Calculation of the 1991-2020 climate normals using CLINO Web Application

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1. Introduction

New climatological standard normals should be calculated of the thirty-year period **1991-2020** responding to the call of the World Meteorological Organization (WMO). As you may recall, the Seventeenth World Meteorological Congress (Cg-17) in 2015, through Resolution 16 (Cg-17) – Report of the Sixteenth Session of the Commission for Climatology, decided to improve the definition of a Climatological Standard Normal. A Climatological Standard Normal now refers to the most recent 30-year period finishing in a year ending with zero (1981–2010, 1991–2020 etc.) rather than to non-overlapping 30-year-periods (1931–1960, 1961–1990 etc.).

While Members are strongly encouraged to comply with the new standard as quickly as possible, WMO continues to serve as a collector of Climatological Standard Normals in order to establish a global holding of comparable and accessible standards. The United States of America National Oceanic and Atmospheric Administration (NOAA), through their National Centres for Environmental Information (NCEI), generously agreed to continue collecting and publishing Climatological Standard Normals globally on behalf of WMO.

WMO therefore invite Members to submit 1991–2020 Climatological Standard Normals for as many stations as possible, including stations registered in OSCAR/Surface, the Observing Systems Capability Analysis and Review tool for the surface-based observations, and in particular for stations that (i) constitute the Regional Basic Climatological Networks (RBCNs), (ii) report monthly CLIMAT messages, and (iii) contribute to the World Weather Records collection.

It is requested that data be calculated, digitized and provided in either EXCEL or text format, following the guidance provided in the WMO Guidelines on the Calculation of Climate Normals (WMO-No. 1203).

To facilitate this task, this application has been developed in R under Shiny to calculate the climatological standard normals values and write them into CSV files in the delivering format specified by WMO. It requires two input files (a Metadata file and a Daily data file). A template for these files can be downloaded via the web application interface.

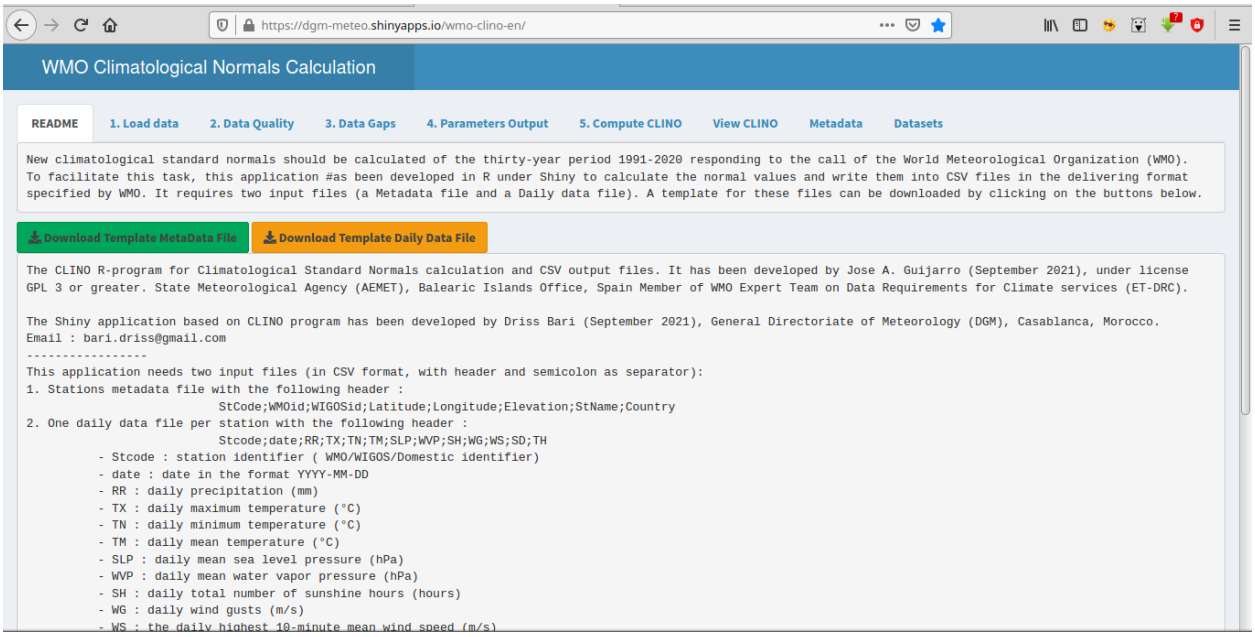

Figure 1: README file about the purpose of the web application.

