68 | 3 02 084 | 1 05 000 |  |  | Delayed replication of 5 descriptors |  |  |  |
| 69 | 3 02 084 | 0 31 000 |  |  | Short delayed descriptor replication factor |  | Numeric, 0 |  |
| 70 | 3 02 084 | 0 20 031 |  |  | Ice deposit (thickness) |  | m, 2 |  |
| 71 | 3 02 084 | 0 20 032 |  |  | Rate of ice accretion (estimated) |  | Code table, 0 |  |
| 72 | 3 02 084 | 0 02 038 |  |  | Method of water temperature and/or salinity measurement |  | Code table, 0 |  |
| 73 | 3 02 084 | 0 22 043 |  |  | Sea/water temperature | Scale: 2 | K, 2 |  |
| 74 | 3 02 084 | 3 02 021 | Waves |  |  |  |  |  |
| 75 | 3 02 084 | 3 02 021 | 0 22 001 |  | Direction of waves |  | degree true, 0 |  |
| 76 | 3 02 084 | 3 02 021 | 0 22 011 |  | Period of waves |  | s, 0 |  |
| 77 | 3 02 084 | 3 02 021 | 0 22 021 |  | Height of waves |  | m, 1 |  |
| 78 | 3 02 084 |  |  |  | *State of ground and snow depth measurement* |  |  |  |
| 79 | 3 02 084 | 1 01 000 |  |  | Delayed replication of 1 descriptor |  |  |  |
| 80 | 3 02 084 | 0 31 000 |  |  | Short delayed descriptor replication factor |  | Numeric, 0 |  |
| 81 | 3 02 084 | 3 02 078 | State of ground and snow depth measurement | | |  |  |  |
| 82 | 3 02 084 | 3 02 078 | 0 02 176 |  | Method of state of ground measurement |  | Code table, 0 | GBON 1.2.2.8 |
| 83 | 3 02 084 | 3 02 078 | 0 20 062 |  | State of ground (with or without snow) |  | Code table, 0 | GBON 1.2.2.8 |
| 84 | 3 02 084 | 3 02 078 | 0 02 177 |  | Method of snow depth measurement |  | Code table, 0 | GBON 1.2.2.9 |
| 85 | 3 02 084 | 3 02 078 | 0 13 013 |  | Total snow depth |  | m, 2 | GBON 1.2.2.9 |
| 86 | 3 02 084 | 0 12 113 |  |  | Ground minimum temperature, past 12 hours | Scale: 2 | K, 2 |  |
| 87 | 3 02 084 |  |  |  | *Cloud data* |  |  |  |
| 88 | 3 02 084 | 1 01 000 |  |  | Delayed replication of 1 descriptor |  |  |  |
| 89 | 3 02 084 | 0 31 000 |  |  | Short delayed descriptor replication factor |  | Numeric, 0 |  |
| 90 | 3 02 084 | 3 02 004 | General cloud information | | |  |  |  |
| 91 | 3 02 084 | 3 02 004 | 0 20 010 |  | Cloud cover (total) |  | %, 0 |  |
| 92 | 3 02 084 | 3 02 004 | 0 08 002 |  | Vertical significance (surface observations) |  | Code table, 0 |  |
| 93 | 3 02 084 | 3 02 004 | 0 20 011 |  | Cloud amount |  | Code table, 0 |  |
| 94 | 3 02 084 | 3 02 004 | 0 20 013 |  | Height of base of cloud |  | m, –1 |  |
| 95 | 3 02 084 | 3 02 004 | 0 20 012 |  | Cloud type |  | Code table, 0 |  |
| 96 | 3 02 084 | 3 02 004 | 0 20 012 |  | Cloud type |  | Code table, 0 |  |
| 97 | 3 02 084 | 3 02 004 | 0 20 012 |  | Cloud type |  | Code table, 0 |  |
| 98 | 3 02 084 | 1 05 000 |  |  | Delayed replication of 5 descriptors |  |  |  |
| 99 | 3 02 084 | 0 31 001 |  |  | Delayed descriptor replication factor |  | Numeric, 0 |  |
| 100 | 3 02 084 | 0 08 002 |  |  | Vertical significance (surface observations) |  | Code table, 0 |  |
| 101 | 3 02 084 | 0 20 011 |  |  | Cloud amount |  | Code table, 0 |  |
| 102 | 3 02 084 | 0 20 012 |  |  | Cloud type |  | Code table, 0 |  |
| 103 | 3 02 084 | 0 33 041 |  |  | Attribute of following value |  | Code table, 0 |  |
| 104 | 3 02 084 | 0 20 013 |  |  | Height of base of cloud |  | m, -1 |  |
| 105 | 3 02 084 | 3 02 036 | Clouds with bases below station level | | |  |  |  |
| 106 | 3 02 084 | 3 02 036 | 1 05 000 |  | Delayed replication of 5 descriptors |  |  |  |
| 107 | 3 02 084 | 3 02 036 | 0 31 001 |  | Delayed descriptor replication factor |  | Numeric, 0 |  |
| 108 | 3 02 084 | 3 02 036 | 0 08 002 |  | Vertical significance (surface observations) |  | Code table, 0 |  |
| 109 | 3 02 084 | 3 02 036 | 0 20 011 |  | Cloud amount |  | Code table, 0 |  |
| 110 | 3 02 084 | 3 02 036 | 0 20 012 |  | Cloud type |  | Code table, 0 |  |
| 111 | 3 02 084 | 3 02 036 | 0 20 014 |  | Height of top of cloud |  | m, -1 |  |
| 112 | 3 02 084 | 3 02 036 | 0 20 017 |  | Cloud top description |  | Code table, 0 |  |
| 113 | 3 02 084 |  |  |  | *Direction of cloud drift 6DLDMDH* |  |  |  |
| 114 | 3 02 084 | 1 01 000 |  |  | Delayed replication of 1 descriptor |  |  |  |
| 115 | 3 02 084 | 0 31 000 |  |  | Short delayed descriptor replication factor |  | Numeric, 0 |  |
| 116 | 3 02 084 | 3 02 047 | Direction of cloud drift | |  |  |  |  |
| 117 | 3 02 084 | 3 02 047 | 1 02 003 |  | Replicate 2 descriptors 3 times |  |  |  |
| 118 | 3 02 084 | 3 02 047 | 0 08 002 |  | Vertical significance (surface observations) |  | Code table, 0 |  |
| 119 | 3 02 084 | 3 02 047 | 0 20 054 |  | True direction from which a phenomenon or clouds are moving or in which they are observed |  | degree true, 0 |  |
| 120 | 3 02 084 | 0 08 002 |  |  | Vertical significance (surface observations) |  | Code table, 0 |  |
| 121 | 3 02 084 | 1 01 000 |  |  | Delayed replication of 1 descriptor |  |  |  |
| 122 | 3 02 084 | 0 31 000 |  |  | Short delayed descriptor replication factor |  | Numeric, 0 |  |
| 123 | 3 02 084 | 3 02 048 | Direction and elevation of cloud | | |  |  |  |
| 124 | 3 02 084 | 3 02 048 | 0 05 021 |  | Bearing or azimuth |  | Degree true, 2 |  |
| 125 | 3 02 084 | 3 02 048 | 0 07 021 |  | Elevation | Elevation angle | Degree, 2 |  |
| 126 | 3 02 084 | 3 02 048 | 0 20 012 |  | Cloud type |  | Code table, 0 |  |
| 127 | 3 02 084 | 3 02 048 | 0 05 021 |  | Bearing or azimuth | Set to missing (cancel) |  |  |
| 128 | 3 02 084 | 3 02 048 | 0 07 021 |  | Elevation | Set to missing (cancel) |  |  |
| 129 | 3 02 085 | “Period” data of sequence 3 07 096 | | | |  |  |  |
| 130 | 3 02 085 | 1 05 000 |  |  | Delayed replication of 5 descriptors |  |  |  |
| 131 | 3 02 085 | 0 31 000 |  |  | Short delayed descriptor replication factor |  | Numeric, 0 |  |
| 132 | 3 02 085 | 0 20 003 |  |  | Present weather |  | Code table, 0 |  |
| 133 | 3 02 085 | 1 03 002 |  |  | Replicate 3 descriptors 2 times |  |  |  |
| 134 | 3 02 085 | 0 04 024 |  |  | Time period or displacement | = –1 hour in the first replication, = –x hours in the second replication, x corresponding to the time period of W1W2 in the SYNOP report | h, 0 |  |
| 135 | 3 02 085 | 0 20 004 |  |  | Past weather (1) |  | Code table, 0 |  |
| 136 | 3 02 085 | 0 20 005 |  |  | Past weather (2) |  | Code table, 0 |  |
| 137 | 3 02 085 |  |  |  | *Intensity of precipitation, size of precipitation element* |  |  |  |
| 138 | 3 02 085 | 1 01 000 |  |  | Delayed replication of 1 descriptor |  |  |  |
| 139 | 3 02 085 | 0 31 000 |  |  | Short delayed descriptor replication factor |  | Numeric, 0 |  |
| 140 | 3 02 085 | 3 02 175 | Intensity of precipitation, size of precipitation element | | |  |  |  |
| 141 | 3 02 085 | 3 02 175 | 0 08 021 |  | Time significance |  | Code table, 0 |  |
| 142 | 3 02 085 | 3 02 175 | 0 04 025 |  | Time period or displacement |  | min, 0 |  |
| 143 | 3 02 085 | 3 02 175 | 0 13 155 |  | Intensity of precipitation (high accuracy) |  | kg m-2s-1, 5 | GBON 1.2.2.8 |
| 144 | 3 02 085 | 3 02 175 | 0 13 058 |  | Size of precipitating element |  | m, 4 |  |
| 145 | 3 02 085 | 3 02 175 | 0 08 021 |  | Time significance |  | Code table, 0 |  |
| 146 | 3 02 085 |  |  |  | *Precipitation, obscuration and other phenomena* |  |  |  |
| 147 | 3 02 085 | 1 02 000 |  |  | Delayed replication of 2 descriptors |  |  |  |
| 148 | 3 02 085 | 0 31 000 |  |  | Short delayed descriptor replication factor |  | Numeric, 0 |  |
| 149 | 3 02 085 | 0 04 025 |  |  | Time period or displacement | = - 10 minutes | min, 0 |  |
| 150 | 3 02 085 | 3 02 076 | Precipitation, obscuration and other phenomena | | |  |  |  |
| 151 | 3 02 085 | 3 02 076 | 0 20 021 |  | Type of precipitation |  | Flag table, 0 |  |
| 152 | 3 02 085 | 3 02 076 | 0 20 022 |  | Character of precipitation |  | Code table, 0 |  |
| 153 | 3 02 085 | 3 02 076 | 0 26 020 |  | Duration of precipitation | (see Note 1) | min, 0 |  |
| 154 | 3 02 085 | 3 02 076 | 0 20 023 |  | Other weather phenomena |  | Flag table, 0 |  |
| 155 | 3 02 085 | 3 02 076 | 0 20 024 |  | Intensity of phenomena |  | Code table, 0 |  |
| 156 | 3 02 085 | 3 02 076 | 0 20 025 |  | Obscuration |  | Flag table, 0 |  |
| 157 | 3 02 085 | 3 02 076 | 0 20 026 |  | Character of obscuration |  | Code table, 0 |  |
| 158 | 3 02 085 |  |  |  | *Lightning data* |  |  |  |
| 159 | 3 02 085 | 1 02 000 |  |  | Delayed replication of 2 descriptors |  |  |  |
| 160 | 3 02 085 | 0 31 000 |  |  | Short delayed descriptor replication factor |  | Numeric, 0 |  |
| 161 | 3 02 085 | 0 04 025 |  |  | Time period or displacement | = -10 minutes | min, 0 |  |
| 162 | 3 02 085 | 0 13 059 |  |  | Number of flashes (thunderstorm) |  | Numeric, 0 |  |
| 163 | 3 02 085 |  |  |  | *Wind data* |  |  |  |
| 164 | 3 02 085 | 0 07 032 |  |  | Height of sensor above local ground (or deck of marine platform) |  | m, 2 | GBON 1.2.2.16 |
| 165 | 3 02 085 | 0 07 033 |  |  | Height of sensor above water surface |  | m, 1 |  |
