

Rainfall Forecasting Training Notes

Requirements

1. Download and install MobaXterm on a Windows PC (<https://mobaxterm.mobatek.net/download-home-edition.html>)



2. Select the installer edition and double click the executable & follow the prompts.

NB: Skip this step if you're using Linux OS

To login in to the server, launch the MobaXterm terminal and type the username and IP address as shown below

```
• MobaXterm Personal Edition v12.4 •
(X server, SSH client and network tools)

> Your computer drives are accessible through the /drives path
> Your DISPLAY is set to 192.168.8.100:0.0
> When using SSH, your remote DISPLAY is automatically forwarded
> Each command status is specified by a special symbol (✓ or ✗)

• Important:
This is MobaXterm Personal Edition. The Professional edition
allows you to customize MobaXterm for your company: you can add
your own logo, your parameters, your welcome message and generate
either an MSI installation package or a portable executable.
We can also modify MobaXterm or develop the plugins you need.
For more information: https://mobaxterm.mobatek.net/download.html

Welcome to Anthony Mwanthi PC
Thu Jul 23 18:57:59 EAST 2020

[2020-07-23 18:57.59]
[Anthony.AnthonyPC] > ssh -Y username@123.456.7.89
```

3. When prompted, enter the password.

NB: These credentials will be provided during the training

Introduction

These notes will take you through the following: -

- ✚ Generation of Rainfall Forecasts from WRF
- ✚ Assessment of WRF forecast bias
- ✚ On-web use of real time satellite data

Tools used in this exercise are NCAR Command Language, NCL (<https://www.ncl.ucar.edu/>) and Climate Data Operators, CDO (<https://code.mpimet.mpg.de/projects/cdo>) which are already installed in the ICPAC cluster.

Requirements: ENTRO System Admin will provide you with the Server access details

Activity I: Generation of Rainfall Forecast from WRF

This activity is automated in the operational ENTRO WRF. However, for training purposes, a manual system will be used.

Once logged in, launched the terminal using CTRL + ALT + T

Navigate to /home/entro/training/20190821 by using the command

```
cd /home/entro/training/20190821
```

We are going to generate a forecast for 3days starting 21st August 2019

The above directories are described as follow.

gfs – contains model input data

wps – contains executables for pre-processing the GFS data into WRF format

wrf – contains executables to run the WRF forecast

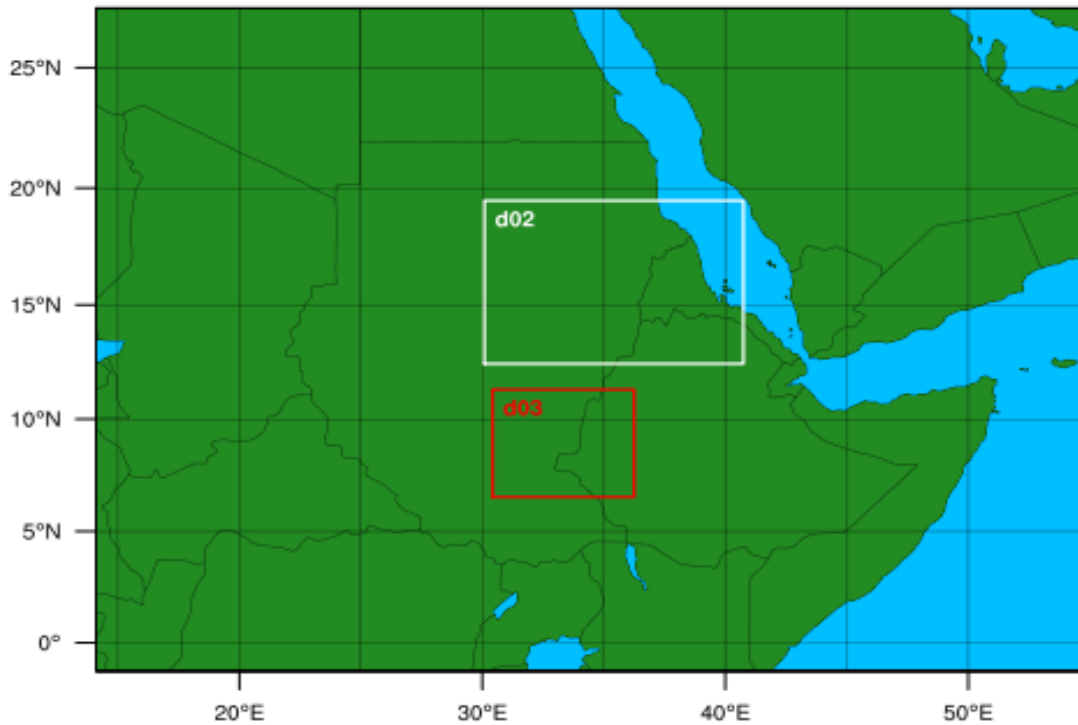
navigated into wps

```
cd wps
```

Plot the domain using the command

```
ncl util/plotgrids_new.ncl
```

WPS Domain Configuration



nano namelist.wps

```
!share
wrf_core = 'ARW',
max_dom = 3,
start_date = '2019-08-21_00:00:00', '2019-08-21_00:00:00', '2019-08-21_00:00:00', '2019-08-21_00:00:00',
end_date = '2019-08-24_00:00:00', '2019-08-24_00:00:00', '2019-08-24_00:00:00', '2019-08-24_00:00:00',
interval_seconds = 10800,
io_form_geogrid = 2,
debug_level = 0,
/

!geogrid
parent_id      = 1,  1,  1,  1,
parent_grid_ratio = 1,  3,  3,  3,
i_parent_start  = 1,  97, 99,  70,
j_parent_start  = 1,  84, 48,  56,
e_we           = 246, 193, 106,  73,
e_sn           = 180, 133,  88,  79,
!geog_data_res = '5m','30s','30s', '30s'
geog_data_res  = 'default','default','default', 'default'
!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!! IMPORTANT NOTE !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
! The default datasets used to produce the MAXSNOALB and ALBEDO12M
! fields have changed in WPS v4.0. These fields are now interpolated
! from MODIS-based datasets.
!
! To match the output given by the default namelist.wps in WPS v3.9.1,
! the following setting for geog_data_res may be used:
!
! geog_data_res = 'maxsnowalb_ncep+albedo_ncep+default', 'maxsnowalb_ncep+albedo_ncep+default',
!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!! IMPORTANT NOTE !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

!G Get Help      !O Write Out    !W Where Is     !K Cut Text     !J Justify      !C Cur Pos      !M-U Undo       !M-A Mark Text  !M-J To Bracket
!X Exit         !R Read File    !\ Replace      !U Uncut Text   !N To Spell     !G Go To Line   !M-E Redo       !M-C Copy Text  !M-W WhereIs Next
```