2. Process of climate normals calculation

The process of climate standard normals calculation follows these main four steps :

2.1 Load daily and metadata files

1. Before uploading daily and metadata data files, **enter missing data indicator** if not (NA,-99999,empty)
2. **Check the used separator and decimal symbols in the input csv files.** There are two possibilities of csv format :
   - `French (Sep = semicolon ';' & Dec = comma ',')`
   - `English (Sep = comma ',' & Dec = point '.').`
3. Upload **one metadata file for all stations** (in CSV format, with header). This file **must** use the following format and header :

```
StCode;WMOid;WIGOSid;Latitude;Longitude;Elevation;StName;Country
```

where :

```
- StCode     : Station code. It must be the same in the daily data file.
- WMOid      : WMO code of the station.
- WIGOSid    : WIGOS code of the station (if defined).
- Latitude   : Station latitude in degrees with four decimals (between -90 and 90).
- Longitude  : Station longitude in degrees with four decimals (between -180 and 180).
- Elevation  : Station elevation in meters.
- StName     : Station name.
- Country    : Name of the country.
```

Example :

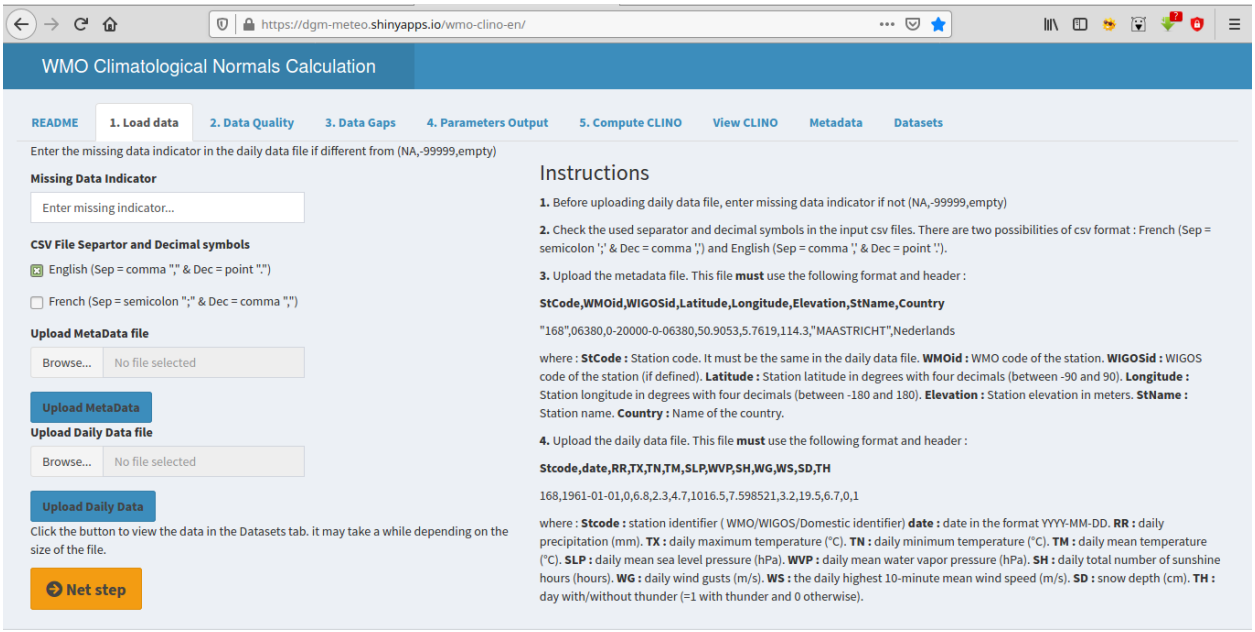

Figure 2: Loading metadata and daily data files

```
StCode,WMOid,WIGOSid,Latitude,Longitude,Elevation,StName,Country
60033,60033,0-20000-0-60033,27.166667,13.216667,64,LAAYOUNE,Morocco
60060,60060,0-20000-0-60060,29.366667,10.183333,50,SIDI IFNI,Morocco
60096,60096,0-20000-0-60096,23.716667,15.933333,11,DAKHLA,Morocco
60100,60100,0-20000-0-60100,35.783333,5.8,15,TANGER-PORT,Morocco
60101,60101,0-20000-0-60101,35.716667,5.9,15,TANGER-AERO,Morocco
60105,60105,0-20000-0-60105,35.183333,6.133333,47,LARACHE,Morocco
```