| 166 | 3 02 085 | 0 08 021 |  |  | Time significance | = 2 Time averaged | Code table, 0 | GBON 1.2.2.18 |
| 167 | 3 02 085 | 0 04 025 |  |  | Time period or displacement | = -10 minutes, or number of minutes after a significant change of wind | min, 0 | GBON 1.2.2.17 |
| 168 | 3 02 085 | 0 11 001 |  |  | Wind direction |  | degree true, 0 | GBON 1.2.2.15 |
| 169 | 3 02 085 | 0 11 002 |  |  | Wind speed |  | m/s, 1 | GBON 1.2.2.15 |
| 170 | 3 02 085 | 0 08 021 |  |  | Time significance | Set to missing |  |  |
| 171 | 3 02 085 | 1 03 003 |  |  | Replicate 3 descriptors 3 times |  |  |  |
| 172 | 3 02 085 | 0 04 025 |  |  | Time period or displacement | = -10 minutes in the first replication, = -60 minutes in the second replication, = -60x3 or 60x6 minutes in the third replication | min, 0 | GBON 1.2.2.20 |
| 173 | 3 02 085 | 0 11 043 |  |  | Maximum wind gust direction |  | degree true, 0 | GBON 1.2.2.19 |
| 174 | 3 02 085 | 0 11 041 |  |  | Maximum wind gust speed |  | m/s, 1 | GBON 1.2.2.19 |
| 175 | 3 02 085 | 0 04 025 |  |  | Time period or displacement | = -10 minutes | min, 0 |  |
| 176 | 3 02 085 | 0 11 016 |  |  | Extreme counterclockwise wind direction of a variable wind |  | degree true, 0 |  |
| 177 | 3 02 085 | 0 11 017 |  |  | Extreme clockwise wind direction of a variable wind |  | degree true, 0 |  |
| 178 | 3 02 085 |  |  |  | *Extreme temperature data* |  |  |  |
| 179 | 3 02 085 | 3 02 077 | Extreme temperature data | | |  |  |  |
| 180 | 3 02 085 | 3 02 077 | 0 07 032 |  | Height of sensor above local ground (or deck of marine platform) |  | m, 2 |  |
| 181 | 3 02 085 | 3 02 077 | 0 07 033 |  | Height of sensor above water surface |  | m, 1 |  |
| 182 | 3 02 085 | 3 02 077 | 0 04 025 |  | Time period or displacement |  | min, 0 |  |
| 183 | 3 02 085 | 3 02 077 | 0 12 111 |  | Maximum temperature, at height and over period specified | Scale: 2 | K, 2 |  |
| 184 | 3 02 085 | 3 02 077 | 0 12 112 |  | Minimum temperature, at height and over period specified | Scale: 2 | K, 2 |  |
| 185 | 3 02 085 | 3 02 077 | 0 07 032 |  | Height of sensor above local ground (or deck of marine platform) | Ground temperature | m, 2 |  |
| 186 | 3 02 085 | 3 02 077 | 0 04 025 |  | Time period or displacement |  | min, 0 |  |
| 187 | 3 02 085 | 3 02 077 | 0 12 112 |  | Minimum temperature at height and over period specified | Scale: 2; Ground temperature | K, 2 |  |
| 188 | 3 02 085 | 0 07 033 |  |  | Height of sensor above water surface | Set to missing (cancel) |  |  |
| 189 | 3 02 085 | 3 02 041 | Extreme temperature data | | |  |  |  |
| 190 | 3 02 085 | 3 02 041 | 0 07 032 |  | Height of sensor above local ground (or deck of marine platform) | Temperature measurement | m, 2 |  |
| 191 | 3 02 085 | 3 02 041 | 0 04 024 |  | Time period or displacement |  | h, 0 |  |
| 192 | 3 02 085 | 3 02 041 | 0 04 024 |  | Time period or displacement | (see Notes 2 and 3) | h, 0 |  |
| 193 | 3 02 085 | 3 02 041 | 0 12 111 |  | Maximum temperature, at height and over period specified | Scale:2 | K, 2 |  |
| 194 | 3 02 085 | 3 02 041 | 0 04 024 |  | Time period or displacement |  | h, 0 |  |
| 195 | 3 02 085 | 3 02 041 | 0 04 024 |  | Time period or displacement | (see Note 2> | h, 0 |  |
| 196 | 3 02 085 | 3 02 041 | 0 12 112 |  | Maximum temperature, at height and over period specified | Scale: 2 | K, 2 |  |
| 197 | 3 02 085 |  |  |  | *Precipitation measurement* |  |  |  |
| 198 | 3 02 085 | 1 06 000 |  |  | Delayed replication of 6 descriptors |  |  |  |
| 199 | 3 02 085 | 0 31 000 |  |  | Short delayed descriptor replication factor |  | Numeric, 0 |  |
| 200 | 3 02 085 | 0 07 032 |  |  | Height of sensor above local ground (or deck of marine platform) |  | m, 2 | GBON 1.2.2.14 |
| 201 | 3 02 085 | 0 02 175 |  |  | Method of precipitation measurement |  | Code table, 0 |  |
| 202 | 3 02 085 | 0 02 178 |  |  | Method of liquid content measurement of precipitation |  | Code table, 0 |  |
| 203 | 3 02 085 | 1 02 005 |  |  | Replicate 2 descriptors 5 times |  |  |  |
| 204 | 3 02 085 | 0 04 024 |  |  | Time period or displacement | = –1 hour in the first replication, = –3, –6, –12 and –24 hours in the other replications | h, 0 | GBON 1.2.2.13 |
| 205 | 3 02 085 | 0 13 011 |  |  | Total precipitation/total water equivalent |  | kg m-2, 1 | GBON 1.2.2.12 |
| 206 | 3 02 085 | 0 07 032 |  |  | Height of sensor above local ground (or deck of marine platform) | Set to missing (cancel) |  |  |
| 207 | 3 02 085 |  |  |  | *Evaporation data* |  |  |  |
| 208 | 3 02 085 | 1 03 000 |  |  | Delayed replication of 3 descriptors |  |  |  |
| 209 | 3 02 085 | 0 31 000 |  |  | Short delayed descriptor replication factor |  | Numeric, 0 |  |
| 210 | 3 02 085 | 0 02 185 |  |  | Method of evaporation measurement |  | Code table, 0 |  |
| 211 | 3 02 085 | 1 01 002 |  |  | Replicate 1 descriptor 2 times |  |  |  |
| 212 | 3 02 085 | 3 02 044 | Evaporation data | |  |  |  |  |
| 213 | 3 02 085 | 3 02 044 | 0 04 024 |  | Time period or displacement | Hours | h, 0 |  |
| 214 | 3 02 085 | 3 02 044 | 0 02 004 |  | Type of instrumentation for evaporation measurement or type of crop for which evapotranspiration is reported |  | Code table, 0 |  |
| 215 | 3 02 085 | 3 02 044 | 0 13 033 |  | Evaporation/evapotranspiration |  | kg m-2, 1 |  |
| 216 | 3 02 085 |  |  |  | *Total sunshine data* |  |  |  |
| 217 | 3 02 085 | 1 02 000 |  |  | Delayed replication of 2 descriptors |  |  |  |
| 218 | 3 02 085 | 0 31 000 |  |  | Short delayed descriptor replication factor |  | Numeric, 0 |  |
| 219 | 3 02 085 | 1 01 002 |  |  | Replicate 1 descriptor 2 times |  |  |  |
| 220 | 3 02 085 | 3 02 039 | Sunshine data (from 1 hour and 24-hour period) | | |  |  |  |
| 221 | 3 02 085 |  | 0 04 024 |  | Time period or displacement | Hours | h, 0 |  |
| 222 | 3 02 085 |  | 0 14 031 |  | Total sunshine |  | min, 0 |  |
| 223 | 3 02 085 |  |  |  | *Radiation data* |  |  |  |
| 224 | 3 02 085 | 1 02 000 |  |  | Delayed replication of 2 descriptors |  |  |  |
| 225 | 3 02 085 | 0 31 000 |  |  | Short delayed descriptor replication factor |  | Numeric, 0 |  |
| 226 | 3 02 085 | 1 01 002 |  |  | Replicate 1 descriptor 2 times |  |  |  |
| 227 | 3 02 085 | 3 02 045 | Radiation data (from 1 hour and 24-hour period) | | |  |  |  |
| 228 | 3 02 085 | 3 02 045 | 0 04 024 |  | Time period or displacement | Hours | h, 0 |  |
| 229 | 3 02 085 | 3 02 045 | 0 14 002 |  | Long-wave radiation, integrated over period specified |  | J m-2, -3 |  |
| 230 | 3 02 085 | 3 02 045 | 0 14 004 |  | Short-wave radiation, integrated over period specified |  | J m-2, -3 |  |
| 231 | 3 02 085 | 3 02 045 | 0 14 016 |  | Net radiation, integrated over period specified |  | J m-2, -4 |  |
| 232 | 3 02 085 | 3 02 045 | 0 14 028 |  | Global solar radiation (high accuracy), integrated over period specified |  | J m-2, -2 |  |
| 233 | 3 02 085 | 3 02 045 | 0 14 029 |  | Diffuse solar radiation (high accuracy), integrated over period specified |  | J m-2, -2 |  |
| 234 | 3 02 085 | 3 02 045 | 0 14 030 |  | Direct solar radiation (high accuracy), integrated over period specified |  | J m-2, -2 |  |
| 235 | 3 02 085 |  |  |  | *Temperature change group 54g0sndT* |  |  |  |
| 236 | 3 02 085 | 1 01 000 |  |  | Delayed replication of 1 descriptor |  |  |  |
| 237 | 3 02 085 | 0 31 000 |  |  | Short delayed descriptor replication factor |  | Numeric, 0 |  |
| 238 | 3 02 085 | 3 02 046 | Temperature change | |  |  |  |  |
| 239 | 3 02 085 |  | 0 04 024 |  | Time period or displacement |  | h, 0 |  |
| 240 | 3 02 085 |  | 0 04 024 |  | Time period or displacement | (see Note 4) | h, 0 |  |
| 241 | 3 02 085 |  | 0 12 049 |  | Temperature change over specified period |  | K, 0 |  |
| 242 | 3 02 085 |  |  |  | *First-order statistics of P, W, T, U data* |  |  |  |
| 243 | 3 02 085 | 1 01 000 |  |  | Delayed replication of 1 descriptor |  |  |  |
| 244 | 3 02 085 | 0 31 000 |  |  | Short delayed descriptor replication factor |  | Numeric, 0 |  |
| 245 | 3 02 085 | 3 02 083 | First order statistics of P, W, T, U data | | |  |  |  |
| 246 | 3 02 085 | 3 02 083 | 0 04 025 |  | Time period or displacement |  | min, 0 |  |
| 247 | 3 02 085 | 3 02 083 | 0 08 023 |  | First order statistics |  | Code table, 0 |  |
| 248 | 3 02 085 | 3 02 083 | 0 10 004 |  | Pressure |  | Pa, –1 |  |
| 249 | 3 02 085 | 3 02 083 | 0 11 001 |  | Wind direction |  | degree true, 0 |  |
| 250 | 3 02 085 | 3 02 083 | 0 11 002 |  | Wind speed |  | m/s, 1 |  |
| 251 | 3 02 085 | 3 02 083 | 0 12 101 |  | Temperature/air temperature | Scale: 2 | K, 2 |  |
| 252 | 3 02 085 | 3 02 083 | 0 13 003 |  | Relative humidity |  | %, 0 |  |
| 253 | 3 02 085 | 3 02 083 | 0 08 023 |  | First-order statistics | Set to missing |  |  |
| 254 | 0 33 005 |  |  |  | Quality information (AWS data) | (see Note 5) | Flag table, 0 |  |
| 255 | 0 33 006 |  |  |  | Internal measurement status information (AWS) |  | Code table, 0 |  |

