The Climate Monitoring Tools

CMT

Version Beta+

Climate Map-making Tools integrating weather, climate, and land information to inform humanitarian response planning. Generating user-friendly products from weather and climate data

by

CPC International Desks

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This simplified package of Climate Monitoring Tools is developed by NOAACPC/CPC International Desks. It is used to download climate data and generate user-friendly products in the form of spatial and time series plots. The spatial plots include maps of total precipitation anomalies, climatology and percent normal. The tools also used to generate spatial maps of drought monitoring tools such as the Seasonal Rainfall Performance Probabilities (SPP), the Soil Moisture, the Runoff Percentiles, the standardized Precipitation Index (SPI) and the Vegetation Health Index (VHI). The tool also contains a module that generates time series plots for a given grid point or station location. For sample products please visit:
https://www.cpc.ncep.noaa.gov/products/international/ZClimToolZ/

A. Introduction:

General

The CPC-CMT is a web-based tool designed to monitor the evolution of seasonal climate conditions. The package contains tools that perform complex tasks organized into smaller and more manageable components/modules. The individuals modules are easy to use and maintain, and also can be run as independent tools. The CMT modules contain codes written in C and FORTRAN programming languages, and GrADS and shell scripts. This version of CMT is designed for command-line usage, to maximize flexibility in using the tools.

System Requirements

The package can be installed in Windows/Cygwin or Linux environments. For effective installation and use of the CMT package, we recommend a computer with minimum of 10GB disk space and 4GB of memory. Moreover, a good internet connection is required for real-time data retrieval and climate monitoring. System recommendations:

- **OS versions – Operating System:**

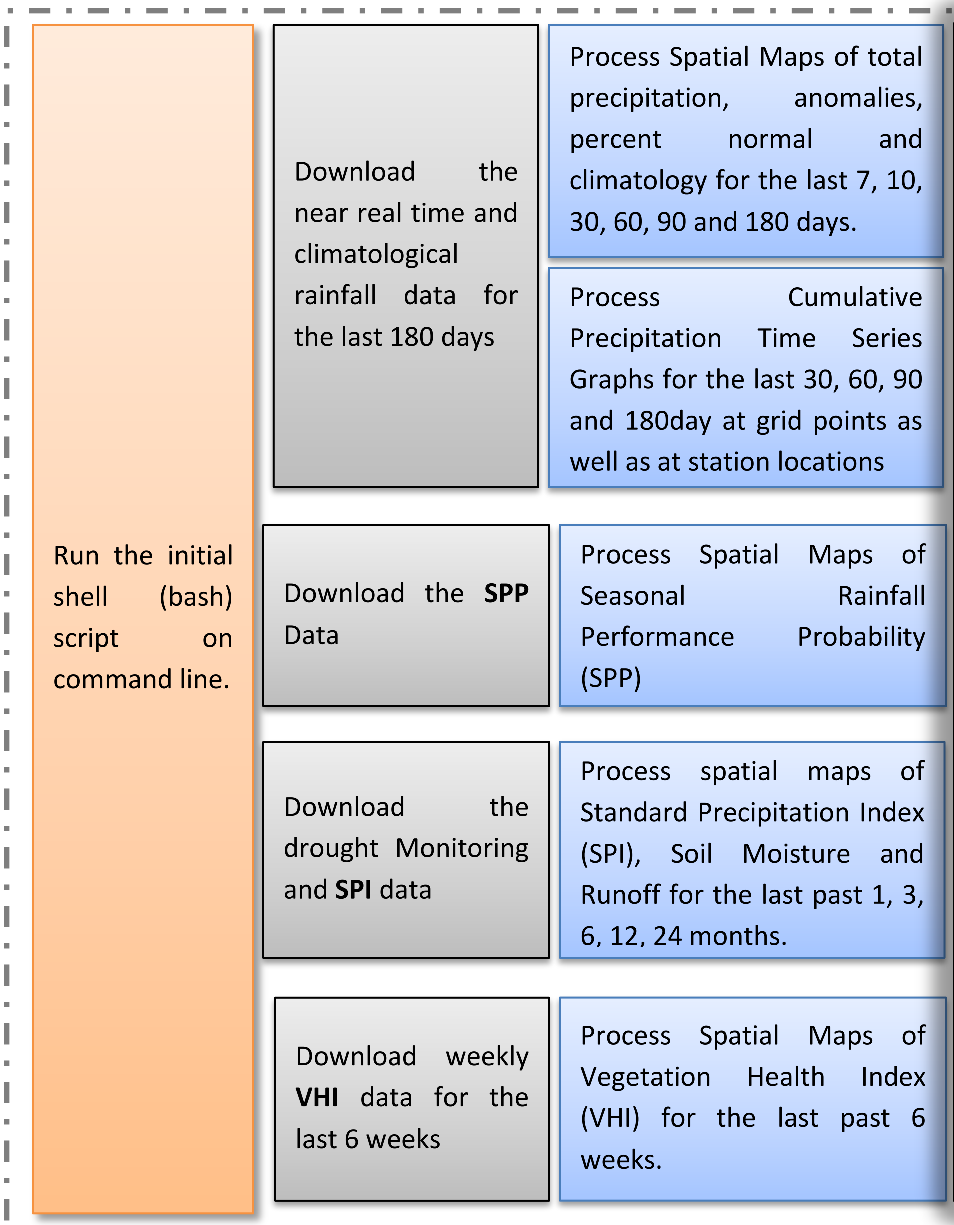
  Windows (32 or 64 bit, version 7.0 or later) + Cygwin (or any other virtual Machine), Linux or Mac