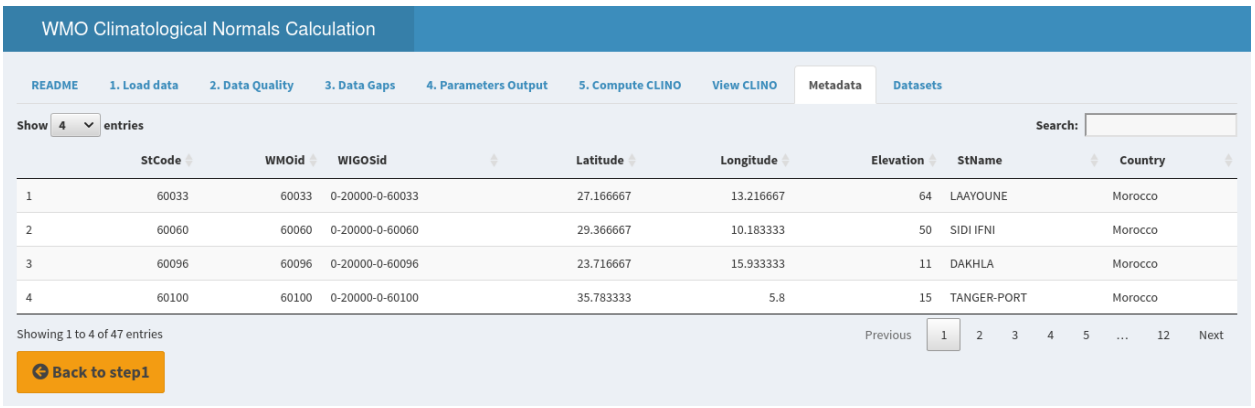

Figure 3: Metadata visualisation for verification

2. Upload **One daily data file per station** (in CSV format, with header). This file **must** use the following format and header :

```
Stcode;date;RR;TX;TN;TM;SLP;WVP;SH;WG;WS;SD;TH
```

where

- `Stcode : station identifier ( WMO/WIGOS/Domestic identifier). It should be the same as in the metadata file`

- date : date in the format YYYY-MM-DD
- RR : daily precipitation (mm)
- TX : daily maximum temperature (°C)
- TN : daily minimum temperature (°C)
- TM : daily mean temperature (°C)
- SLP : daily mean sea level pressure (hPa)
- WVP : daily mean water vapor pressure (hPa)
- SH : daily total number of sunshine hours (hours)
- WG : daily wind gusts (m/s)
- WS : the daily highest 10-minute mean wind speed (m/s)
- SD : snow depth (cm)
- TH : day with/without thunder (=1 with thunder and 0 otherwise)

N.B.: **It should noted that these files contain the predefined columns in the precise shown order.**

Example :

```
Stcode,date,RR,TX,TN,TM,SLP,WVP,SH,WG,WS,SD,TH
60033,1991-01-01,0,22.6,14,18.3,1015.5,7,7.5,11.1,10,-99999,0
60033,1991-01-02,0,26.5,15.6,21.1,1015.1,8,8.1,17,11,-99999,0
60033,1991-01-03,0,24.3,13.2,18.8,1013.2,6,6.9,17,8,-99999,0
60033,1991-01-04,0,23.5,14.6,19.1,1013.1,10,7.3,16.8,14,-99999,0
60033,1991-01-05,0,22,13.2,17.6,1012.8,7,7.1,19.4,10,-99999,0
```

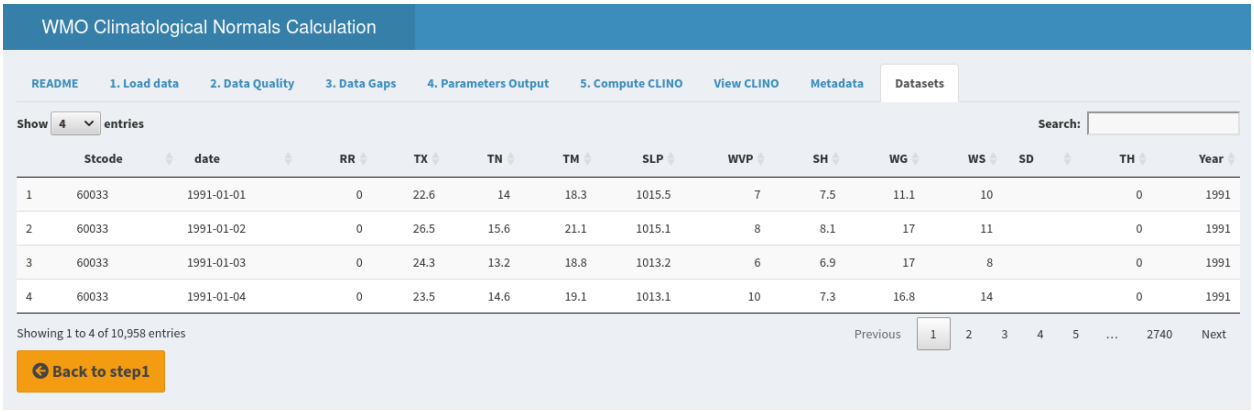

Figure 4: View of daily data for verification

2.2 Data quality control

Climatological Standard Normals, by nature, constitute high-quality data. Members are encouraged to carefully reject stations with doubtful time series data.