Notes:

1. Duration of precipitation <0 26 020> represents number of minutes in which precipitation was registered.

(2) Within RA III, the maximum daytime temperature and the minimum night-time temperature is reported (i.e. the ending time of the period may not be equal to the nominal time of the report). To construct the required time range, descriptor 0 04 024 has to be included two times. If the period ends at the nominal time of the report, value of the second 0 04 024 shall be set to 0.

(3) Within RA IV, the maximum temperature at 1200 UTC is reported for the previous calendar day (i.e. the ending time of the period is not equal to the nominal time of the report). To construct the required time range, descriptor 0 04 024 has to be included two times. If the period ends at the nominal time of the report, value of the second 0 04 024 shall be set to 0.

(4) To construct the required time range, descriptor 0 04 024 has to be included two times.

(5) To represent Intensity of precipitation, type of precipitation and state of functionality, 0 20 024 <Code table), 0 20 021 (Flag table) and 0 33 005 (Flag table) are used, respectively.

**GBON 1.1.2 BUFR sequence Snow observation, snow density, snow water equivalent <3 07 103>**

|  | | |
| --- | --- | --- |
| **TABLE**  **REFERENCE** | **TABLE**  **REFERENCES** | **ELEMENT NAME** |
| **F X Y** |
|  |  |  |
| 3 07 103 | (Snow observation, snow density, snow water equivalent) | |
|  | 3 01 150 | WIGOS identifier |
|  | 3 07 101 | Snow observation |
|  | 0 13 117 | Snow density (liquid water content) |
|  | 0 03 028 | Method of snow water equivalent measurement |
|  | 0 13 163 | Snow water equivalent |

**GBON BUFR template 3 07 103 further expands as follows.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **#** | **FXY Expansion** | | | **Element name** | **Description** | **Unit, Scale** | **GBON Regulation** |
| 1 | 3 01 150 | WIGOS identifier | |  |  |  | GBON 1.2.1.2 |
| 2 | 3 01 150 | 0 01 125 |  | WIGOS identifier series |  | Numeric, 0 |  |
| 3 | 3 01 150 | 0 01 126 |  | WIGOS issuer of identifier |  | Numeric, 0 |  |
| 4 | 3 01 150 | 0 01 127 |  | WIGOS issue number |  | Numeric, 0 |  |
| 5 | 3 01 150 | 0 01 128 |  | WIGOS local identifier (character) |  | CCITT IA5, 0 |  |
| 6 | 3 07 101 | Snow observation | |  |  |  |  |
| 7 | 3 07 101 | 3 01 089 | National station identification | |  |  |  |
| 8 | 3 07 101 | 3 01 089 | 0 01 101 | State identifier |  | Code table, 0 |  |
| 9 | 3 07 101 | 3 01 089 | 0 01 102 | National station number |  | Numeric, 0 |  |
| 10 | 3 07 101 | 0 01 019 |  | Long station or site name |  | CCITT IA5, 0 |  |
| 11 | 3 07 101 | 0 02 001 |  | Type of station |  |  | GBON 1.2.1.4 |
| 12 | 3 07 101 | 3 01 011 | Year, month, day | |  |  | GBON 1.2.1.5 |
| 13 | 3 07 101 | 3 01 011 | 0 04 001 | Year |  | a, 0 |  |
| 14 | 3 07 101 | 3 01 011 | 0 04 002 | Month |  | mon, 0 |  |
| 15 | 3 07 101 | 3 01 011 | 0 04 003 | Day |  | d, 0 |  |
| 16 | 3 07 101 | 3 01 012 | Hour, minute | |  |  |  |
| 17 | 3 07 101 | 3 01 012 | 0 04 004 | Hour |  | h, 0 |  |
| 18 | 3 07 101 | 3 01 012 | 0 04 005 | Minute |  | min, 0 |  |
| 19 | 3 07 101 | 3 01 021 | Latitude/longitude (high accuracy) | |  |  |  |
| 20 | 3 07 101 | 3 01 021 | 0 05 001 | Latitude (high accuracy) |  | deg, 5 | GBON 1.2.1.6 |
| 21 | 3 07 101 | 3 01 021 | 0 06 001 | Longitude (high accuracy) |  | deg, 5 | GBON 1.2.1.6 |
| 22 | 3 07 101 | 0 07 030 |  | Height of station ground above mean sea level |  | m, 1 | GBON 1.2.1.7 |
| 23 | 3 07 101 | 0 07 032 |  | Height of sensor above local ground (or deck of marine platform) |  | m, 2 | GBON 1.2.2.3 |
| 24 | 3 07 101 | 0 12 101 |  | Temperature/air temperature |  | K, 2 | GBON 1.2.2.4 |
| 25 | 3 07 101 | 0 07 032 |  | Height of sensor above local ground (or deck of marine platform) |  | m, 2 | GBON 1.2.23 |
| 26 | 3 07 101 | 0 02 177 |  | Method of snow depth measurement |  | Code table, 0 | GBON 1.2.2.8 |
| 27 | 3 07 101 | 0 20 062 |  | State of the ground (with or without snow) |  | Code table, 0 | GBON 1.2.2.8 |
| 28 | 3 07 101 | 0 13 013 |  | Total snow depth |  | m, 2 | GBON 1.2.2.9 |
| 29 | 0 13 117 |  |  | Snow density (liquid water content) |  | kg m-3, 0 | GBON 1.2.2.10\* |
| 30 | 0 03 028 |  |  | Method of snow water equivalent measurement |  | Code table, 0 | GBON 1.2.2.10\* |
| 31 | 0 13 163 |  |  | Snow water equivalent |  | kg m-2, 0 | GBON 1.2.2.10\* |

**GBON 1.2 REPORTING PRACTICES FOR SURFACE FIXED LAND STATIONS**

**GBON 1.2.1 Station identification, time, coordinates**

**GBON 1.2.1.1 Sequence for WIGOS station identifier**

The sequence WIGOS station identifier (WSI) <3 01 150> shall be added before the first element if not included in the sequence.

**GBON 1.2.1.2 WSI values**

The elements of sequence WSI <3 01 150> shall not be set to missing and shall have the values corresponding with the station record in <https://oscar.wmo.int/surface>.

**GBON 1.2.1.3 Traditional station identifier**

WMO block number <0 01 001> and WMO station number <0 01 002> shall report the traditional station identifiers (TSI) when available to ensure the continuity of data use, otherwise set to missing value.

**GBON 1.2.1.4 Type of station**

Type of station <0 02 001> shall be reported to indicate the type of the station operation (manned, automatic or hybrid). If a station operates as a manned station for a part of the day and as an automatic station for the rest of the day, code figure 2 (Hybrid) may be used in all reports. It is preferable, however, to use code figure 1 (Manned) in reports produced under the supervision of an observer, and a code figure 0 (Automatic) in reports produced while the station operates in the automatic mode.

**GBON 1.2.1.5 Time of observation**

Year <0 04 001>, month <0 04 002>, day <0 04 003>, hour <0 04 004> and minute <0 04 005> of the actual time of observation shall be reported. The actual time of observation shall be the time at which the barometer is read.

**GBON 1.2.1.6 Station location**

Latitude <0 05 001> and longitude <0 06 001> of the station shall be reported in degrees with precision in 10–5 of a degree.

**GBON 1.2.1.7 Station and barometer height**

Height of station ground above mean sea level <0 07 030> and height of barometer above mean sea level <0 07 031> shall be reported in metres with precision in tenths of a metre.

**GBON 1.2.2 GBON required parameters**

In accordance with GBON provisions the *Manual on WIGOS* (WMO-No. 1160), paragraph 3.2.2) a GBON surface land observing station shall observe a minimum number of required variables. The reporting practices for the GBON required variables are described in the following section. The BUFR template <3 07 096> provides the necessary elements to report a full SYNOP observation in BUFR. The variables normally reported in a SYNOP are recommended for GBON stations and their reporting practices are described in regulation B/C1. Reporting of variables not required by GBON is recommended but shall not affect the required GBON transmission schedule, nor substantially delay the reporting.

Snow is a GBON required parameter and shall be reported using BUFR template <3 07 103> (see 1.1.2) and the relevant elements in template <3 07 096>. Two different messages shall be produced for the BUFR templates <3 07 096> and <3 07 103> if the station is reporting snow and other GBON parameters.

**GBON 1.2.2.1 Pressure units**

Pressure <0 10 004> at the station level, for example at the level defined by height of barometer above mean sea level <0 07 031>, shall be reported in pascals with precision in tens of pascals.

**GBON 1.2.2.2 Pressure accuracy**

Pressure <0 10 004> at the station level shall be included with the pressure reduced to mean sea level <0 10 051>. High-level stations that cannot report pressure reduced to mean sea level <0 10 051> with a satisfactory degree of accuracy can report with the geopotential height <0 10 009> of a standard isobaric surface as agreed by regional decision.

**GBON 1.2.2.3 Sensor height for temperature and humidity**

Height of sensor above local ground <0 07 032> for temperature and humidity data <3 02 072> shall be reported in metres with precision in hundredths of a metre. This datum represents the actual height of temperature and humidity sensors above ground at the point where the sensors are located.

**GBON 1.2.2.4 Temperature units accuracy**

Temperature/air temperature <0 12 101> shall be reported in kelvin with precision in hundredths of a kelvin.

Notes:

(1) Temperature data shall be reported with precision in hundredths of a degree even if they are measured with the accuracy in tenths of a degree. This requirement is based on the fact that conversion from the Kelvin to the Celsius scale has often resulted into distortion of the data values.

(2) Temperature t (in degrees Celsius) shall be converted into temperature T (in kelvin) using equation: T = t + 273.15.

**GBON 1.2.2.5 Dewpoint temperature units**

Dewpoint temperature <0 12 103> shall be reported in kelvin (with precision in hundredths of a kelvin).

Note: Notes 1 and 2 under Regulation GBON 1.2.2.4 shall apply.

**GBON 1.2.2.6 Relative humidity units**

Relative humidity <0 13 003> shall be reported in units of a per cent.

**GBON 1.2.2.7 Instrument failure**

**When the data are not available as a result of a temporary instrument failure,** these values **shall be included as missing values.**

**GBON 1.2.2.8 State of ground**

State of ground (with or without snow) <0 20 062> and method of state of ground measurement <0 02 176> shall be reported. The synoptic hour at which this datum is reported shall be determined by regional decision. In addition to the synoptic hour, this datum should be reported at other synoptic hours, i.e. four times a day.

**GBON 1.2.2.9 Snow depth**

Total snow depth <0 13 013> and method of snow depth measurement <0 02 177> shall be reported when total snow depth is observed or set to missing when it’s not observed.

**GBON 1.2.2.9.1 Snow depth units**

Total snow depth <0 13 013>shall be reported in metres (with precision in hundredths of a metre). The synoptic hour at which this datum is reported shall be determined by regional decision. In addition to the synoptic hour, this datum should be reported at other synoptic hours, i.e. four times a day.

**GBON 1.2.2.9.2 No snow depth to report**

Total snow depth shall be reported as 0.00 m if absence of snow, ice and other forms of solid precipitation on the ground is observed at the time of observation. A snow depth value of “–0.01 m” shall indicate a little (less than 0.005 m) snow. A snow depth value of “–0.02 m” shall indicate “snow cover not continuous”.