Run geogrid as by the command `./geogrid.exe`

`cdo vardes geo_em.d01.nc`

This will provide with a list of variables

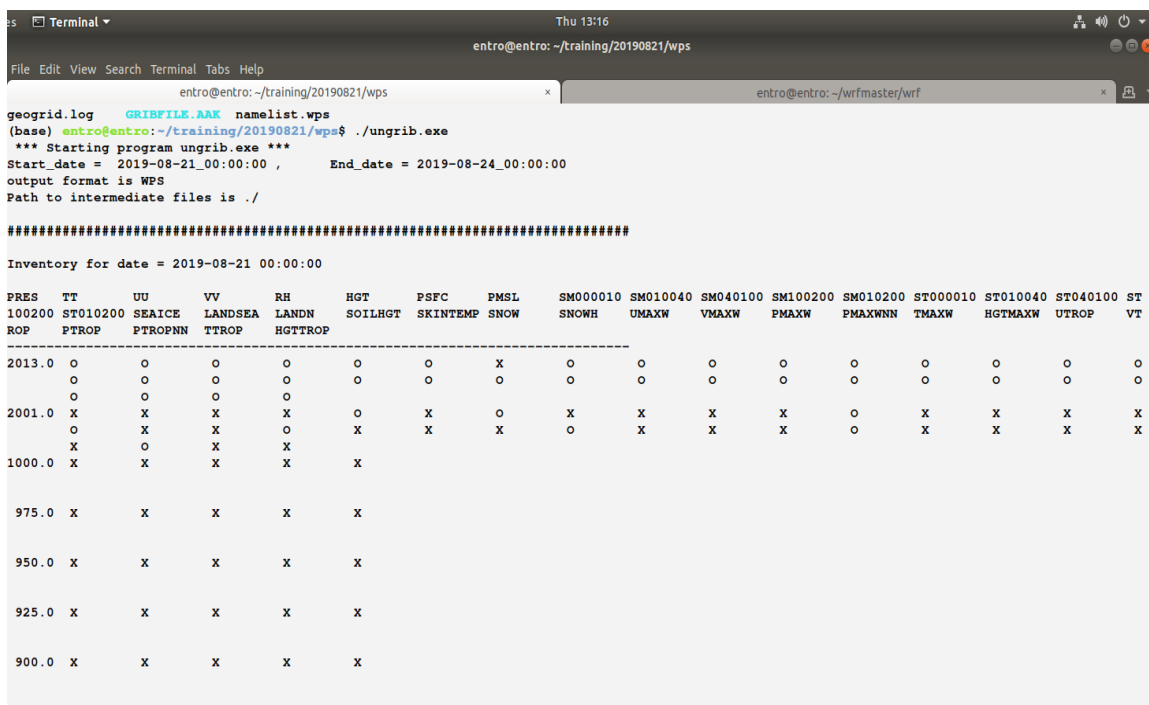
`./link_grib.csh ../gfs/*`

List the content of WPS and the linked files are given names starting with GRIBFILE.???



```
entro@entro: ~/training/20190821/wps
File Edit View Search Terminal Tabs Help
entro@entro: ~/training/20190821/wps x entro@entro: ~/wrfmaster/wrf x
(base) entro@entro:~/training/20190821/wps$ ls
arch GRIBFILE.AAA GRIBFILE.AAL namelist.wps.all_options
clean GRIBFILE.AAB GRIBFILE.AAM namelist.wps.fire
compile GRIBFILE.AAC GRIBFILE.AAN namelist.wps.global
configure GRIBFILE.AAD GRIBFILE.AAO namelist.wps.nmm
configure.wps GRIBFILE.AAE GRIBFILE.AAP README
geo_em.d01.nc GRIBFILE.AAF link_grib.csh ungrrib
geo_em.d02.nc GRIBFILE.AAG logfile.log ungrrib.exe
geo_em.d03.nc GRIBFILE.AAH metgrid ungrrib.log
geogrid GRIBFILE.AAI metgrid.exe util
geogrid.exe GRIBFILE.AAJ metgrid.log Vtable
geogrid.log GRIBFILE.AAK namelist.wps
(base) entro@entro:~/training/20190821/wps$
```

Run ungrrib with `./ungrrib.exe`



```
geogrid.log GRIBFILE.AAK namelist.wps
(base) entro@entro:~/training/20190821/wps$ ./ungrrib.exe
*** Starting program ungrrib.exe ***
Start_date = 2019-08-21_00:00:00 , End_date = 2019-08-24_00:00:00
output format is WPS
Path to intermediate files is ./

#####
Inventory for date = 2019-08-21 00:00:00
PRES TT UU VV RH HGT PSFC PMSL SM000010 SM010040 SM040100 SM100200 SM010200 ST000010 ST010040 ST040100 ST
100200 ST010200 SEAICE LANDSEA LANDN SOILHGT SKINTEMP SNOW SNOWH UMAXV VMAXV PMAXV PMAXWNN TMAXV HGTMAXV UTROP VT
ROP FTROP PTROPNN TTROP HGTTRAP
-----
2013.0 o o o o o o o X o o o o o o o o o o
o o o o o o o o o o o o o o o o o
o o o o o o o o o o o o o o o o
2001.0 X X X X X o X o X X X o X X X X X X
o X X X o X X o X X X X X X X X X
X o X X X
1000.0 X X X X X
975.0 X X X X X
950.0 X X X X X
925.0 X X X X X
900.0 X X X X X
... ..
```