Data quality control refers to the process of ensuring that errors in the data are detected and flagged. It involves checking the data to assess representativeness in time, space and internal consistency , and flagging any potential errors or inconsistencies.

The purpose of quality control is to ensure that meteorological and climate data available to potential users are sufficiently reliable to be used with confidence. Quality control is therefore part of the overall data quality assessment.

Types of Data Quality Control Tests :

- Format tests : Checks should be made for repeated observations or impossible dates, etc.
- Completeness tests : For some elements, missing data are much more critical than for others. Total monthly rainfall amounts may also be strongly compromised by a few days of missing data, particularly when a rain event occurred during the missing period.
- Consistency tests : The four primary types of consistency checks are internal, temporal, spatial and summarization.
- Tolerance tests : set upper or lower limits to the possible values of a climatological element (such as wind direction, cloud cover, and past and present weather)

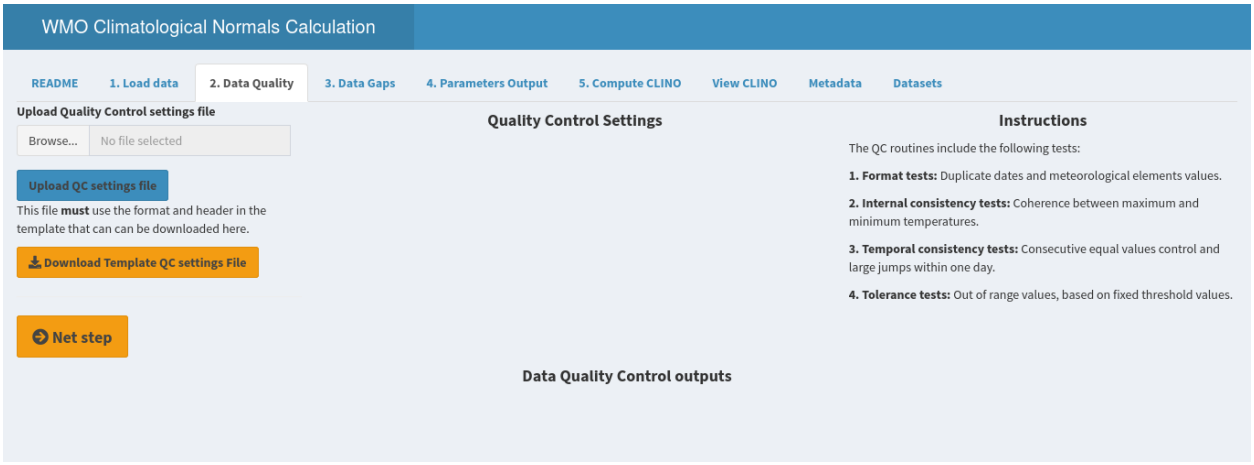

Figure 5: uploading the quality control settings

The Quality Control routines include the following tests:

1. Format tests: Duplicate dates and meteorological elements values.
2. Internal consistency tests: Coherence between maximum and minimum temperatures.
3. Temporal consistency tests: Consecutive equal values control and large jumps within one day.
4. Tolerance tests: Out of range values, based on fixed threshold values.

Before performing the quality control, the user should upload the QC settings file. Please upload the template file and modify it if necessary :

```
lab.parameter,lower.lim,upper.lim,jump.rate,flat.rate
TX,-50,50,15,4
TN,-50,50,15,4
TM,-50,50,15,4
RR,0,150,50,4
SLP,940,1040,15,4
WVP,0,40,10,4
SH,0,16,12,4
SD,0,30,10,4
TH,0,1,10,4
WG,0,60,15,4
WS,0,60,15,4
```

For each meteorological element, please specify the following features :

- lower.lim : upper limit to the possible values of the climatological element
- upper.lim : lower limit to the possible values of the climatological element
- jump.rate : upper limit of the variation of an element within one day
- flat.rate : upper limit of number of identical values for the climatological element

