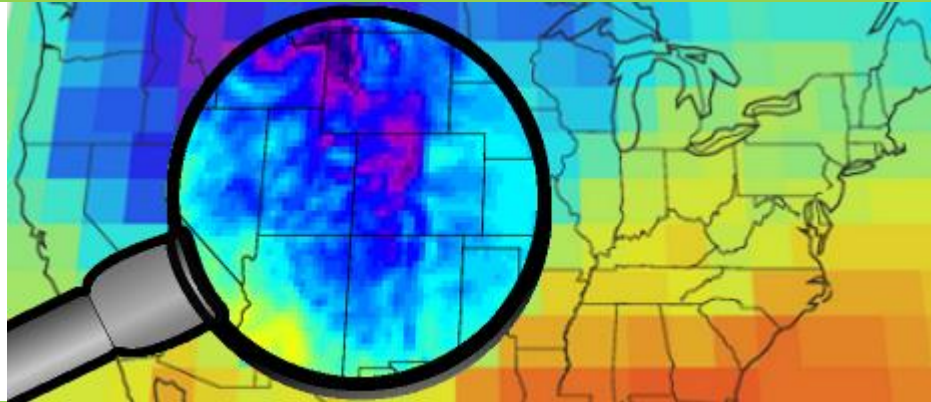
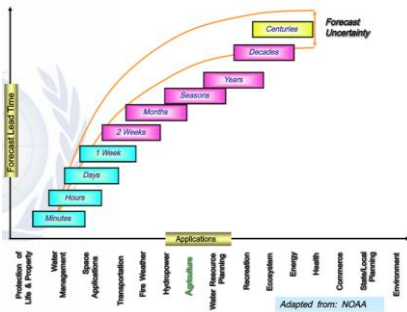




Grid Data Utilization for Ungauged Watersheds



Jihoon Park

2018.10.16

Table of contents

1. Required software installation

2. R program environment setting

3. GIS data construction

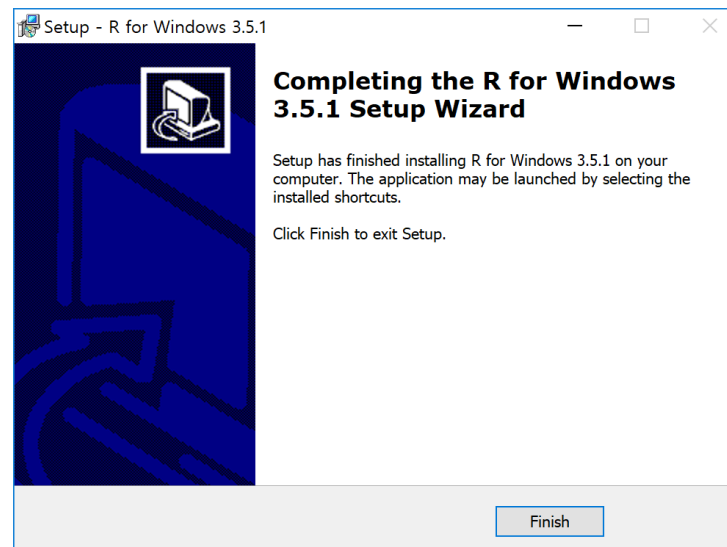
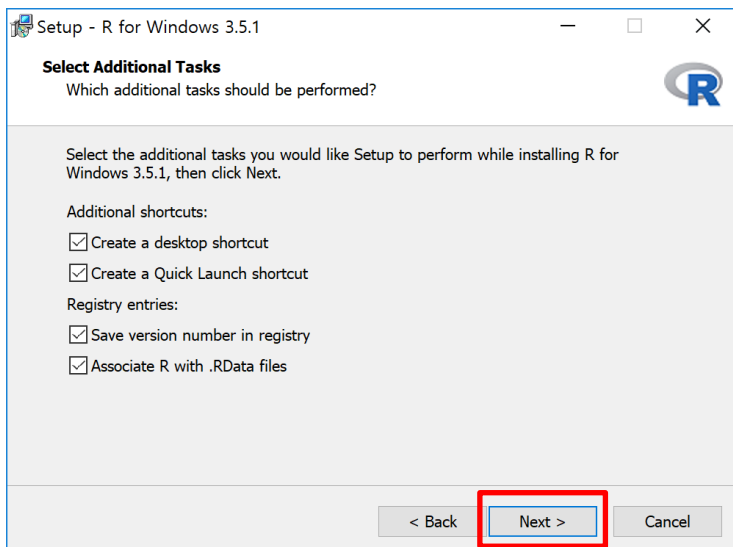
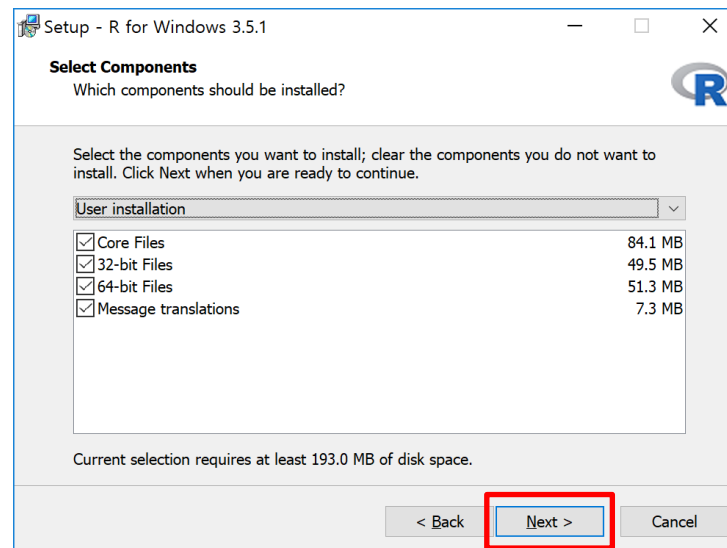
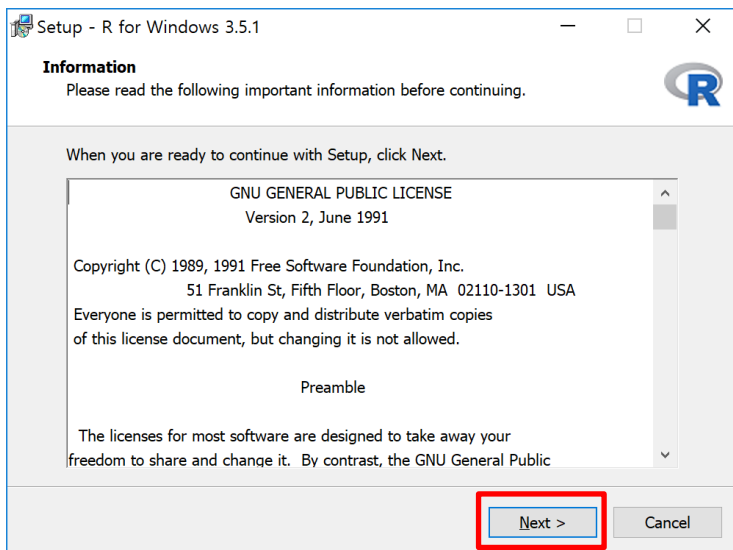
4. Grid data extraction and comparison

1. Required software installation

- **Software for grid data extraction**
 1. R: <https://cran.r-project.org/bin/windows/base/>
 2. Rtools: <https://cran.r-project.org/bin/windows/Rtools/>
 3. R-Studio: <https://www.rstudio.com/products/RStudio/>
- **netCDF data viewer program**
 4. Panoply: <https://www.giss.nasa.gov/tools/panoply/download/>
- **GIS software**
 5. QGIS: <https://qgis.org/ko/site/>
- **All programs was already downloaded in "D:\W2018_SDTPWTools"**

