Handbook

DAYCLI: Report of daily values at a land station reported monthly

The DAYCLI report, which includes daily temperatures and precipitations, is exchanged into a specific WMO binary format, the Binary Universal Form for the Representation of meteorological data, commonly named BUFR. Please see the specific BUFR c DAYCLI template that designs the structure of the data values in the Manual on Codes, Part B Binary Codes, WMO-No. 306.

This handbook is designed for meteorologists who will be in charge of collecting the necessary information on data and metadata required for the DAYCLY report. In particular, national practices regarding the time slots for daily parameters, calculation methods and the quality of the data and of the siting/measurement of the sensor will be needed. This handbook does not intend to assist in compiling into BUFR the DAYCLI report.

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# Introduction

Recognising the increasing importance of monitoring extremes in a variable and changing climate, with their concomitant effects on climate-sensitive activities, this document describes requirements for the DAYCLI report. With the DAYCLI report Member Countries’ National Meteorological and Hydrological Services (NMHSs) are providing daily information on key climate variables, submitted as a monthly report. Six variables are monitored, these being: **maximum temperature, minimum temperature, mean temperature, precipitation, depth of fresh snow, and depth of total snow on the ground**.

DAYCLI messages have a number of requirements, including:

* [*Defining the climatological day against the Universal Time Coordinated (UTC) to which the values of the variables measured at a station are assigned to*.]
* Recording the time periods over which the daily extremes, means or accumulation are reported. These may vary between countries and between variables, depending on historic reporting practices.
* Information on quality control processes necessary to provide information on confidence in the data are indicated by quality flags.
* Information on whether a temperature or precipitation value has been aggregated over several days and whether a reported value can be treated as an upper or lower bound, for example due to an overflowing rain gauge.

This handbook is based on the following principles:

* It recognises that individual NMHSs have the best knowledge on the quality of the data it holds;
* It provides a means, and guidance, for all Members to share high-quality data;
* It remains as simple as possible, and support ongoing practices as far as possible;
* It proposes a basic framework on data quality coding that can eventually later into more general useevolve .

This handbook sets out details on how to record the individual elements of the DAYCLI report ready for encoding to BUFR and exchange worldwide. It does not give explanation on how to encode the DAYCLI report into BUFR.

To assist Members in applying the data quality flagging requirements for DAYCLI, this handbook provides a number of use cases, detailing advice on how to record data under certain situations which, while relatively unusual, provide extremely valuable climatic/hydrological information, such as aggregations, overflowing raingauges, and readings that fall outside of instrumental range.

# Which stations should report a DAYCLI?

*Consult the WIGOS colleagues, SERCOM/SC-CS, INFCOM SC-IMT*

# [Ensure there is a way for WMO members to declare a station (through OSCAR ?) that send CLIMAT or DAYCLI message which were represented with the deprecated Regional Basic Climatological Network (RBCN) Summary of observational requirements

The DAYCLI report conveys daily values of the 6 following observed variables, with their unit and reported resolution specified in the Table 1 below:

*Table 1. Required variables and reporting resolution*

|  |  |  |
| --- | --- | --- |
| **Element name** | **Unit** | **Reporting resolution** |
| Total accumulated precipitation | mm | 0.1 |
| Depth of fresh snow | cm | 1 |
| Total snow depth | cm | 1 |
| Max Temperature | °, C | 0.1 |
| Min Temperature | °C | 0.1 |
| Mean Temperature | °C | 0.1 |

Notes:

See the Guide to Instruments and Methods of Observation (WMO-No. 8, Volume I, Annex 1A) that gives the reported resolution as well as the required measurement uncertainty.

In addition to these values, a set of information also called metadata accompany the DAYCLI report:

* the time difference from UTC to obtain the climatological day;
* the periods of measurement assigned to each variable;
* the Siting classification and the Measurement Quality Classification (MQC) assigned to the instruments that measure the temperatures and the precipitations
* the computation method used to obtain the mean daily temperature;
* and finally, information on quality on each value of the variables indicated by quality flag.

# Climatological day and periods of measurement

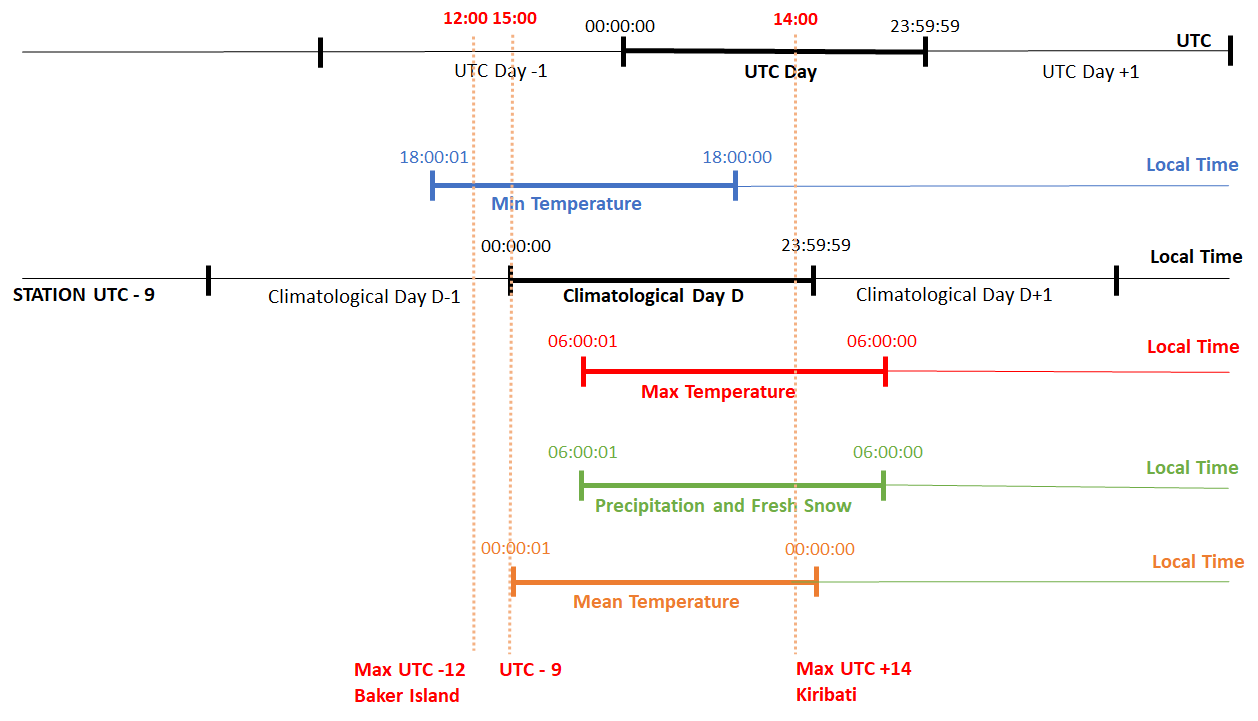
The definition of the “climatological day” for a station is the 24 hour period that, by national convention, defines the day to which the observations or measurements of the various variables at a meteorological station will be assigned to. ~~A country may have several climatological days but a point of measurement, a meteorological station, has only 1 reference climatological day~~.