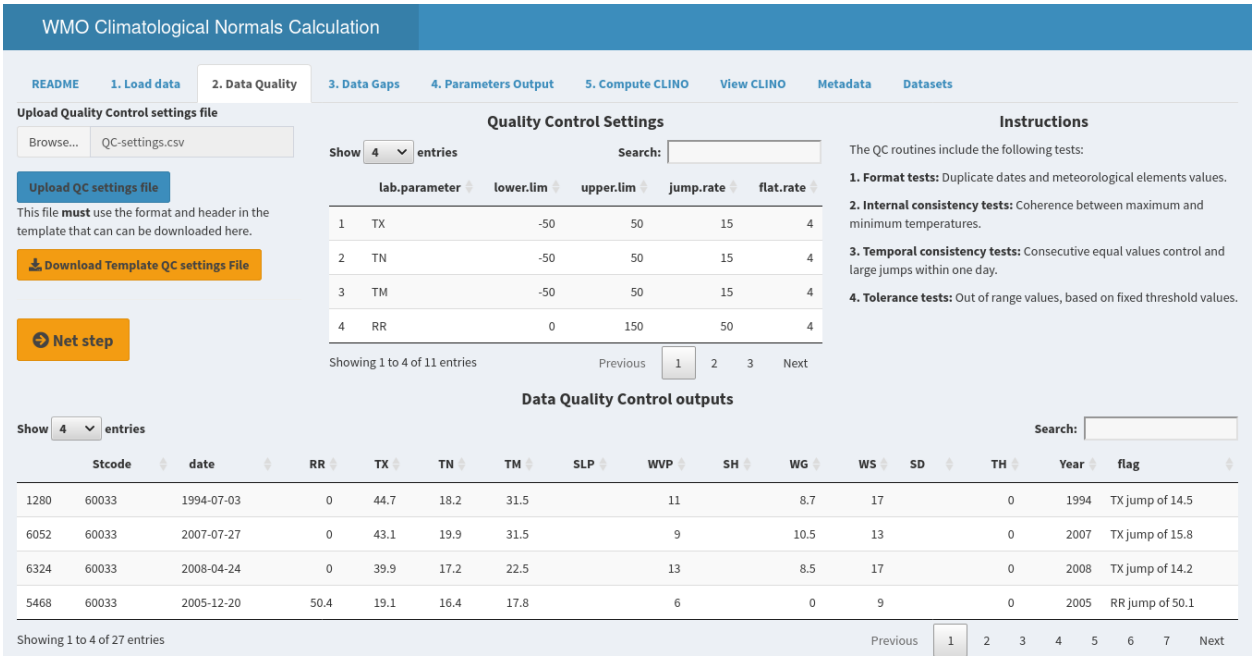

Figure 6: The output of the quality control procedure

2.3 Data completeness criteria

For missing values options with respect to WMO standards, the user can choose one or both of the two options.

Following the Guide to Climatological Practices (WMO, 2011), it is recommended that, **for individual monthly values calculation** (where a monthly value is the mean of that month's daily values), it should not be calculated if either of the following criteria are satisfied:

- Observations are missing for 11 or more days during the month;

- Observations are missing for a period of 5 or more consecutive days during the month.

Besides, the Guide to Climatological Practices (WMO, 2011) recommends that, **for a normal or average** to be calculated for a given month, **data should be available for at least 80% of the years in the averaging period**. This equates to having data available for that month in 24 or more out of the 30 years for a climatological standard normal or a reference normal.

2.4 Target parameters

A parameter is a statistical descriptor of a climate element. Most observed elements are formed into means, sums, or counts for understanding the state of the element for a representative calendar month. WMO-No. 1203 describes the most fundamental parameter calculation methods such as :

```
Calculation_Name,Calculation_Code,Parameter calculation method descriptions from WMO-No. 1203
Mean,1,Mean Parameter - mean of daily values during the month
Max,2,Extreme Parameter Maximum - highest value during month
Min,3,Extreme Parameter Minimum - lowest value during month
Sum,4,Sum Parameter - sum of daily values during month
Count,5,Count Parameter - Number of days expressed as % of available days
Q0,6,Quintile Parameter 0 - Lower bound of quintile 1 (Extreme Minimum)
```