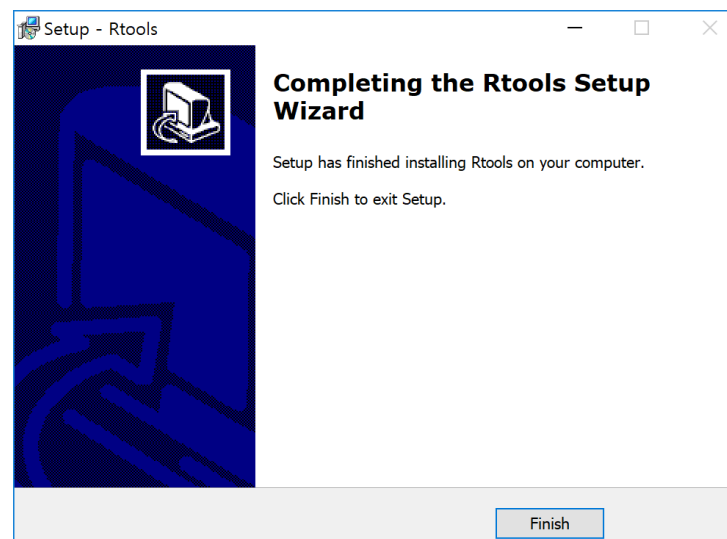
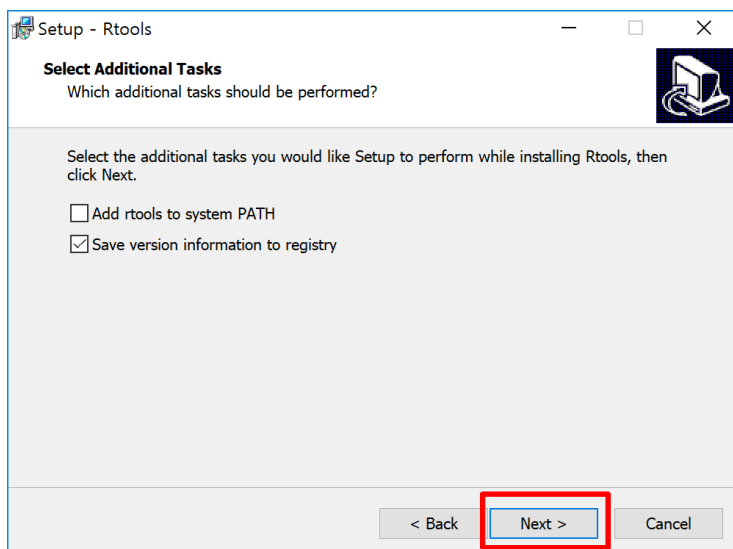
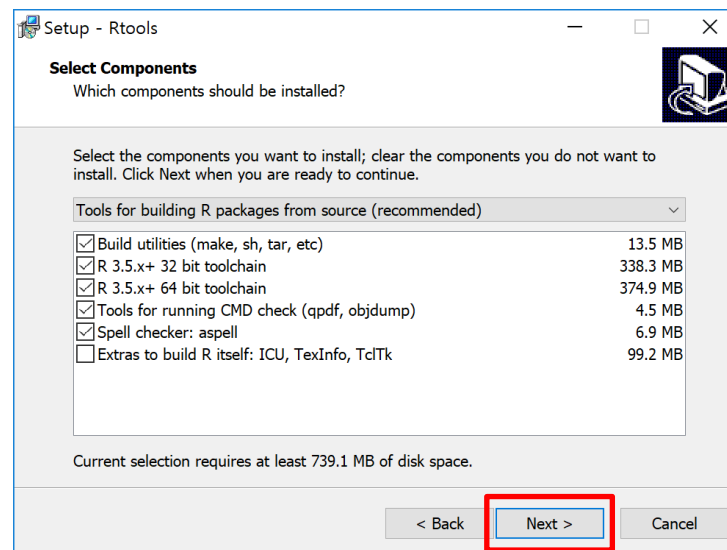
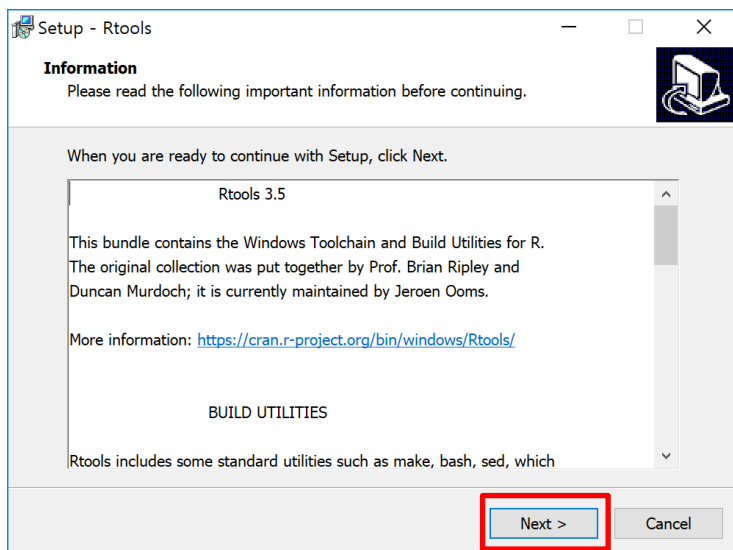
1. Required software installation

- Run "R-3.5.1-win.exe"



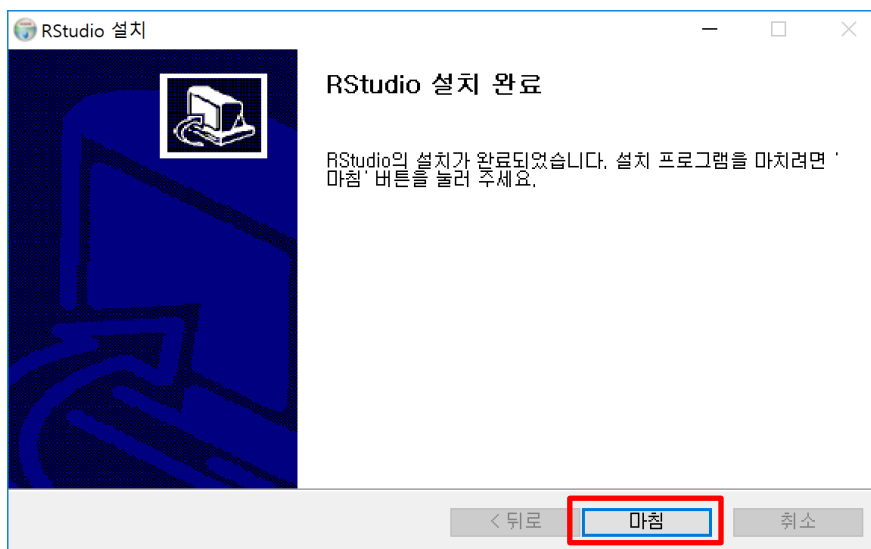
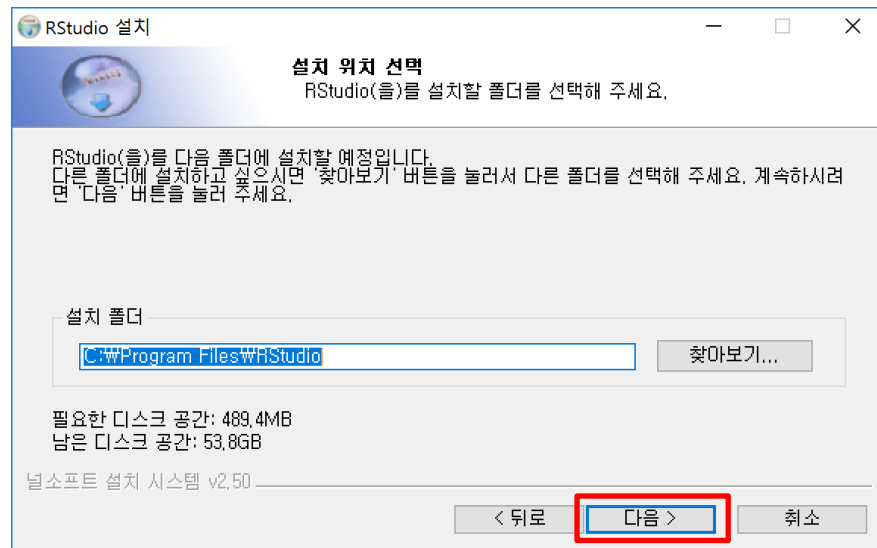
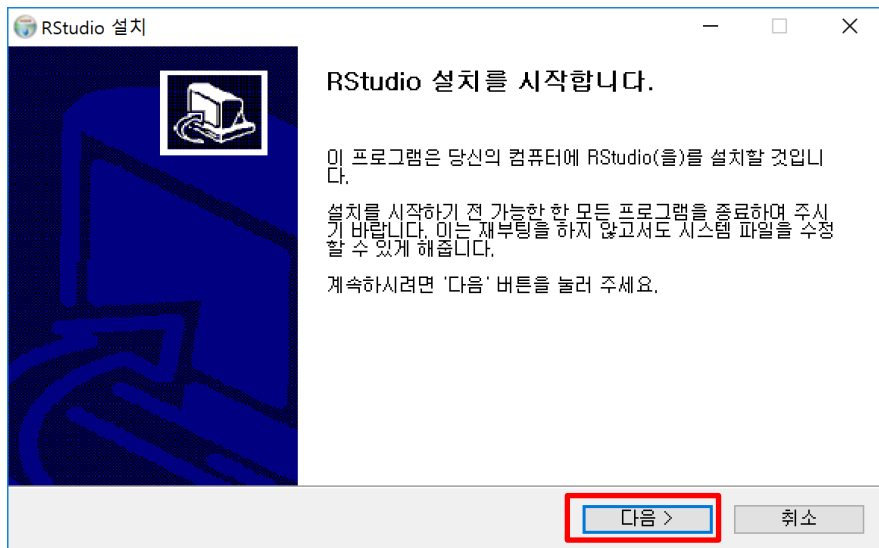
1. Required software installation

- Run “Rtools35.exe”



1. Required software installation

- Run “RStudio-1.1.456.exe”

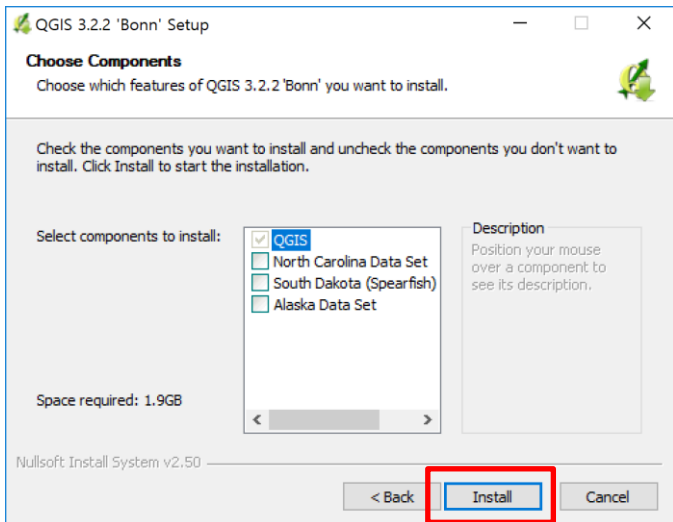
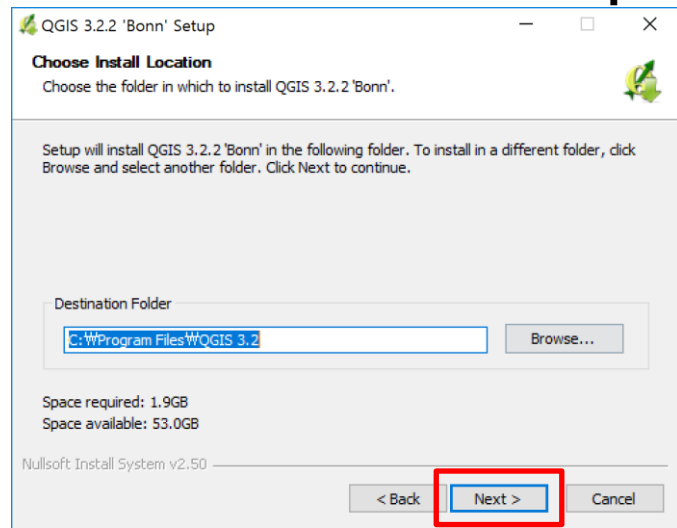
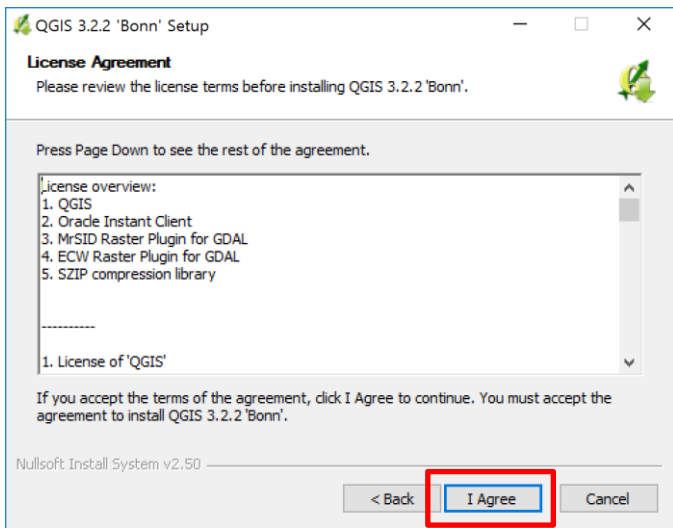