In principle, at an automated station it is possible to define any 24-hour window as the climatological day. However, it is preferred where possible to maintain consistency over time in the definition, as changing the definition at a station may introduce an inhomogeneity (or bias) into the record. As, historically, many stations were manual (and many national networks still contain a substantial proportion of manual observations), national observation times for the climatological day are often influenced by which time is most practical for observers (e.g. observation times in the morning are more common than midnight). Some countries may use different observation times for their NMHS-staffed (or automated) network to those used for their volunteer network.

The climatological day is typically defined in terms of UTC, Local Standard Time (LST; local time with any use of summer/daylight savings time removed), or local clock time (including summer/daylight savings time where used) (LCT). In some countries with multiple time zones a common UTC observation time is used nationally. For some others it is not the case and the different time zones are kept as they are. The use of UTC or LST is preferred where possible.

In some cases, locations use different time windows for different variables. In some cases the value may also be attributed to a day offset from the day of observations, e.g. if the daily maximum temperature is measured for the 24 hours ending at 0900 LST, it may be attributed to the previous day (which is the day when the maximum temperature is most likely to have occurred). A possible example is:

* for daily fresh snow the period used could start from 06:00:01 of the assigned climatological day (D) to 06:00:00 of the next day (D+1)
* for daily precipitations the period used could start from 06:00:01 of the assigned climatological day (D) to 06:00:00 of the next day (D+1)
* for daily Maximum Temperature the period used could start from 06:00:01 of the assigned climatological day (D) to 06:00:00 of the assigned climatological day (D+1)
* for daily Minimum Temperature the period used could start from 18:00:01 of the day before the assigned climatological day (D-1) to 18:00:00 of the assigned climatological day (D)
* for daily Mean Temperature the period used could be from 00:00:01 of the assigned climatological day (D) to 00:00:00 of the next day (D+1)

*Figure 1, Example of a station with a local time zone is -9 hours from UTC*

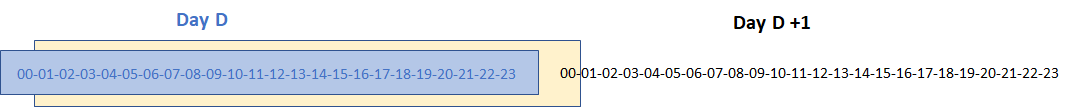
Other possible convention, also used by some NMHSs, is for example:

* for daily Mean Temperature the period used could be from 00:00:00 of the assigned climatological day (D) to 23:59:59 of the assigned climatological day (D).

Indeed, if we take the case of an NMHS that observes the 24 temperature values and plots them over 1 climatological day, assigning them the hours from 00h to 23h. This NMHS can calculate the average for the climatological day by deciding:

1. either to calculate it with the 24 values from 00h to 23h of the same climatological day
2. or to calculate it with the 24 values from 01h of day D to 00h of the following day.

*Figure 2, Time slot conventions for a climatological day*



The second convention, from 01h of day D to 00h of the following day, is particularly relevant when addressing the case of Minimum or Maximum temperature. Effectively, the hourly Minimum or Maximum of the temperature observes at 00h is representative of the Minimum or Maximum temperature that occurs during 23h to 00h, so more representative of the day before.

An offset that could take the value -1, 0 or +1 is used to indicate if the starting time of the concerned time period of the variable belongs to the previous climatological day, the assigned climatological day or the following climatological day:

offset = -1: the starting time of the concerned time period belongs to the previous climatological day

offset = 0: the starting time of the concerned time period belongs to the current climatological day

offset = 1: the starting time of the concerned time period belongs to the following climatological day

*Table 2, example for the 2nd of January 2020 in a “virtual”station:*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Climatological day | Parameter | Value | Period of measurement | offset |
| 2/01/2020 | Precipitation | 10 mm | 06:00:01 to 06:00:00 | 0 |
| 2/01/2020 | Fresh snow | 3 cm | 06:00:01 to 06:00.00 | 0 |
| 2/01/2020 | Total snow depth | 250 cm | 06:00:01 to 06:00.00 | 0 |
| 2/01/2020 | Max T. | 20 °C | 06:00:01 to 06:00:00 | 0 |
| 2/01/2020 | Min T. | -4.3°C | 18:00:01 to 18:00:00 | -1 |
| 2/01/2020 | Mean T. | 7.9°C | 00:00:00 to 23:59:59 | 0 |

*Add into the BUFR template a new information: the Time difference from UTC (Coordinated Universal Time) used for the climatological day*

~~Please note: if you are making a change in period of measurement, it is preferable to launch the change at the beginning of a month, as the measurement periods are identical for the whole month.~~

# Siting classification & Measurement Quality Classification (MQC)

Two indicators are part of the DAYCLI report that give quality information on the observations at each measurement point. The first is the siting classification and the second the measurement quality classification.

## Siting classification

The siting classification rates the location and environment surrounding a sensor based on likelihood of the environment and siting of the sensor leading to a modification of the property measured prior to its measurement. For example, a heat source located near a thermometer that modifies the parcel of air prior to the temperature being measured, and leads to the parcel of air no longer being representative of the surrounding environment.

For the DAYCLI report two sensors are relevant: (1) the air temperature and (2) the precipitation. Snow sensors may also be relevant if used.

This classification is divided into 5 classes from 1 to 5. Hence, a class 1 site can be considered as a WMO reference site. A class 5 site is a site where nearby obstacles create an inappropriate environment for a meteorological measurement that is intended to be representative of a wide area (at least tens of km2). The smaller the siting class, the higher the representativeness of the measurement for a wide area. In a perfect world, all sites would be in class 1, but the real world is not perfect and some compromises are necessary. A site with a poor class number (large number) can still be valuable for a specific application (e.g. urban climatology) needing a measurement in this particular site, including its local obstacles.

Siting classifications are defined in the WMO guide to Instrument and methods of observation, Volume I – Measurements of Meteorological Variables (WMO-No. 8), 2023 Edition and its ANNEX 1.D. SITING CLASSIFICATIONS FOR SURFACE OBSERVING STATIONS ON LAND. Chapter 2 covers temperature and Chapter 3 precipitation.