Once ungrrib is done, it will produce files by the naming format GFS:YYYY-MM-DD_HH for the next step is to run metgrid by the command `./metgrid.exe`

```

Thu 13:28
entro@entro: ~/training/20190821/wps
Deleting file: ./FFILE:2019-08-23_15
Deleting file: ./FFILE:2019-08-23_18
Deleting file: ./FFILE:2019-08-23_21
Deleting file: ./FFILE:2019-08-24_00
*****
Done deleting temporary files.
*****
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
! Successful completion of ungrib. !
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
(base) entro@entro:~/training/20190821/wps$
(base) entro@entro:~/training/20190821/wps$ ls
arch          geogrid.exe  GFS:2019-08-21_21  GFS:2019-08-23_00  GRIBFILE.AAA  GRIBFILE.AAJ  metgrid          ungrib
clean        geogrid.log  GFS:2019-08-22_00  GFS:2019-08-23_03  GRIBFILE.AAB  GRIBFILE.AAK  metgrid.exe     ungrib.exe
compile     GFS:2019-08-21_00  GFS:2019-08-22_03  GFS:2019-08-23_06  GRIBFILE.AAC  GRIBFILE.AAL  metgrid.log     ungrib.log
configure   GFS:2019-08-21_03  GFS:2019-08-22_06  GFS:2019-08-23_09  GRIBFILE.AAD  GRIBFILE.AAM  namelist.wps    util
configure.wps GFS:2019-08-21_06  GFS:2019-08-22_09  GFS:2019-08-23_12  GRIBFILE.AAE  GRIBFILE.AAN  namelist.wps.all_options Vtable
geo_em.d01.nc GFS:2019-08-21_09  GFS:2019-08-22_12  GFS:2019-08-23_15  GRIBFILE.AAF  GRIBFILE.AAO  namelist.wps.fire
geo_em.d02.nc GFS:2019-08-21_12  GFS:2019-08-22_15  GFS:2019-08-23_18  GRIBFILE.AAG  GRIBFILE.AAP  namelist.wps.global
geo_em.d03.nc GFS:2019-08-21_15  GFS:2019-08-22_18  GFS:2019-08-23_21  GRIBFILE.AAH  link_grib.csh  namelist.wps.nmm
geogrid     GFS:2019-08-21_18  GFS:2019-08-22_21  GFS:2019-08-24_00  GRIBFILE.AAI  logfile.log    README
(base) entro@entro:~/training/20190821/wps$ ./metgrid.exe
Processing domain 1 of 3
Processing 2019-08-21_00
GFS
Processing 2019-08-21_03
GFS
Processing 2019-08-21_06
GFS
Processing 2019-08-21_09
GFS
Processing 2019-08-21_12
GFS

```

The metgrid interpolates, the wrf input data into the domain.

```

Thu 13:40
entro@entro: ~/training/20190821/wps
GFS
Processing 2019-08-22_06
GFS
Processing 2019-08-22_09
GFS
Processing 2019-08-22_12
GFS
Processing 2019-08-22_15
GFS
Processing 2019-08-22_18
GFS
Processing 2019-08-22_21
GFS
Processing 2019-08-23_00
GFS
Processing 2019-08-23_03
GFS
Processing 2019-08-23_06
GFS
Processing 2019-08-23_09
GFS
Processing 2019-08-23_12
GFS
Processing 2019-08-23_15
GFS
Processing 2019-08-23_18
GFS
Processing 2019-08-23_21
GFS
Processing 2019-08-24_00
GFS
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
! Successful completion of metgrid. !
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Note: The following floating-point exceptions are signalling: IEEE_OVERFLOW_FLAG IEEE_UNDERFLOW_FLAG IEEE_DENORMAL
(base) entro@entro:~/training/20190821/wps$

```

Successful execution prints the output above and will produce files by the domains with the names met_em.d01*.

```

File Edit View Search Terminal Tabs Help
entro@entro: ~/training/20190821/wps x  entro@entro: ~/wrfmaster/wrf x  entro@entro: ~/wrfmaster/wrf x  entro@entro: ~/wrf
clean GRIBFILE.AAB met_em.d01.2019-08-23_09:00:00.nc met_em.d03.2019-08-21_15:00:00.nc
compile GRIBFILE.AAC met_em.d01.2019-08-23_12:00:00.nc met_em.d03.2019-08-21_18:00:00.nc
configure GRIBFILE.AAD met_em.d01.2019-08-23_15:00:00.nc met_em.d03.2019-08-21_21:00:00.nc
configure.wps GRIBFILE.AAE met_em.d01.2019-08-23_18:00:00.nc met_em.d03.2019-08-22_00:00:00.nc
geo_em.d01.nc GRIBFILE.AAF met_em.d01.2019-08-23_21:00:00.nc met_em.d03.2019-08-22_03:00:00.nc
geo_em.d02.nc GRIBFILE.AAG met_em.d01.2019-08-24_00:00:00.nc met_em.d03.2019-08-22_06:00:00.nc
geo_em.d03.nc GRIBFILE.AAH met_em.d02.2019-08-21_00:00:00.nc met_em.d03.2019-08-22_09:00:00.nc
geogrid GRIBFILE.AAI met_em.d02.2019-08-21_03:00:00.nc met_em.d03.2019-08-22_12:00:00.nc
geogrid.exe GRIBFILE.AAJ met_em.d02.2019-08-21_06:00:00.nc met_em.d03.2019-08-22_15:00:00.nc
geogrid.log GRIBFILE.AAK met_em.d02.2019-08-21_09:00:00.nc met_em.d03.2019-08-22_18:00:00.nc
GFS:2019-08-21_00 GRIBFILE.AAL met_em.d02.2019-08-21_12:00:00.nc met_em.d03.2019-08-22_21:00:00.nc
GFS:2019-08-21_03 GRIBFILE.AAM met_em.d02.2019-08-21_15:00:00.nc met_em.d03.2019-08-23_00:00:00.nc
GFS:2019-08-21_06 GRIBFILE.AAN met_em.d02.2019-08-21_18:00:00.nc met_em.d03.2019-08-23_03:00:00.nc
GFS:2019-08-21_09 GRIBFILE.AAO met_em.d02.2019-08-21_21:00:00.nc met_em.d03.2019-08-23_06:00:00.nc
GFS:2019-08-21_12 GRIBFILE.AAP met_em.d02.2019-08-22_00:00:00.nc met_em.d03.2019-08-23_09:00:00.nc
GFS:2019-08-21_15 link_grib.csh met_em.d02.2019-08-22_03:00:00.nc met_em.d03.2019-08-23_12:00:00.nc
GFS:2019-08-21_18 logfile.log met_em.d02.2019-08-22_06:00:00.nc met_em.d03.2019-08-23_15:00:00.nc
GFS:2019-08-21_21 met_em.d01.2019-08-21_00:00:00.nc met_em.d02.2019-08-22_09:00:00.nc met_em.d03.2019-08-23_18:00:00.nc
GFS:2019-08-22_00 met_em.d01.2019-08-21_03:00:00.nc met_em.d02.2019-08-22_12:00:00.nc met_em.d03.2019-08-23_21:00:00.nc
GFS:2019-08-22_03 met_em.d01.2019-08-21_06:00:00.nc met_em.d02.2019-08-22_15:00:00.nc met_em.d03.2019-08-24_00:00:00.nc
GFS:2019-08-22_06 met_em.d01.2019-08-21_09:00:00.nc met_em.d02.2019-08-22_18:00:00.nc metgrid
GFS:2019-08-22_09 met_em.d01.2019-08-21_12:00:00.nc met_em.d02.2019-08-22_21:00:00.nc metgrid.exe
GFS:2019-08-22_12 met_em.d01.2019-08-21_15:00:00.nc met_em.d02.2019-08-23_00:00:00.nc metgrid.log
GFS:2019-08-22_15 met_em.d01.2019-08-21_18:00:00.nc met_em.d02.2019-08-23_03:00:00.nc namelist.wps
GFS:2019-08-22_18 met_em.d01.2019-08-21_21:00:00.nc met_em.d02.2019-08-23_06:00:00.nc namelist.wps.all_options
GFS:2019-08-22_21 met_em.d01.2019-08-22_00:00:00.nc met_em.d02.2019-08-23_09:00:00.nc namelist.wps.fire
GFS:2019-08-23_00 met_em.d01.2019-08-22_03:00:00.nc met_em.d02.2019-08-23_12:00:00.nc namelist.wps.global
GFS:2019-08-23_03 met_em.d01.2019-08-22_06:00:00.nc met_em.d02.2019-08-23_15:00:00.nc namelist.wps.nmm
GFS:2019-08-23_06 met_em.d01.2019-08-22_09:00:00.nc met_em.d02.2019-08-23_18:00:00.nc README
GFS:2019-08-23_09 met_em.d01.2019-08-22_12:00:00.nc met_em.d02.2019-08-23_21:00:00.nc ungrib
GFS:2019-08-23_12 met_em.d01.2019-08-22_15:00:00.nc met_em.d02.2019-08-24_00:00:00.nc ungrib.exe
GFS:2019-08-23_15 met_em.d01.2019-08-22_18:00:00.nc met_em.d03.2019-08-21_00:00:00.nc ungrib.log
GFS:2019-08-23_18 met_em.d01.2019-08-22_21:00:00.nc met_em.d03.2019-08-21_03:00:00.nc util
GFS:2019-08-23_21 met_em.d01.2019-08-23_00:00:00.nc met_em.d03.2019-08-21_06:00:00.nc Vtable
GFS:2019-08-24_00 met_em.d01.2019-08-23_03:00:00.nc met_em.d03.2019-08-21_09:00:00.nc
(base) entro@entro: ~/training/20190821/wps$