1. Required software installation

1. Run "JavaSetup8u181.exe"
2. Run "BANDIZIP-SETUP-KR.EXE"
3. Unzip "PanoplyWin-4.9.4.zip"

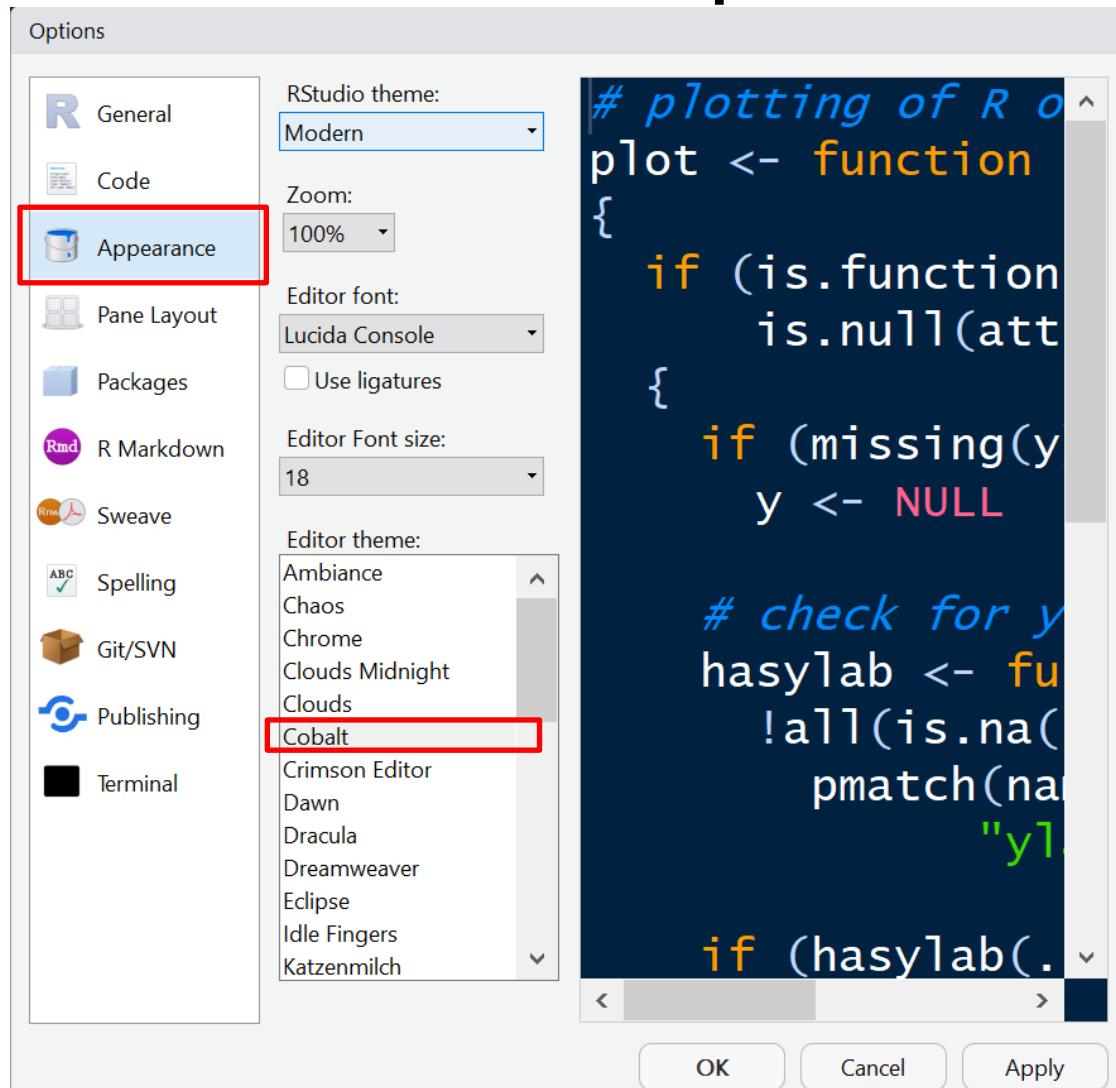
1. Required software installation

- Run “QGIS-OSGeo4W-3.2.2-1-Setup-x86_64.exe”
 - If Windows OS is 32bit, run “QGIS-OSGeo4W-3.2.2-1-Setup-x86.exe”



2. R program environment setting

- Rstudio -> Tools -> Global options



The screenshot shows the RStudio Options dialog box with the 'Appearance' tab selected. The 'RStudio theme' is set to 'Modern', 'Zoom' is 100%, 'Editor font' is 'Lucida Console', and 'Editor Font size' is 18. The 'Editor theme' list has 'Cobalt' selected. A preview window on the right shows R code with the Cobalt theme applied.

Options

General

Code

Appearance

Pane Layout

Packages

R Markdown

Sweave

Spelling

Git/SVN

Publishing

Terminal

RStudio theme: Modern

Zoom: 100%

Editor font: Lucida Console

Use ligatures

Editor Font size: 18

Editor theme:

- Ambiance
- Chaos
- Chrome
- Clouds Midnight
- Clouds
- Cobalt
- Crimson Editor
- Dawn
- Dracula
- Dreamweaver
- Eclipse
- Idle Fingers
- Katzenmilch

```
# plotting of R o
plot <- function
{
  if (is.function
      is.null(att
  {
    if (missing(y
        y <- NULL

# check for y
hasylab <- fu
!all(is.na(
  pmatch(na
    "y1

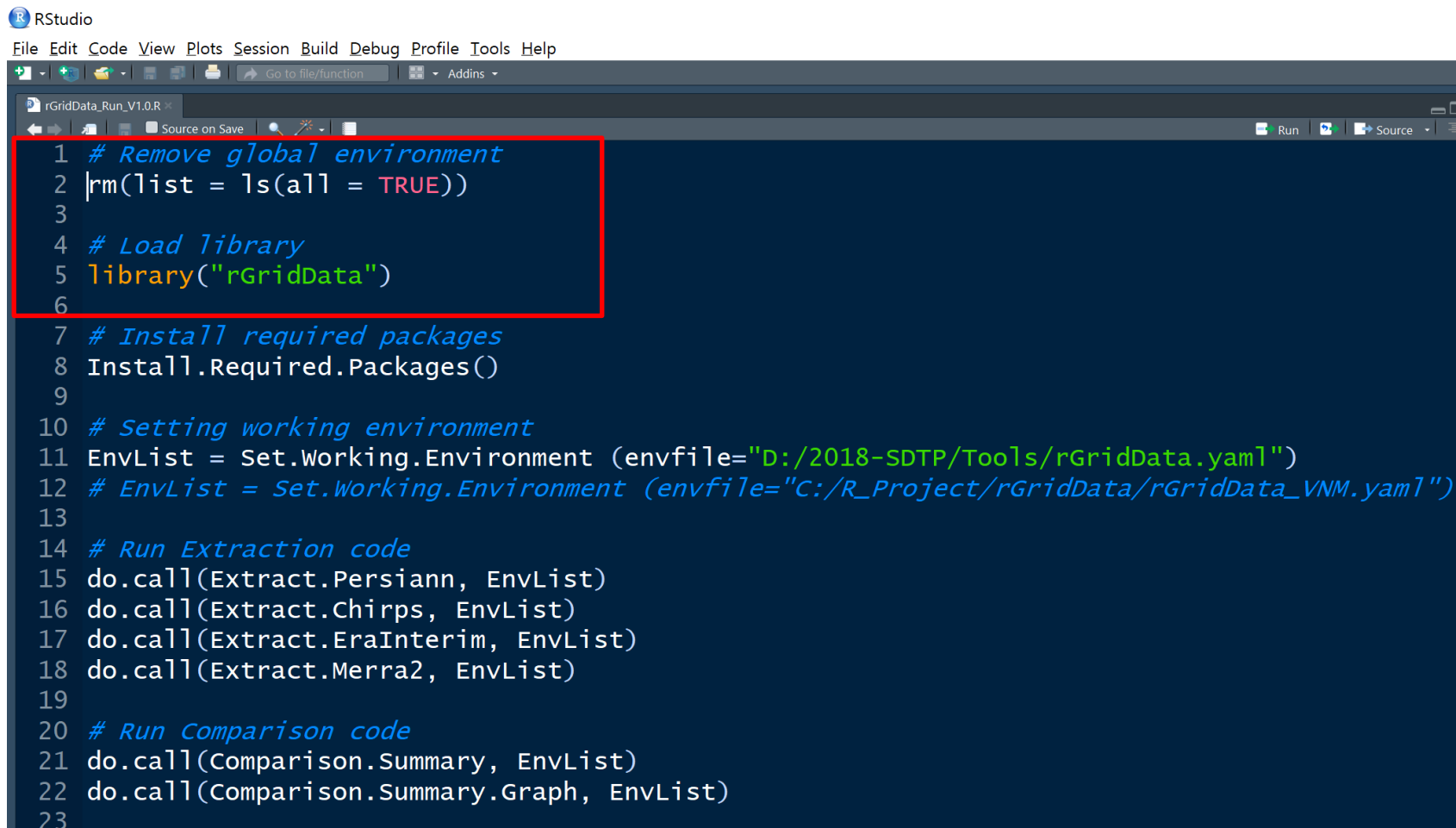
if (hasylab(.