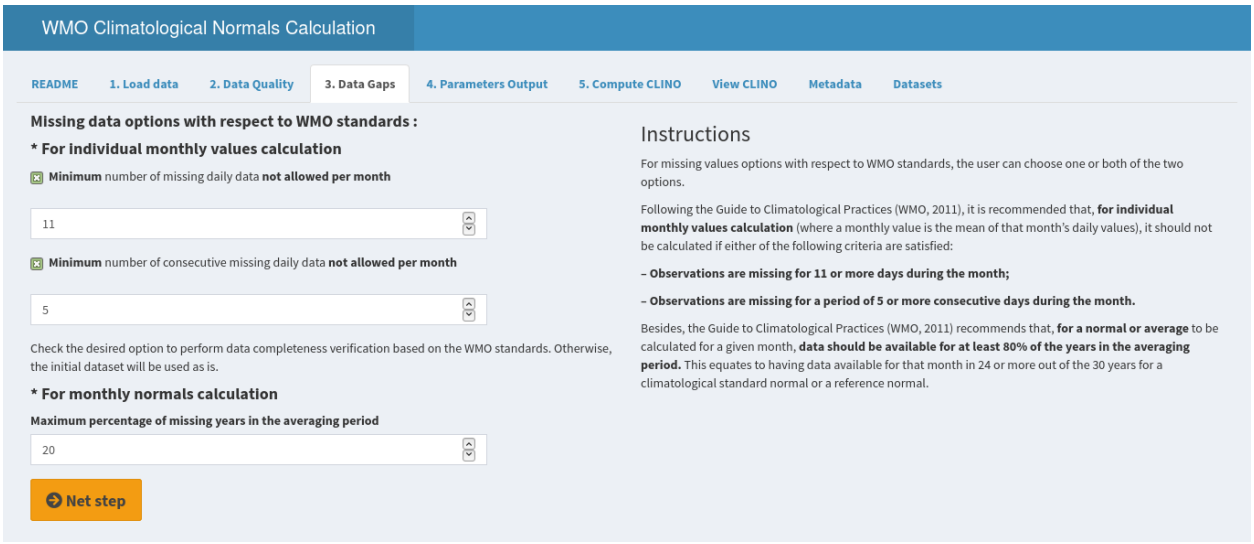

Figure 7: Configuration of the data completeness criteria to be applied to the dataset

```
Q1,7,Quintile Parameter 1 - Upper bound of quintile 1
Q2,8,Quintile Parameter 2 - Upper bound of quintile 2
Q3,9,Quintile Parameter 3 - Upper bound of quintile 3
Q4,10,Quintile Parameter 4 - Upper bound of quintile 4
Q5,11,Quintile Parameter 5 - Upper bound of quintile 5 (Extreme Maximum)
```

There are also some additional parameter calculation methods that are derived from the 1961–1990 Climatological Standard Normals collection effort. Some Members may also wish to use these statistics, especially the "Number of Years Used to Calculate Normal" statistic, NOY.

```
Calculation_Name,Calculation_Code,Parameter calculation method descriptions from WMO-No. 1203
Median,12,Median Monthly Value
SDMean,13,Standard Deviation of Mean Monthly Value
SDMeanD,14,Standard Deviation of Mean Daily Value
MaxDate,15,Date (Year/Day) of Occurrence of Extreme Maximum Daily Value
MinDate,16,Date (Year/Day) of Occurrence of Extreme Minimum Daily Value
MinMon,17,Minimum Monthly Value
DMinMon,18,Year of Occurrence of Minimum Monthly Value
MaxMon,19,Maximum Monthly Value
DMaxMon,20,Year of Occurrence of Maximum Monthly Value
NOY,98,Number of Years Used to Calculate Normal
Custom,99,Custom Parameter or Statistic Specified by Contributor
```

Climate parameters are defined as an aspect of climate that can be statistically described, such as mean air temperature, precipitation total, or mean sea level pressure. Subject to limitations on available data, **there are eight principal climatological surface parameters that should always be reported in station climate normals submissions if possible**.

```
Parameter_Code, Parameter_Name, Units
1, Precipitation_Total, mm
2, Number_of_Days_with_Precipitation_>=_1 mm, count
3, Daily_Maximum_Temperature, Deg_C
4, Daily_Minimum_Temperature, Deg_C
5, Daily_Mean_Temperature, Deg_C
6, Mean_Sea_Level_Pressure, hPa
```

```
7, Mean_Vapor_Pressure, hPa
8, Total_Number_of_Hours_of_Sunshine, hours
```

The EXCEL submission template contains these fields (as well as the secondary parameters). The suggested submission format includes the use of the parameter name in a header above a data table. In order to assure compatibility between EXCEL and ASCII *.csv submissions, parameter name words are linked by underscores with no spaces, and units of temperature are spelled out in basic ASCII characters (Deg_C). Finally, it should be noted that additional climatological surface parameters derived for the same element but using a different calculation method (e.g. median precipitation total, extreme maximum daily maximum temperature, etc.) can be reported on additional spreadsheet rows in conjunction with each principal climatological surface parameter.