```

The metgrid outputs, which holds the right meteorological data for WRF input are named from the start to end of the forecast. This should also conform in the namelist.input

The next step is to navigate into the wrf the directory

```
cd ../wrf
```

Link the products of metgrid in wps to wrf as follows

```
ln -s ../wps/met_em.d0*
```

```

File Edit View Search Terminal Help
GNU nano 2.9.3 namelist.input

&time_control
! run_days = 0,
! run_hours = 24,
! run_minutes = 0,
! run_seconds = 0,
start_year = 2019, 2019, 2019,
start_month = 08, 08, 08, 01,
start_day = 21, 21, 21, 18,
start_hour = 00, 00, 00, 00,
start_minute = 00, 00, 00, 00,
start_second = 00, 00, 00, 00,
end_year = 2019, 2019, 2019, 2019,
end_month = 08, 08, 08, 01,
end_day = 24, 24, 24, 21,
end_hour = 00, 00, 00, 00,
end_minute = 00, 00, 00, 00,
end_second = 00, 00, 00, 00,
interval_seconds = 10800,
input_from_file = .true., .false., .false., .false.,
history_interval = 180, 180, 180, 180,
frames_per_outfile = 1000, 1000, 1000, 1000,
restart = .false.,
restart_interval = 5000,
io_form_history = 2,
io_form_restart = 2,
io_form_input = 2,
io_form_boundary = 2,
diag_print = 0,
output_diagnostics = 1,
auxhist3_outname = "wrfdaily_d<domain>_<date>"
auxhist3_interval = 360, 60, 60, 60,
frames_per_auxhist3 = 1000, 1000, 1000, 1000

[ Read 142 lines ]
^G Get Help ^O Write Out ^W Where Is ^R Cut Text ^J Justify ^C Cur Pos ^M-U Undo ^M-A Mark Text ^M-] To Bracket
^X Exit ^R Read File ^A Replace ^U Uncut Text ^T To Spell ^_ Go To Line ^M-E Redo ^M-C Copy Text ^M-W WhereIs Next

