Volume

1

NATIONAL DROUGHT MITIGATION CENTER

Composite Drought Index

User Guide

COMPOSITE DROUGHT INDEX

User Guide

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Section 1

Installing the required Software for running the CDI

All required software to create a working CDI is covered in this section.

To create a working version of the Composite Drought Index the user will be required to install Anaconda2 2019.10 or better. Additionally, the user will need to install three python packages not included int the installation of the Anaconda2 applications. These three packages are available freely from the Anaconda Cloud and their installation is covered as well.

Installing Anaconda2

We first will cover installing the Anaconda2 development platform. The current supported version is Anaconda2-2019.10 and has only been tested on Windows 10 OS. Preliminary tests have been done using the latest stable Anaconda release Anaconda3-2020.07 and results indicate that CDI scripts are stable and the output is consistent so if an IT department has an issue with installation of an older version the CDI will function the same if the three modules are installed into the newer Anaconda3 version. The procedures that follow are for the supported version but will be identical for the newer version.

Hardware and OS requirements

The CDI has been designed to run efficiently on minimal hardware, but we recommend the Anaconda minimum hardware and software requirements

Anaconda System requirements

- License: Free use and redistribution under the terms of the End User License Agreement - Anaconda® Individual Edition.
- Operating system: Windows 8 or newer, 64-bit macOS 10.13+, or Linux, including Ubuntu, RedHat, CentOS 6+, and others.
- If your operating system is older than what is currently supported, you can find older versions of the Anaconda installers in our archive that might work for you. See Using Anaconda on older operating systems for version recommendations.
- System architecture: Windows- 64-bit x86, 32-bit x86; MacOS- 64-bit x86; Linux- 64-bit x86, 64-bit Power8/Power9.
- Minimum 5 GB disk space to download and install.

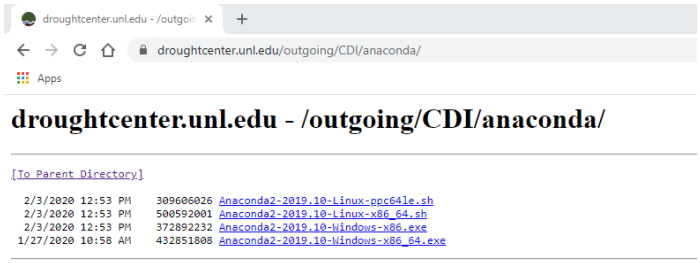
On Windows, macOS, and Linux, it is best to install Anaconda for the local user, which does not require administrator permissions and is the most robust type of installation. However, if you need to, you can install Anaconda system wide, which does require administrator permissions.

These requirements are taken directly from:

https://docs.anaconda.com/anaconda/install/

Getting the Anaconda package

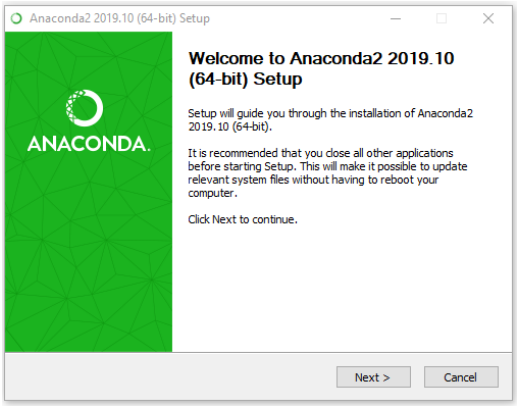
The supported anaconda package can be found several places on the internet but for simplicity the NDMC has the package available on their website at the following URL https://droughtcenter.unl.edu/outgoing/CDI/anaconda/.



There are four versions of the supported Anaconda application. The main two to be concerned with are the -86.exe and x86_64.exe. If you are using Windows 10 or any Windows Server OS, you will need the x86_64.exe.