**GBON 1.2.2.9.3 Snow depth definition**

The measurement shall include snow, ice and all other forms of solid precipitation on the ground at the time of observation.

**GBON 1.2.2.9.4 Snow depth is not uniform**

When the depth is not uniform, the average depth over a representative area shall be reported.

**GBON 1.2.2.10 Additional snow observations in sequence 3 07 103**

When observed, snow density (liquid water content) <0 13 117>, method of snow water equivalent measurement <0 03 028> and snow water equivalent <0 13 163> shall be reported with sequence 3 07 103 (see GBON 1.1.2).

**GBON 1.2.2.11 Intensity of precipitation**

Intensity of precipitation (high accuracy) <0 13 155> shall be determined by the intensity at the time of the observation.

**GBON 1.2.2.12 Total precipitation/total water equivalent**

Total precipitation/total water equivalent <0 13 011> shall be reported for the last 24 hours in kilograms per square metre (with precision in tenths of a kilogram per square metre). If no precipitation was observed during the period of reference, it shall be reported as 0.0 kg m–2. Trace shall be reported as “–0.1 kg m–2”.

**GBON 1.2.2.13 Total precipitation/total water equivalent time period**

Time period or displacement <0 04 024> for total precipitation/total water equivalent <0 13 011> shall be reported as -24 hours.

**GBON 1.2.2.14 Total precipitation/total water equivalent sensor height**

Height of sensor above local ground (or deck of marine platform) <0 07 032> for total precipitation/total water equivalent <0 13 011> shall be reported in metres (with precision in hundredths of a metre). This datum represents the actual height of the rain gauge rim above ground at the point where the rain gauge is located.

**GBON 1.2.2.15 Wind direction and speed**

The wind direction <0 11 001> shall be reported in degrees true and the wind speed <0 11 002> shall be reported in metres per second (with precision in tenths of a metre per second). Surface wind direction measured at a station within 1° of the North Pole or within 1° of the South Pole shall be reported in such a way that the azimuth ring shall be aligned with its zero coinciding with the Greenwich 0° meridian.

Calm shall be reported by setting wind direction to 0 and wind speed to 0. Variable shall be reported by setting wind direction to 0 and wind speed to a positive *non-missing* value.

**GBON 1.2.2.16 Wind sensor height**

Height of sensor above local ground (or deck of marine platform) <0 07 032> for wind measurement shall be reported in metres (with precision in hundredths of a metre). This datum represents the actual height of the sensors above ground at the point where the sensors are located.

**GBON 1.2.2.17 Wind time period**

The time period or displacement <0 04 025> for wind shall be reported as –10 minutes. However, when the 10-minute period includes a discontinuity in the wind characteristics, only data obtained after the discontinuity shall be used for reporting the mean values, and hence the period <0 04  025> in these circumstances shall be correspondingly reduced.

**GBON 1.2.2.18 Wind time period**

Time significance <0 08 021>qualifier for time period or displacement <0 04 025> for wind shall be set to 2 (time averaged).

**GBON 1.2.2.19 Wind gust**

Maximum wind gust direction <0 11 043> shall be reported in degrees true and speed of the maximum wind gust speed <0 11 041> shall be reported in metres per second (with precision in tenths of a metre per second).

**GBON 1.2.2.20 Wind gust time period**

Time period or displacement <0 04 025> for maximum wind gust direction <0 11 043>

maximum wind gust speed <0 11 041> shall be determined by regional or national decision and reported as a negative value in minutes.

**GBON 2 REPORTING GBON UPPER AIR OBSERVATIONS**

**GBON 2.1 BUFR sequences for upper air stations**

The following BUFR sequence should be used for reporting GBON variables from upper air stations. BUFR sequences different from the one listed below may be used if the reporting practices for GBON variables in GBON 2.2 can be applied

**GBON 2.1.1 BUFR Sequence for representation of TEMP, TEMP SHIP and TEMP MOBIL observation type data with higher precision of pressure and geopotential height <3 09 057>**

|  | | | |
| --- | --- | --- | --- |
| **Row**  **#** | **TABLE**  **REFERENCE** | **TABLE**  **REFERENCES** | **ELEMENT NAME** |
| F X Y |
| 1 | 3 09 057 | (Sequence for representation of TEMP, TEMP SHIP and TEMP MOBIL observation type data with higher precision of pressure and geopotential height) | |
| 2 |  | 3 01 150 | WIGOS identifier |
| 3 |  | 3 01 111 | Identification of launch site and instrumentation for P, T, U and wind measurements |
| 4 |  | 3 01 128 | Additional information on radiosonde ascent |
| 5 |  | 3 01 113 | Date/time of launch |
| 6 |  | 3 01 114 | Horizontal and vertical coordinates of launch site |
| 7 |  | 3 02 049 | Cloud information reported with vertical soundings |
| 8 |  | 0 22 043 | Sea/water temperature |
| 9 |  | 1 01 000 | Delayed replication of 1 descriptor |
| 10 |  | 0 31 002 | Extended delayed descriptor replication factor |
| 11 |  | 3 03 056 | Temperature, dewpoint and wind data at a pressure level with radiosonde position and higher precision of pressure and geopotential height |
| 12 |  | 1 01 000 | Delayed replication of 1 descriptor |
| 13 |  | 0 31 001 | Delayed descriptor replication factor |

GBON BUFR template 3 07 057 further expands as follows.

| **#** | **FXY Expansion** | | | | **Element name** | **Description** | **Unit, Scale** | **GBON Regulation** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 3 09 057 | Sequence for representation of TEMP, TEMP SHIP and TEMP MOBIL observation type data with higher precision of pressure and geopotential height | | | | | | |
| 2 | 3 09 057 | 3 01 150 | WIGOS identifier | |  |  |  |  |
| 3 | 3 09 057 | 3 01 150 | 0 01 125 |  | WIGOS identifier series |  | Numeric, 0 |  |
| 4 | 3 09 057 | 3 01 150 | 0 01 126 |  | WIGOS issuer of identifier |  | Numeric, 0 |  |
| 5 | 3 09 057 | 3 01 150 | 0 01 127 |  | WIGOS issue number |  | Numeric, 0 |  |
| 6 | 3 09 057 | 3 01 150 | 0 01 128 |  | WIGOS local identifier (character) |  | CCITT IA5, 0 |  |
| 7 | 3 09 057 | 3 01 111 | Identification of launch site and instrumentation for P, T, U and wind measurements | | | | | |
| 8 | 3 09 057 | 3 01 111 | 3 01 001 | WMO block and station numbers | |  |  |  |
| 9 | 3 09 057 | 3 01 111 | 3 01 001 | 0 01 001 | WMO block number |  | Numeric, 0 |  |
| 10 | 3 09 057 | 3 01 111 | 3 01 001 | 0 01 002 | WMO station number |  | Numeric, 0 |  |
| 11 | 3 09 057 | 3 01 111 | 0 01 011 |  | Ship or mobile land station identifier |  | CCITT IA5, 0 |  |
| 12 | 3 09 057 | 3 01 111 | 0 02 011 |  | Radiosonde type |  | Code table, 0 |  |
| 13 | 3 09 057 | 3 01 111 | 0 02 013 |  | Solar and infrared radiation correction |  | Code table, 0 |  |
| 14 | 3 09 057 | 3 01 111 | 0 02 014 |  | Tracking technique/status of system used |  | Code table, 0 |  |
| 15 | 3 09 057 | 3 01 111 | 0 02 003 |  | Type of measuring equipment used |  | Code table, 0 |  |
| 16 | 3 09 057 | 3 01 128 | Additional information on radiosonde ascent | | |  |  |  |
| 17 | 3 09 057 | 3 01 128 | 0 01 081 |  | Radiosonde serial number |  | CCITT IA5, 0 |  |
| 18 | 3 09 057 | 3 01 128 | 0 01 082 |  | Radiosonde ascension number |  | Numeric, 0 |  |
| 19 | 3 09 057 | 3 01 128 | 0 01 083 |  | Radiosonde release number |  | Numeric, 0 |  |
| 20 | 3 09 057 | 3 01 128 | 0 01 095 |  | Observer identification |  | CCITT IA5, 0 |  |
| 21 | 3 09 057 | 3 01 128 | 0 02 015 |  | Radiosonde completeness |  | Code table, 0 |  |
| 22 | 3 09 057 | 3 01 128 | 0 02 016 |  | Radiosonde configuration |  | Flag table, 0 |  |
| 23 | 3 09 057 | 3 01 128 | 0 02 017 |  | Correction algorithms for humidity measurements |  | Code table, 0 |  |
| 24 | 3 09 057 | 3 01 128 | 0 02 066 |  | Radiosonde ground receiving system |  | Code table, 0 |  |
| 25 | 3 09 057 | 3 01 128 | 0 02 067 |  | Radiosonde operating frequency |  | Hz, -5 |  |
| 26 | 3 09 057 | 3 01 128 | 0 02 080 |  | Balloon manufacturer |  | Code table, 0 |  |
| 27 | 3 09 057 | 3 01 128 | 0 02 081 |  | Type of balloon |  | Code table, 0 |  |
| 28 | 3 09 057 | 3 01 128 | 0 02 082 |  | Weight of balloon |  | kg, 3 |  |
| 29 | 3 09 057 | 3 01 128 | 0 02 083 |  | Type of balloon shelter |  | Code table, 0 |  |
| 30 | 3 09 057 | 3 01 128 | 0 02 084 |  | Type of gas used in balloon |  | Code table, 0 |  |
| 31 | 3 09 057 | 3 01 128 | 0 02 085 |  | Amount of gas used in balloon |  | kg, 3 |  |
| 32 | 3 09 057 | 3 01 128 | 0 02 086 |  | Balloon flight train length |  | m, 1 |  |
| 33 | 3 09 057 | 3 01 128 | 0 02 095 |  | Type of pressure sensor |  | Code table, 0 |  |
| 34 | 3 09 057 | 3 01 128 | 0 02 096 |  | Type of temperature sensor |  | Code table, 0 |  |
| 35 | 3 09 057 | 3 01 128 | 0 02 097 |  | Type of humidity sensor |  | Code table, 0 |  |
| 36 | 3 09 057 | 3 01 128 | 0 02 103 |  | Radome |  | Flag table, 0 |  |
| 37 | 3 09 057 | 3 01 128 | 0 02 191 |  | Geopotential height calculation |  | Code table, 0 |  |
| 38 | 3 09 057 | 3 01 128 | 0 25 061 |  | Software identification and version number |  | CCITT IA5, 0 |  |
| 39 | 3 09 057 | 3 01 128 | 0 35 035 |  | Reason for termination |  | Code table, 0 |  |
| 40 | 3 09 057 | 3 01 113 | Date/time of launch | |  |  |  |  |
| 41 | 3 09 057 | 3 01 113 | 0 08 021 |  | Time significance | = 18 Launch time | (see Note 11) | |
| 42 | 3 09 057 | 3 01 113 | 3 01 011 | Year, month, day | | Launch time |  |  |
| 43 | 3 09 057 | 3 01 113 | 3 01 011 | 0 04 001 | Year |  | a, 0 |  |
| 44 | 3 09 057 | 3 01 113 | 3 01 011 | 0 04 002 | Month |  | mon, 0 |  |
| 45 | 3 09 057 | 3 01 113 | 3 01 011 | 0 04 003 | Day |  | d, 0 |  |
| 46 | 3 09 057 | 3 01 113 | 3 01 013 | Hour, minute, second | | Launch time |  |  |
| 47 | 3 09 057 | 3 01 113 | 3 01 013 | 0 04 004 | Hour |  | h, 0 |  |
| 48 | 3 09 057 | 3 01 113 | 3 01 013 | 0 04 005 | Minute |  | min, 0 |  |
| 49 | 3 09 057 | 3 01 114 | Horizontal and vertical coordinates of launch site | | |  |  |  |
| 50 | 3 09 057 | 3 01 114 | 3 01 021 | Latitude/longitude (high accuracy) | |  |  |  |
| 51 | 3 09 057 | 3 01 114 | 3 01 021 | 0 05 001 | Latitude (high accuracy) |  | deg, 5 |  |
| 52 | 3 09 057 | 3 01 114 | 3 01 021 | 0 06 001 | Longitude (high accuracy) |  | deg, 5 |  |
| 53 | 3 09 057 | 3 01 114 | 0 07 030 |  | Height of station ground above mean sea level | | m, 1 |  |
| 54 | 3 09 057 | 3 01 114 | 0 07 031 |  | Height of barometer above mean sea level |  | m, 1 |  |
| 55 | 3 09 057 | 3 01 114 | 0 07 007 |  | Height |  | m, 0 |  |
| 56 | 3 09 057 | 3 01 114 | 0 33 024 |  | Station elevation quality mark (for mobile stations) | | Code table, 0 |  |
| 57 | 3 09 057 | 3 02 049 | Cloud information reported with vertical soundings | | |  |  |  |
| 58 | 3 09 057 | 3 02 049 | 0 08 002 |  | Vertical significance (surface observations) |  | Code table, 0 |  |
| 59 | 3 09 057 | 3 02 049 | 0 20 011 |  | Cloud amount | Low or middle clouds Nh | Code table, 0 |  |
| 60 | 3 09 057 | 3 02 049 | 0 20 013 |  | Height of base of cloud | h | m, -1 |  |
| 61 | 3 09 057 | 3 02 049 | 0 20 012 |  | Cloud type | Low clouds CL | Code table, 0 |  |
| 62 | 3 09 057 | 3 02 049 | 0 20 012 |  | Cloud type | Middle clouds CM | Code table, 0 |  |
| 63 | 3 09 057 | 3 02 049 | 0 20 012 |  | Cloud type | High clouds CH | Code table, 0 |  |
| 64 | 3 09 057 | 3 02 049 | 0 08 002 |  | Vertical significance (surface observations) | Set to missing | Code table, 0 |  |
| 65 | 3 09 057 | 0 22 043 |  |  | Sea/water temperature | Scale: 2 | K, 2 |  |
| 66 | 3 09 057 | 1 01 000 |  |  | Delayed replication of 1 descriptor |  |  |  |
| 67 | 3 09 057 | 0 31 002 |  |  | Extended delayed descriptor replication factor | |  |  |
| 68 | 3 09 057 | 3 03 056 | Temperature, dewpoint and wind data at a pressure level with radiosonde position and higher precision of pressure and geopotential height | | | | | |
| 69 | 3 09 057 | 3 03 056 | 0 04 086 |  | Long time period or displacement | Since launch time | s, 0 |  |
| 70 | 3 09 057 | 3 03 056 | 0 08 042 |  | Extended vertical sounding significance |  | Flag table, 0 |  |
| 71 | 3 09 057 | 3 03 056 | 2 07 001 |  | Increase scale, reference value and data width | |  |  |
| 72 | 3 09 057 | 3 03 056 | 0 07 004 |  | Pressure | Scale: 0 | Pa, -1 |  |
| 73 | 3 09 057 | 3 03 056 | 0 10 009 |  | Geopotential height | Scale: 1 | gpm, 0 |  |
| 74 | 3 09 057 | 3 03 056 | 2 07 000 |  | Increase scale, reference value and data width | Cancel |  |  |
| 75 | 3 09 057 | 3 03 056 | 0 05 015 |  | Latitude displacement (high accuracy) | Since launch site | deg, 5 |  |
| 76 | 3 09 057 | 3 03 056 | 0 06 015 |  | Longitude displacement (high accuracy) | Since launch site | deg, 5 |  |
| 77 | 3 09 057 | 3 03 056 | 0 12 101 |  | Temperature/air temperature | Scale: 2 | K, 2 |  |
| 78 | 3 09 057 | 3 03 056 | 0 12 103 |  | Dewpoint temperature | Scale: 2 | K, 2 |  |
| 79 | 3 09 057 | 3 03 056 | 0 11 001 |  | Wind direction |  | degree true, 0 | |
| 80 | 3 09 057 | 3 03 056 | 0 11 002 |  | Wind speed |  | m/s, 1 |  |
| 81 | 3 09 057 | 1 01 000 |  |  | Delayed replication of 1 descriptor |  |  |  |
| 82 | 3 09 057 | 0 31 001 |  |  | Delayed descriptor replication factor |  |  |  |
| 83 | 3 09 057 | 3 03 051 | Wind shear data at a pressure level with radiosonde position | | | |  |  |
| 84 | 3 09 057 | 3 03 051 | 0 04 086 |  | Long time period or displacement | Since launch time | s, 0 |  |
| 85 | 3 09 057 | 3 03 051 | 0 08 042 |  | Extended vertical sounding significance |  | Flag table, 0 |  |
| 86 | 3 09 057 | 3 03 051 | 0 07 004 |  | Pressure |  | Pa, -1 |  |
| 87 | 3 09 057 | 3 03 051 | 0 05 015 |  | Latitude displacement (high accuracy) | Since launch site | deg, 5 |  |
| 88 | 3 09 057 | 3 03 051 | 0 06 015 |  | Longitude displacement (high accuracy) | Since launch site | deg, 5 |  |
| 89 | 3 09 057 | 3 03 051 | 0 11 061 |  | Absolute wind shear in 1 km layer below |  | m/s, 1 |  |
| 90 | 3 09 057 | 3 03 051 | 0 11 062 |  | Absolute wind shear in 1 km layer above |  | m/s, 1 |  |