```

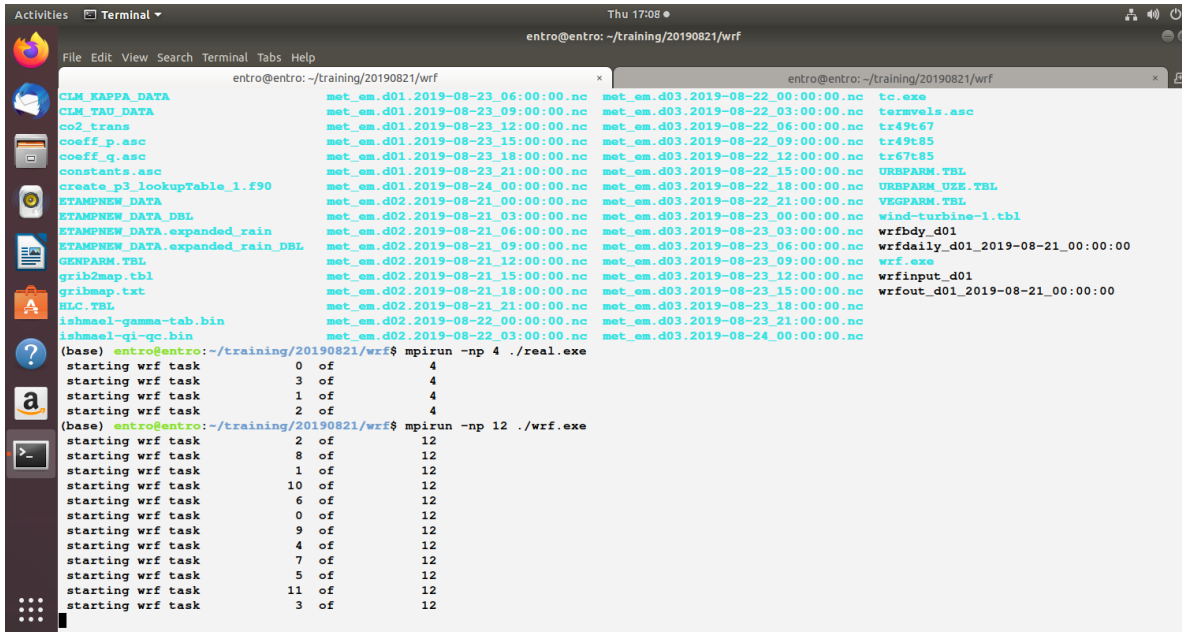
Execute real.exe by the command `mpirun -np 4 ./real.exe` as shown below.

```

entro@entro: ~/training/20190821/wrf
File Edit View Search Terminal Help
CAMtr_volume_mixing_ratio.A1B met_em.d01.2019-08-21_12:00:00.nc met_em.d02.2019-08-23_09:00:00.nc README.namelist
CAMtr_volume_mixing_ratio.A2 met_em.d01.2019-08-21_15:00:00.nc met_em.d02.2019-08-23_12:00:00.nc README.rasm_diag
CAMtr_volume_mixing_ratio.RCP4.5 met_em.d01.2019-08-21_18:00:00.nc met_em.d02.2019-08-23_15:00:00.nc README.telist
CAMtr_volume_mixing_ratio.RCP6 met_em.d01.2019-08-21_21:00:00.nc met_em.d02.2019-08-23_18:00:00.nc real.exe
CAMtr_volume_mixing_ratio.RCP8.5 met_em.d01.2019-08-22_00:00:00.nc met_em.d02.2019-08-23_21:00:00.nc RRTM_DATA
capacity.asc met_em.d01.2019-08-22_03:00:00.nc met_em.d02.2019-08-24_00:00:00.nc RRTM_DATA_DBL
CCN_ACTIVATE_BIN met_em.d01.2019-08-22_06:00:00.nc met_em.d03.2019-08-21_00:00:00.nc RRTMG_LW_DATA
CLM_ALB_ICE_DFS_DATA met_em.d01.2019-08-22_09:00:00.nc met_em.d03.2019-08-21_03:00:00.nc RRTMG_LW_DATA_DBL
CLM_ALB_ICE_DRC_DATA met_em.d01.2019-08-22_12:00:00.nc met_em.d03.2019-08-21_06:00:00.nc RRTMG_SW_DATA
CLM_ASM_ICE_DFS_DATA met_em.d01.2019-08-22_15:00:00.nc met_em.d03.2019-08-21_09:00:00.nc RRTMG_SW_DATA_DBL
CLM_ASM_ICE_DRC_DATA met_em.d01.2019-08-22_18:00:00.nc met_em.d03.2019-08-21_12:00:00.nc rsl.error.0000
CLM_DRDSDTO_DATA met_em.d01.2019-08-22_21:00:00.nc met_em.d03.2019-08-21_15:00:00.nc rsl.out.0000
CLM_EXT_ICE_DFS_DATA met_em.d01.2019-08-23_00:00:00.nc met_em.d03.2019-08-21_18:00:00.nc SOILPARM.TBL
CLM_EXT_ICE_DRC_DATA met_em.d01.2019-08-23_03:00:00.nc met_em.d03.2019-08-21_21:00:00.nc SOILPARM.TBL_Kishne_2017
CLM_KAPPA_DATA met_em.d01.2019-08-23_06:00:00.nc met_em.d03.2019-08-22_00:00:00.nc tc.exe
CLM_TAU_DATA met_em.d01.2019-08-23_09:00:00.nc met_em.d03.2019-08-22_03:00:00.nc tarwvls.asc
co2_trans met_em.d01.2019-08-23_12:00:00.nc met_em.d03.2019-08-22_06:00:00.nc tr49t67
coeff_p.asc met_em.d01.2019-08-23_15:00:00.nc met_em.d03.2019-08-22_09:00:00.nc tr49t85
coeff_q.asc met_em.d01.2019-08-23_18:00:00.nc met_em.d03.2019-08-22_12:00:00.nc tr67t85
constants.asc met_em.d01.2019-08-23_21:00:00.nc met_em.d03.2019-08-22_15:00:00.nc URBPARM.TBL
create_p3_lookupTable_1.f90 met_em.d01.2019-08-24_00:00:00.nc met_em.d03.2019-08-22_18:00:00.nc URBPARM.UZE.TBL
ETAMPNEW_DATA met_em.d02.2019-08-21_00:00:00.nc met_em.d03.2019-08-22_21:00:00.nc VEGPARM.TBL
ETAMPNEW_DATA_DBL met_em.d02.2019-08-21_03:00:00.nc met_em.d03.2019-08-23_00:00:00.nc wind-turbine-1.tbl
ETAMPNEW_DATA.expanded_rain met_em.d02.2019-08-21_06:00:00.nc met_em.d03.2019-08-23_03:00:00.nc wrfbdy_d01
ETAMPNEW_DATA.expanded_rain_DBL met_em.d02.2019-08-21_09:00:00.nc met_em.d03.2019-08-23_06:00:00.nc wrfdaily_d01_2019-08-21_00:00:00
GENPARM.TBL met_em.d02.2019-08-21_12:00:00.nc met_em.d03.2019-08-23_09:00:00.nc wrf.exe
grib2map.tbl met_em.d02.2019-08-21_15:00:00.nc met_em.d03.2019-08-23_12:00:00.nc wrfinput_d01
gribmap.txt met_em.d02.2019-08-21_18:00:00.nc met_em.d03.2019-08-23_15:00:00.nc wrfout_d01_2019-08-21_00:00:00
HLC.TBL met_em.d02.2019-08-21_21:00:00.nc met_em.d03.2019-08-23_18:00:00.nc
Ishmael-gamma-tab.bin met_em.d02.2019-08-22_00:00:00.nc met_em.d03.2019-08-23_21:00:00.nc
Ishmael-gi-gc.bin met_em.d02.2019-08-22_03:00:00.nc met_em.d03.2019-08-24_00:00:00.nc
(base) entro@entro:~/training/20190821/wrf$ mpirun -np 4 ./real.exe
starting wrf task 0 of 4
starting wrf task 3 of 4
starting wrf task 1 of 4
starting wrf task 2 of 4

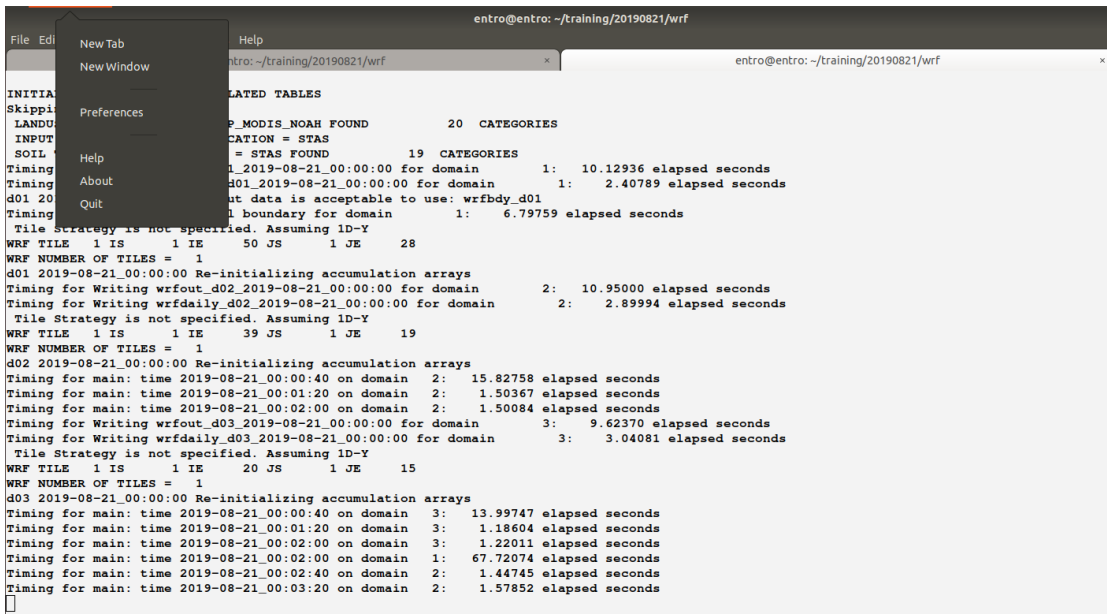
```