- **Required Packages:**

  GrADS (v2.0.2.oga.2), unzip, GNU FORTRAN Compiler, GNU precision calculator (bc), wget, and ImageMagick, GDAL (v2.1.2 or later). The installation procedures of these packages are provided separately in the PPT presentation. **It's extremely important that you read instructions and install all the prerequisite packages in your machine prior trying to install and run CMT.**

CMT Structure Modules

Most tasks in the current version of CMT run in the background, and users may not have a chance to see tasks in in the intermediate steps (between running the initial shell script and getting the final web-based products). To get a grasp on CMT, one must understand what is going on "under the hood". Fig 1 illustrates the sequences of CMT package run. When you run the main (initial) script, the embedded scripts and programs will - download data, - compute and generate spatial maps and time series plots, - and finally you will see a pop up, on your browser, a web page on which the some key products are displayed. The list of these products include: - Spatial Precipitation Maps, -Cumulative Precipitation Time-series plots of Seasonal Rainfall Performance Probability (SPP), Standardized Precipitation Index (SPI), Soil Moisture and Runoff Percentiles (CPC Leaky Bucket Model) and Vegetation Health Index (VHI).



Run the initial shell (bash) script on command line.

Download the near real time and climatological rainfall data for the last 180 days

Process Spatial Maps of total precipitation, anomalies, percent normal and climatology for the last 7, 10, 30, 60, 90 and 180 days.

Process Cumulative Precipitation Time Series Graphs for the last 30, 60, 90 and 180day at grid points as well as at station locations

Download the **SPP** Data

Process Spatial Maps of Seasonal Rainfall Performance Probability (SPP)

Download the drought Monitoring and **SPI** data

Process spatial maps of Standard Precipitation Index (SPI), Soil Moisture and Runoff for the last past 1, 3, 6, 12, 24 months.

Download weekly **VHI** data for the last 6 weeks

Process Spatial Maps of Vegetation Health Index (VHI) for the last past 6 weeks.