```

OK Cancel Apply

2. R program environment setting

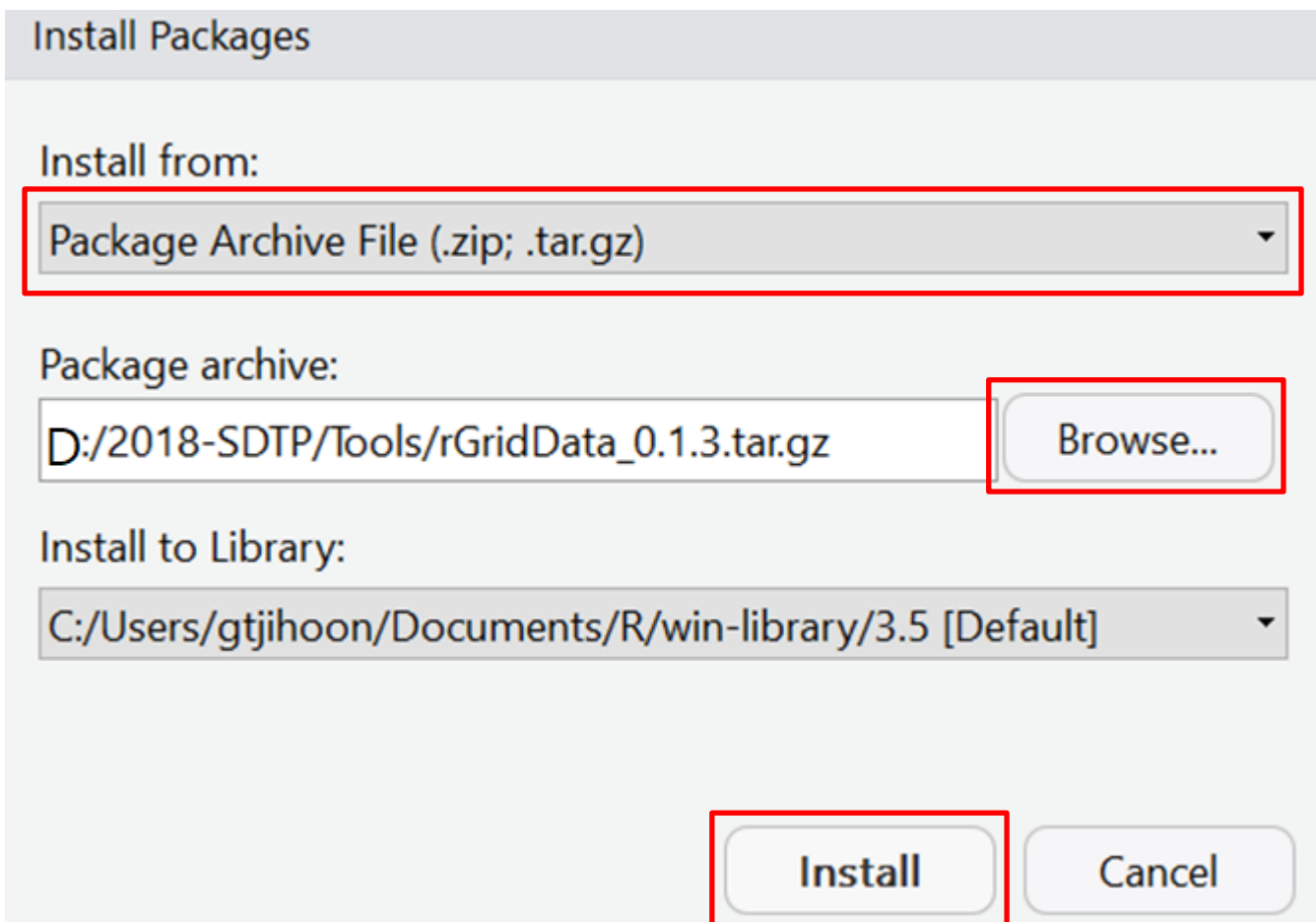
- Rstudio -> File -> Open File -> "D:\W2018-SDTP\Tools\WrGridData_Run_V1.0.R"



```
RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function Addins
rGridData_Run_V1.0.R
Source on Save Run Source
1 # Remove global environment
2 rm(list = ls(all = TRUE))
3
4 # Load library
5 library("rGridData")
6
7 # Install required packages
8 Install.Required.Packages()
9
10 # Setting working environment
11 EnvList = Set.Working.Environment (envfile="D:/2018-SDTP/Tools/rGridData.yaml")
12 # EnvList = Set.Working.Environment (envfile="C:/R_Project/rGridData/rGridData_VNM.yaml")
13
14 # Run Extraction code
15 do.call(Extract.Persiann, EnvList)
16 do.call(Extract.Chirps, EnvList)
17 do.call(Extract.EraInterim, EnvList)
18 do.call(Extract.Merra2, EnvList)
19
20 # Run Comparison code
21 do.call(Comparison.Summary, EnvList)
22 do.call(Comparison.Summary.Graph, EnvList)
23
```

2. R program environment setting

- Install “rGridData” package



Install Packages

Install from:
Package Archive File (.zip; .tar.gz)

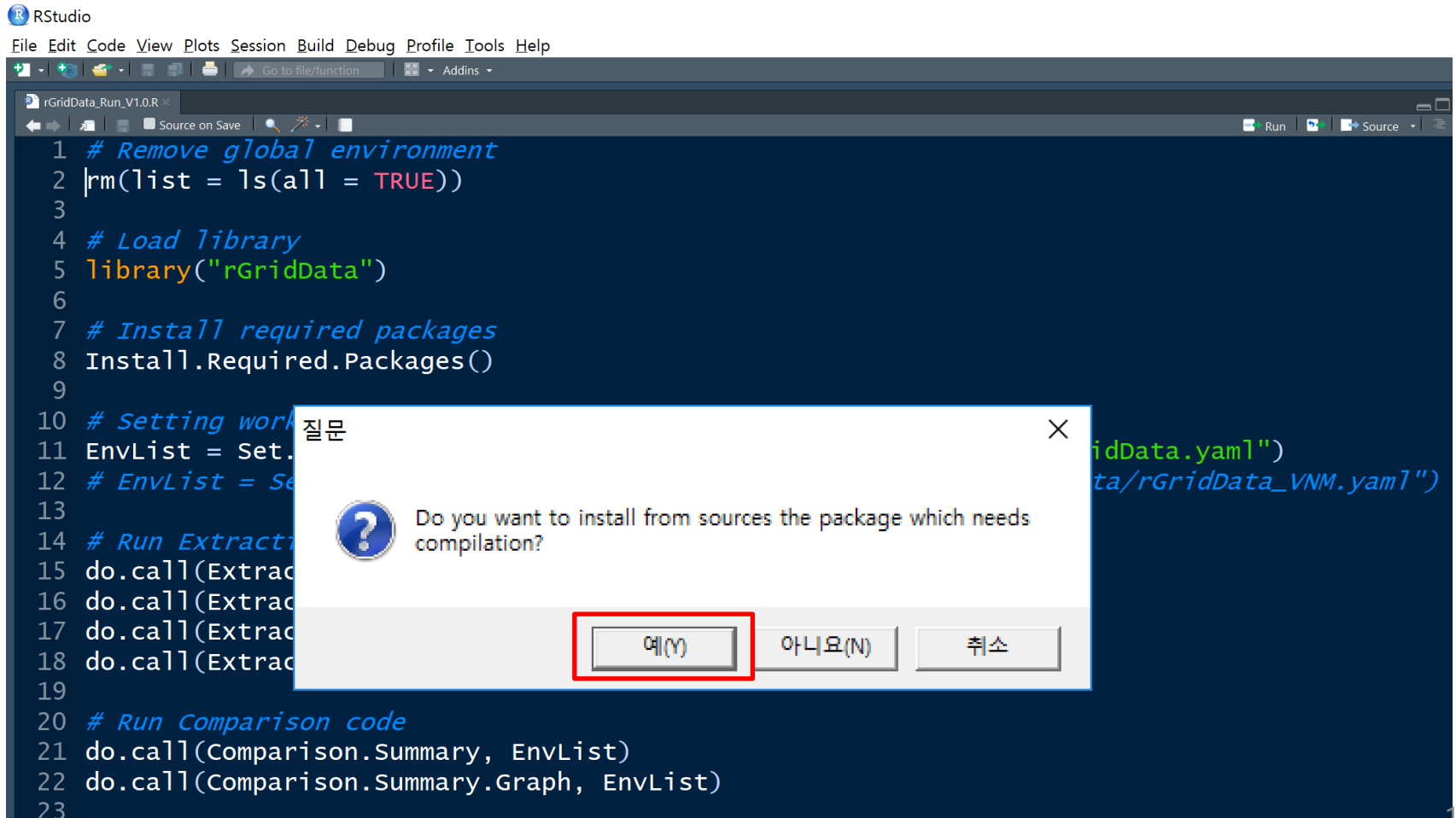
Package archive:
D:/2018-SDTP/Tools/rGridData_0.1.3.tar.gz Browse...