Execute wrf.exe by the command `mpirun -np 12 ./wrf.exe` as shown below. This implies run wrf in parallel using 12 processors



Open another terminal to monitor the progress to the WRF using the command

tail -f rsl.out.0000 and sample output is below



After say 2-3 hours, WRF run will be complete. The rainfall forecasts will be contained in files named wrfdaily_d0* for the respective domains.

Successful completion prints the message

SUCCESS COMPLETE WRF

The next steps involve plotting daily WRF rainfall data.

This is achieved by using the script *6EN_WRF_Precip_plot.ncl* which is provided in the available in the */home/entro/training/20190821/plots/* directory

The user is only used to edit the following sections:-

Data & Plot directory

```
10
11   DATADir   = "/home/entro/training/20190821/wrf/"
12   plts     = "/home/entro/training/20190821/plots/"
--
```

Plot domain, type of plot and shapefiles to use

```
27 ; Set the domain
28   latS = 2.000
29   latN = 23.00
30   lonW = 21.40
31   lonE = 48.00
32
33 ; We generate plots, but what kind do we prefer?
34   type = "x11"
35 ; type = "pdf"
36   type = "png"
37 ; type = "eps"
38
39 ; shape files
40   dirSHP      = "/home/entro/shapefiles/"
41   f1 = "SouthSudan.shp"
42   rv = "nile_river_6ca.shp"
--
```

Plot colors and levels

```
164
165   wetlevels   = (/0.1,1,2,5,10,15,20,25,30,50/) ; "mm/day"
166   wetcolors = (/ "gray98" \
167                , "PaleTurquoise", "PaleGreen", "SeaGreen3" , "Yellow" \
168                , "Orange", "HotPink", "Red", "Violet", "Purple", "Brown"/)
169
```

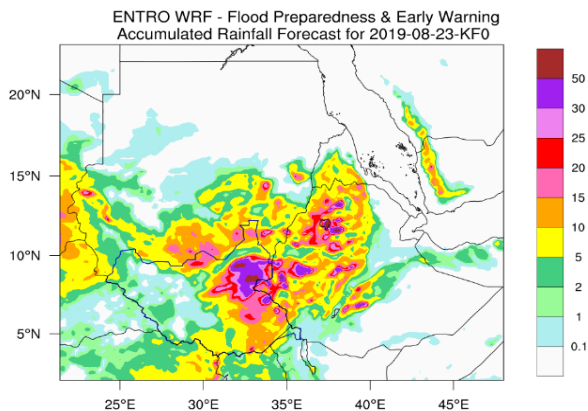
WRF rainfall & largesclae rainfall

```
90 ; Get non-convective, convective and total precipitation
91 ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
92   rain_exp = wrf_user_getvar(a, "RAINNCVMEAN", -1)
93   rain_con = wrf_user_getvar(a, "RAINCVMEAN", -1)
94   rain_tot = rain_exp + rain_con
95
```

It is important to note that to get total rainfall, once has to sum the convective and non-convective rainfall as shown above.

Once edited, the script is ready for use to plot WRF rainfall data

The script is executed from the terminal using the command `ncl 6EN_WRF_Precip_plot.ncl` to generate sample plots similar to the plot shown below



Activity III: Assessment of WRF forecast bias

From the operational forecast directory `/home/entro/forecasts/YYYYMMDD` we take a case of 20200411.

The extracted WRF forecasted rainfall for the Eastern Nile is located at `/home/entro/forecasts/YYYYMMDD/post` bearing the name `wrf-ppt_202004-11_EN.nc` being the forecast for the next three days.

- a) Download CHIRPS data so the forecast period.

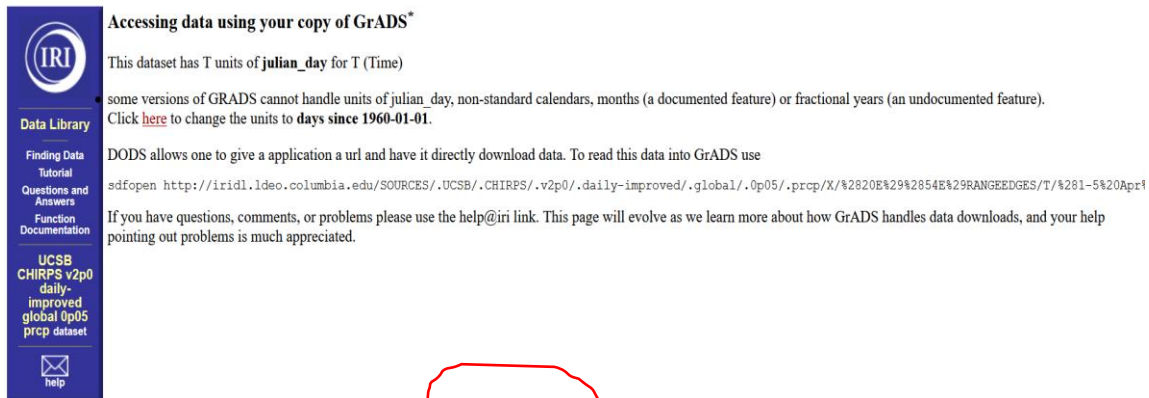
We need to download CHIRPS rainfall data for the same period as the forecast.

To achieve this, paste the link below in your browser (paste and go!)

<https://iridl.ldeo.columbia.edu/SOURCES/UCSB/.CHIRPS/.v2p0/.daily-improved/.global/.0p05/.prcp/X/%2820E%29%2852E%29RANGEEDGES/T/%2811-13%20Apr%202020%29VALUES/Y/%2826N%29%284N%29RANGEEDGES/downloadsGrADS.html>

NB: Modify the highlighted sections (in Bold) to match your forecast period (i.e. the dates 11-13 and month, Apr.

