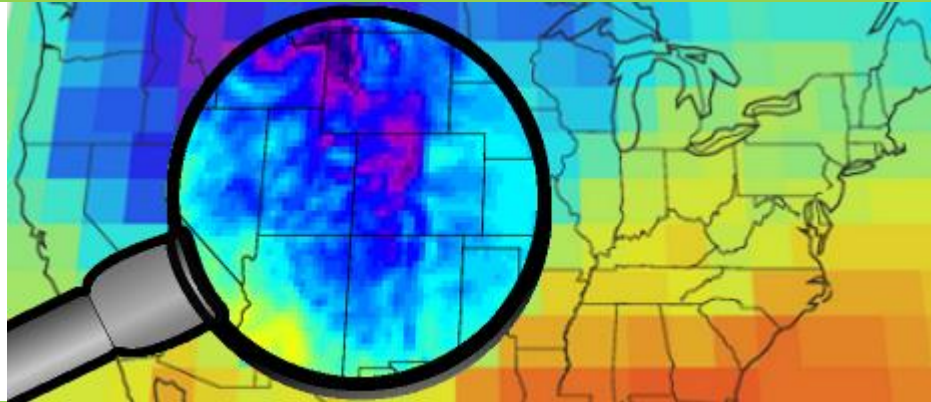
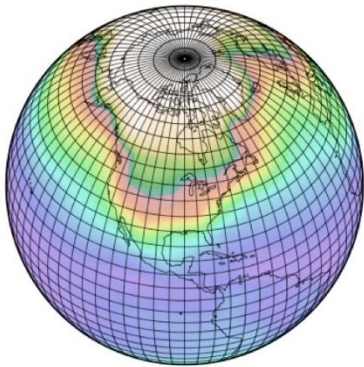