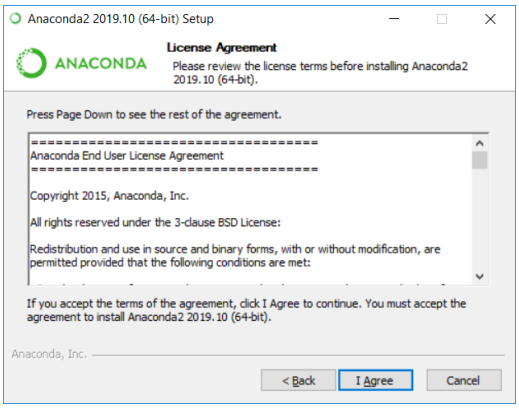
Installing the package

1. Double click the downloaded installer to launch.

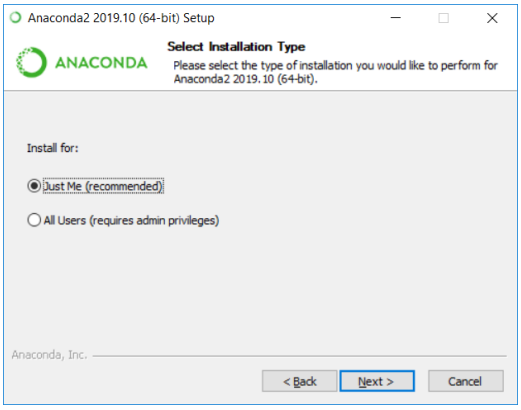


2. Click **Next >**

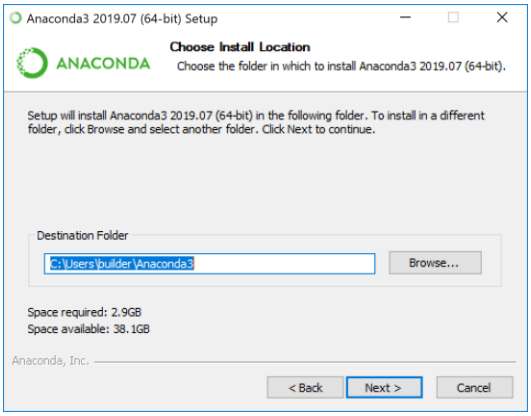
3. Read the licensing terms and click "I Agree".



4. Select an install for "Just Me" and click Next.

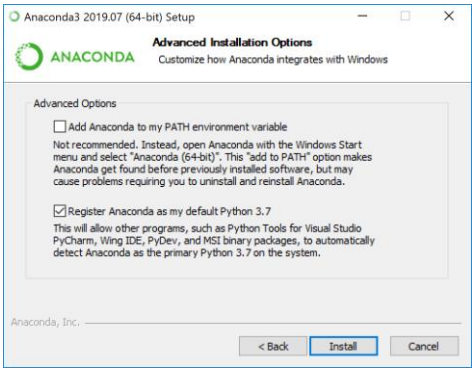


5. Select a destination folder to install Anaconda and click the Next button. Use the default.



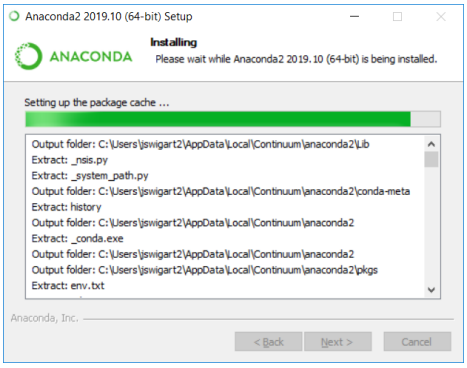
6. Choose whether to add Anaconda to your PATH environment variable. We recommend NOT adding Anaconda to the PATH environment

variable, since this can interfere with other software. Instead, use Anaconda software by opening Anaconda Navigator or the Anaconda Prompt from the Start Menu.



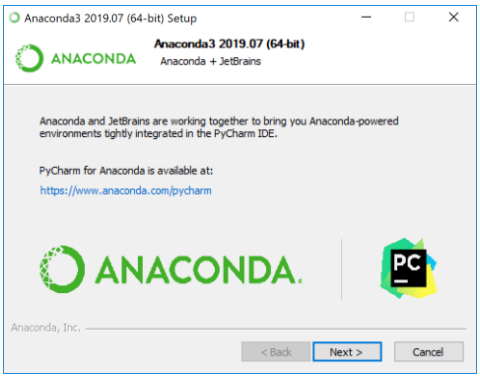
7. Choose whether to register Anaconda as your default Python. Unless you plan on installing and running multiple versions of Anaconda or multiple versions of Python, accept the default and leave this box checked. We recommend that unless you have expert Python help on staff you accept the default here as it can become overly complicated to run multiple versions of either Anaconda or Python.

8. Click the Install button. If you want to watch the packages Anaconda is installing, click Show Details.

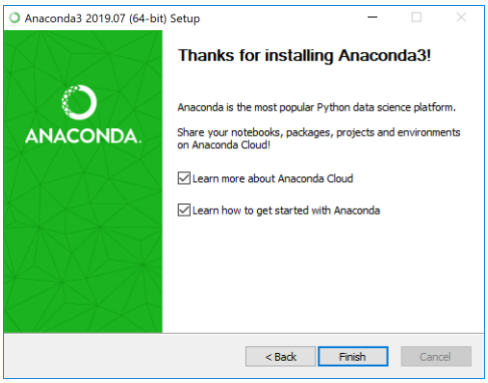


9. Click the Next button.

10. Install Anaconda without PyCharm, click the Next button.



11. After a successful installation you will see the "Thanks for installing Anaconda" dialog box:



12. If you wish to read more about Anaconda Cloud and how to get started with Anaconda, check the boxes "Learn more about Anaconda Cloud" and "Learn how to get started with Anaconda". For this installation uncheck these boxes. Click the Finish button.