**GBON 2.2 REPORTING PRACTICES**

**GBON 2.2.1 Identification of launch site and instrumentation for P, T, U and wind measurements <3 01 111>**

**GBON 2.2.1.1 Sequence for WIGOS station identifier**

The sequence WIGOS station identifier (WSI) <3 01 150> shall be added before the first element if not included in the sequence.

**GBON 2.2.1.2 WSI values**

The elements of sequence WSI <3 01 150> shall not be set to missing and shall have the values corresponding with the station record in <https://oscar.wmo.int/surface>.

**GBON 2.2.1.3 Identification of launch site**

WMO block number <0 01 001> and WMO station number <0 01 002> shall be always reported as a non-missing value in reports from a fixed land station. WMO block and station number may be included in reports from a fixed sea station if available.

Ship or mobile land station identifier <0 01 011> shall be always reported not exceeding 9 characters in reports from ships or mobile stations. Ship or mobile station identifier <0 01 011> shall be always set to a missing value in reports from a fixed land station.

**GBON 2.2.1.4 Instrumentation for P, T, U and wind measurement**

Radiosonde type <0 02 011>, solar and infrared radiation correction <0 02 013>, tracking techniques/status of system used <0 02 014> and type of measuring equipment used < 0 02 003> shall be reported.

**GBON 2.2.2 Date/time of launch <3 01 113>**

Time significance <0 08 021> shall always be set to 18 to indicate that the following entries specify the date and time of launching the radiosonde.

The true time of launch shall be reported with year, month day <3 01 011> and hour, minute, second <3 01 013>.

Time of launch <3 01 013> shall be reported with the highest possible accuracy available. If the launch time is not available with second accuracy, the entry <0 04 006> for seconds shall be set to zero.

**GBON 2.2.3 Horizontal and vertical coordinates of launch site <3 01 114>**

Latitude (high accuracy) <0 05 001> and longitude (high accuracy) <0 06 001> of the launch site shall be reported in degrees with precision in 10–5 of a degree.

Height of station ground above mean sea level <0 07 030> and height of barometer above mean sea level <0 07 031> shall be reported in metres with precision in tenths of a metre.

Height <0 07 007> of release of sonde above mean sea level shall be reported in metres.

Station elevation quality mark <0 33 024> shall be reported to indicate the accuracy of the vertical coordinates of the mobile land station. Fixed land stations and sea stations shall report this datum as a missing value.

Note: The official altitude of the aerodrome (HA) shall not be used to report Height of station ground above mean sea level <0 07 030> in BUFR messages from aerodromes. Those are two different vertical coordinates. "Height of station ground above mean sea level" for each station should be made available to the encoding centre concerned, which may be a centre within the same NMHS or other NMC/RTH.

**GBON 2.2.4 Cloud information reported with vertical sounding <3 02 049>**

**GBON 2.2.4.1 Vertical significance (surface observations) – Code table 0 08 002**

To specify vertical significance <0 08 002> within the sequence 3 02 049, a code figure shall be selected in the following way:

(a) If low clouds are observed, then code figure 7 (Low cloud) shall be used;

(b) If there are no low clouds but middle clouds are observed, then code figure 8 (Middle clouds) shall be used;

(c) If there are no low and there are no middle clouds but high clouds are observed, then code figure 0 shall be used;

(d) If sky is obscured by fog and/or other phenomena, then code figure 5 (Ceiling) shall be used;

(e) If there are no clouds (clear sky), then code figure 62 (Value not applicable) shall be used;

(f) If the cloud cover is not discernible for reasons other than (d) above or observation is not made, then code figure 63 (Missing value) shall be used.

**GBON 2.2.4.2 Cloud amount (of low or middle clouds) – Code table 0 20 011**

Amount of all the low clouds (clouds of the genera Stratocumulus, Stratus, Cumulus, and Cumulonimbus) present or, if no low clouds are present, the amount of all the middle clouds (clouds of the genera Altocumulus, Altostratus, and Nimbostratus) present.

**GBON 2.2.4.2.1** Cloud amount shall be reported as follows:

(a) If there are low clouds, then the total amount of all low clouds, as actually seen by the observer during the observation shall be reported for the cloud amount;

(b) If there are no low clouds but there are middle clouds, then the total amount of the middle clouds shall be reported for the cloud amount;

(c) If there are no low clouds and there are no middle clouds but there are high clouds (clouds of the genera Cirrus, Cirrocumulus, and Cirrostratus), then the cloud amount shall be reported as zero.

**GBON 2.2.4.2.2**

Amount of Altocumulus perlucidus or Stratocumulus perlucidus (“mackerel sky”) shall be reported using code figure 7 or less since breaks are always present in this cloud form even if it extends over the whole celestial dome.

**GBON 2.2.4.2.3**

When the clouds reported for cloud amount are observed through fog or an analogous phenomenon, the cloud amount shall be reported as if these phenomena were not present.

**GBON 2.2.4.2.4**

If the clouds reported for cloud amount include contrails, then the cloud amount shall include the amount of persistent contrails. Rapidly dissipating contrails shall not be included in the value for the cloud amount.

**GBON 2.2.4.3 Height of base of lowest cloud**

Height above surface of the base <0 20 013> of the lowest cloud seenshall be reported inmetres (with precision in tens of metres).

Note: The term « height above surface » shall be considered as being the height above the official aerodrome elevation or above station elevation at a non-aerodrome station or the height above water surface of sea or lake.

**GBON 2.2.4.3.1**

When the station is in fog, a sandstorm or in blowing snow but the sky is discernible, the base of the lowest cloud shall refer to the base of the lowest cloud observed, if any. When, under the above conditions, the sky is not discernible, the base of the lowest cloud shall be replaced by vertical visibility.

**GBON 2.2.4.3.2**

When no cloud is reported (total cloud cover = 0) the base of the lowest cloud *shall be reported as a missing value.*

**GBON 2.2.4.3.3**

When, by national decision, clouds with bases below the station are reported from the station and clouds with bases below and tops above the station are observed, the base of the lowest cloud *shall be reported having a negative value if the base of cloud is discernible, or as a missing value.*

**GBON 2.2.4.4 Cloud type of low, middle and high clouds – Code table 0 20 012**

Clouds of the genera Stratocumulus, Stratus, Cumulus, and Cumulonimbus (low clouds) shall be reported for the first entry 0 20 012, clouds of the genera Altocumulus, Altostratus, and Nimbostratus (middle clouds) shall be reported for the second entry 0 20 012 and clouds of the genera Cirrus, Cirrocumulus, and Cirrostratus (high clouds) shall be reported for the third entry 0 20 012.