# Downscaling of Seasonal Forecast Data Using *rSForecast* (I) : Hindcast



Jaepil Cho

2016/08/24

# Overview

**1. Required Tools and Data**

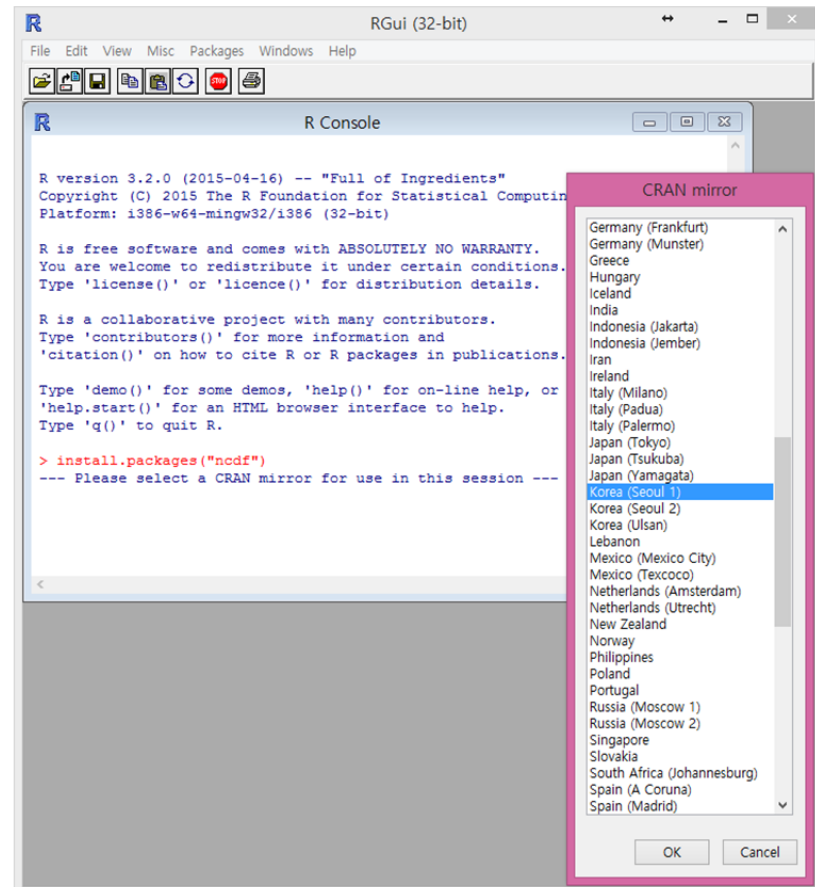
**2. Hands-on using sforecast**

❖ Model construction for Hindcast period

# Required Tools and Data

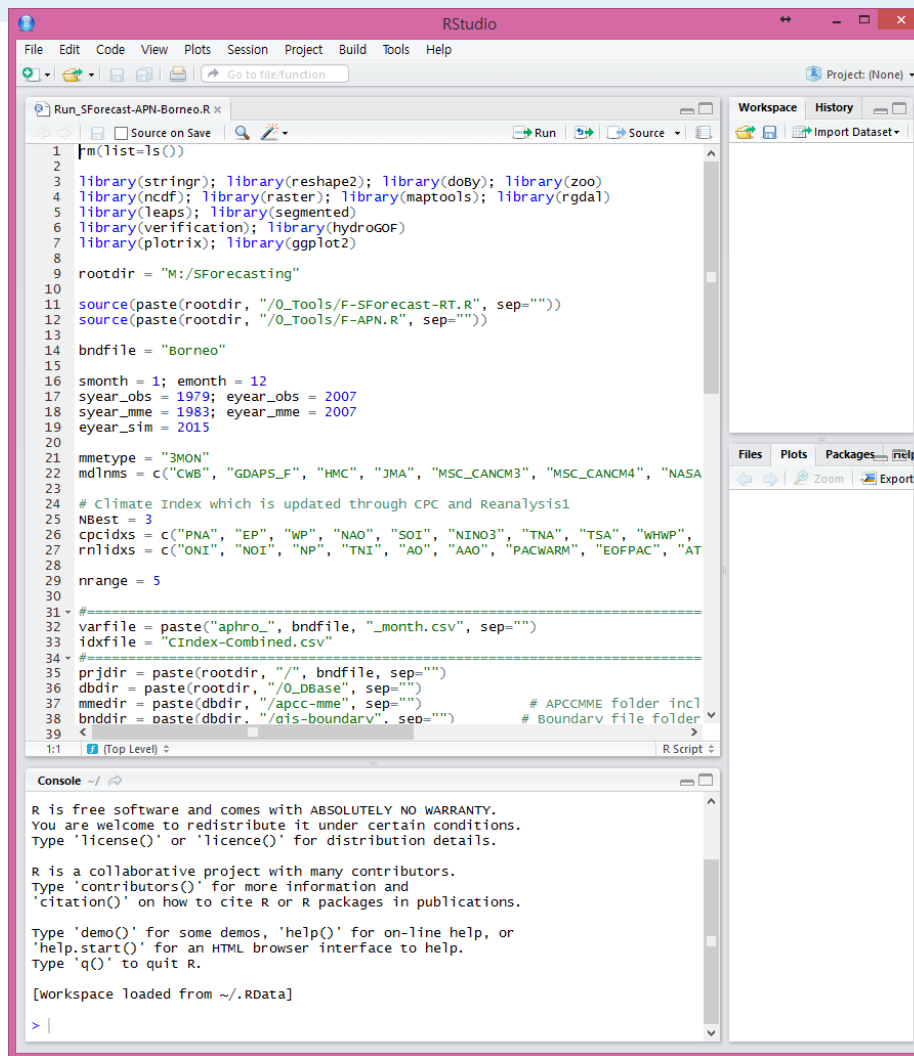
## Tools: R (programming language)

- ❖ Open source
  - GNU GPL license
- ❖ Cross-platform
  - Windows, Linux, Mac OS X
- ❖ Packages
  - lots of user-created packages for statistical analysis, graphical devices, data import/export capabilities.
- ❖ Website
  - <http://www.r-project.org/>



# Tools: RStudio

- R user interface
  - Integrated Development Environment(IDE)
- Cross-platform
  - Windows, Linux, Mac OS X
- License
  - GNU Affero GPL v3
- Website
  - <http://www.rstudio.com/>

```

1 |m(list=ls())
2
3 |library(stringr); library(reshape2); library(doby); library(zoo)
4 |library(ncdf); library(raster); library(maptools); library(rgdal)
5 |library(leaps); library(segmented)
6 |library(verification); library(hydroGOF)
7 |library(plotrix); library(ggplot2)
8
9 rootdir = "M:/SForecasting"
10
11 source(paste(rootdir, "/0_Tools/F-SForecast-RT.R", sep=""))
12 source(paste(rootdir, "/0_Tools/F-APN.R", sep=""))
13
14 bndfile = "Borneo"
15
16 smonth = 1; emonth = 12
17 syear_obs = 1979; eyear_obs = 2007
18 syear_mme = 1983; eyear_mme = 2007
19 eyear_sim = 2015
20
21 mmetype = "3MON"
22 mdlms = c("CWB", "GDAPS_F", "HMC", "JMA", "MSC_CANCM3", "MSC_CANCM4", "NASA
23
24 # Climate Index which is updated through CPC and Reanalysis1
25 NBest = 3
26 cpcidxs = c("PNA", "EP", "WP", "NAO", "SOI", "NINO3", "TNA", "TSA", "WHWP",
27 rnlidxs = c("ONI", "NOI", "NP", "TNI", "AO", "AAO", "PACWARM", "EOFAC", "AT
28
29 nrange = 5
30
31 #=====
32 varfile = paste("aphro_", bndfile, "_month.csv", sep="")
33 idxfile = "CIndex-Combined.csv"
34 #=====
35 prjdir = paste(rootdir, "/", bndfile, sep="")
36 dbdir = paste(rootdir, "/0_DBase", sep="")
37 mmdir = paste(dbdir, "/apcc-mme", sep="") # APCCMME folder incl
38 bnddir = paste(dbdir, "/ois-boundary", sep="") # Boundary file folder
39 <
40
41:1 | (Top Level) | R Script |
  