Install to Library:
C:/Users/gtjihoon/Documents/R/win-library/3.5 [Default]

Install Cancel

2. R program environment setting

- Install required packages



The screenshot shows the RStudio interface with a script editor containing R code. A dialog box titled "질문" (Question) is overlaid on the code, asking "Do you want to install from sources the package which needs compilation?". The "예(Y)" (Yes) button is highlighted with a red box.

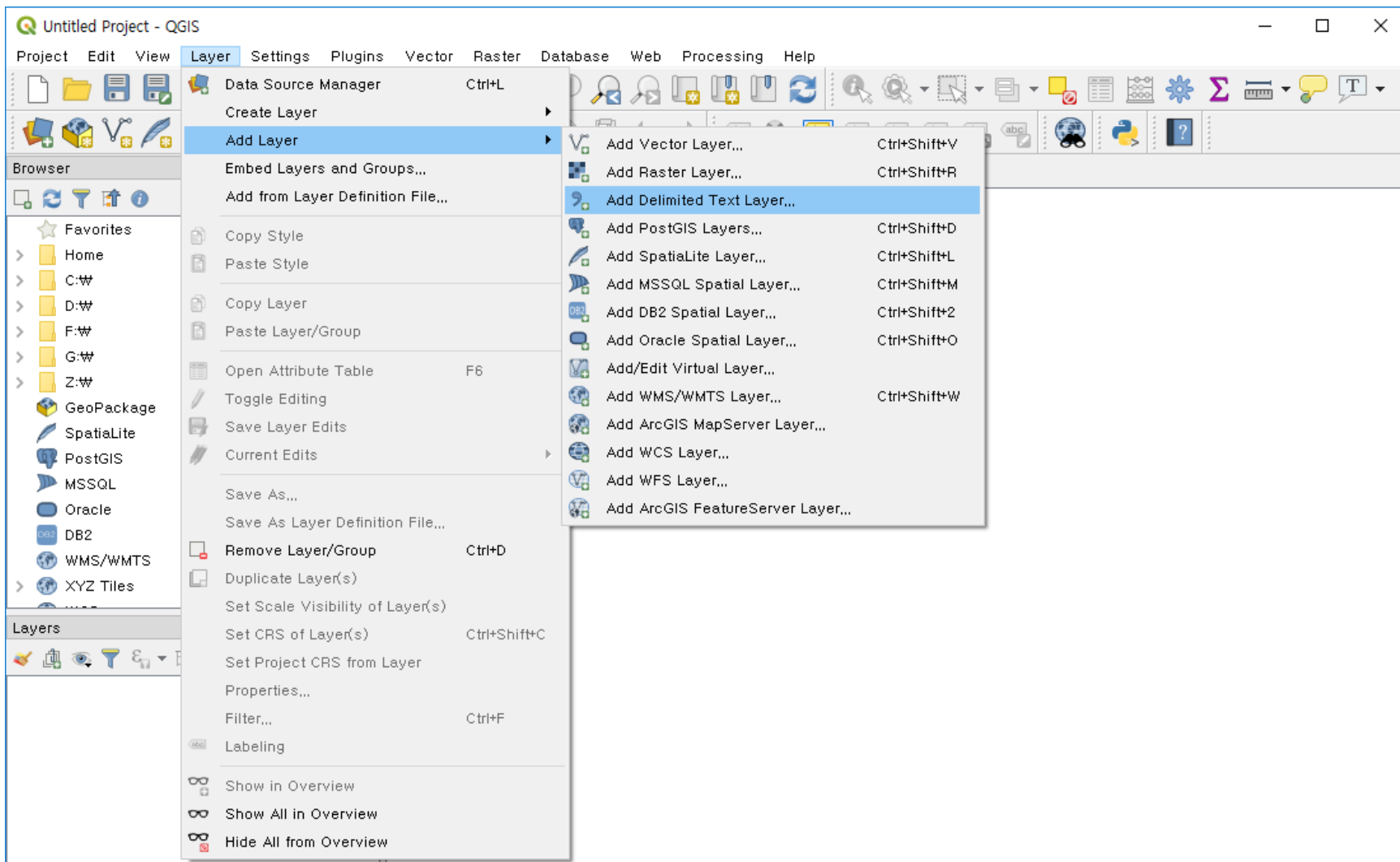
```
1 # Remove global environment
2 rm(list = ls(all = TRUE))
3
4 # Load library
5 library("rGridData")
6
7 # Install required packages
8 Install.Required.Packages()
9
10 # Setting work
11 EnvList = Set
12 # EnvList = Se
13
14 # Run Extract
15 do.call(Extract
16 do.call(Extract
17 do.call(Extract
18 do.call(Extract
19
20 # Run Comparison code
21 do.call(Comparison.Summary, EnvList)
22 do.call(Comparison.Summary.Graph, EnvList)
23
```

질문

Do you want to install from sources the package which needs compilation?

예(Y) 아니요(N) 취소

3. GIS data construction



3. Download geographic data by country

DIVA-GIS: <http://www.diva-gis.org/gdata>



The screenshot shows the DIVA-GIS website interface. At the top, there is a blue navigation bar with three buttons: 'Download program', 'Documentation', and 'Free Spatial Data'. Below the navigation bar, the text 'Home' is visible. The main heading is 'Download data by country'. Below this heading, there is a sub-heading: 'Select and download free geographic (GIS) data for any country in the world'. A horizontal line separates this text from the form below. The form consists of two dropdown menus. The first is labeled 'Country' and has 'South Korea' selected. The second is labeled 'Subject' and has 'Administrative areas' selected. Below the dropdown menus is an 'OK' button.

Download program Documentation Free Spatial Data

Home

Download data by country

Select and download free geographic (GIS) data for any country in the world

Country
South Korea ▼

Subject
Administrative areas ▼

OK

3. Grid data presentation using Panoply

Panoply: Sources

File Edit View History Bookmarks Plot Window Help

Create Plot Combine Plot Open Dataset 장첩저(W) Remove Remove All Hide Info

Name	Long Name	Type
chirps-v2.0.1981, da...	chirps-v2.0.1981.days_p25...	Local File
latitude	latitude	1D
longitude	longitude	1D
precip	Climate Hazards group Inf...	Geo2D
time	time	

Variable "precip"

```
float precip(time=365, latitude=32, longitude=36
convective precipitation rate
ate Hazards group InfraRed P
;
9999.0f;
9.0f; //
n = -50.0
x = 50.0f
n = -180.
x = 180.0
, 32, 36;
```

Create Plot

More than one type of plot can be created from the variable 'precip'. What type would you like to create?

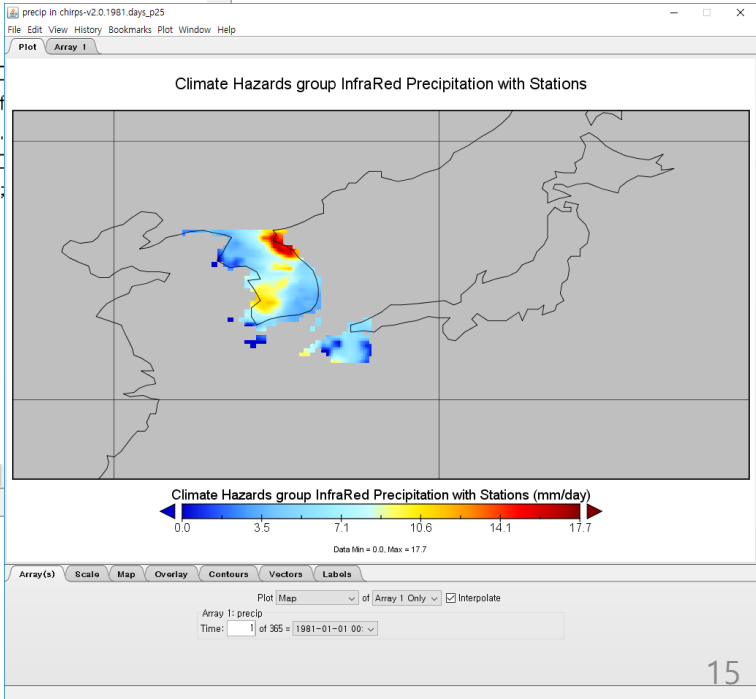
Create georeferenced Longitude-Latitude plot

Create 2D plot using latitude for X axis and longitude for Y axis

Create horizontal line plot along latitude axis

Create Cancel

Show: All variables



4. Grid data extraction and comparison

- Grid data by country
 - CHIRPS: ftp://ftp.chg.ucsb.edu/pub/org/chg/products/CHIRPS-2.0/global_daily/netcdf/
 - PERSIANN-CDR: <https://www.ncei.noaa.gov/data/precipitation-persiann/access/>
 - ERA-Interim: <http://apps.ecmwf.int/datasets/data/interim-full-daily/levtype=sfc/>
 - MERRA2: <https://disc.gsfc.nasa.gov/datasets?keywords=%22MERRA-2%22&page=1&source=Models%2FAnalyses%20MERRA-2>
- Station data by country(ASOS)
 - Station information (Lat, Lon, etc.)
 - Daily observation data

4. Grid data information

Data type		descriptions				
		Spatial scale	Temporal scale of raw data	variables provided	data period	Update
Satellite	CHIRPS-p25	25 km	daily	prec only	1981~2018	monthly update with 1-month delay
	PERSIANN	25 km	daily	prec only	1983~2017	Annual update
Reanalysis	MERRA2	50 km	hourly	Precipitation, Max./Min. Temperature	1980~2018	monthly update with 1-month delay
	ERA-Interim	75 km	prec: 12-hourly temp: 4-hourly	Precipitation, Max./Min. Temperature	1979~2018	monthly update with 1-month delay

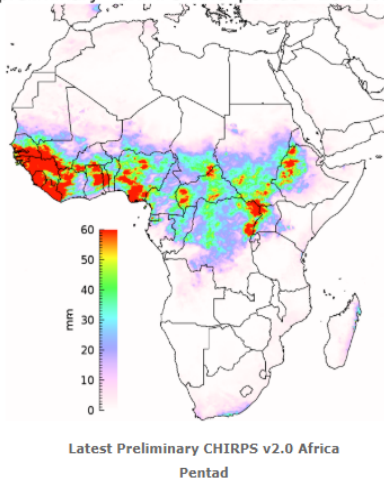
4. Satellite data information

CHIRPS

What is CHIRPS?

Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) is a 30+ year quasi-global rainfall dataset. Spanning 50°S-50°N (and all longitudes), starting in 1981 to near-present, CHIRPS incorporates 0.05° resolution satellite imagery with in-situ station data to create gridded rainfall time series for trend analysis and seasonal drought monitoring. As of February 12th, 2015, version 2.0 of CHIRPS is complete and available to the public. For detailed information on CHIRPS, please refer to [our paper in Scientific Data](#).

preliminary CHIRPS v2.0 pentad 2018.09.1

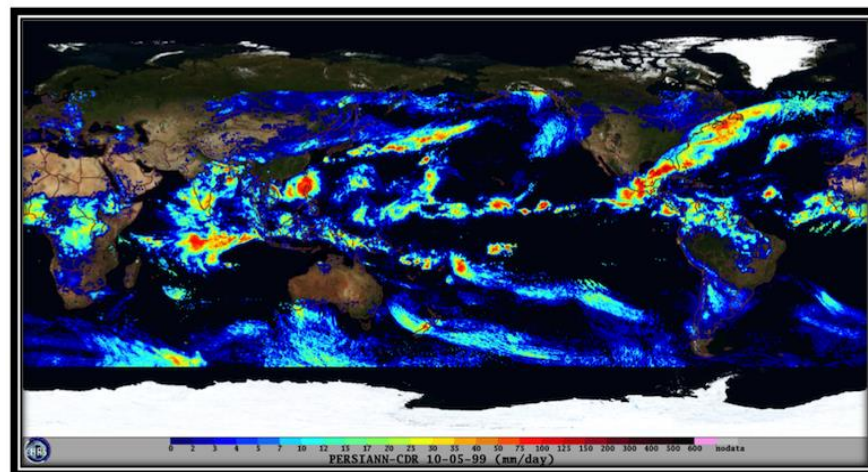


History and Intent

Since 1999, U.S. Geological Survey (USGS) and CHG scientists, supported by funding from the U.S. Agency for International Development (USAID), the National Aeronautics and Space Administration (NASA), and the National Oceanic and Atmospheric Administration (NOAA), have been developing techniques for producing rainfall maps, especially where surface data is sparse.

<http://chg.geog.ucsb.edu/data/chirps/>

PERSIANN-CDR



This dataset provides a high quality Climate Data Record (CDR) of Precipitation.

This global precipitation dataset is intended to support Climatologists, Hydrologists, Hydrometeorologists, and Hydroclimatologists in various forms of climate research, including extreme event (flood and drought) analysis.

Principal Investigator: Soroosh Sorooshian, University of California - Irvine

Cite dataset when used as a source. See the dataset's DOI landing page for citation details at [doi:10.7289/V51V5BWQ](https://doi.org/10.7289/V51V5BWQ)

<https://www.ncdc.noaa.gov/cdr/atmospheric/precipitation-persiann-cdr>

4. Country information

- Country code and Time zone

Country Name	ISO3	ISO2	Time zone	Xmin (degree)	Ymin (degree)	Xmax (degree)	Ymax (degree)
Chile	CHL	CL	UTC-3/-5	-109.5	-56.0	-66.4	-17.5
China	CHN	CN	UTC+8	73.6	18.2	134.8	53.6
Indonesia	IDN	ID	UTC+8/+9	95.0	-11.0	141.0	5.9
Malaysia	MYS	MY	UTC+8	98.9	0.9	119.3	7.4
Mexico	MEX	MX	UTC-6/-7	-118.5	14.5	-86.7	32.7
Nepal	NPL	NP	UTC+5:45	80.1	26.4	88.2	30.4
Papua New Guinea	PNG	PG	UTC+10/+11	140.8	-11.7	159.5	-0.9
Peru	PER	PE	UTC-5	-81.3	-18.3	-68.7	0.0
Philippines	PHL	PH	UTC+8	116.9	4.6	126.6	21.1
Taiwan	TWN	TW	UTC+8	116.7	20.7	122.0	26.4
Thailand	THA	TH	UTC+7	97.3	5.6	105.6	20.5
Vietnam	VNM	VN	UTC+7	102.1	8.4	109.5	23.4

4. Time zone map

- Time zone map: <https://www.timeanddate.com/time/map/>

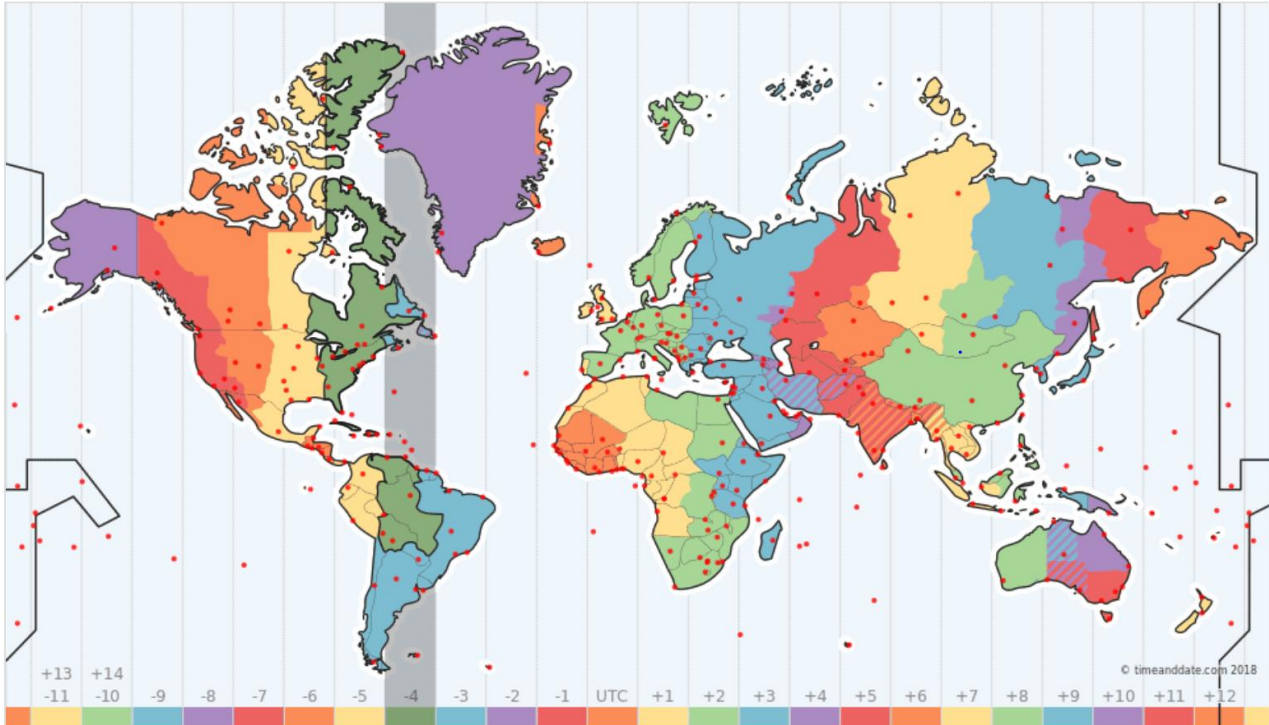
https://www.timeanddate.com/time/map/

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Time Zone Converter | Meeting Planner | Event Time Announcer | **Time Zone Map** | Time Zone Abbreviations | Time Zone News | Daylight Saving Time

Home / Time Zones / Map

Time Zone Map



© timeanddate.com 2018

Search city:

4. Set the control file(Yaml file)

- Rstudio -> File -> Open File -> "D:\W2018-SDTP\ToolsWrGridData.yaml"

```
1 CntryCode: VNM      #Country Code
2 shift_hrs: 7       #Timezone (UTC+shift_hrs)
3
4 prjdir: D:/2018-SDTP/GridDataExt
5 dbdir: D:/2018-SDTP/Database
6
7 persiannidir: $(dbdir)/grid_daily_$(CntryCode)/PERSIANN
8 chirpsdir: $(dbdir)/grid_daily_$(CntryCode)/CHIRPS-p25
9 eradir: $(dbdir)/grid_daily_$(CntryCode)/ERA-Interim
10 merra2dir: $(dbdir)/grid_daily_$(CntryCode)/MERRA2
11 stnobsdir: $(prjdir)/Observed/User
12 ghcndir: $(prjdir)/Observed/GHCN
13 stndir: User
14 stnfile: Station-Info.csv # If you use GHCN data, just leave it blank.
15 gisdir: $(prjdir)/GISDB
16 gisfile: $(CntryCode)_stns
17 pointopt: TRUE
18 GisID: ID
```

4. Set the control file(Yaml file)

- Rstudio -> File -> Open File -> "D:\W2018-SDTPWToolsWrGridData.yaml"