**GBON 2.2.4.4.1**

The reporting of type of low, middle and high clouds shall be as specified in the *International Cloud Atlas* (WMO-No. 407), Volume I.

**GBON 2.2.5 Sea/water temperature**

Sea/water temperature <0 22 043> shall be reported in kelvin (with precision in hundredths of a kelvin). Sea/water temperature data shall be reported with precision in hundredths of a degree even if they are available with the accuracy in tenths of a degree.

Notes:

(1) This requirement is based on the fact that conversion from the Kelvin to the Celsius scale has often resulted into distortion of the data values.

(2) Temperature t (in degrees Celsius) shall be converted into temperature T (in kelvin) using equation: T = t + 273.15.

**GBON 2.2.5.1** Sea/water temperature shall always be included in reports from sea stations, when data are available.

**GBON 2.2.6 Temperature, dewpoint and wind data at pressure levels**

Temperature, dewpoint and wind data at pressure levels obtained during the radiosonde ascent shall be included in descending order with respect to pressure. Data at each pressure level shall be included only once. For example, if a significant level with respect to air temperature and relative humidity and a standard isobaric surface coincide, data for that level shall be included only once, the multiple attributes being indicated by Extended vertical sounding significance <0 08 042> as specified in GBON 2.2.6.2.2

**GBON 2.2.6.1 Number of reported pressure levels**

The number of reported pressure levels shall be indicated by Extended delayed descriptor replication factor <0 31 002> in BUFR.

The number of pressure levels shall never be set to a missing value and set to a positive value in a NIL report. If data compression is to be used, BUFR Regulation 94.6.3, Note 2, sub-note ix shall apply.

**GBON 2.2.6.1.1**

All required data from the entire radiosonde ascent shall be reported in a BUFR message that shall be produced when the sounding is completed. In interest of timely data delivery, however, a BUFR message should be sent when level 100 hPa is reached.

**GBON 2.2.6.2 Temperature, dewpoint and wind data at a pressure level with radiosonde position <3 03 056>**

**GBON 2.2.6.2.1 Long time displacement (since launch time)**

Long time period or displacement <0 04 086> represents the time offset from the launch time specified in Regulation GBON 2.2.2, and shall be reported in seconds if available.

**GBON 2.2.6.2.2 Extended vertical sounding significance – Flag table 0 08 042**

This datum shall be used to specify vertical sounding significance in the following way (see Regulation GBON 2.2.7):

(a) Bit No. 1 set to 1 indicates surface;

(b) Bit No. 2 set to 1 indicates a standard level;

(c) Bit No. 3 set to 1 indicates a tropopause level;

(d) Bit No. 4 set to 1 indicates a maximum wind;

(e) Bit No. 5 set to 1 indicates a level significant with respect to temperature

(f) Bit No. 6 set to 1 indicates a level significant with respect to relative humidity;

(g) Bit No. 7 set to 1 indicates a level significant with respect to wind;

(h) Bit No. 8 set to 1 indicates beginning of missing temperature data and bit No. 9 set to 1 indicates end of missing temperature data;

(i) Bit No. 10 set to 1 indicates beginning of missing humidity data and bit No. 11 set to 1 indicates end of missing humidity data;

(j) Bit No. 12 set to 1 indicates beginning of missing wind data bit No. 13 set to 1 indicates end of missing wind data;

(k) Bit No. 14 set to 1 indicates the top of wind sounding;

(l) Bit No. 15 set to 1 indicates a level determined by regional decision;

(m) All bits set to 0 indicate a level determined by national decision or a level of no significance that has been included when high-resolution data are reported;

(n) All bits set to 1 indicate a missing value.

**GBON 2.2.6.2.3 Pressure**

Pressure <0 07 004> shall be reported in pascals (with precision of pascals).

**GBON 2.2.6.2.4 Geopotential height**

Geopotential height <0 10 009> of the level shall be reported in geopotential metres.

**GBON 2.2.6.2.5 Radiosonde drift – latitude and longitude displacements**

Latitude displacement <0 05 015> represents the latitude offset from the latitude of the launch site specified in Regulation GBON 2.2.3, and shall be reported in degrees with precision in 10–5 of a degree if available. Longitude displacement <0 06 015> represents the longitude offset from the longitude of the launch site specified in Regulation GBON 2.2.3, and shall be reported in degrees with precision in 10–5 of a degree if available.

**GBON 2.2.6.2.6 Temperature**

Temperature <0 12 101> shall be reported in kelvin (with precision in hundredths of a kelvin). Temperature data shall be reported with precision in hundredths of a degree even if they are measured with the accuracy in tenths of a degree.

Notes:

(1) This requirement is based on the fact that conversion from the Kelvin to the Celsius scale has often resulted into distortion of the data values.

(2) Temperature t (in degrees Celsius) shall be converted into temperature T (in kelvin) using equation: T = t + 273.15.

**GBON 2.2.6.2.7 Dewpoint temperature**

Dewpoint temperature <0 12 103> shall be reported in kelvin (with precision in hundredths of a kelvin.

Notes:

(1) This requirement is based on the fact that conversion from the Kelvin to the Celsius scale has often resulted into distortion of the data values.

(2) Temperature t (in degrees Celsius) shall be converted into temperature T (in kelvin) using equation: T = t + 273.15.

**GBON 2.2.6.2.7.1**

Dewpoint temperature data shall be derived using the function (or a near equivalent) for a relationship between saturation vapour pressure over Water and air temperature (specified in the *Technical Regulations* (WMO-No. 49)). Dewpoint temperature data shall not be reported when the air temperature is outside the range stated by WMO for the application of the function; a lesser range may be used as a national practice.

**GBON 2.2.6.2.8 Wind direction and speed**

The wind direction <0 11 001> shall be reported in degrees true and the wind speed <0 11 002> shall be reported in metres per second (with precision in tenths of a metre per second).

Wind direction measured at a station within 1° of the North Pole or within 1° of the South Pole shall be reported in such a way that the azimuth ring shall be aligned with its zero coinciding with the Greenwich 0° meridian. *The wind direction at each level should be consistent with the reported longitude at that level.*

**GBON 2.2.6.2.8.1.1**

When during an ascent the pressure data can no longer be obtained, but wind data can be obtained, the wind data so obtained shall not be

Reported in the BUFR message in which data are described by the common sequence 3 09 056. These wind data so obtained

may be reported using BUFR template TM 309051 suitable PILOT, PILOT SHIP or PILOT MOBIL data.

**GBON 2.2.6.2.8.1.2**

Only wind data obtained from the radiosonde ascent by either visual or electronic means shall be included in the BUFR message in

Which data are described by the common sequence 3 09 057. Wind data obtained by means other than a radiosonde-type ascent

shall not be included in a message under common sequence 3 09 057.

**GBON 2.2.7 Criteria for reporting standard and significant levels**

**GBON 2.2.7.1 Surface**

The surface level shall be always reported.

Note: The value of extended vertical sounding significance <0 08 042> at the surface level shall indicate that this level is also a level significant with respect to temperature, relative humidity and wind, i.e. not only bit No. 1 but also bits Nos. 5, 6 and 7 shall be set to 1.

**GBON 2.2.7.2 Standard levels**

**GBON 2.2.7.2.1**

The standard levels of 1 000, 925, 850, 700, 500, 400, 300, 250, 200, 150, 100, 70, 50, 30, 20 and 10 hPa shall be reported in ascending order with respect to altitude.

**GBON 2.2.7.2.2**

When the geopotential of a standard level is lower than the altitude of the reporting station, the time displacement, latitude displacement and longitude displacement for that level shall be set to zero and the air temperature, dewpoint temperature and wind data for that level shall be reported as missing values.

**GBON 2.2.7.2.3**

When air temperature, dewpoint temperature or wind data at a standard level are not available, the corresponding entries for that level shall be reported as missing values.

**GBON 2.2.7.2.4**

Whenever it is desired to extrapolate a sounding for the computation of the geopotential at a standard level, the following rules shall apply:

(a) Extrapolation is permissible if, and only if, the pressure difference between the minimum pressure of the sounding and the isobaric surface for which the extrapolated value is being computed does not exceed one quarter of the pressure at which the extrapolated value is desired, provided the extrapolation does not extend through a pressure interval exceeding 25 hPa;

(b) For the purpose of geopotential calculation, and for this purpose only, the sounding will be extrapolated, using two points only of the sounding curve on a T-log p diagram, namely that at the minimum pressure reached by the sounding and that at the pressure given by the sum of this minimum pressure and the pressure difference, mentioned in (a) above.

**GBON 2.2.7.3 Tropopause level(s)**

**GBON 2.2.7.3.1**

When a tropopause (one or more) is observed, the corresponding number of levels shall be included (indicated by <0 08 042> bit No. 3 set to 1).

**GBON 2.2.7.3.2**

When no tropopause data are observed, no level shall be indicated by bit No. 3 of <0 08 042> set to 1.

**GBON 2.2.7.4 Maximum wind level(s)**

**GBON 2.2.7.4.1**

When a maximum wind level (one or more) is reported, the corresponding number of levels shall be included in the report indicated by bit No. set to 1 in Extended vertical sounding significance <0 08 042>.

Notes:

(1) Criteria for determining maximum wind levels are given in Regulations below.

(2) As a maximum wind level is also a level significant with respect to wind, bit No. 7 as well as bit No. 4 shall be set to 1 in the Extended vertical sounding significance <0 08 042>.

**GBON 2.2.7.4.2**

When no maximum wind level is observed, no level shall be indicated by bit No. 4 of <0 08 042> set to 1.

**GBON 2.2.7.4.3**

A maximum wind level:

(a) Shall be determined by consideration of the list of significant levels for wind speed, as obtained by means of the relevant recommended or equivalent national method (see the Note under Regulation GBON 2.2.7.7.2) and *not* by consideration of the original wind-speed curve;

(b) Shall be located above the 500-hPa isobaric surface and shall correspond to a speed of more than 30 metres per second.

Note: A maximum wind level is defined as a level at which the wind speed is greater than that observed immediately above and below that level.

**GBON 2.2.7.4.4**

Whenever more than one maximum wind level exists, these levels shall be reported as follows:

(a) The level of greatest maximum wind speed shall be always included;

(b) The other levels shall be included in the report only if their speed exceeds those of the two adjacent minima by at least 10 metres per second;

(c) Furthermore, the highest level attained by the sounding shall be indicated as a maximum wind level, provided:

(i) It satisfies the criteria set forth in Regulation GBON 2.2.5.4.3 above;

(ii) It constitutes the level of the greatest speed of the whole sounding.

**GBON 2.2.7.4.5**

If the top of the wind sounding corresponds to the highest wind speed observed throughout the ascent, this level shall be indicated by Extended vertical sounding significance <0 08 042> – bit No. 4 set to 1 (maximum wind level), bit No. 7 set to 1 (level significant with respect to wind) and bit No. 14 set to 1 (top of wind sounding).

Note: For the purpose of the above regulation, the “top of the wind sounding” is to be understood as the highest level for which wind data are available.

**GBON 2.2.7.5 Levels significant with respect to temperature**

**GBON 2.2.7.5.1**

The reported significant levels alone shall make it possible to reconstruct the air temperature profile within the limits of the criteria specified.

If the criteria for determination of significant levels with respect to air temperature are satisfied at a particular point of altitude, data for all variables (if available) shall be reported for that level.