*Figure 1, Rain gauge siting classification example*



## Measurement quality classification

The measurement quality classification rates an instrument or sensor based on its expected uncertainty, taking factors such as the sensor used, the sensor housing and coupling, calibration and maintenance schedule and environmental factors that affect the sensor into account.

For example, due to the design of a thermometer housing or screen there may be excessive evaporation under wet conditions, leading to a cooling of the sensor and a biased low reading. Alternatively, the housing may warm excessively under strong sunlight, leading to a biased high reading.

Four measurement quality classes are defined, from A class to D class. Table 3 below lists the current thresholds for the different classes.The classes are broadly aligned with the requirements specified in the WMO Observing System Capabilities and Requirements (OSCAR) database, with Class A corresponding to the "Goal" level, Class B to "Breakthrough" and Class C to the "Threshold" level. Further information, including example calculations, can be found in the *Guide to Instruments and Methods of Observation (WMO-No. 8) – Volume I, Annex 1.G.* Note that as snow is often measured manually with a ruler (if observed at all) it is not listed here.

*Table 3: Measurement quality classifications and thresholds for air temperature and accumulated liquid precipitation, taken from the Guide to Instruments and Methods of Observation (WMO-No. 8). Uncertainties are expressed at the 95 % confidence level.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measurand** | **Class A** | **Class B** | **Class C** | **Class D** |
| Air temperature | 0.2 K | 0.6 K | 1.0 K | Greater than Class C or unknown |
| Liquid precipitation amount (daily accumulated | Greater of 1 mm or 2 % | Greater of 3 mm or 5 % | Greater of 5 mm or 10 % |

# Computation of the mean temperature

The principle behind the DAYCLI message is to exchange so-called high-quality data, in other words, data that should have been subjected to quality controls and that should be homogeneous in terms of management (measurement, control, calculation) to the station's historical data series to which it could refer. Changing the method of calculation may introduce a systematic bias (or inhomogeneity) into the data.

To comply with this principle, the method used to calculate the average daily temperature is included in the message. In conjunction with these methods, recommendations on how to deal with missing data will be discussed.

## Method used to calculate the daily mean temperature

The different methods, which are, so far, known to be used by WMO Members, are listed in the following BUFR Table 3. These are all methods used with the available data to approximate the “true” daily mean (defined using the integral of the daily temperature curve); for example, the weighted means (codes 3 and 4) are attempts to estimate the full daily mean from a limited number of fixed-hour observations.

These methods depend on the frequency with which meteorological parameters are measured over time, and the techniques used to obtain as close as possible a correct approximation of the daily average. For the most part, they are the result of the constraints of human observation, where 24-hour measurements were not always possible. These methods include the average of:

* Maximum and minimum temperatures.
* 8 values spaced 3 hours apart, known as synoptic standard times;
* 24 hourly values spaced 1 hour apart;
* 3 weighted values;
* 3 weighted values and maximum and minimum temperatures for the day;
* 4 values spaced 6 hours apart, known as main or intermediate synoptic standard times;
* all 1440 Minute values in a day;

*Table 3: Averaging methods for air temperature and associated BUFR code figures  
BUFR code table 0-08-094*

|  |  |
| --- | --- |
| **Code figure** | **Description** |
| 0 | Average of maximum and minimum values: Tm = (Tx + Tn)/2 (see Note) |
| 1 | Average of the 8 observations taken every three hours |
| 2 | Average of the 24 hourly observations |
| 3 | Weighted average of 3 observations: Tm = (aT1 + bT2 + cT3) (see Note) |
| 4 | Weighted average of 3 observations and also maximum and minimum values:  Tm = (aT1 + bT2 + cT3 + dTx + eTn) (see Note) |
| 5 | Automatic weather station complete integration from minute data |
| 6 | Average of the 4 observations taken every six hours |

*Note: The letters a, b, c, d and e generically represent the weight associated with the respective temperature T. The sub-index of T: 1, 2, 3, x and n represent the values measured at different times or maximum (x) or minimum (n) values.*

It is recommended that countries maintain a consistent calculation method over time. For example, a national meteorological and hydrological service (NMHS) could decide to continue to exchange temperature data from a station that has been calculating mean temperature for over fifty years, using the 8 standard times for surface observations corresponding to the station's climatological day (e.g. at 00, 03, 06, 09, 12, 15, 18 and 21 hour).

Another NMHS could exchange the daily average temperature of some of its newly automated stations, calculating it from all the day's minute data, i.e. the average of 1,440 values.

It is therefore very difficult to dictate a strict, general rule for all the stations worldwide, or even within a single country. At the very least, the NMHS is advised to:

* continue to maintain homogeneous data series in terms of calculation methods. Depending on the products or services required, a NMHS may maintain several time series for the same parameter and for the same station, but over different periods and with different methods. For example, an average daily temperature series calculated from 8 observations and another average time series calculated from 1440 observations. The NMHS is free to exchange either one or the other method.
* always describe the calculation method used for data exchanged with DAYCLI. Note that if the method used by an NMHS is not listed in the BUFR table 0-08-094 the NMHS could report it to WMO for addition.

In summary, the best statistical approximation of an average is based on the integration of continuous observations over a period of time; the higher the frequency of observations, the more accurate the average. However, practical considerations generally preclude the calculation of a daily average from a large number of observations evenly distributed over a 24-hour period because many observing sites do not measure an element continuously, and historically many stations have made observations manually, sometimes with only one or two observations per day. It is also because the world is still in a phase of automatization progress of weather stations and in automatization of data collection and management.

~~In the medium and long term, the trend should be towards greater automation of meteorological stations and, consequently, exchanges with greater possibilities of average accuracy~~.

## How to handle missing data in the computation of the mean temperature

There is no uniform standard to handle missing data in the computation of a daily mean of a parameter. The rules are varied and depend on the calculation method used and local practices. The following are examples of rules used by NMHSs for managing missing data depending on the samples. These guidelines do not provide an exhaustive list of rules, but rather highlights their diversity.

### Daily mean using 1440 1-Minute values

There are various rules that are currently implemented in automatic weather stations (AWS), in data collection platforms (platforms that collect and manage AWS data) and Climate data management system (CDMS). One of them is the rule 1/10 explained below:

**Rule 1/10**

If 1/10 of the values or more are missing (i.e. 144 values or more out of the 1440-Minute values) then the corresponding daily data is considered to be missing.

### Daily mean using 24 Hourly values

A variety of methods are used:

**Rule 1/10**

If 1/10 or more of the values are missing (i.e. 3 values or more out of the 24-Hourly values) then the daily mean shall be computed with the 8 values at synoptic standard times (e.g. at 00, 03, 06, 09, 12, 15, 18 and 21 hour). And if 1 or more value among the 8 values at synoptic standard times is missing the daily mean is considered as missing.