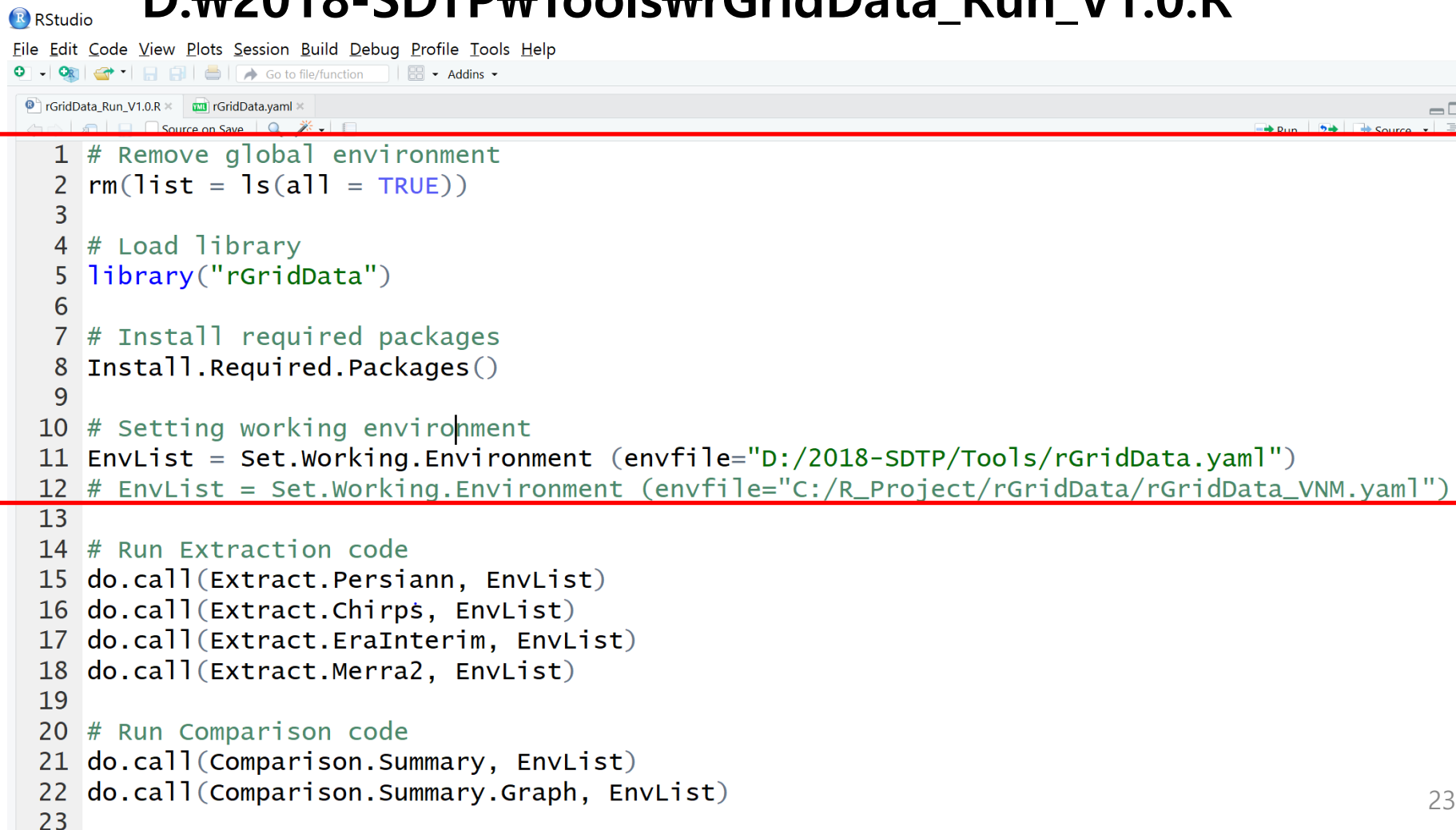
```
20- EraVarNames:
21   - prec           #Precipitation (mm)
22   - tmax          #Max. temperature (C)
23   - tmin          #Min. temperature (C)
24- Merra2VarNames:
25   - prec           #Precipitation (mm)
26   - tmax          #Max. temperature (C)
27   - tmin          #Min. temperature (C)
28   - tavg          #Avg. temperature (C)
29
```

```
30 year: 1983
31 year: 2015
```

```
32- CmpVarNames:
33   - prec           #Precipitation (mm)
34   - tmax          #Max. temperature (C)
35   - tmin          #Min. temperature (C)
36- CmpGridNames:
37   - PERSIANN
38   - CHIRPS
39   - ERA
40   - MERRA2
```

4. Set working environment(R script)

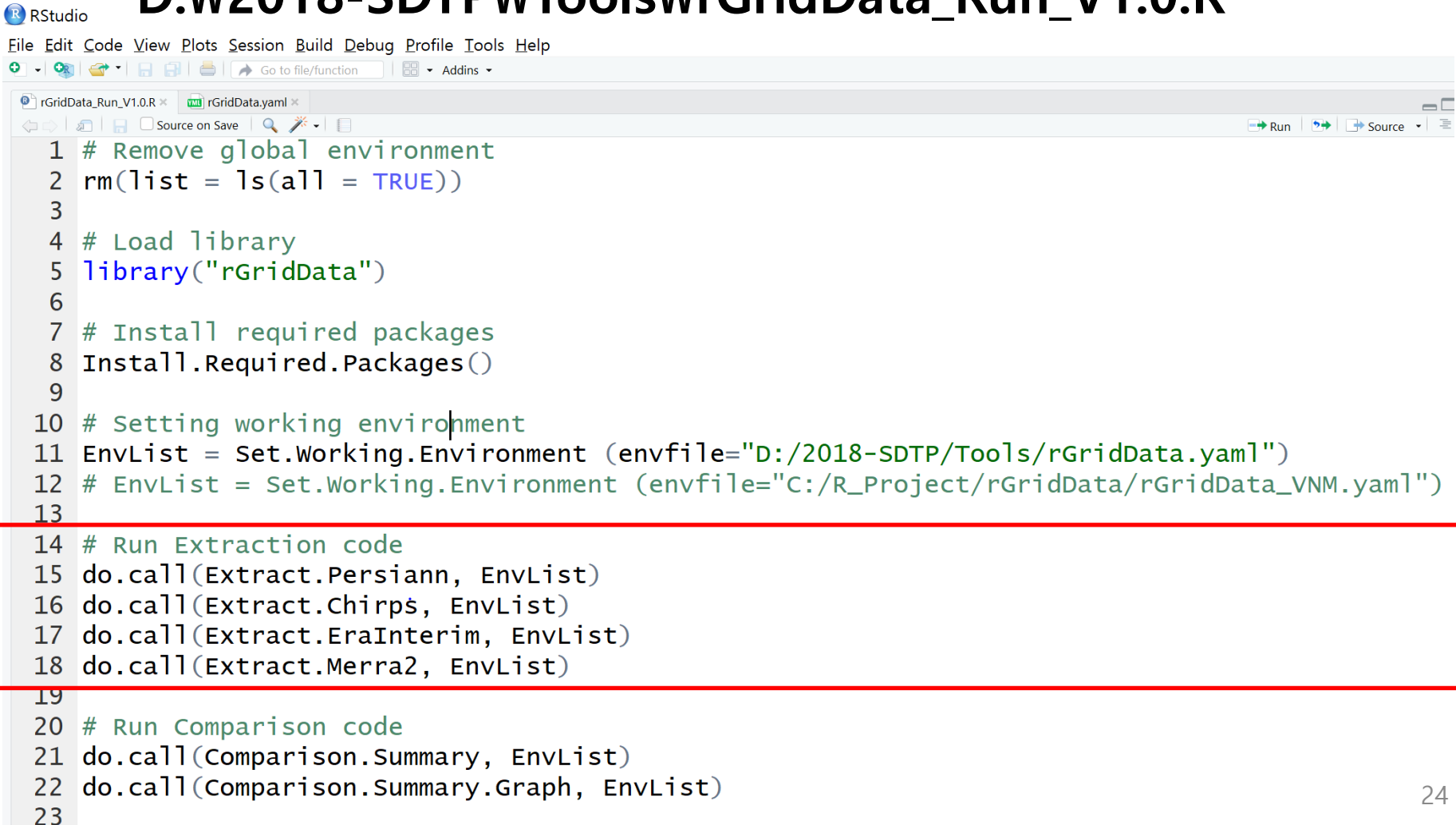
- Rstudio -> File -> Open File ->
"D:\W2018-SDTP\ToolsWrGridData_Run_V1.0.R"



```
RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function Addins
rGridData_Run_V1.0.R rGridData.yaml
Source on Save Run Source
1 # Remove global environment
2 rm(list = ls(all = TRUE))
3
4 # Load library
5 library("rGridData")
6
7 # Install required packages
8 Install.Required.Packages()
9
10 # Setting working environment
11 EnvList = Set.Working.Environment (envfile="D:/2018-SDTP/Tools/rGridData.yaml")
12 # EnvList = Set.Working.Environment (envfile="C:/R_Project/rGridData/rGridData_VNM.yaml")
13
14 # Run Extraction code
15 do.call(Extract.Persiann, EnvList)
16 do.call(Extract.Chirps, EnvList)
17 do.call(Extract.EraInterim, EnvList)
18 do.call(Extract.Merra2, EnvList)
19
20 # Run Comparison code
21 do.call(Comparison.Summary, EnvList)
22 do.call(Comparison.Summary.Graph, EnvList)
23
```