Select [netcdf file](#) to download the rainfall data



Accessing data using your copy of GrADS*

This dataset has T units of **julian_day** for T (Time)

- some versions of GRADS cannot handle units of **julian_day**, non-standard calendars, months (a documented feature) or fractional years (an undocumented feature). Click [here](#) to change the units to **days since 1960-01-01**.

DODS allows one to give an application a url and have it directly download data. To read this data into GrADS use

```
sdfopen http://iridl.ldeo.columbia.edu/SOURCES/.UCSB/.CHIRPS/.v2p0/.daily-improved/.global/.0p05/.prcp/X/%2820E%29%2854E%29RANGEEDGES/T/%281-5%20Apr%202020%29%2811-13%29
```

If you have questions, comments, or problems please use the help@iri link. This page will evolve as we learn more about how GrADS handles data downloads, and your help pointing out problems is much appreciated.

[help](#)

*On GrADS startup, the config line should read **Config: ... DODS-enabled ...**, otherwise DODS (a.k.a. OpenDAP) is not installed and giving GrADS a URL instead of a local file name will result in a file-not-found error. In that case, you can use `sdfopen` after you download the [netcdf file](#).

Rename the file from `data.nc` to [chirpsYYYYMMDDs-DDe.nc](#) e.g. [chirps202004-11_13.nc](#) for rainfall for the period 11-13 of April 2020.

b) Confirm the WRF grids to the CHIRPS

The WRF is at 6km while the CHIRPS is at 5km. A uniform grid is necessary for comparative analysis. Re-gridding the WRF data to the CHIRPS grid is done as follows: -

The CHIRPS grids are contained in the file named [chirpsgrid.txt](#)

Using the `chirpsgrid.txt`, we remap the WRF grids as shown below; -

```
cdo remapbil,chirpsgrids.txt wrf-ppt_20200411-13_EN.nc wrf-ppt_20200411-13_ENrgd.nc
```

Both [wrf-ppt_20200411-13_ENrgd.nc](#) and [chirps20200411-13.nc](#) should be available at `/home/entro/forecasts/YYYYMMDD/post` 

At this point, your data is ready for Bias Analysis

c) Compute & Plot the Bias Map using NCL

We shall compute the Mean Bias i.e. [\(Forecast Ave. – Obs Ave\)](#) to get the bias in mm of rainfall per day.

A script by name [WRFPrecipBias.ncl](#) is prepared for you. However, the following sections need to be modified to match the data utilized/user preference

The user is required to set the domain as defined in `latS=`, `latN=`, `lonW=` and `lonE=` in the previous section and the valid date, `vdate = "2020-04-11-13"`

```
17 vdate = "20200411-13"  
18 type ="PNG"  
19 imgDir = "./"  
20  
21 ; Define your domai, just as in wrf  
22 latS      = 4.1  
23 latN      = 24  
24 lonW      = 21.4  
25 lonE      = 42.0  
26  
27 levs      = ispan(-20,20,5)  
28 colors    = "NCV_blu_red"  
29
```

In Summary the user is required to defined the above section

- valid dates – 20200411-13
- plot type – PNG
- plot location – “./” for current directory
- analysis domains – as defined by longitude-latitude extends
- plot levels – `ispan(-20,20,5)` indicates -20 to 20 at at an interval of 5
- color scheme to use – “NCV_blu_red”. The use can choose other color schemes from the [web link](https://www.ncl.ucar.edu/Document/Graphics/color_table_gallery.shtml)
https://www.ncl.ucar.edu/Document/Graphics/color_table_gallery.shtml

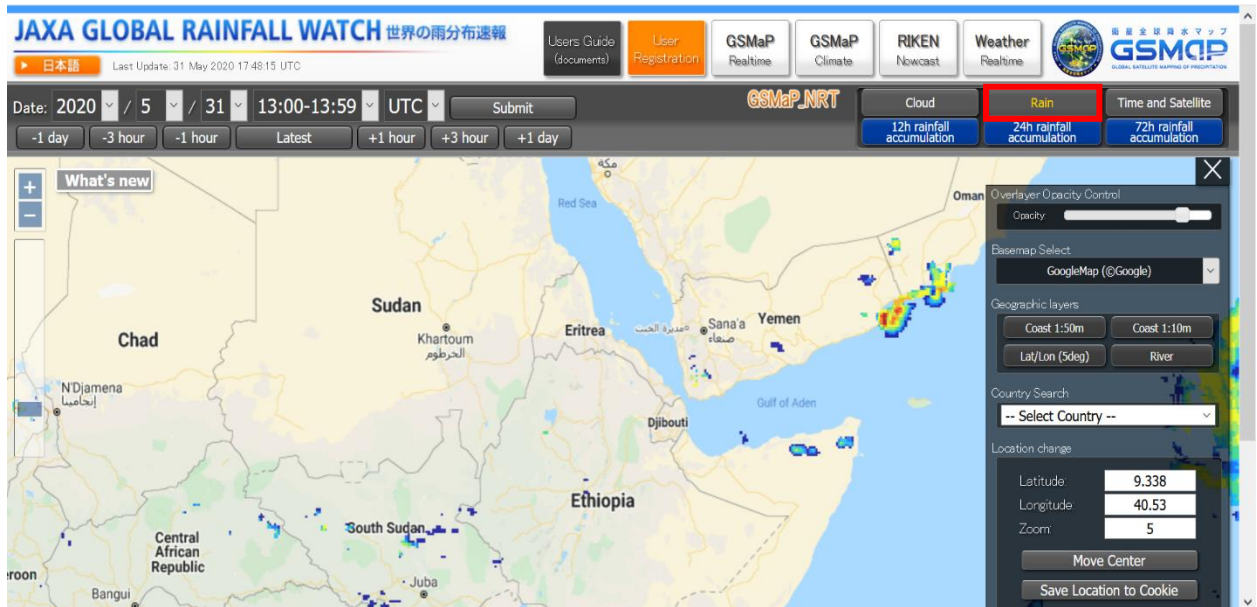
Activity III: For your consideration

- (i) Discuss the spatial distribution of the biases?
- (ii) What are the minimum and maximum values of the biases score? What does this imply in forecasting?