Some NMHSs are less restrictive and increase the percentage of missing values allowed to 1/6. Other allows to compute a daily mean with 4 values for main standard times (00, 06, 12,18) or 4 values from intermediate standard times (03, 09, 15, 21).

**Rule 3 consecutive or 5 global**

If 3 **consecutive** values or more are missing among the 24-Hourly values then the daily mean shall be computed with the rule 2/8 with the 8-Hourly values at standard times (see the rule 2/8 below).

Also, If 5 **global** values or more are missing among the 24-Hourly values then the daily mean shall be computed with the rule 2/8 with the 8-Hourly values at standard times (see the rule 2/8 below).

### Daily mean using 8 3-Hourly values at standard time

**Rule 2/8**

if 2 or more Hourly values among the 8 values at standard times are missing then the daily mean is considered as missing

**Rule 1/****8**

If 1 value among the 8 standard times for surface observations (00, 03, 06, 09, 12, 15, 18, 21) is missing then the mean shall be computed with the 4 main standard times (00, 06, 12, 18) or the 4 intermediate standard times (03, 09, 15, 21).

### Daily mean using 4 6-Hourly values at main or intermediate standard time

**Rule 1/4**

If 1 among the 4 main standard times (00, 06, 12, 18) or if 1 among the 4 intermediate standard times (03, 09, 15, 21) is missing then the mean is considered as missing.

## Conclusion

|  |
| --- |
| Given the variety of climatological practices in place in meteorological services, it is recommended that NMHSs:   * report their current method to calculate the mean daily temperature into the DAYCLI message; * carefully study any change in calculation method and its consequences before implementing it; * in case of modification (new station, new equipment) favor a better approximation of the temperature calculation, for example by increasing the sample (e.g. from 4 values at main standard times to 24 hourly values) without, however, undermining the homogeneity of certain long series of data; * And, if no missing data management rule is implemented, adopt one. |

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

## *References for the reviewers*

### *Method for computation of the mean of the daily temperature and how to handle missing data*

***WMO/TD-No.341, 1989, Calculation of monthly and annual 30-year standard normal***

*The recommendation for some parameters is to use either the 24 hourly observations or the 8 synoptic observations plus one Flag to indicate the number of observations used for the calculation.*

***WMO/TD-No. 1188, 2009, Handbook on CLIMAT and CLIMAT TEMP Reporting***

*“Mean daily values shall be calculated on the basis of observations either at the UTC main standard times for surface synoptic observations or at both the UTC main and intermediate standard times for surface synoptic observations for each day in local time (0000 - 2359). As an exception, observational days for precipitation are defined from 0601 UTC to 0600 UTC of the following day (hence, six hours of the following UTC day shall be considered as belonging to the preceding UTC day).”* ***page 11***

*“The daily mean air temperature Tday-j is the arithmetic mean of all four or eight air temperature values observed during a day j.”* ***page 11***

*“The main standard times for surface synoptic observations are 0000, 0600, 1200 and 1800 UTC. The intermediate standard times for surface synoptic observations are 0300, 0900, 1500 and 2100 UTC.*

*Mean daily values shall be calculated as an average of observation values at the UTC standard times for surface synoptic observations which correspond to a given day j in local time (0000 - 2359 local time) for all days of the respective month. All four or eight observations shall be used for daily averaging.”*

*If any value necessary for the calculation of a mean daily value is missing, the missing value, if possible, should be taken from appropriate autographic records. If this cannot be done, and if it was intended to calculate the mean daily value on the base of eight standard times for surface synoptic observations, then only the four main or intermediate standard times for surface synoptic observations shall be used for calculation. If this cannot be done, the respective daily mean value shall be marked as missing. It is not allowable to use less than four either main or intermediate standard times for surface synoptic observations for the calculation of a mean daily value.”* ***Page 12***

***WMO-No. 1203, 2017, WMO Guidelines on the Calculation of Climate Normals***

*“Definition of observation day, and the way in which daily mean temperature is calculated, should be according to national standards and documented in metadata (see also section 4.9). Different methods are in operational use for the calculation of daily mean temperature.”* ***Page 3****.*

### *Summary on rules used by NMHSs or describe in guidelines*

|  |  |  |  |
| --- | --- | --- | --- |
| ***System or guidelines*** | ***Mean- Average*** | ***Cumul*** | ***Extreme*** |
| *WMO-No.1203* | *According national practice* | *According national practice* | *According national practice* |
| *WMO-No 100* | *No indication* | *No indication* | *No indication* |
| *WMO TD 341* | *24 or 8 standard + Flag* | *No indication* | *No indication* |
| *WMO TD 1188* | *24 or 8 standard or 4 main/intermediate* | *No indication* | *No indication* |
| *NOAA* | *Variety of ways* | *No indication* | *No indication* |
| *MF OKAPI* | *1/6* | *100% complete* | *100% complete* |
| *MF NORMALS* | *3 consecutive or 5 global* | *100% complete* | *Available values* |
| *MF CLIMSOL* | *1/10* | *100% complete* | *100% complete* |
| *Denmark* | *24, (TX +Tn)/2, 8 standard* |  |  |
| *Canada* | *1/10* | *100% complete* | *Available values* |

*MF means Météo-France that has different rules according the system used (CLIMSOL, OKAPI and the Normals)*

*An interesting document describe the rules for computing daily data in Denmark, Finland, Norway, Sweden (Norwegian Meteorological Institute, met.no report no. 03/2007 Climate: NORDGRID, a preliminary investigation on the potential for creation of a joint Nordic gridded climate dataset by Anna Jansson, Ole Einar Tveito, Pentti Pirinen, Michael Scharling.*

***For Canada***

*https://climate.weather.gc.ca/doc/Canadian\_Climate\_Normals\_1981\_2010\_Calculation\_Information.pdf*

*https://climat.meteo.gc.ca/doc/Documentation\_technique.pdf*

***NOAA***

*NOAA for Local Climatological Data (LCD) Dataset Documentation*

*https://www.ncdc.noaa.gov/cdo-web/datasets" https://www.ncdc.noaa.gov/cdo-web/datasets*

*https://www1.ncdc.noaa.gov/pub/data/normals/1981-2010/documentation/" https://www1.ncdc.noaa.gov/pub/data/normals/1981-2010/documentation/*

*https://www1.ncdc.noaa.gov/pub/data/ghcn/daily/readme.txt*

*Times are in Local Standard Time (LST) and Daylight Savings Time is not used*

# Quality Control and Quality Flags

## Principles

NMHSs have different methods for, and different capacities with regard to, climatological data quality control. WMO No 1269 (“*WMO Guidelines on surface station climate data Quality Control and Quality Assurance for climate applications*”) provides general guidance on quality control (QC), along with examples of specific tests, and it is recommended that readers consult this publication. However there is as yet no current global standard approach to the **flagging** of climatological data quality, and therefore no standard quality flagging system.