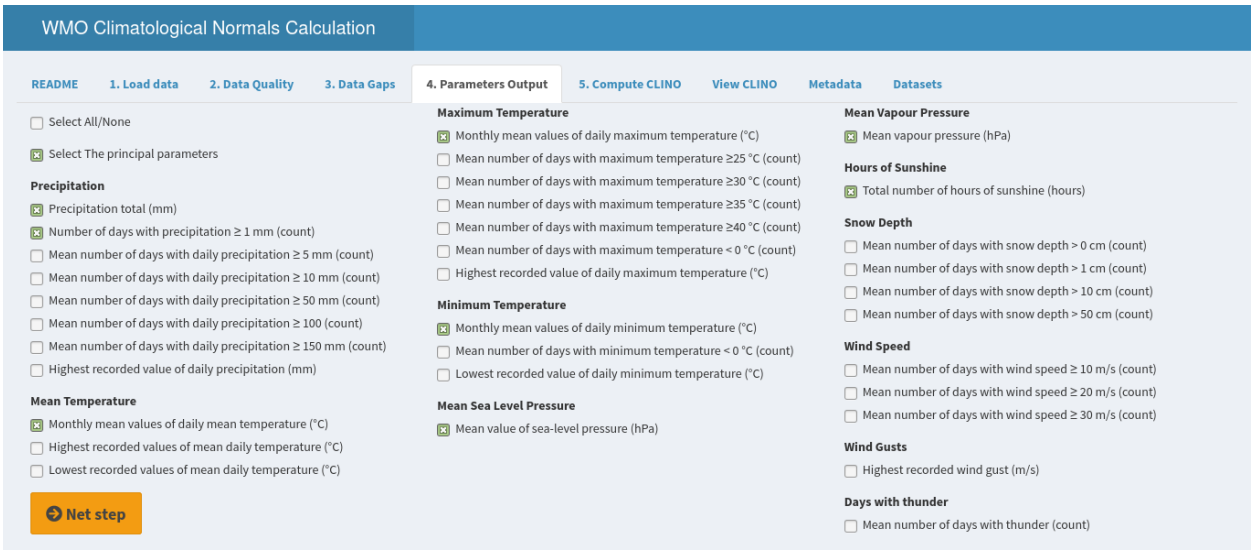

Figure 8: Choice of the clino parameters to be computed during the normals calculation

2.5 Climate normals computation

Click on the button (Compute WMO normals) to perform the climatological standard normals with respect the WMO guidelines.

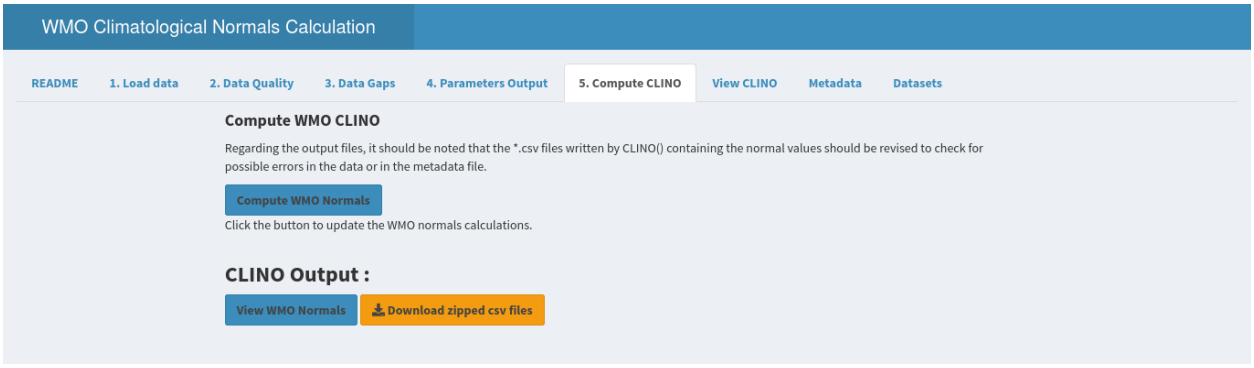

Figure 9: Performing the WMO normals calculation

To view the climatological standard normals, please click on the button (**View WMO normals**) and to download the csv ASCII file to be sent to the WMO secretariat, please click the related button (**download**

zipped csv files).