```

```

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

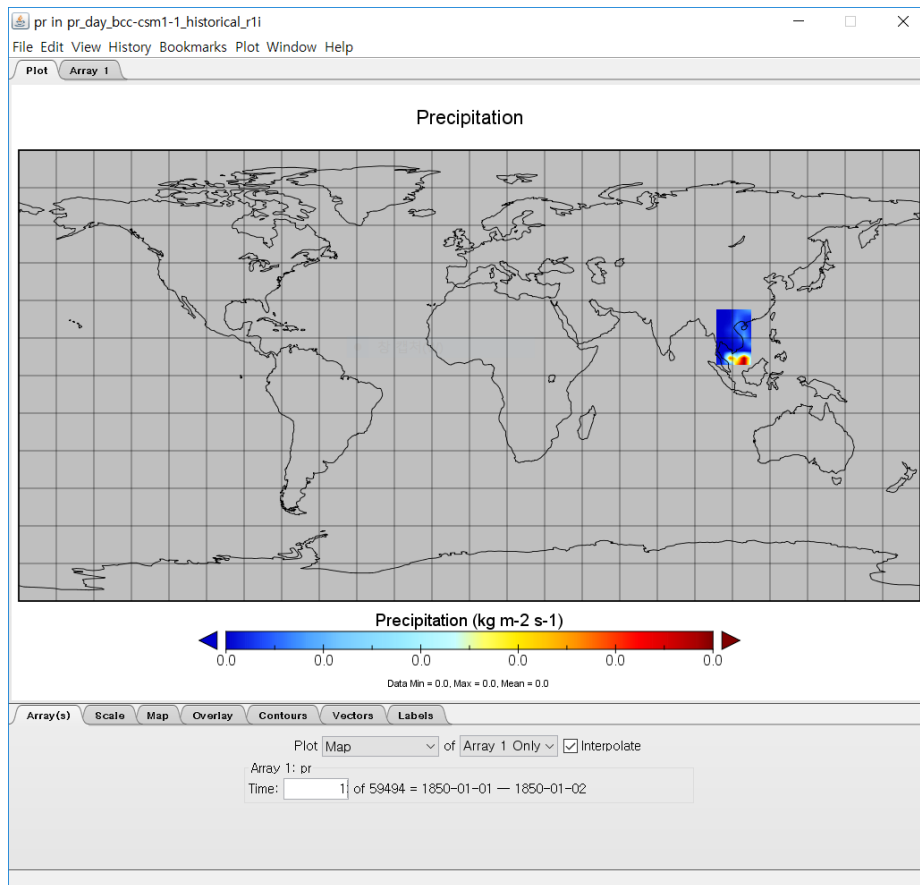
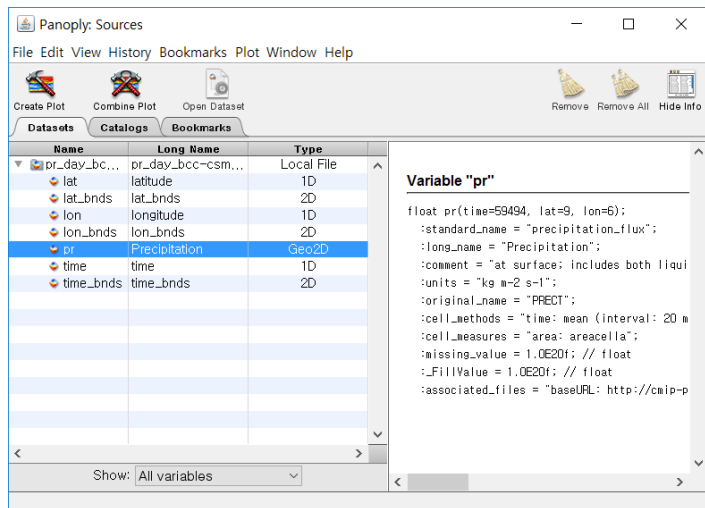
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

[workspace loaded from ~/.RData]

> |
  
```

# Tools: Panoply

- Cross-platform
  - Windows, Linux, Mac OS X
- Website
  - <http://www.giss.nasa.gov/tools/panoply/download.html>