**GBON 2.2.7.5.2**

The following shall be included as “mandatory” significant temperature levels:

(a) Surface level and the highest level of the sounding;

(b) A level between 110 and 100 hPa;

(c) Bases and tops of inversions and isothermal layers which are at least 20 hPa thick, provided that the base of the layer occurs below the 300-hPa level or the first tropopause, whichever is the higher;

(d) Bases and tops of inversion layers which are characterized by a change in temperature of at least 2.5 ºC, provided that the base of the layer occurs below the 300-hPa level or the first tropopause, whichever is the higher.

(e) The inversion layers of (c) and (d) may be comprised of several thinner inversion layers separated by thin layers of temperature lapse. To allow for this situation, the tops of the inversion layers of (c) and (d) shall each be at a level such that no further inversion layers, whether thick or thin, shall occur for at least 20 hPa above the level.

**GBON 2.2.7.5.3**

The following shall be included as “additional” significant levels. They shall be selected in the order given, thereby giving priority to representing the temperature profile. As far as possible, these additional levels shall be the actual levels at which prominent changes in the lapse rate of air temperature occur:

(a) Levels which are necessary to ensure that the temperature obtained by linear interpolation (on a T-log P or essentially similar diagram) between adjacent significant levels shall not depart from the observed temperature by more than 1 ºC below the first significant level reported above the 300-hPa level or the first tropopause, whichever level is the lower, or by more than 2 ºC thereafter;

(b) Levels which are necessary to limit the interpolation error on diagrams other than T-log P. These levels shall be such that the pressure at one significant level divided by the pressure of the preceding significant layer shall exceed 0.6 for levels up to the first tropopause and shall be determined by use of the method for selecting additional levels but with application of tighter criteria.

**GBON 2.2.7.5.4**

When a significant level with respect to air temperature and a standard level coincide, data for that level shall be reported only once.

**GBON 2.2.7.6 Levels significant with respect to relative humidity**

**GBON 2.2.7.6.1**

The reported significant levels alone shall make it possible to reconstruct the relative humidity profiles within the limits of the criteria specified.

If the criteria for determination of significant levels with respect to relative humidity are satisfied at a particular point of altitude, data for all variables (if available) shall be reported for that level.

**GBON 2.2.7.6.2**

The following shall be included as “mandatory” significant humidity levels:

(a) Surface level and the highest level of the sounding;

(b) A level between 110 and 100 hPa;

(c) Bases and tops of inversions and isothermal layers which are at least 20 hPa thick, provided that the base of the layer occurs below the 300-hPa level or the first tropopause, whichever is the higher;

(d) Bases and tops of inversion layers which are characterized by a change in relative humidity of at least 20 per cent, provided that the base of the layer occurs below the 300-hPa level or the first tropopause, whichever is the higher.

Note: The inversion layers of (c) and (d) may be comprised of several thinner inversion layers separated by thin layers of temperature lapse. To allow for this situation, the tops of the inversion layers of (c) and (d) shall each be at a level such that no further inversion layers, whether thick or thin, shall occur for at least 20 hPa above the level.

**GBON 2.2.7.6.3**

The following shall be included as “additional” significant levels. They shall be selected in the order given, thereby giving priority to representing the temperature profile. As far as possible, these additional levels shall be the actual levels at which prominent changes in the lapse rate of air temperature occur:

(a) Levels which are necessary to ensure that the relative humidity obtained by linear interpolation between adjacent significant levels shall not depart by more than 15 per cent from the observed values. (The criterion of 15 per cent refers to an amount of relative humidity and NOT to the percentage of the observed value, e.g. if an observed value is 50 per cent, the interpolated value shall lie between 35 per cent and 65 per cent.);

(b) Levels which are necessary to limit the interpolation error on diagrams other than T-log P. These levels shall be such that the pressure at one significant level divided by the pressure of the preceding significant layer shall exceed 0.6 for levels up to the first tropopause and shall be determined by use of the method for selecting additional levels but with application of tighter criteria.

**GBON 2.2.7.6.4**

When a significant layer with respect to relative humidity and a standard level coincide, data for that level shall be reported only once.

**GBON 2.2.7.7 Levels significant with respect to wind**

**GBON 2.2.7.7.1**

Significant wind levels shall be chosen so that the data from them alone shall make it possible to reconstruct the wind profile with sufficient accuracy for practical use.

If the criteria for determination of significant levels with respect to wind speed and direction are satisfied at a particular point of altitude, data for all variables (if available) shall be reported for that level.

**GBON 2.2.7.7.2**

Criteria for determining significant levels with respect to changes in wind speed and direction:

(a) The direction and speed curves (in function of the log of pressure or altitude) can be reproduced with their prominent characteristics;

(b) These curves can be reproduced with the accuracy of at least 10 degrees true for direction and five metres per second for speed.

Note: To satisfy these criteria, the following method of successive approximations is recommended, but other methods of attaining equivalent results may suit some national practices better and may be used:

(i) The surface level and highest level for which wind data are available constitute the first and the last significant levels. The deviation from the linearly interpolated values between these two levels is then considered. If no direction deviates by more than 10 degrees true and no speed by more than five metres per second, no other significant level need be reported. Whenever one parameter deviates by more than the limit specified in paragraph (b) above the level of greatest deviation becomes a supplementary significant level for both parameters;

(ii) The additional significant levels so introduced divide the sounding into two layers. In each separate layer, the deviation from the linearly interpolated values between the base and the top are then considered. The process used in paragraph (i) above is repeated and yields other significant levels. These additional levels in turn modify the layer distribution, and the method is applied again until any level is approximated to the above-mentioned specified values.

**GBON 2.2.7.8 Beginning and end of missing temperature data**

**GBON 2.2.7.8.1**

A layer for which temperature data are missing shall be indicated by reporting the boundary levels of the layer, provided that the layer is at least 20 hPa thick. The boundary levels are the levels closest to the bottom and the top of the layer for which temperature data are available. The boundary levels are not required to meet “significant temperature level” criteria.

**GBON 2.2.7.9 Beginning and end of missing humidity data**

**GBON 2.2.7.9.1**

A layer for which dewpoint temperature data are missing shall be indicated by reporting the boundary levels of the layer, provided that the layer is at least 20 hPa thick. The boundary levels are the levels closest to the bottom and the top of the layer for which dewpoint temperature data are available. The boundary levels are not required to meet “significant humidity level” criteria.

**GBON 2.2.7.10 Beginning and end of missing wind data**

**GBON 2.2.7.10.1**

A layer for which wind data are missing shall be indicated by reporting the boundary levels of the layer, provided that the layer is at least 50 hPa thick. The boundary levels are the levels closest to the bottom and the top of the layer for which the observed data are available. The boundary levels are not required to meet “significant wind level” criteria.

**GBON 2.2.8 Wind shear data**

**GBON 2.2.8.1 Number and order of levels for which wind shear is reported**

**GBON 2.2.8.1.1**

The number of levels with wind shear data shall be indicated by Delayed descriptor replication factor 0 31 001 in BUFR and by a four-digit number in the Data Section corresponding to the position of the replication descriptor in the Data Description Section of CREX.

Notes:

(1) The number of levels with wind shear data shall never be set to a missing value.

(2) The number of levels with wind shear data shall be set to a positive value in a NIL report.

(3) The number of levels with wind shear data shall be set to zero if data for vertical wind shear are not computed and required.

(4) If data compression is to be used, BUFR Regulation 94.6.3, Note 2, sub-note ix shall apply.

**GBON 2.2.8.1.2**

Whenever wind shear data are reported for more than one level, these maximum wind levels shall be included in the same order as in the sequence <3 03 056>, i.e. in descending order with respect to pressure.

**GBON 2.2.8.2 Wind shear data at a pressure level with radiosonde position <3 03 051>**

**GBON 2.2.8.2.1 Long time displacement (since launch time)**

Long-time displacement <0 04 086> represents the time offset from the launch time specified in Regulation GBON 2.2.2, and shall be reported in seconds if available.

**GBON 2.2.8.2.2 Extended vertical sounding significance – Flag table 0 08 042**

A level, for which wind shear data are reported, shall be indicated by vertical sounding significance <0 08 042> – bit No. 4 set to 1 (maximum wind level) and by bit No. 7 set to 1 (level significant with respect to wind). Moreover, if the top of the wind sounding corresponds to the highest wind speed observed throughout the ascent, this level shall be indicated also by bit No. 14 set to 1 (top of wind sounding).

**GBON 2.2.8.2.3 Pressure**

Pressure <0 07 004> shall be reported in pascals with precision in tens of pascals.

**GBON 2.2.8.2.4 Latitude and longitude displacements**

Latitude displacement <0 05 015> represents the latitude offset from the latitude of the launch site specified in Regulation GBON 2.2.3, and shall be reported in degrees with precision in 10–5 of a degree if available. Longitude displacement 0 06 015 represents the longitude offset from the longitude of the launch site specified in Regulation GBON 2.2.3, and shall be reported in degrees with precision in 10–5 of a degree if available.

**GBON 2.2.8.2.5 Wind shear data**

Absolute wind shear in 1 km layer below <0 11 061> and absolute wind shear in 1 km layer above <0 11 062> shall be reported in metres per second (with precision in tenths of a metre per second), if data for vertical wind shear are computed and required.

**GBON 2.2.9 Data required by regional or national reporting practices**

If regional or national reporting practices require inclusion of temperature, humidity and/or wind data at additional levels, these data shall be reported using sequence <3 03 056> for temperature, dewpoint, wind at a pressure level. Regulation GBON 2.2.6 shall apply.

(1) A level determined by regional decision shall be indicated by Extended vertical sounding significance <0 08 042> – bit No. 15 set to 1.

(2) A level determined by national decision shall be indicated by Extended vertical sounding significance <0 08 042> – all bits set to 0.

**GBON 2.2.9.1 Additional data required by reporting practices in RA I**

Temperature, dewpoint, wind data at additional levels shall be reported in compliance with Regulation GBON 2.2.9.

**GBON 2.2.9.2 Additional data required by reporting practices in RA II**

**GBON 2.2.9.2.1**

No additional data are required by regional reporting practices in RA II.

**GBON 2.2.9.2.2**

The inclusion of wind shear data shall be left to national decision. Members are recommended to include these data as often as possible.

**GBON 2.2.9.3 Additional data required by reporting practices in RA III**

No regional requirements are indicated for reporting TEMP, TEMP SHIP and TEMP MOBIL data in RA III.

**GBON 2.2.9.4 Additional data required by reporting practices in RA IV**

**GBON 2.2.9.4.1**

When available, temperature, dewpoint, wind data for levels 7, 5, 3, 2 and 1 hPa shall be reported in compliance with Regulation GBON 2.2.9.

**GBON 2.2.9.4.2**

When required, additional information shall be reported using RA IV BUFR template for data representation of TEMP, TEMP SHIP and TEMP MOBIL data as shown in Annex I to Part B/C25.

**GBON 2.2.9.5 Additional data required by reporting practices in RA V**

No regional requirements are indicated for reporting TEMP, TEMP SHIP and TEMP MOBIL data in RA V.

**GBON 2.2.9.6 Additional data required by reporting practices in RA VI**

**GBON 2.2.9.6.1**

The inclusion of wind shear data shall be left to national decision. Members are recommended to include these data as often as possible.

**GBON 2.2.9.6.2**

Wind direction and speed shall be reported:

(i) For 900 or 1 000 metres above the surface;

(ii) For 800 hPa level;

(iii) For 600 hPa level.

## Annex 3 to draft Resolution X/X (EC-76)

**changes to the Manual on Codes due to WMO Reform**

**Manual on Codes Volume I.2**

**- INTRODUCTION**

…

Coded messages are used for the international exchange of meteorological information comprising observational data provided by the ~~World Weather Watch (WWW) Global Observing~~ ~~System~~ WMO Integrated Global Observing System and processed data provided by the ~~WWW~~ Global Data-processing and Forecasting System. Coded messages are also used for the international exchange of observed and processed data required in specific applications of meteorology to various human activities and for exchanges of information related to meteorology.