Pop up, in the browser, a web page interface showing all the products (spatial and time series plots) needed by users to monitor evolution of seasonal climate conditions. The current CMT output products include:

- ✓ ***Spatial Precipitation Maps and Cumulative Precipitation Time-series:*** *provides users with near-real time monitoring of daily evolution of rainfall, useful for early drought detection.*
- ✓ ***Seasonal Rainfall Performance Probability****:* *Evaluates the probability of seasonal precipitation over the target area to finish at pre-defined anomaly thresholds from the date the outlook is issued. SPP can contribute to decision making in agriculture, water, health and food security.*
- ✓ ***Standardized Precipitation Index (SPI):*** *Index to measure the severity of droughts and used in operational droughts monitoring.*
- ✓ ***Soil Moisture Percentile (CPC Leaky Bucket Model):*** *drought monitoring index providing the rank of soil moisture content relative to agricultural records. Very useful in agricultural production, the low values may indicate moisture stressed crops and (agricultural) droughts.*
- ✓ ***Runoff Percentiles (CPC Leaky Bucket Model)****:* *Computed with method similar to that of soil moisture, this index is related to the flow of water on the surface and hydrology. The Low values could indicate droughts.*

Vegetation Health Index: a proxy characterizing vegetation health or a combine estimation of moisture and thermal conditions.

B. CMT Setup

1. **The first step in setting up CMT is to define the right geographical domain for your area of your interest.** The following steps will guide you through setting up your geographical domain and the required parameters:

   - Using your text editor, open a new text file name *country***_latlon,** where *country* refers to the region or area of interest. You need to enter geographical domain information for your area of interest in the following format:

     Country_name   S_lat   N_Lat   W_lon   E_Lon   xlint   ylint   title_ypos   colorbar_ydisp

     By default, you may consider the following values, or you may use your own:
     xlint=2, ylint=2, title_ypos=9.0 and colorbar_ydisp=-0.1.

     For example if the target area is *Niger*, we may assume that Niger is embedded in a domain box of [11°N-24°N/1°W-17°E]. The *country***_latlon** filename becomes **niger_latlon**. Then we can enter the following values using our text editor, and save the text file as niger_latlon and:

     niger   11   24   -1   17   2   2   9.0   -0.1

   - Create another new file, with a name *country***_stns.txt,** where *country* refers to the region or area of interest. This file is used to enter locations and names of your ground stations in the following format :

     0   stn_lat1   stn_lon1   station_name1
     0   stn_lat2   stn_lon2   station_name2
     0   .   .   .
     0   .   .   .
     0   .   .   .

   - Download GIS shapefiles of the international and administrative boundaries for area of interest. These files are available online at: http://www.diva-gis.org/gdata.

     - Using the above link download shapefiles of your country. The name of the downloaded file may look like, *CNTRYISO****_adm.zip****, where CNTRYISO* is the international ISO Code of the country of interest. For example, if your area of interest is Ethiopia, its ISO code is ETH and the downloaded file will assume a file name, ***ETH_adm.zip.*** In the case of Nigeria (NGA), the file will be named ***NGA_adm.zip***.

     - Uncompress the zip file using either a window utility, or use the ***unzip*** command if you operate under the Linux environment. The name of the uncompressed file will have a form that looks like *CNTRYISO****_adm***. Under Linux environment, you may uncompress and rename the file using a single command:

```
~]$ unzip CNTRYISO_adm.zip -d CNTRYISO_adm
```

2. At this step make sure that you have copy of the compressed CMT code, **CMTK_SOFTWARE.tar.gz.**
   - You need to create your working directory (CMTK_country), and uncompress the file using the following command :

     ```
     mkdir CMTK_country
     ```

     where, *country* is the name of the country or area of interest.