4. Extract grid data by station location(R script)

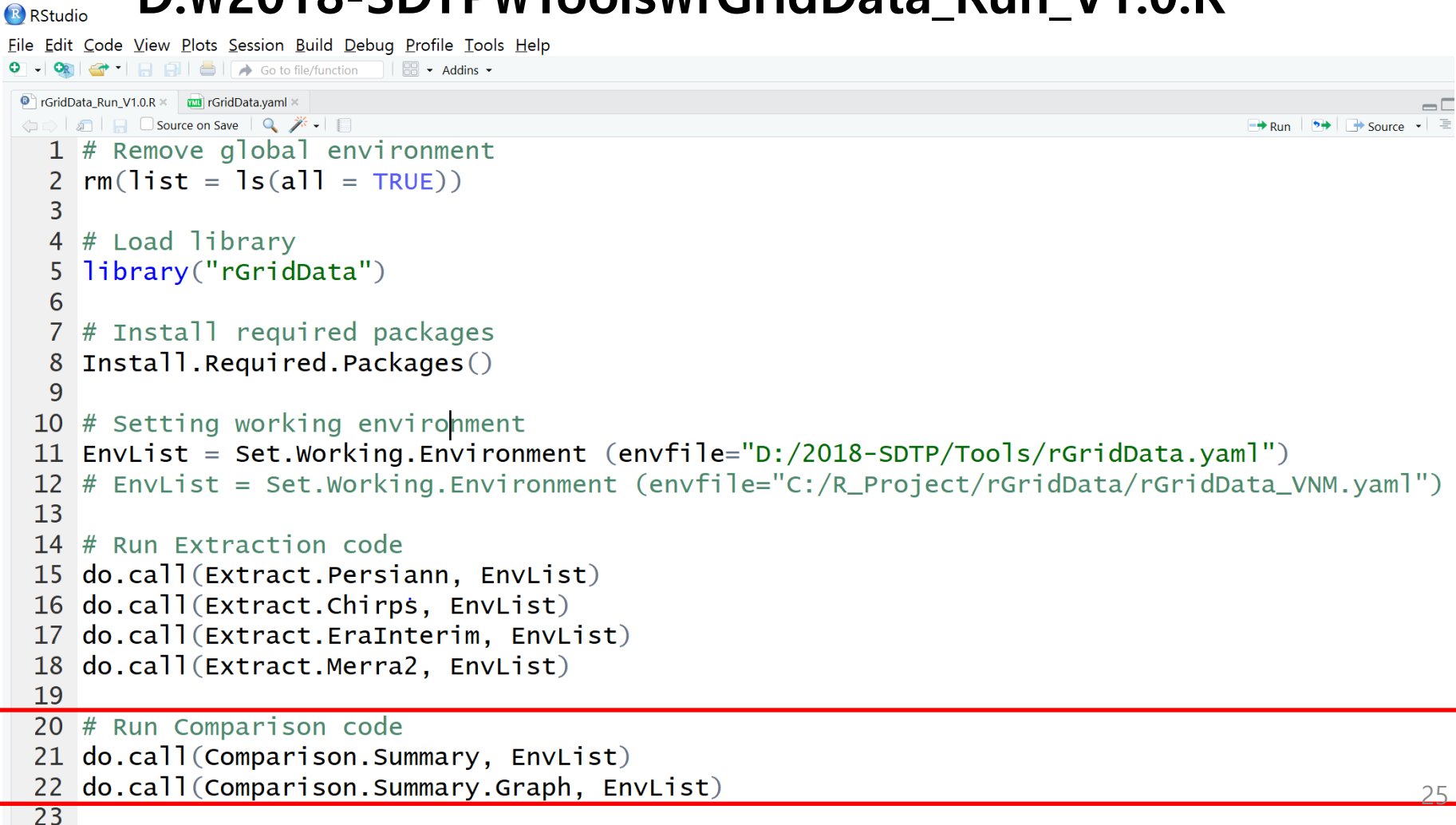
- Rstudio -> File -> Open File -> "D:\W2018-SDTP\ToolsWrGridData_Run_V1.0.R"



```
RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function Addins
rGridData_Run_V1.0.R rGridData.yaml
Source on Save Run Source
1 # Remove global environment
2 rm(list = ls(all = TRUE))
3
4 # Load library
5 library("rGridData")
6
7 # Install required packages
8 Install.Required.Packages()
9
10 # Setting working environment
11 EnvList = Set.Working.Environment (envfile="D:/2018-SDTP/Tools/rGridData.yaml")
12 # EnvList = Set.Working.Environment (envfile="C:/R_Project/rGridData/rGridData_VNM.yaml")
13
14 # Run Extraction code
15 do.call(Extract.Persiann, EnvList)
16 do.call(Extract.Chirps, EnvList)
17 do.call(Extract.EraInterim, EnvList)
18 do.call(Extract.Merra2, EnvList)
19
20 # Run Comparison code
21 do.call(Comparison.Summary, EnvList)
22 do.call(Comparison.Summary.Graph, EnvList)
23
```

4. Compare grid and station data(R script)

- Rstudio -> File -> Open File ->
"D:\W2018-SDTP\ToolsWrGridData_Run_V1.0.R"

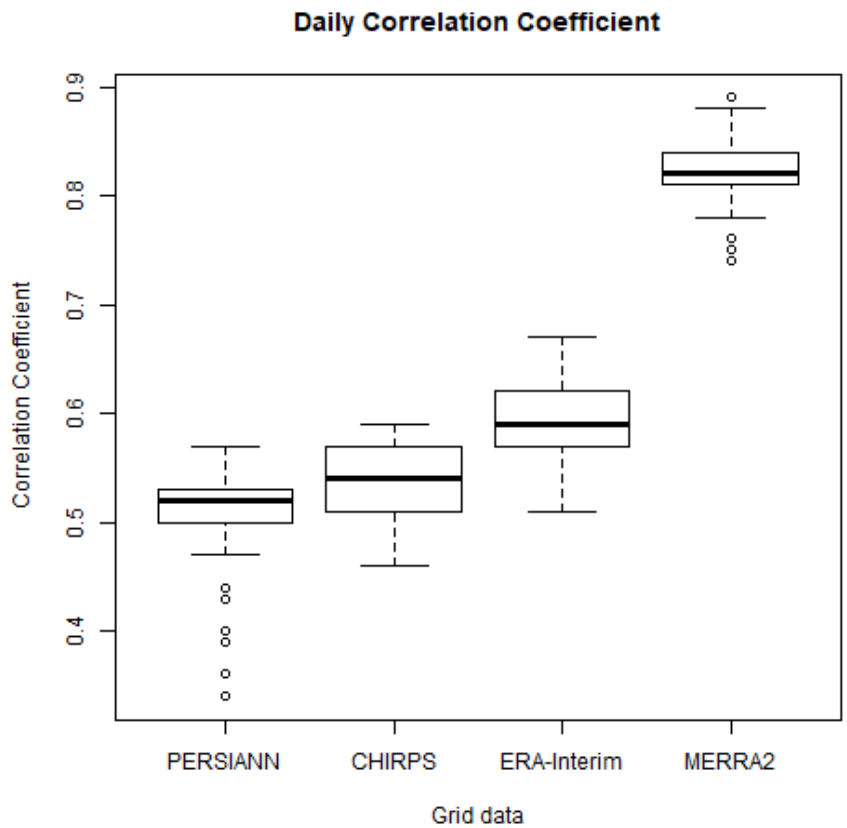
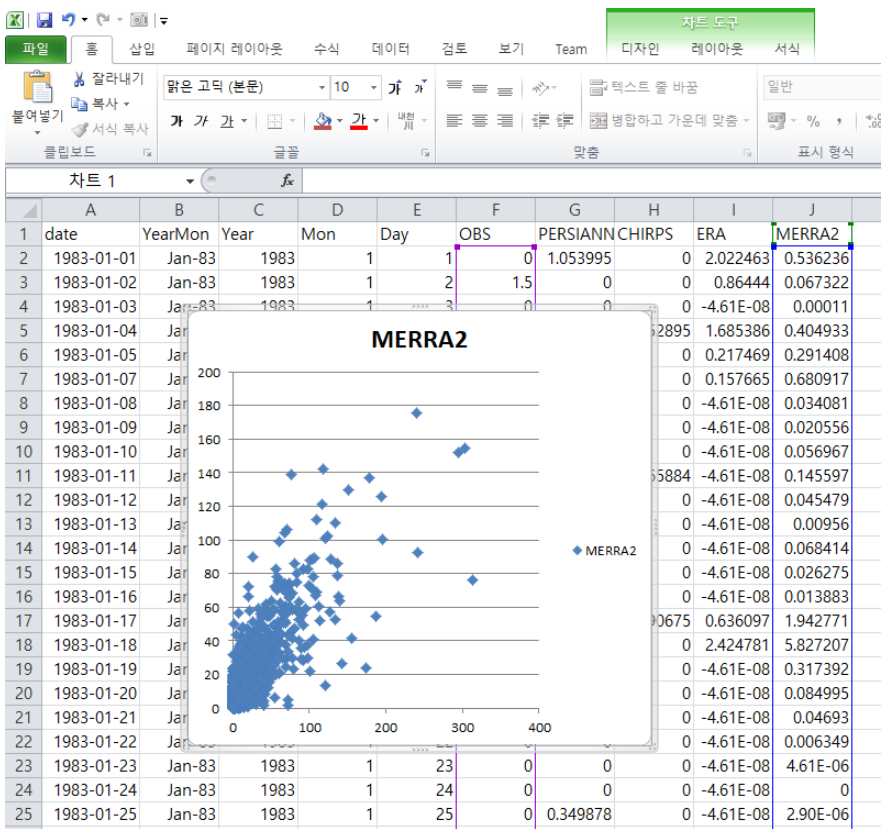


The screenshot shows the RStudio interface with a script editor open. The script contains the following R code:

```
1 # Remove global environment
2 rm(list = ls(all = TRUE))
3
4 # Load library
5 library("rGridData")
6
7 # Install required packages
8 Install.Required.Packages()
9
10 # Setting working environment
11 EnvList = Set.Working.Environment (envfile="D:/2018-SDTP/Tools/rGridData.yaml")
12 # EnvList = Set.Working.Environment (envfile="C:/R_Project/rGridData/rGridData_VNM.yaml")
13
14 # Run Extraction code
15 do.call(Extract.Persiann, EnvList)
16 do.call(Extract.Chirps, EnvList)
17 do.call(Extract.EraInterim, EnvList)
18 do.call(Extract.Merra2, EnvList)
19
20 # Run Comparison code
21 do.call(Comparison.Summary, EnvList)
22 do.call(Comparison.Summary.Graph, EnvList)
23
```

The code is executed in a RStudio session. The script is titled "rGridData_Run_V1.0.R" and the source file is "rGridData.yaml". The code includes comments and function calls for removing the global environment, loading the "rGridData" library, installing required packages, setting the working environment, and running extraction and comparison code. The last three lines (20-22) are highlighted with a red box.

4. Comparison results(R script)





Any questions?

Jihoon Park
gtjihoon@apcc21.org



By HikingArtist.com

Thank You!