Create a virtual environment

The scripts to create the CDI need to be run in a version of Python 3.7. To accomplish this a virtual environment need to be created.

1. Check conda is installed and in your PATH

Open a terminal client.

Enter conda -V into the terminal command line and press enter.

If conda is installed you should see something like the following.

$ conda -V

conda 3.8.1

2. Check conda is up to date

In the terminal client enter

conda update conda

Update any packages if necessary by typing y to proceed.

3. Create a virtual environment for your project

In the terminal client enter the following where yourenvname is the name you want to call your environment.

conda create -n yourenvname python=3.7 anaconda

Press y to proceed. This will install the Python version and all the associated anaconda packaged libraries at "path_to_your_anaconda_location/anaconda/envs/yourenvname"

4. Activate your virtual environment.

To activate or switch into your virtual environment, simply type the following where yourenvname is the name you gave to your environement at creation.

source activate yourenvname

Activating a conda environment modifies the PATH and shell variables to point to the specific isolated Python set-up you created. The command prompt will change to indicate which conda environemnt you are currently in by prepending (yourenvname). To see a list of all your environments, use the command conda info -e.

5. Install additional Python packages to a virtual environment.

To install additional packages only to your virtual environment, enter the following command where yourenvname is the name of your environment, and [package] is the name of the package you wish to install. Failure to specify "-n yourenvname" will install the package to the root Python installation.

conda install -n yourenvname [package]

If the conda install format fails please try to use the PIP install (you may need to install PIP using conda install pip at the conda commandline). PIP installs follow a similar format to conda but you should make sure the conda commandline has your virtual environment active.

pip install [package]

The packages needed to run the updated version of the CDI are the following:

a) h5py
b) netCDF4
c) imageio
d) scipy
e) rasterio

6. Deactivate your virtual environment.

To end a session in the current environment, enter the following. There is no need to specify the envname - ~~which ever~~whichever is currently active will be deactivated, and the PATH and shell variables will be returned to normal.

source deactivate

7. Delete a no longer needed virtual environment

To delete a conda environment, enter the following, where yourenvname is the name of the environment you wish to delete.

conda remove -n yourenvname -all

Section

2

Installing the required raw data to run the CDI

The CDI currently has four indicators and this section covers their sources and procedures to store them for proper running of the CDI

The CDI requires raw data to be available as inputs to create the monthly indices. These data are currently free to access and download. The CDI uses precipitation from CHIRPS, LST and NDVI from MODIS and LDAS soil moisture products.

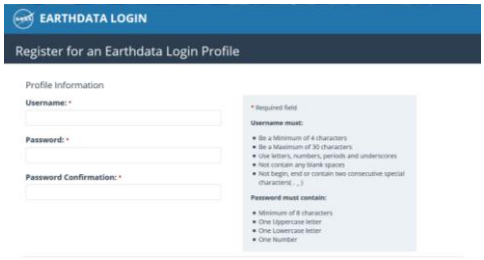
Installing Data

The first step in preparing the raw data is to create the file structure. We would suggest a drive with a combined 750GB of space as the LDAS soil moisture data is quite large. This data can be on a network share however this will cause processing and network speed issues if at all possible, the CDI should be processed on the same machine as the data is stored.

NASA Earthdata account

To obtain NASA Earthdata login

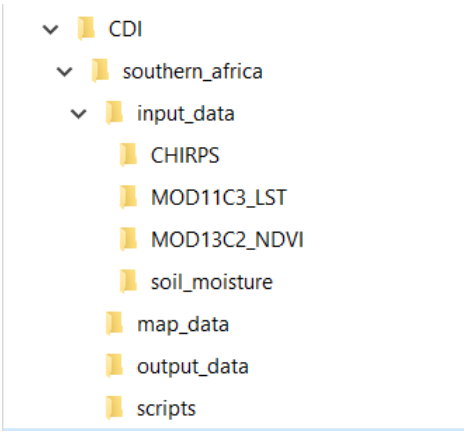
Go to: https://urs.earthdata.nasa.gov/users/new



Fill in the required information and click REGISTER FOR EARTHDATA LOGIN

Input Directory Structure

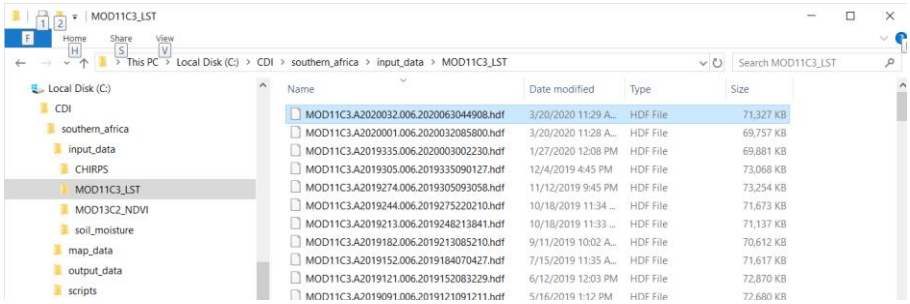
Create the following file structure on your C-drive:



The Python scripts used in the CDI process reference specific file locations so this file structure is necessary if you do not want to alter the file references in the scripts.