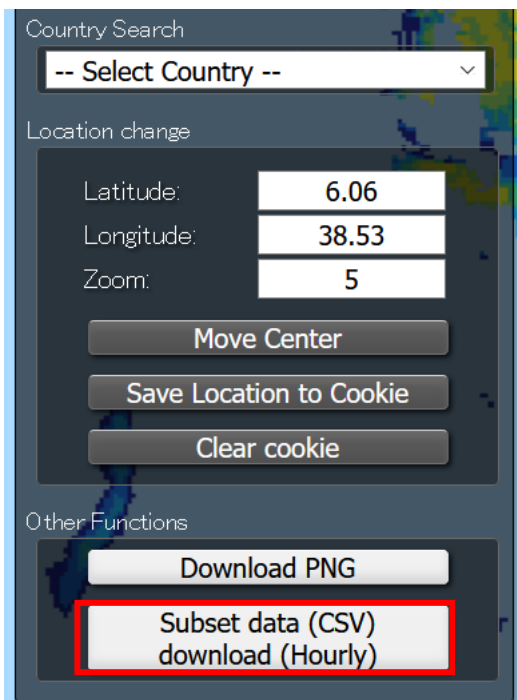
Near-Real Time Satellite Rainfall data

This example demonstrates how to utilize JAXA’s GSMaP near-realtime satellite rainfall data from the webpage <https://sharaku.eorc.jaxa.jp/GSMaP/index.htm>

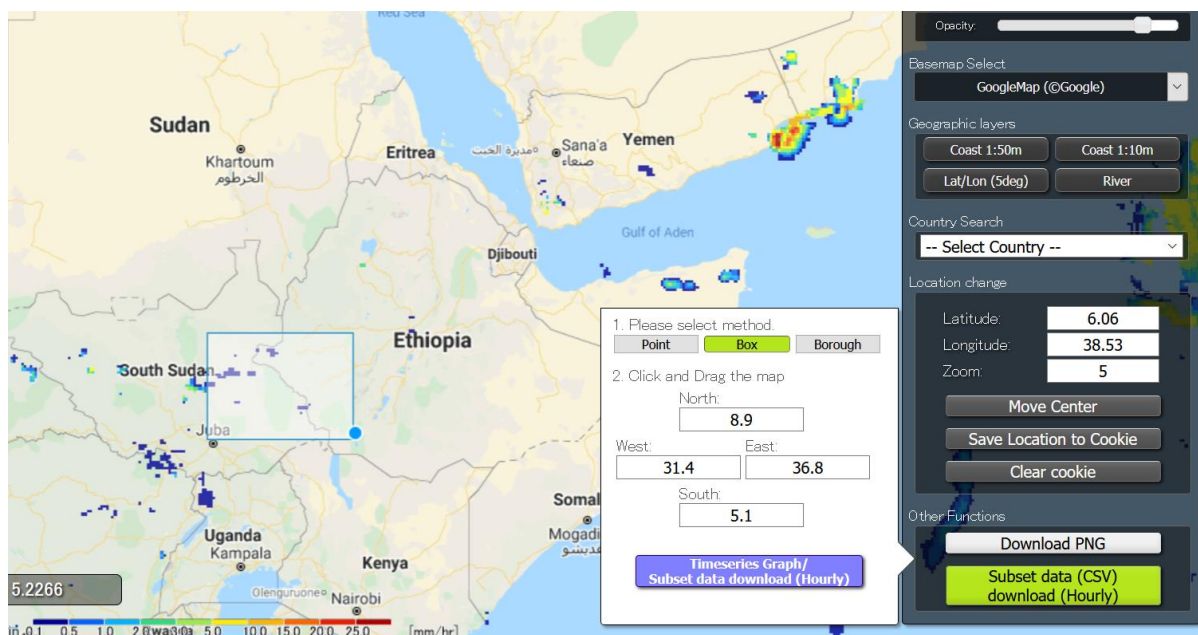
Zoom to the Eastern Nile region using the mouse and select the ‘**Rain**’ tab as highlighted below.



From the tab on the right, scroll down to the Subset data (CSV) download (Hourly) section highlighted below

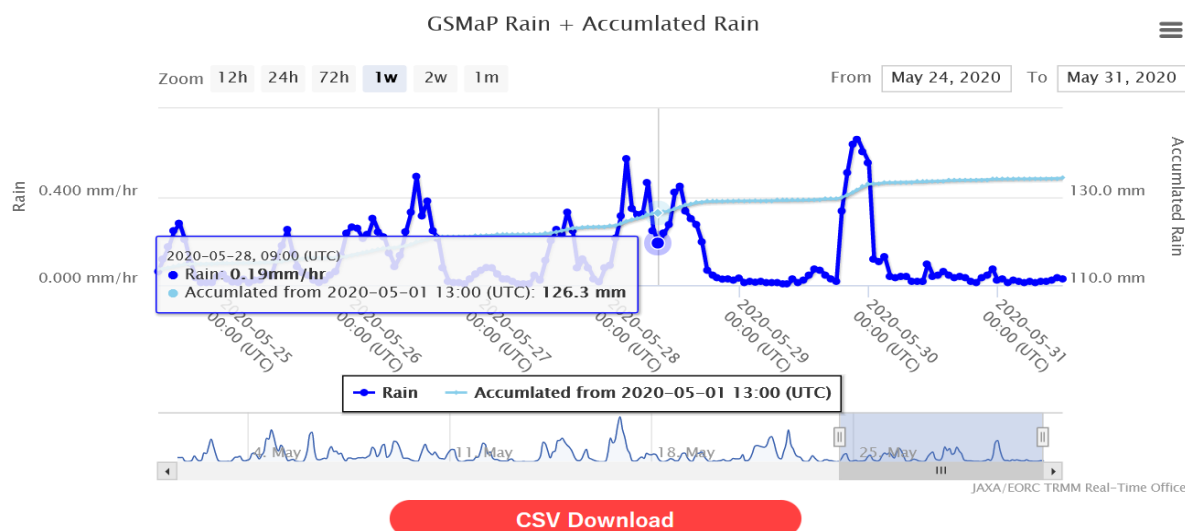


Thereafter, either set the latitude and longitude for a given location using the **point** option. In this example, we select the **Box** option. Subsequently, make a regional section on the map using the cursor and the domain extend will be indicated as below, for the BAS region.



Once the spatial selection is made, generate the **Timeseries Graph**

The averaged rainfall over the selected domain will be displayed such as the time series below. The plot can be adjusted from a range of **12hour** to **1month** since the current date.



You need to register from [here](#) for downloading the CSV data.

If you have already registered for downloading the binary data via ftp site, you can use the same ID/PW.

For registered users, one can download the timeseries data in CSV format by using the **CSV Download** option.

Work Further: Generate a similar timeseries using Country and sub-country regions as an example given below by using the **Borough** option.

1. Please select method.

2. Select Borough.

Ethiopia ▾

- Addis Abeba ▾
- Addis Abeba ▾
- Bole ▾

END OF THE EXERCISE!

Questions/Feedback?