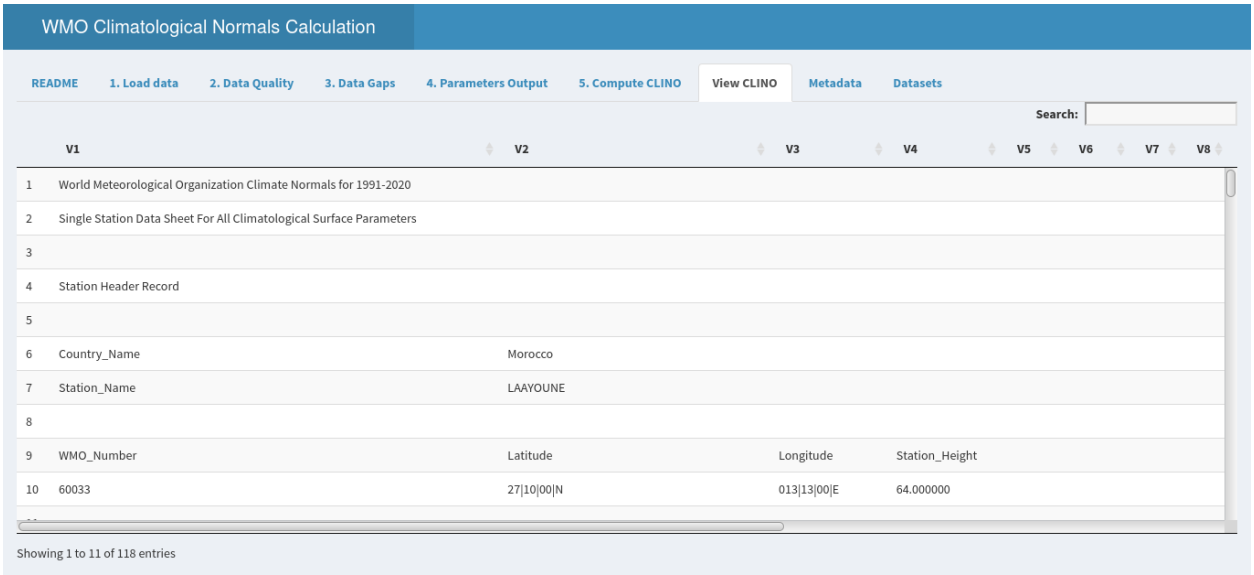

Figure 10: View of the WMO normals for verification and validation

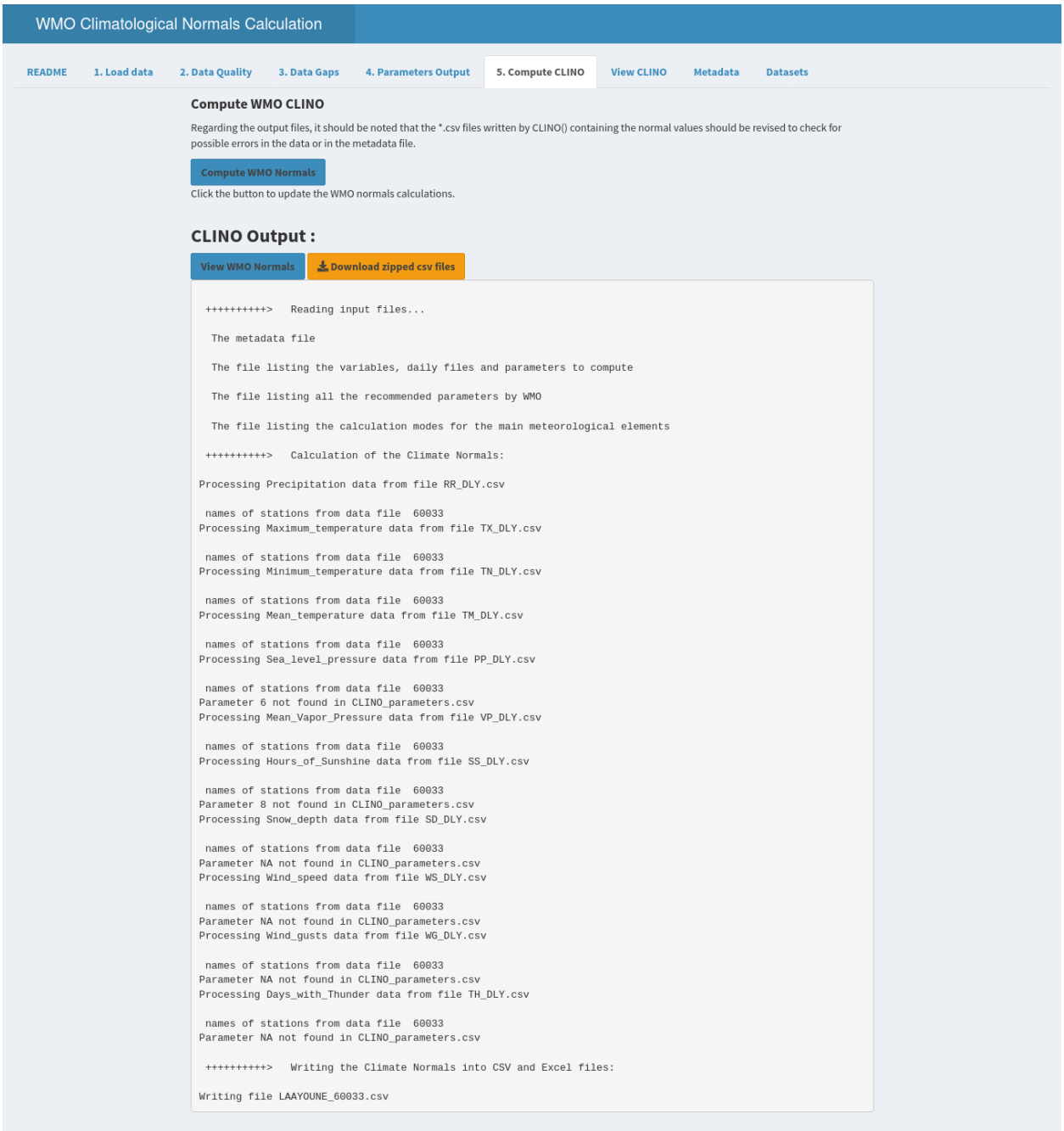

Figure 11: The output of the CLINO() function