Nevertheless, the DAYCLI report format specifies several quality control guidance criteria that define in general terms the confidence that may be applied to the data, and also enable identification and reflection of some common issues that apply to daily data, such as multi-day precipitation aggregations, instrument failures or range issues, etc. This Guidance approaches the evaluation and flagging of data quality, and possible limitations for data to be exchanged at the global level via DAYCLI, according to the following principles:

* + the NMHS and its personnel have the best knowledge on the quality of the data held;
  + noting certain new requirements, and the time-bound requirements for DAYCLI messages, the requirements will remain as simple as possible;
  + aim to enable provision to users of as much as information as possible on the data, including in unusual situations such as extreme events;
  + the framework on data quality coding in this Guidance will form a basis that it is hoped will eventually evolve towards homogeneous procedures for quality flags.

A range of Use Case scenarios are provided in the following Section These are designed to assist Members in identifying and correctly interpreting certain scenarios that, while in many cases are unusual, are of vital importance to properly flag extreme or ambiguous events.

## Quality information on data value

**The Table 4** below lists the quality codes (QC) to be applied to data values

*Table 4: QC flags of daily climate data.*

|  |  |
| --- | --- |
| Code Quality Flag | Meaning |
| 0 | Data checked and declared good |
| 1 | Data checked and declared suspect |
| 2 | Data checked and declared aggregated |
| 3 | Data checked and declared out of instrument range |
| 4 | Data checked and declared aggregated and out of instrument range |
| 5 | Parameter is not measured at the station |
| 6 | Daily value not provided |
| 7 | Data unchecked |
| 8…254 | Reserved |
| 255 | Missing (QC info not available) |

**Data checked.**  The data have been checked by personnel or systems assigned the relevant authority, and an adjudication made as to whether the data are declared to be fit (or unfit) for at least immediate operational use;

### 0 - Data checked and declared “Good”

Checks inspire confidence that the value assessed is a true representation of the variable for that day. A piece of data (datum) may fail one QC test, but confirmatory evidence may exist that the datum is still reliable. For instance, an extremely high temperature value is supported by similarly extreme values at neighbouring stations.

### 1 - Data checked and declared “Suspect”

Observation fails more than one QC test, is on the whole regarded as probably accurate, but there is some minor doubt. Overall, the operator would have at least medium confidence in the data, so it should still be exchanged.

**Note[[1]](#footnote-2):** WhereQC checks indicate low confidence in the value, or it is known to be wrong, the value should be regarded as Doubtful or Wrong. Such data should not be exchanged; instead it should be coded as “missing” (Code 6).

### 2 – Data checked and declared “Aggregated”

In this case the amount of precipitation assigned for a day actually represents the amount of precipitation accumulated over several days. This situation is commonly associated with manual stations where, for instance, the gauge is not read over a weekend period. It can also occur for snowfall amount, including where snow blocks a gauge.

It may also happen that a temperature value (minimum or maximum) may represent the lowest/highest value across a period of several days. In such cases, unless it is obvious which day the extreme occurred on, “Aggregated” is recommended.

### 3 – Data checked and declared “Out of instrument range/instrument failure”

This covers the special case where the total amount of precipitation cannot be determined due to exceeding the capacity of an instrument such as a raingauge (or instrumental failure), but a lower bound is known, i.e. the capacity of the gauge, or the total at which instrument failure occurs. This situation typically applies in heavy rainfall situations which have obvious climatological and hydrological significance, and where the gauge is manually read. In such cases it is useful to record the fact that a significant precipitation event occurred, the exact amount of which is unknown, but at least exceeds a known threshold (i.e., the capacity of the gauge).

Such a flag could also be considered in cases where an automated instrumentation-related failure (e.g. loss of communications, etc) enables a lower bound to be established; for instance, during a rainfall event where precipitation has occurred, but the instrument fails before the end of the rain event. In such cases it is at the discretion of the NMHS as to whether this approach should be used, or whether the value is simply flagged as “missing[[2]](#endnote-2)”. See the Use Case example 6.3.4 below.

A similar situation may occur in the case of new snow depth if a gauge becomes blocked with snow (see example in 6.3.8 below).

### 4 -Data checked and declared aggregated and out of instrument range

As the name implies, this is a combination of the previous two situations, flagging a situation where the amount of precipitation assigned for a day represents an accumulated total spanning two or more days, AND the situation represents an overflowed gauge /underestimated total case.

### 5 – Parameter is not measured at the station.

The station does not have the instrumentation to be able to measure this parameter. E.g. no instrument for measuring snow. This classification would also apply if the instrumentation is available, but is non-operational at that date due to maintenance, damage or some other cause.

### 6 – Data value not provided.

The daily value is missing. There are several possible reasons for this: - transmission problem; observer absent; a doubtful value that the data provider considers so unlikely that it is not scientifically justifiable to provide it (see above under note “*Data checked and declared Suspect*”

### 7 - Data unchecked [[3]](#footnote-3)

No QC processes have been performed on the data other than perhaps AWS Central Processing Unit tests, database ingest checks, etc which will normally be confined to format or constraint tests, and thus will only catch gross errors, e.g., data that are physically impossible, or nearly so. When assigning “Data unchecked” to a value to be reported in DAYCLI messages, the implication is that no additional QC checking has been performed on the data except format or constraint tests, that is, there have been no checks on internal consistency, statistical (range) checks, temporal or spatial consistency checks, or other checks as described in WMO No 1269, Annex 1.

### 255 – Quality control information is unavailable.

A data value is available, but no information is provided on quality control, even as to whether the value has been checked or not.

To assist Members, some examples of typical situations, and recommendations on how to assign Quality Flags, are provided in the next Section.

## Illustrative Use Cases for the assignment of QC flags in DAYCLI reports.

**T**his Section provides examples of how to correctly code the QC flags indicating quality, including some of the more complex cases.

Note: it is important to distinguish between situations where:

* a parameter (e.g. snowfall) is not measured;
* measurements are generally made, but a daily value is not provided; or
* QC information is not provided (i.e. QC missing = flag 255 in schema).

### Use case: Parameter not measured at the station

Typical examples of such cases include, for instance, snow in a tropical lowland country, or snow is only measured seasonally. In that case, the QC code is 5: Parameter is not measured at the station.