   - Change your directory to CMTK_*country,* using the following command line

     ```
     cd CMTK_country
     ```

   - Make sure that the compressed package (CMTK_SOFTWARE.tar.gz) is in your current folder (CMTK_country) and run the following command:

     ```
     tar -xzvf CMTK_SOFTWARE.tar.gz --strip-components=1
     ```

3. Copy your domain related files to appropriate directories.
   - Copy your *country***_latlon** and *country***_stns.txt** (see 1.a and 1.b), files into: `CMTK_country/ClimToolKit/fix/`

   - Copy the folder containing your administrative shapefiles (`CNTRYISO_adm` see 1.c) into: `CMTK_country/ClimToolKit/gis_resources/countries/`

   - Finally, from your current directory (CMTK_country), make all the scripts in executable :

     ```
     chmod a+x *
     ```

     ```
     ./do_this_first.sh
     ```

4. **Generate country masks for the region of interest**.

While monitoring the climate you may want to focus only on a very specific area (defined by the shapefile). To make that possible, run the bash script named ***script_generate_mask.sh*** in the following way:

```
./script_generate_mask.sh country CNTRYISO
```

where,

- *country:* represent the name of the target country or area (Ethiopia, Nigeria, Philippines, ...)
- *CNTRYISO: represent the* ISO code of the target country. For example have ETH for Ethiopia, NGA for Nigeria, PHL for Philippines, ...

This will generate 6 masks of well-defined resolutions, namely: *0.036°x0.036°, 0.1°x0.1°, 0.25°x0.25°, 0.5°x0.5°, 1.0°x1.0°.* CMT input data come with various spatial grid sizes, so the above script is built to ensure the compatibility between input data grid sizes and the corresponding country mask files. The generated mask file are copied in the appropriate folder, refer the following table if you want to know their locations on your system:

Files names	Locations
country_vhimasks0p036.ctl, ***country***_vhimasks0p036.dat	CMTK_*country*/ClimToolKit /gis_resources/country_masks0p036/
country_0p1.ctl, ***country***_0p1.dat	CMTK_*country*/ClimToolKit /gis_resources/country_masks0p1/
	CMTK_*country*/ClimToolKit /gis_resources/country_masks0p1/365dcal/
	CMTK_*country*/ClimToolKit /gis_resources/country_masks0p1a/
	CMTK_*country*/ClimToolKit /gis_resources/country_masks0p1a/365dcal/
country_0p25.ctl, ***country***_0p25.dat	CMTK_*country*/ClimToolKit /gis_resources/country_masks0p25/
country_0p5.ctl, ***country***_0p5.dat	CMTK_*country*/ClimToolKit /gis_resources/country_masks0p5/
country_1p0.ctl, ***country***_1p0.dat	CMTK_*country*/ClimToolKit /gis_resources/country_masks1p0/

5. Configuration of the folder named *country*_grid (eg : nigeria_grid)

Under the folder **CMTK_***country*, run the bash script named, ***script_getpixcoord_plot_gridmap.sh*** in the following way:

```
./script_getpixcoord_plot_gridmap.sh country CNTRYISO grdRsl
```

where,

- ○ *country:* represent the name of the target country or area (Ethiopia, Nigeria, Philippines, ...)
- ○ *CNTRYISO: represent the* ISO code of the target country. For example have ETH for Ethiopia, NGA for Nigeria, PHL for Philippines, ...
- ○ *grdRsl*: is the desired grid map resolution to be used to display the time series. It's recommended to use ***1p0*** for larger countries and ***0p5*** or even ***0p25*** for the smaller ones.

This will generate two important files,

- ✓The first, named *country***_grid.png** is located under the folder **ClimToolKit/***country***_grid/stn_grid.** The result is a map displaying the country of interest along with the marks representing the grid points and stations locations.
- ✓The second, named ***latlon_*country*.txt*** can be founded under ***ClimToolKit/fix*** folder. The file contains the pixel coordinates of all the marks appearing on the previous *png* file.

6. Editing the "pix body html" and other html files.

These files will be used to organize you maps and times series plot plots on a web page. To do so, from your **CMTK_***country folder, run the* ***generate_dedicated_HTML.sh*** script in the following way:

`./generate_dedicated_HTML.sh country`,

where, *country* is the coordinates is the name of the target country.