LST data download

Look in the 'input_data' folder in the CDI directory and then the MOD113C_LST folder. Sort by name to see the most recent data at the top.



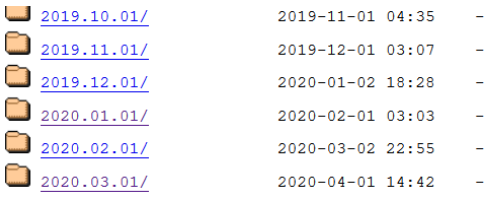
Look at the filename of the dataset at the top. In this case the dataset name is:

MOD11C3.A2020032.006.2020063044908.hdf

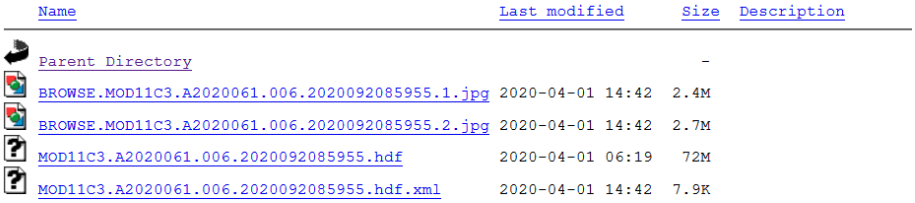
The 'MOD11C3' indicates that this is a MODIS LST file. The next portion of the filename is 'A2020032'. This indicates the starting date for the dataset. The starting date for MODIS data refers to the day of the month, in this case 32 which corresponds to February. The following table shows the day of month for each month in the calendar. The first two columns contain the non-leap year dates and the second two columns indicate the leap year dates.

Non leap year		Leap year	
Day of year	Date	Day of year	Date
1	20190101	1	20200101
32	20190201	32	20200201
60	20190301	61	20200301
91	20190401	92	20200401
121	20190501	122	20200501
152	20190601	153	20200601
182	20190701	183	20200701
213	20190801	214	20200801
244	20190901	245	20200901
274	20191001	275	20201001
305	20191101	306	20201101
335	20191201	336	20201201

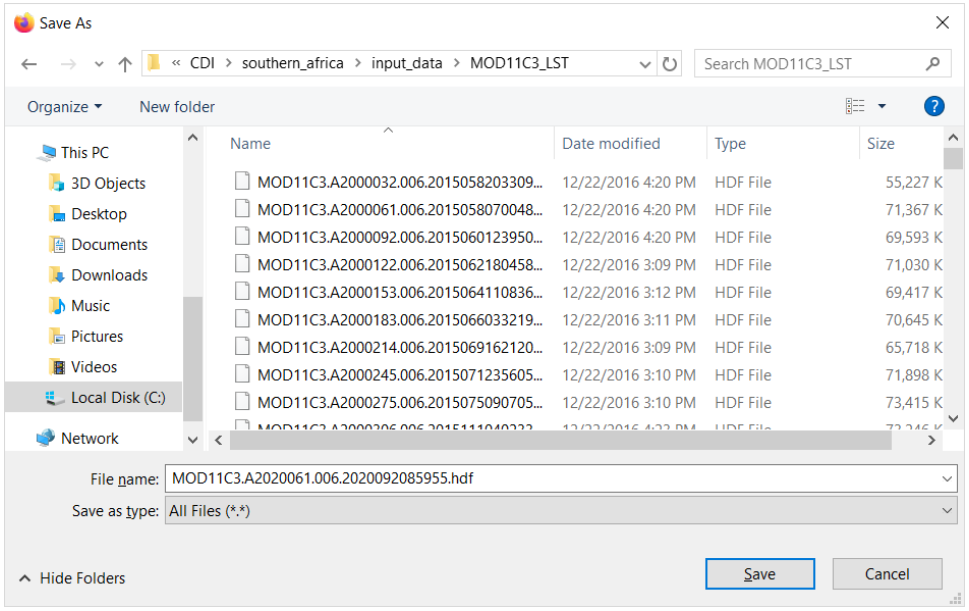
The next data set needed is the March data.
Go to: https://e4ftl01.cr.usgs.gov/MOLT/MOD11C3.006/
Enter your Earthdata username and password if prompted.
Scroll to the bottom of the page to see the most recent data.



In this case the most recent dataset is for March. Click on the 2020.03.01 to see the folder's content.



The file we need is the one ending in .hdf. Right click on the .hdf file, select 'Save file as…', navigate to the LST folder in the input data folder and save the dataset.