**- PART B, BINARY CODES, A. FM SYSTEM OF NUMBERING BINARY CODES**

Each binary code bears a number, preceded by the letters FM. Before 2018, ~~T~~this number ~~is~~ was followed by a Roman numeral to identify the session of CBS which either approved the binary code as a new one or made the latest amendment to its previous version. A binary code approved or amended by correspondence after a session of CBS received~~s~~ the number of that session. After 2018, this number is followed by the year it was approved and the sequence number of the fast-track procedure, if applicable.

Furthermore, an indicator term is used to designate the binary code colloquially and is therefore called a “code name”.

Notes on nomenclature:

1. Changes and augmentations to the structure of the GRIB data representation shall be identified as different “GRIB edition numbers”. The current edition number is 2.

Changes to the content of any of the tables, including the grid definitions, shall be identified as different “table versions”. Previous tables were Version 23; the version described in this edition is “Tables Version 24”. Further GRIB editions and table versions may be generated independently of one another in the future as requirements dictate;

1. Changes and augmentations to the structure of the BUFR data representation shall be identified as different “BUFR edition numbers”. The current edition number is 4.

Changes to the content of the parameter Tables A, B, C and D shall be identified as different “table versions”. The previous tables were Version 32; the changes described in this edition will become “Tables A, B, C and D, Version 33”. Further BUFR editions and table versions may be generated independently of one another in the future as requirements dictate.

The FM system of numbering the binary codes, together with the corresponding code names and their reference list of approved decisions ~~CBS approved decision~~, is the following:

**FM SYSTEM OF BINARY CODE**

**FM 92–XIV GRIB General regularly distributed information in binary form**

Res. 4 (EC-LIII), Rec. 9 (CBS-01), approved by the President of WMO, Res. 8 (EC-LV), Res. 2 (EC-LVII), Res. 10 (EC-LIX), Res. 7 (EC-LXI) and adoption between CBS sessions (2010, 2012, 2013 and 2014)

**FM 94–XIV BUFR Binary universal form for the representation of meteorological data**

Res. 1 (EC-XL), Rec. 23 (CBS-89), approved by the President of WMO, Rec. 22 (CBS-91), approved by the President of WMO, Rec. 15 (CBS-93), approved by the President of WMO, Rec. 16 (CBS-94), approved by the President of WMO, Res. 4 (EC-XLVII), Rec. 14 (CBS-95), approved by the President of WMO, Rec. 15 (CBS-96), approved by the President of WMO, Res. 4 (EC-XLIX), Rec. 9 (CBS-97), approved by the President of WMO, Rec. 10 (CBS-98), approved by the President of WMO, Res. 8 (EC-LI), Rec. 8 (CBS-99), Rec. 9 (CBS-00), approved by the President of WMO, Res. 4 (EC-LIII), Rec. 9 (CBS-01), approved by the President of WMO, Res. 8 (EC-LV), Res. 2 (EC-LVII), Res. 10 (EC-LIX), Res. 7 (EC-LXI), and adoption between CBS sessions (2010, 2012 and 2013)

**- BUFR Table D**

**Category 01 – Location and identification sequences**

|  |  | Category 01 |  |
| --- | --- | --- | --- |
| TABLE  REFERENCE | TABLE  REFERENCES | ELEMENT NAME | ELEMENT DESCRIPTION |
| F X Y |
|  |  |  |  |
|  |  | (Encrypted ship's call sign and encryption method) (see Notes 2 and~~,~~ 3 ~~and 4~~) |  |
| 3 01 018 | 0 01 114 | Encrypted ship or mobile land station identifier (base64 encoding) |  |
|  | 0 25 185 | Encryption method |  |
|  | 0 25 186 | Encryption key version |  |
|  |  |  |  |

Notes:

…

~~(4) The encryption keys will be managed by the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology Focal Point on Ship Masking.~~

**- PART C, COMMON FEATURES TO BINARY AND ALPHANUMERIC CODES, a. FM SYSTEM OF NUMBERING BINARY CODES**

Each table-driven code bears a number, preceded by the letters FM. Before 2018, ~~This~~ this number ~~is~~ was followed by a Roman numeral to identify the session of CBS which either approved the code as a new one or made the latest amendment to its previous version. A code approved or amended by correspondence after a session of CBS received~~s~~ the number of that session.

Furthermore, an indicator term is used to designate the code colloquially and is therefore called a “code name”.

Note on nomenclature:

Changes and augmentations to the structure of the CREX data representation shall be identified as different “CREX edition numbers”. The previous edition number was 1. The new edition number is 2.

Changes to the content of the parameter Tables A, B, C and D shall be identified as different “table versions”. The previous tables were Version 32; the changes described in this edition will become “Tables A, B, C and D, Version 33”.

Further CREX editions and table versions may be generated independently of one another in the future as requirements dictate.

The FM system of numbering the codes, together with the corresponding code names and their reference list of ~~CBS approved decision~~ approved decisions, is the following:

**FM SYSTEM OF TABLE-DRIVEN ALPHANUMERIC CODES**

FM 95–XIV CREX Character form for the representation and exchange of data Res. 8 (EC-LI), Rec. 8 (CBS-99), Rec. 9 (CBS-00), approved by the President of WMO, Res. 4 (EC-LIII), Rec. 9 (CBS-01), approved by the President of WMO, Res. 2 (EC-LVII), Res. 10 (EC-LIX) and Res. 7 (EC-LXI), and adoption between CBS sessions (2010, 2012 and 2013)

**Manual on Codes Volume I.3**

**- INTRODUCTION**

…

Coded messages are used for the international exchange of meteorological information comprising observational data provided by the ~~World Weather Watch (WWW) Global Observing System~~ WMO Integrated Global Observing System and processed data provided by the ~~WWW~~ Global Data-processing and Forecasting System. Coded messages are also used for the international exchange of observed and processed data required in specific applications of meteorology to various human activities and for exchanges of information related to meteorology.

* **FM SYSTEM OF NUMBERING XML MARKUP LANGUAGE APPLICATION SCHEMAS**

Each XML application schema bears a number, preceded by the letters FM. Before 2018, ~~T~~this number ~~is~~ was followed by a numeral to identify the session of the Commission for Basic Systems (CBS) that either approved the XML application schema as a new one or made the latest amendment to its previous version. An XML application schema approved or amended by correspondence after a CBS session received~~s~~ the number of that session. After 2018, this number is followed by the year it was approved and the sequence number of the fast-track procedure, if applicable.

Furthermore, an indicator term is used to designate the XML representation colloquially and is therefore called a “code name”.

Notes on nomenclature:

(a) Changes and augmentations to the structure of the XML data representation shall be identified as different “editions”. Each edition of the XML code is allocated a unique namespace. To distinguish between editions, namespaces include EITHER a year field, denoting the year in which those changes and augmentations were begun, OR a version number. For example, FM 202-16 METCE-XML has the namespace <http://def.wmo.int/metce/2013> (initial year of work 2013) whilst FM 205-16 IWXXM-XML has the namespace <http://icao.int/iwxxm/2.1> (version number 2.1).

(b) Changes to the content of any of the supporting tables are backward compatible. Terms used within the supporting tables may be deprecated; they will not be deleted. Once changes to the supporting tables are approved, a snapshot containing all the supporting tables required for XML codes will be published. Each snapshot is referred to as a “table version”. The current table version for XML codes is Version 1.

(c) Backward-compatible changes, including addition of new elements or attributes to supporting tables, do not require a new edition of the XML code.

(d) Further XML code editions and table versions may be generated independently of one another in the future as requirements dictate.

The following table lists XML application schemas included within the FM numbering system, together with the corresponding code names and their reference list of approval decisions. ~~Of the World Meteorological Congress, the Executive Council or CBS, .~~

**FM System of extensible markup language representations**

|  |  |
| --- | --- |
| **FM 201-15 Ext. COLLECT‑XML** | Collection of reports that use the same XML application schemas.  Resolution 32 (Cg-17) |
| **FM 201-16 COLLECT‑XML** | Collection of reports that use the same XML application schemas.  Resolution 9 (EC-69) |
| **FM 202-15 Ext. METCE‑XML** | Foundation Meteorological Information. *Modèle pour l’échange des informations sur le temps, le climat et l’eau* (Model for the Exchange of Information on Weather, Climate and Water). A set of foundation building blocks to support application schemas in the domains of interest to WMO, notably the weather, climate, hydrology, oceanography and space weather disciplines.  Resolution 32 (Cg-17) |
| **FM 202-16 METCE‑XML** | Foundation Meteorological Information. *Modèle pour l’échange des informations sur le temps, le climat et l’eau* (Model for the Exchange of Information on Weather, Climate and Water). A set of foundation building blocks to support application schemas in the domains of interest to WMO, notably the weather, climate, hydrology, oceanography and space weather disciplines.  Resolution 9 (EC-69) |
| **FM 203-15 Ext. OPM‑XML** | Observable Property Model. Based on work by the Open Geospatial Consortium (OGC) Sensor Web Enablement Domain Working Group, this allows observable properties (also known as quantity kinds) to be aggregated into groups, and for any qualification or constraint relating to those observable properties to be described explicitly.  Resolution 32 (Cg-17) |
| **FM 204-15 Ext. SAF‑XML** | Simple Aeronautical Features. Allows items such as airports or runways to be described to the level of detail required for reporting weather information for international civil aviation purposes.  Resolution 32 (Cg-17) |
| **FM 205-15 Ext. IWXXM‑XML** | ICAO Meteorological Information Exchange Model. Defines the reports required by the International Civil Aviation Organization (ICAO) – with information content equivalent to that in the alphanumeric METAR/SPECI, TAF and SIGMET code forms – that are built from the components of the packages managed by WMO.  Resolution 32 (Cg-17) |
| **FM 205-16 IWXXM‑XML** | ICAO Meteorological Information Exchange Model. Defines the reports required by the International Civil Aviation Organization (ICAO) – with information content equivalent to that in the alphanumeric METAR/SPECI, TAF, SIGMET, AIRMET, Tropical Cyclone Advisory, and Volcanic Ash Advisory code forms – that are built from the components of the packages managed by WMO.  Resolution 9 (EC-69) |
| **FM 205-2018 IWXXM‑XML** | ICAO Meteorological Information Exchange Model. Defines the reports required by the International Civil Aviation Organization (ICAO) – with information content equivalent to that in the alphanumeric METAR/SPECI, TAF, SIGMET, AIRMET, Tropical Cyclone Advisory, Volcanic Ash Advisory and Space Weather Advisory code forms – that are built from the components of the packages managed by WMO.  Fast-track procedure in accordance with Resolution 21 (Cg-17) |
| **FM 221-16  TSML‑XML** | Representation of information as time series.  Resolution 9 (EC‑69) |
| **FM 231-16  WMLTS‑XML** | Hydrological Time Series. Allows a monotonic series of observations over time to be described to the level of detail required for accurate representation as time series, with specific consideration for hydrological data.  Resolution 11 (EC-69) |
| **FM 232-16  WMLRGS‑XML** | Ratings, Gaugings and Sections. Allows the description of the process and conversions used to determine hydrological observations such as river discharge.  Resolution 11 (EC-69) |
| **FM 232-2020  WMLGW‑XML** | WaterML 2 Groundwater. Used for the exchange of hydrogeological information in XML in accordance with the “WaterML 2: Part 4 – GroundWaterML 2 (GWML2)” schemas.  Fast-track procedure in accordance with Resolution 21 (Cg-17) |
| **FM 241-16  WMDR-XML** | WMO Integrated Global Observing System (WIGOS) metadata representation. Allows WIGOS metadata to be exchanged.  The code tables supporting WIGOS metadata are included in this code form.  The code tables were approved by Resolution 10 (EC-69). |

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