7. Monitoring the Climate

Once the steps from 1 to 6 have been properly completed, your CMT is ready to run. Once your CMT setup is done for your area of interest, you don't need to repeat steps 1 – 6. At this stage, you are good to go with generating products that will help to monitor climate over your region of interest. Depending on your needs you have two majors' possibilities, process in **Operational** or in **Rainfall Review** modes. From your **CMTK_*country*** directory run ***zstart.sh*** script in the following ways:

- ***Running in operational mode***

```
bash zstart.sh rdtaset country CNTRYISO dnl_yes mask_yes
                           or
 bash zstart.sh rdtaset country CNTRYISO dnl_yes mask_no
                           or
 bash zstart.sh rdtaset country CNTRYISO dnl_no mask_yes
                           or
  bash zstart.sh rdtaset country CNTRYISO dnl_no mask_no
```

rdtaset: refer to rainfall dataset you may want to use. The available options are ARC2 or CPCUNI. ARC2 is a rainfall database available only for African Countries.

country : name of the target country or area (Ethiopia, Nigeria, Philippines, ...)

CNTRYISO*:* ISO code of the target country. so we usually have ETH for Ethiopia, NGA for Nigeria, PHL for Philippines, ...

dnl_yes (recommended): if you need to download data and plot the result
dnl_no: if you already get all the data and you are just interest in plotting.

mask_yes: for drawing data only over the areas you are interested in (delineated by the shapefile)
mask_no: for drawing data over the domain the defined in the file *country*_**latlon.**

e.g. : Assuming that you are interested in generating some climate products for the last 180 days over Zambia or Philippines, the command line should like:

```
    bash zstart.sh ARC2 Zambia ZMB dnl_yes mask_yes          # for Zambia
                                or
   bash zstart.sh CPCUNI Philippines PHL dnl_yes mask_yes    # for Philippines
```

- ***Run CMT in Rainfall Review Mode:*** *you want to focus on a very specific period and get some details information about on the rainfall performance.*

Indeed, in the current version contains a module that meets this need. The Script that makes it possible is ***zstart_clim_rvw.sh*** and its usage syntax is as follows:

```
bash zstart_clim_rvw.sh rdtaset country CNTRYISO dnl_yes mask_yes yyyymmdd1 yyyymmdd2
                                     or
 bash zstart_clim_rvw.sh rdtaset country CNTRYISO dnl_yes mask_no yyyymmdd1 yyyymmdd2
```

Where, *yyyymmdd1* and *yyyymmdd2* are respectively the start and end dates of the target period. They should be in the format YYYYMMDD. Please refer to previous lines for the description of the other parameters.

The user should be aware that by running CMT in Rainfall Review, only rain based products are generated. So as before, for the period specified you will have:

Classical products	*Additional products on the quality of registered rainfall*
✓ *spatial precipitation maps (total, anomaly, percent of normal, climatology)* ✓ *Precipitation time series at stations and grid points locations.*	✓ *total number of rain days and associate anomalies* ✓ *maximum consecutive number of wet days,* ✓ *maximum consecutive number of dry days,* ✓ *total number of heavy rain days (R >= 10 mm)* ✓ *total number of very heavy rain days (R >= 20 mm)* ✓ *maximum consecutive number of heavy rain days* ✓ *maximum consecutive number of very heavy rain days*

e.g.: Assuming that you are interested in having the rainfall performance during the 2019 MAM season over Ethiopia or the 2018-2019 DJF season over Philippines, the command line should like:

```
bash zstart_clim_rvw.sh ARC2 Ethiopia ETH dnl_yes mask_yes 20190301 20190531        # for Ethiopia
```

or

```
bash zstart_clim_rvw.sh CPCUNI Philippines PHL dnl_yes mask_yes 20190301 20190531  #  for Philippines
```

By default, it's assumed that your web page browser is google-chrome or firebox.

The best still to come.

"... LIFE IS REALLY GOOD"