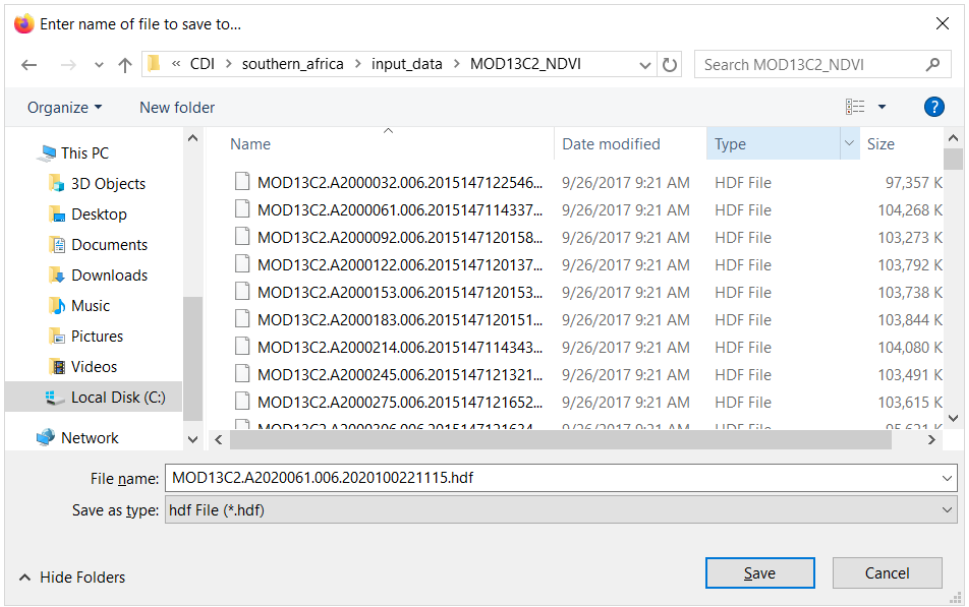


NDVI data download

The procedure for the NDVI data is the same as that of the LST data the only change is the website.

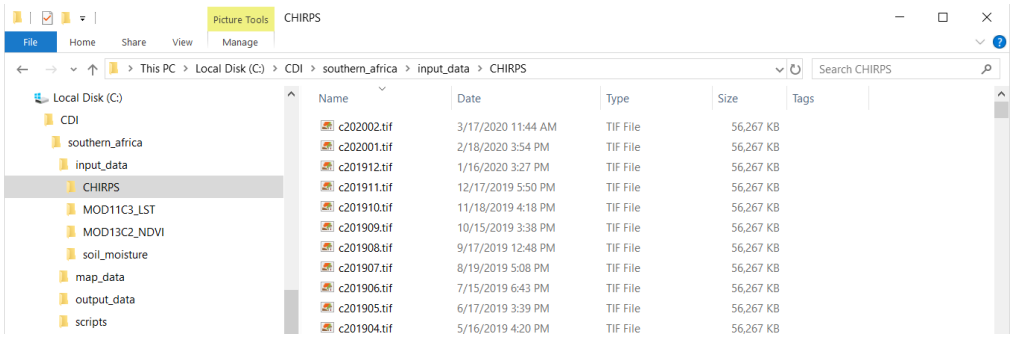
Go to: https://e4ftl01.cr.usgs.gov/MOLT/MOD13C2.006/

And save the data to the NDVI folder under the input data folder.