Coding:

**Depth snow value Associated QC information QC code**

Missing Parameter is not measured at the station 5

### Use case: Parameter measured at the station, but the value for the day is missing.

In this case, the daily value (in this case for maximum temperature) is missing and so of course QC cannot be carried out. Alternatively, value is regarded as doubtful or wrong[[4]](#endnote-3).

Coding:

**Tmax Associated QC information QC code**

Missing Daily value not provided 6

### Use case: QC not provided

Parameter is measured, daily value is present, but daily QC is missing. The QC code is 255. Note that this is separate from the case where there is an aggregation, as in Use case 5 (sub-Section 6.3.5).

It is also separate from the case where QC is not carried out (Code 7).

Coding:

**Tmax Associated QC information QC code**

* 1. QC information not provided 255

### Use case: Gauge overflowed/out of instrument range

A daily value is measured, but there is an overflow for a raingauge, or perhaps a blocked gauge in the case of snow, and therefore the best we can say is that we can specify a minimum amount, but no more than that. In that case, the QC code is 3. In that case, we can understand with high confidence that the measurement exceeds a known minimum, but we don't know what the actual amount is/was

Coding:

**Date Precipitation Associated QC information QC code**

Day 1 203 mm Data checked and declared 3

out of instrument range

Note that this classification might also be considered when obvious instrumental failure leads to a value or total that is almost certainly not representative of the daily total or extreme. For instance, a lightning-induced power failure stops recording of rainfall by an AWS, or some event stops measurements before the daily maximum/minimum temperature has been reached. The 2nd example below represents this situation.

Day 1 17.6 mm Data checked and declared 3

out of instrument range [[5]](#footnote-4)

### Use case: Aggregation

In this case, observations are not available for some individual days, but the aggregated total (or highest/lowest value in the case of temperature) is known.

In the case of precipitation: because of an observer problem or absence, the rain gauge (typically manually-read) has accumulated a precipitation amount over 4 days (from DAY 2 to DAY 5 in the example below). In this example, the precipitation amount for these 4 days is reported at DAY 5 (32.5 mm), following an earlier overflow situation. From DAY 2 to DAY 5 the QC information is set to 2 “Data checked and declared aggregated”, which allows an inference to be drawn on how many days the aggregation corresponds to. So in this case, a total of 32.5mm has occurred on days 2-5, but it is not possible to determine the daily split. For Day 6, noting that the aggregation problem has been solved, this particular day reported no additional precipitation.

Note that if it is known for sure that no precipitation has occurred on one or more days during the aggregation period, it is recommended to include the value as 0.0, and the QC flag set to “Good” See also the example in Use Case 6.8 below.

Coding:

**Date Precipitation Associated QC information QC code**

Day 1 203 mm Data checked, and declared out of instrument range 3

Day 2 Missing Data checked and declared aggregated 2

Day 3 Missing Data checked and declared aggregated 2

Day 4 Missing Data checked and declared aggregated 2

Day 5 32.5 mm Data checked and declared aggregated 2

Day 6 0 mm Data checked and declared good 0

### Use case: Aggregation with instrument in maintenance

This refers to the case where, if we know that data missing over five days, with a known total on the sixth, includes a period where the station or sensor was undergoing maintenance[[6]](#footnote-5), or observations were not possible due to some other cause, then we could distinguish in the daily messages between "data missing" during the maintenance period, where observations did not occur (say, on Days 2-3 in the example below), and aggregated (where we know that on days 4-5 measurements did occur, but we don't know the daily split). Or if the maintenance took place on Days 2-3 the sequence of flags would be: Day1 - aggregated; days 2-3 missing; days 4-5 aggregated (with the total aggregation on Day 5). The major distinguishing feature being that we know no data were available for two of the days in the sequence (Data missing – QC flag 5), and that the aggregation period represents the remaining periods flagged as aggregated (QC Flag 2).

In the example below, no value is available on Day 1, but measurement instruments are functional. On Days 2 and 3 the instruments are out of service, and therefore it is impossible to retrieve any data for these days. On Day 4, instrument is back in service, but no value is available. In Day 5, an aggregated value of 32.5mm is available, which includes the data from Days 4 and 5, and possibly even Day 1.

Note that this would obviously not include cases where data accumulated in Day 1, or any part of Days 2,3, were permanently lost. For instance, a raingauge washed away in a flood, or destroyed. In that case, the aggregation period would resume at Day 4, and the observations on Days 1, 2 and 3 would be flagged as 5.

Such a situation may also apply to other aggregated parameters, namely new snow depth, or Maximum/Minimum temperature. Again, following the example below, the aggregations for these parameters do not include any possible contributions from Days 2 and 3.

Coding:

**Date Precipitation Associated QC information QC code**

Day 1 Missing Data checked and declared aggregated 2

Day 2 Missing Parameter is not measured at the station 5

Day 3 Missing Parameter is not measured at the station 5

Day 4 Missing Data checked and declared aggregated 2

Day 5 32.5 Data checked and declared aggregated 2

### Use case: Aggregation with overflow/out of information range

Refers to cases where there is aggregated precipitation, and at the end, an amount of precipitation that exceeds the raingauge capacity is recorded. This may happen, for example, in cases where a heavy rainfall event occurs when the observer is absent (or needs to be evacuated!), or at isolated typically mountainous locations where a gauge is not checked every day, and orographic effects can lead to large accumulations.

Coding:

**Date Precipitation Associated QC information QC code**

Day 1 3.5 mm Data checked and declared good 0

Day 2 Missing Data checked and declared aggregated 2

Day 3 Missing Data checked and declared aggregated 2

Day 4 Missing Data checked and declared aggregated 2

Day 5 203mm Data checked and declared aggregated and out of

instrument range 4

### Use case: Solid precipitation aggregation with snowmelt over subsequent days

In this situation, heavy snow blocks an automated gauge, then subsequently melts over the next few days, producing spurious precipitation. In the following scenario, which happened at a high altitude station in southeastern Australia in July 2022, heavy precipitation - mainly in the form of snow - was recorded over the first two days. The 38.8mm recorded on the first day was likely a minimum amount, and hence was allotted a flag of 3. Precipitation totals for Days 3 and 4 were known to have been recorded on fine days with no precipitation, so the amounts on those days were purely snowmelt. On the fifth day there was a likely mix of snowmelt and new precipitation. Day 6 was believed to be entirely new precipitation.

Note that ideally, QC processes would cross-check against daily snow amounts. However, if the snow blockage continues for a long period of time – say, in excess of one week – the likelihood is that even when the snow does melt, the total amount measured may be underestimated. In that case a QC flag of 4 may be appropriate.