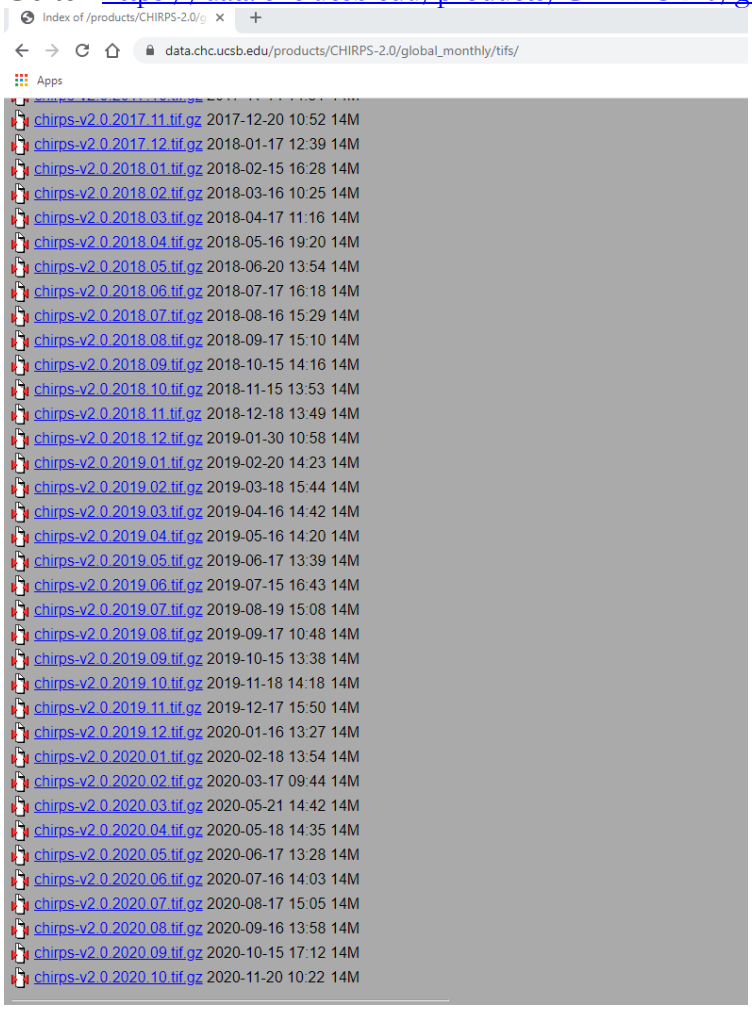
CHIRPS data download

Look in the 'input_data' folder in the CDI directory and then the CHIRPS folder. Sort by name to see the most recent data at the top.

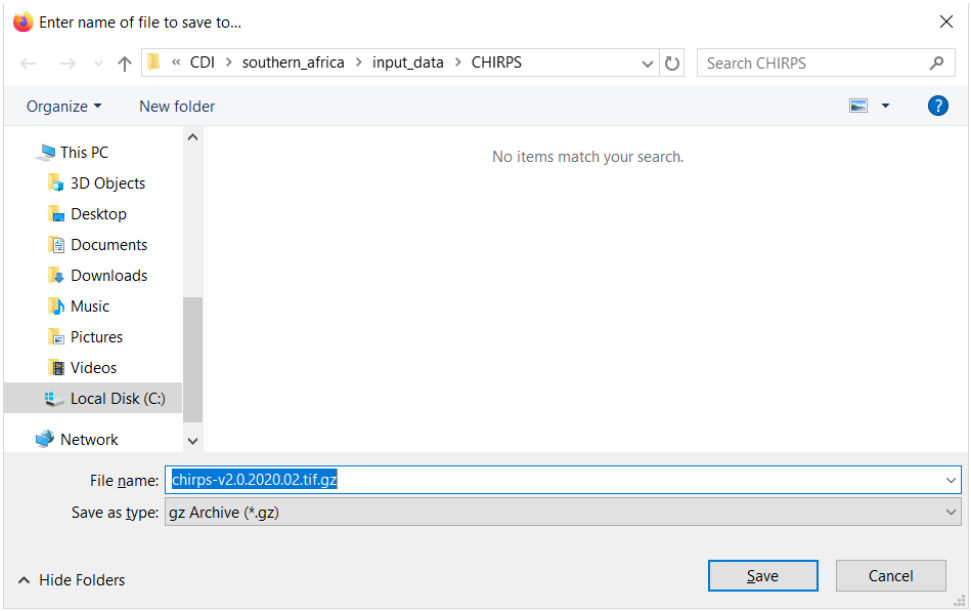


Note that CHIRPS filenames have a month of year date as opposed to the day of year like the LST and NDVI data. In this case the most recent dataset has 202002 in the name indicating the data are for February 2020 and we will need the March data to calculate an updated CDI.

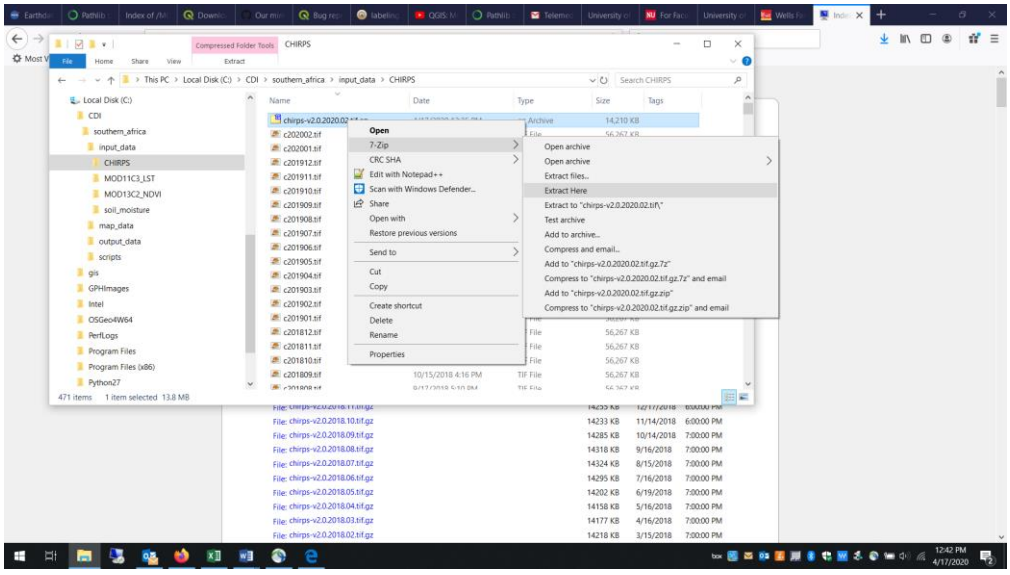
Go to: https://data.chc.ucsb.edu/products/CHIRPS-2.0/global_monthly/tifs/



Take not of the dates under the 'Last Modified' column. The most recent dataset available is the February data and these were posted on 3/17/2020. CHIRPS data availability is usually the limit on when you can run the CDI for the previous month. Note that most of the dates are from the middle of the month. You will need to check back at this website often to see when the previous month's data are available, maybe starting on the 10th of the month or so. Right click on the desired dataset, choose 'Save link as…' and navigate to the CHIRPS folder under the input_data folder and save the data:



In windows explorer, navigate to the CHIRPS folder and right click on the file you just downloaded and select 7-Zip. The CHIRPS files are compressed with GZIP and need to be extracted with 7-Zip. Select 'Extract here' from the 7-Zip menu.

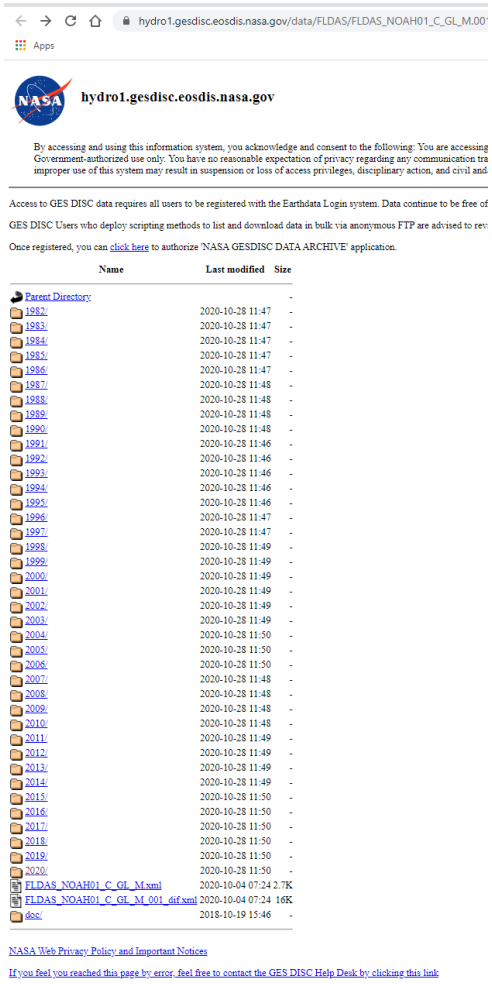


You should now see the file you downloaded and the same file uncompressed with a file extension of '*.tif'. Delete the .gz file. Right click on the tif file and select 'Rename'. Replace 'chirps-v2.0.' with 'c' and remove the decimal between the year and month. The filename should now be changed from 'chirps-v2.0.2020.02.tif' to 'c202002.tif'.

Soil Moisture data download

The soil moisture data is remarkably similar to the LST and NDVI data sets. The main difference being that it is located

Go to: https://hydro1.gesdisc.eosdis.nasa.gov/data/FLDAS/FLDAS_NOAH01_C_GL_M.001/



You can download them individually here which requires you to sign in. Enter your Earthdata username and password when prompted. You may also create a download script using wget to download new datasets or bulk download many datasets.

Section

3

Installing and running the CDI scripts

The CDI currently has fifteen scripts, a lib directory, and a configuration file.

The CDI scripts included will process the raw data, rank the individual indicator, weight and combine the indicator into a raw cdi value and create a final rank CDI value. The first time these scripts are run will take much more time than successive monthly runs as the entire history must be run before a single month can be completed windows must also index all of the data the first time through. Additionally, the soil moisture data starts as 10km and the first run of the scripts must clip the data to the country extent and rescale it to 5KM which Is the single most time consuming operation in the CDI processing.

Installing the scripts and output directories

The scripts are bundled into a zip file that can be downloaded from the NDMC website. Once the are installed on the processing machine the last requirement is to create the working and output data directories.