**Date Precipitation Associated QC information QC code**

Day 1 38.8 mm Data checked and declared out of 3

instrument range

Day 2 23.6 mm Data checked and declared aggregated 2

Day 3 9.2 mm Data checked and declared aggregated 2

Day 4 8.8 mm Data checked and declared aggregated 2

Day 5 3.5 mm Data checked and declared aggregated 2

Day 6 8.0 mm Data checked and declared good 0

### Use case: Missing complete set of values for daily computation.

This case described a situation where not all values are available to compute “perfectly” a daily value. Note that this does not apply only to mean temperature – it may be that, for instance, data are missing around the time of maximum or minimum temperature. In this case, coding should be based on the NMHS’s normal practices, utilising also professional discretion as to the likely impact of the missing data. For instance:

* Where the calculation method to determine a mean daily temperature is to use all 1440 0ne-Minute values (60mn\*24) from an AWS, but some are missing;
* Where the calculation method to determine a daily value (e.g. mean temperature) is to use 24 one-hourly values, but one or several are missing; or
* Where the calculation method to determine a daily value is to use the 8 main synoptic hours of the day (or four, or three), one or several values are missing; or
* An AWS is offline for a period where the minimum or maximum temperature might feasibly have occurred.

In these cases, the NMHS (data provider) may choose from several possibilities:

1. Notwithstanding the missing values, the NMHS data provider considers that the calculated value is still reliable. In that case the encoding would be:

Example:

**TMin Associated QC information QC code**

10.4 Data checked and declared good 0

2. The data provider considers that the missing data may render the value suspect (e.g., night/day imbalance in observations used to compute mean temperature; or values missing around likely time of daily minimum/maximum temperature), but that the value may still be of sufficient value to share worldwide. In that case, the encoding would be:

**TMin Associated QC information QC code**

10.4 Data checked and declared suspect 1

3. The data provider considers that the data is highly suspect, e.g. of the 8 main synoptic hours, 6 are missing; or sufficient values are missing around the likely time of the minimum and maximum temperature that it is highly likely the true Tmin or Tmax is missed. In this case, it would be assumed that the available data does not represent a true assessment of the daily conditions, and therefore the data would be regarded as “doubtful”, i.e, to share it would be misleading. If this assessment is made by the Member’s NMHS, the coding would be:

**TMax Associated QC information QC code**

Missing Daily value not provided 6

# Coding format and examples of correctly-formatted messages.

According to the Manual on Codes (WMO No 306, 2022 edition)[[7]](#footnote-6), BUFR sequence **3 07 075** includes the information required for a complete DAYCLI report as shown in **Table 7** below. This format includes metadata for the particular station, including high accuracy latitude and longitude, the height of the station ground above mean sea level and the height of the sensor above local ground, along with the information on Siting and Measurement Quality Classification, climatological day definition for each parameter, method of computation of mean temperature, accompanied by a Data section consisting of between 28 and 31 lines (each representing one day of the month) containing the observed parameters and assigned quality flags.

|  |  |  |  |
| --- | --- | --- | --- |
| 3 07 075 | 3 01 150 | WIGOS identifier |  |
|  | 3 01 001 | WMO block and station number |  |
|  | 3 01 021 | Latitude/longitude (high accuracy) |  |
|  | 0 07 030 | Height of station ground above mean sea level |  |
|  | 0 08 095 | Siting and measurement quality classification for temperature |  |
|  | 0 08 096 | Siting and measurement quality classification for precipitation |  |
|  | 0 08 094 | Method used to calculate the average daily temperature |  |
|  | 3 01 011 | Year, month, day |  |
|  |  | *Total accumulated precipitation* |  |
|  | 0 04 023 | Time period or displacement | = 0 when beginning time of the period is on the same day as reference date  = –1 when beginning time of the period is on the day before reference date |
|  | 3 01 013 | Hour, minute, second | Beginning time of the period |
|  | 2 04 008 | Add associated field | 8 bits long |
|  | 0 31 021 | Associated field significance | Set as 5 for 8-bit indicator of quality control |
|  | 0 13 060 | Total accumulated precipitation |  |
|  | 2 04 000 | Add associated field | Cancel |
|  |  | *Depth of fresh snow* |  |
|  | 0 04 023 | Time period or displacement | = 0 when beginning time of the period is on the same day as reference date  = –1 when beginning time of the period is on the day before reference date |
|  | 3 01 013 | Hour, minute, second | Beginning time of the period |
|  | 2 04 008 | Add associated field | 8 bits long |
| 3 07 075 (continued) | 0 31 021 | Associated field significance | Set as 5 for 8-bit indicator of quality control |
|  | 0 13 012 | Depth of fresh snow |  |
|  | 2 04 000 | Add associated field | Cancel |
|  |  | *Total snow depth* |  |
|  | 0 04 023 | Time period or displacement | = 0 when beginning time of the period is on the same day as reference date  = –1 when beginning time of the period is on the day before reference date |
|  | 3 01 013 | Hour, minute, second | Beginning time of the period |
|  | 2 04 008 | Add associated field | 8 bits long |
|  | 0 31 021 | Associated field significance | Set as 5 for 8-bit indicator of quality control |
|  | 0 13 013 | Total snow depth |  |
|  | 2 04 000 | Add associated field | Cancel |
|  |  | *Max, min, mean temperature* |  |
|  | 0 07 032 | Height of sensor above local ground | For temperature measurement |
|  | 1 07 003 | Replicate 7 descriptors 3 times |  |
|  | 0 04 023 | Time period or displacement | = 0 when beginning time of the period is on the same day as reference date  = –1 when beginning time of the period is on the day before reference date |
|  | 3 01 013 | Hour, minute, second | Beginning time of the period |
|  | 0 08 023 | First-order statistics | 2 – maximum;  3 – minimum;  4 – mean |
|  | 2 04 008 | Add associated field | 8 bits long |
|  | 0 31 021 | Associated field significance | Set as 5 for 8-bit indicator of quality control |
|  | 0 12 101 | Temperature/air temperature |  |
|  | 2 04 000 | Add associated field | Cancel |
|  | 0 08 023 | First-order statistics | Set as missing value |

*Table 7. BUFR template 3 07 075 for the submission of daily temperature and precipitation values for monthly climate report***.**

To expand further, the information required for a complete DAYCLI message is as follows:

**SECTION 1** (essentially metadata – includes Station ID information, Climatological Day information).

**&STATION ID**

**3 01 150 WIGOS IDENTIFIER =**

**3 01 001 WMO IDENTIFIER =**

**3 01 021 LATITUDE =** ! values in degrees and decimals of degrees to five decimal points, from -90 to 90

**3 01 021 LONGITUDE =** ! values in degrees and decimals of degrees to five decimal points, from -180 to 180

**0 07 030 HEIGHT OF STATION GROUND ABOVE MSL** (ie height above Mean Sea Level - metres)

**0 07 032 HEIGHT OF TEMPERATURE SENSOR** above local ground (metres). Note that this metadata is required only for the temperature fields in the BUFR template, and corresponds to 0 07 032.