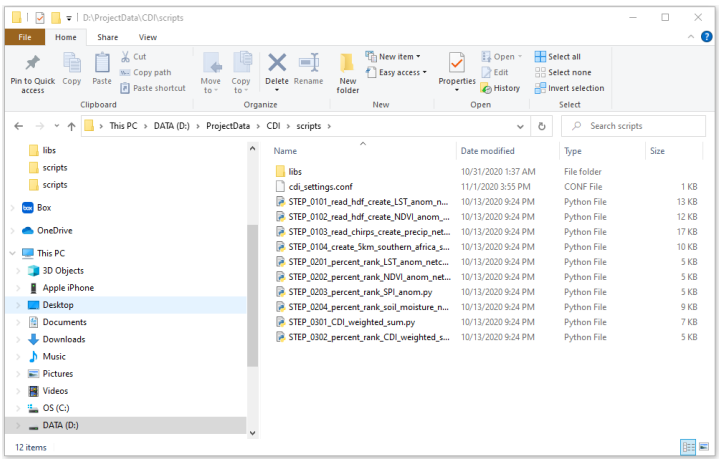
Download script bundle

The script bundle containing the latest version of the CDI scripts, libraries and configuration file is located here:

https://droughtcenter.unl.edu/outgoing/CDI/software/scripts/CDI_ProductionScripts.zip

Install scripts

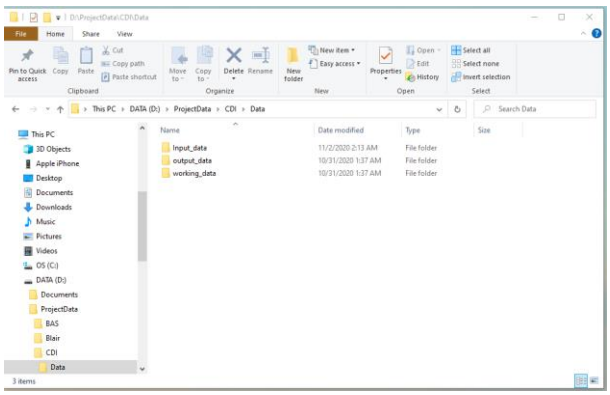
The downloaded bundle can be unzipped and placed into the CDI structure created on your machine. The following is the recommended structure and location.



As you can see the scripts main directory is created within the main CDI directory and the scripts and configuration file reside in the base of this directory along with the libs directory that contain common libraries for use in the various scripts.

Create directories

The final two directories that need to be created are the working directory and the output directory. These two directories can be named and placed wherever you wish but it is recommended that stay within the CDI structure for optimum performance.



As you can see the recommended directory structure is to divide the data directory into input, output and working data directories.

Input _data contains the 5KM and 10KM raw data with 5KM being LST, NDVI and CHIRPS raw data and the 10KM containing the LDAS raw soil moisture.

Output_data contains the final netCDF files created in each scripted step.

Working_data contains all the intermediate files created in the processing and production of the output files. **IMPORTANT NOTE** Do not remove or delete these files unless you wish to reprocess the entire history of the CDI. If you do this it will be like running the CDI for the first time once again and the processing time will be similar to the first time the process runs when it is installed.

Configuration files

The configuration files eliminate the need for editing individual scripts placing all the repetitive script editing into 3 filesfile. These files should be edited to reflect operating environment before you run any of the scripts. The file can be edited in any file editing software including notepad. Do not use an application like Word or something similar as it is likely to add formatting that will stop the configuration file from working properly.

cdi_directory_settings.conf

- Lines 2-7 contain all the raw data directories
- Lines 8-11 contain the hdf groups used to handle the different hdf 4 and 5 possible data types
- Line 12 is the scratch directory
- Lines 13 is the geotiff directory
- Line 14 is the output directory
- Line 15 is the map_sources directory
- Line 16 is the map_export directory

cdi_project_settings.conf

- Line 2 your country of regions common name
- Line 3 bounding coordinates for your country or region
- Line 4 The SPI time periods to be computed
- Lines 6-11 contain the common name used for each input variable
- Lines 12-16 contain the weights for the indicators included in the CDI
- Lines 18-19 contain variable to be used in mapping and final data output

cdi_pattern_settings.conf

- This contains the raw data patterns for the input data of the cdi. You should only need to edit this if adding a new data types.

These lines should be edited to reflect your installation paths. The file patterns should not be edited unless there is a change to the naming conventions for the raw data.

Once this file has been edited for your environment save it and exit.

Running Scripts

The individual scripts should be opened in Spyder which is in the Start Menu under the Anconda3 installation

Script order

The scripts have steps in their naming convention and should be run in this order for ease of use. Certain script may be run out of order, but it is not recommended.

- Step 0000 – This script can be used to execute all of the steps sequentially without need to open each script individually.
- Steps 1010 – 0104 prepare the various raw datasets to be used in the CDI.
- Steps 0201 – 0204 rank the prepared data sets into monthly sets that can be used to create the raw CDI
- Step 0301 weights the inputs and creates the raw summed CDI value
- Step 0302 creates the final ranked CDI value
- Step 0303 creates geotiffs that will be used in mapping the final datasets

Index

No index entries found.