**0 08 095 SITING AND MEASUREMENT QUALITY CLASSIFICATION – TEMPERATURE** . Section 4, Table 4, above)

**0 08 096 SITING AND MEASUREMENT QUALITY CLASSIFICATION – PRECIPITATION** (Section 4, Table 4, above)

**0 08 096 COMPUTATION METHOD FOR THE AVERAGE OF TEMPERATURE**

Refer to Section 5 above.

**3 01 011 YEAR, MONTH, DAY**

**Note also that each of these observations should be recorded at the observation time consistent with the reporting practices for the Member NMHSs, , and should reflect conditions over the previous 24 hour period.**

**In accordance with the BUFR template table above, these elements of the Climatological Day are represented as follows: by the groups 0 04 023 (offset periods) and 3 01 013 (start time)**

**0 04 023 Offset periods.**

**Offset periods** are described as:

DT = 0 (when beginning time of the period is on the same day as the reporting/reference date, as expressed in UTC)

DT = -1 (previous day). A typical example might be where precipitation measured during the reporting/reference period is allocated to the start of the period, which may be on the previous day).

**3 01 013 Beginning Time of the period. Defined as Hour, minute and second.**

Examples of coding:

Maximum temperature DT=0 \*\*\* &STIME\_TX HOUR=06 MINUTE=00 SECOND=01

Minimum temperature DT=-1 \*\*\* &STIME\_TN HOUR=18 MINUTE=00 SECOND=01

Mean temperature DT=-1 \* \*\* &STIME\_TM HOUR=00 MINUTE=00 SECOND=01

Total Accumulated precipitation (RR) DT=0 \*\*\* &STIME\_RR HOUR=06 MINUTE=00 SECOND=01

Fresh snow (DS) DT=0 \*\*\* &STIME\_DS HOUR=06 MINUTE=00 SECOND=01

Total snow depth (TSD) DT=0 \*\*\* &STIME\_TSD HOUR=06 MINUTE=00 SECOND=00. Instantaneous measurement DT=0 by default

An example of the Data Section is provided at Annex 1.

# Submission of DAYCLI messages

Regular submission of DAYCLI (and CLIMAT) Reports via WMO/GTS channels in the current code is a minimum requirement.

DAYCLI Reports, as with CLIMAT reports, should be provided not later than the 5th day of the month following the month to which the data refer**.**

Notwithstanding the 5 day limit specified above: for both DAYCLI and CLIMAT messages, Members are urged to provide late submissions[[8]](#footnote-7).

For some Members, the collection and compilation of coded climatic data from national segments of the Global Telecommunication System has proved to be more efficient and timely than the traditional method of monthly clerical Report forms. Report forms continue to be required from such stations, however, as a means of verification and in some countries to meet legal or statutory needs. For automated systems, it is obviously necessary to use equally robust and reliable communications systems. The other commonly used forms of data transmission are regular mail, electronic mail, facsimile, telephone and hard copies.

Finally, where changes are made to the DAYCLI report (e.g., following delayed-mode Quality Control processes, Members are urged to provide amended submissions. Provision for identifying updated versions in BUFR is described in the Manual on Codes (WMO No 306), Section 1, Octet 9, p.267.

# Registration and de-registration of DAYCLI stations**[[9]](#footnote-8)**.

When a Member wishes to register an additional station for the submission of DAYCLI reports, the process shall be as follows:

PLACEHOLDER: There is, as yet, no formal method to do this.

Similarly, for the deletion of a CLIMAT/DAYCLI reporting station, the procedure shall be as follows.

PLACEHOLDER: There is, as yet, no formal method to do this.

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# References

**WMO No 1188, 2009.** Handbook on CLIMAT and CLIMAT TEMP reporting.

**WMO/TD No 1477/GCOS No 127 (2009).** Practical help for compiling CLIMAT reports.

**WMO No 8, 2020**. Guide to Instruments and Methods of Observation – Volume 1, ANNEX 1.G

**WMO No 306, 2022.** Manual on Codes (April 2020 version, containing later Fast Track Amendments), ), specifically Table D, Ref 3 07 075.

WMO-No. 488

WMO-No. 1160 Manual on the WMO Integrated Global Observing System

***WMO/TD-No.341, 1989, Calculation of monthly and annual 30-year standard normal***

***WMO-No. 1203, 2017, WMO Guidelines on the Calculation of Climate Normals***

***WMO-No. 100***

**GCOS – 245, 2022**. The 2022 GCOS ECVs Requirements

Effects of changes in algorithms used for the calculation of Australian mean temperature, Blair Trewin, National Climate Centre, Bureau of Meteorology, Australian, (Manuscript received August 2002; revised October 2003) <http://www.bom.gov.au/jshess/docs/2004/trewin_hres.pdf>

1. In order to ensure maximum traceability, NMHSs should document their practices as to when a value is adjudged doubtful or wrong. And in line with Provenance metadata requirements, the original observation needs to be stored in some shape or form. [↑](#footnote-ref-2)
2. [↑](#endnote-ref-2)
3. Note. Notwithstanding the requirement to provide DAYCLI (and CLIMAT) reports within the standard period, as defined in Section 8 below, NMHSs are encouraged to provide updated quality assessments at a later stage, again in accordance with the provisions of Section 8 [↑](#footnote-ref-3)
4. [↑](#endnote-ref-3)
5. In this case, the NMHS may determine that an instrumental failure has led to an unrepresentative value, but may still believe there is value in presenting the value. While such situations are likely to be rare, the NMHS may, at its discretion, regard the measurement as having some value, albeit heavily qualified. For instance, a rainfall value in an otherwise desert climate. In this case, it is clear that the value does not reflect the limits of the instrumentation, but rather that the instrument/sensor failed [↑](#footnote-ref-4)
6. Note that Maintenance is intended as a generic term here. It can also include cases where observations were not possible due to some other causes, such as destruction of the instrument, an extended outage at an AWS, or some other cause. [↑](#footnote-ref-5)
7. Updated April 2022 under Fast-Track Procedure. [↑](#footnote-ref-6)
8. For CLIMAT, monitoring centres such as DWD process reports received about 25 days after the end of each month. This is partly to account for delays in receipt of monthly statistics sent by post. In addition, Reports received still later will still add value to the global climate record, and are archived for later processing. [↑](#footnote-ref-7)
9. Despite the current lack of formal processes for the following elements, it is most likely that the registration/deregistration process will take place via the existing processes for CLIMAT stations, with the aim of ensuring that this information is reflected in OSCAR. [↑](#footnote-ref-8)