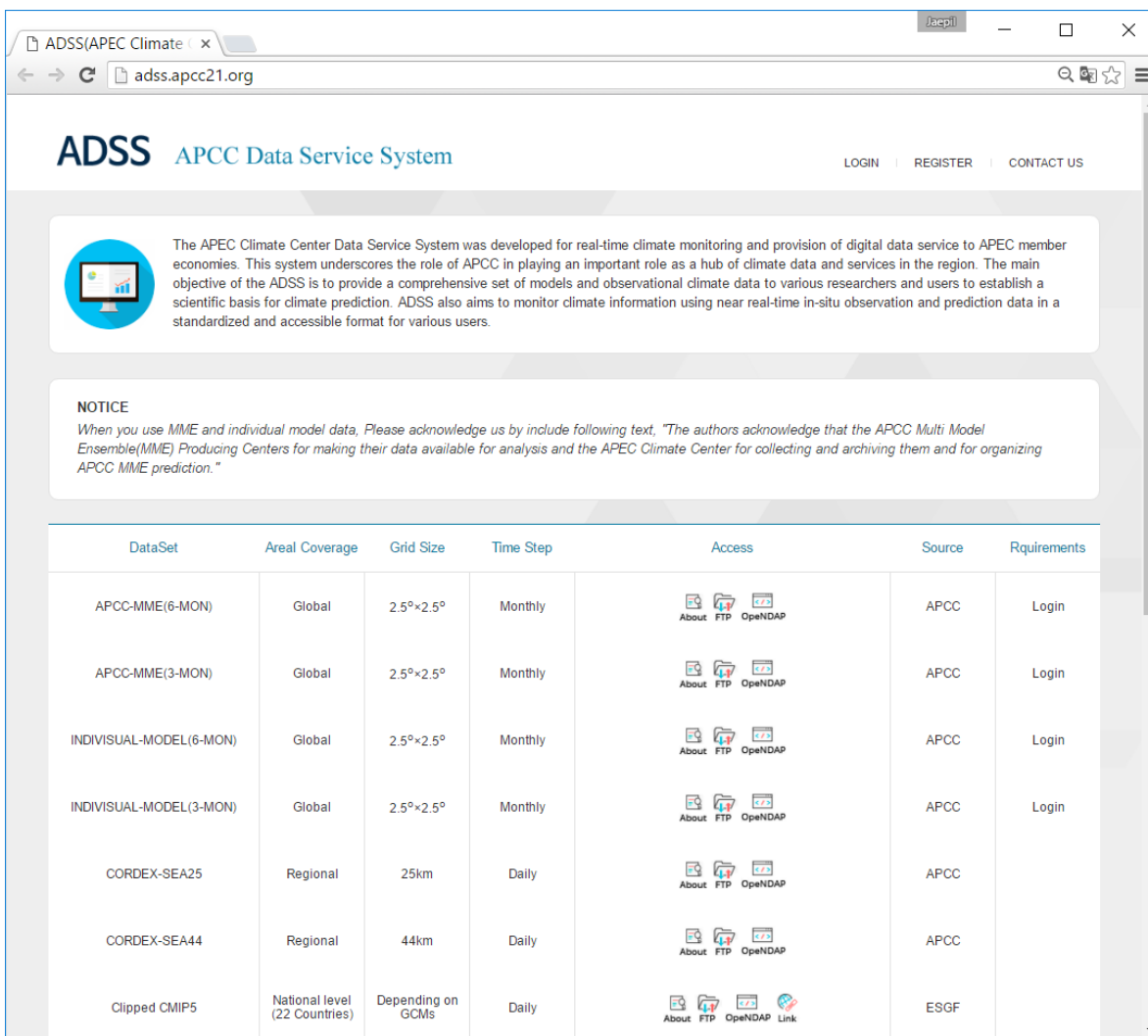
# Data: Available individual models for **real-time forecast**

Model acronym	Institution(country)	Lead time	Ensemble size
BCC	Beijing Climate Center (China)	3 month	8
CWB	Central Weather Bureau (Taipei)	3 month	10
HMC	Hydrometeorological Centre of Russia (Russia)	3 month	20
IRI_CA	International Research Institute for Climate and Society (USA)	3 month	24
APCC	APEC Climate Center (Korea)	6 month	10
CMCC	Centro Euro-Mediterraneo sui Cambiamenti Climatici (Italy)	6 month	9
MSC	Meteorological Service of Canada (Canada)	6 month	20
NASA	National Aeronautics and Space Administration (USA)	6 month	9
NCEP	NCEP Climate Prediction Center (USA)	6 month	15
PNU	Pusan National University (Korea)	6 month	5
POAMA	Centre for Australian Weather and Climate Research /Bureau of Meteorology (Australia)	6 month	10

3MON: 4 GCMs, 6MON: 7 GCMs

# Data: APCC Data Service System (ADSS)

ID: jpcho96  
PW: APCC21ORG

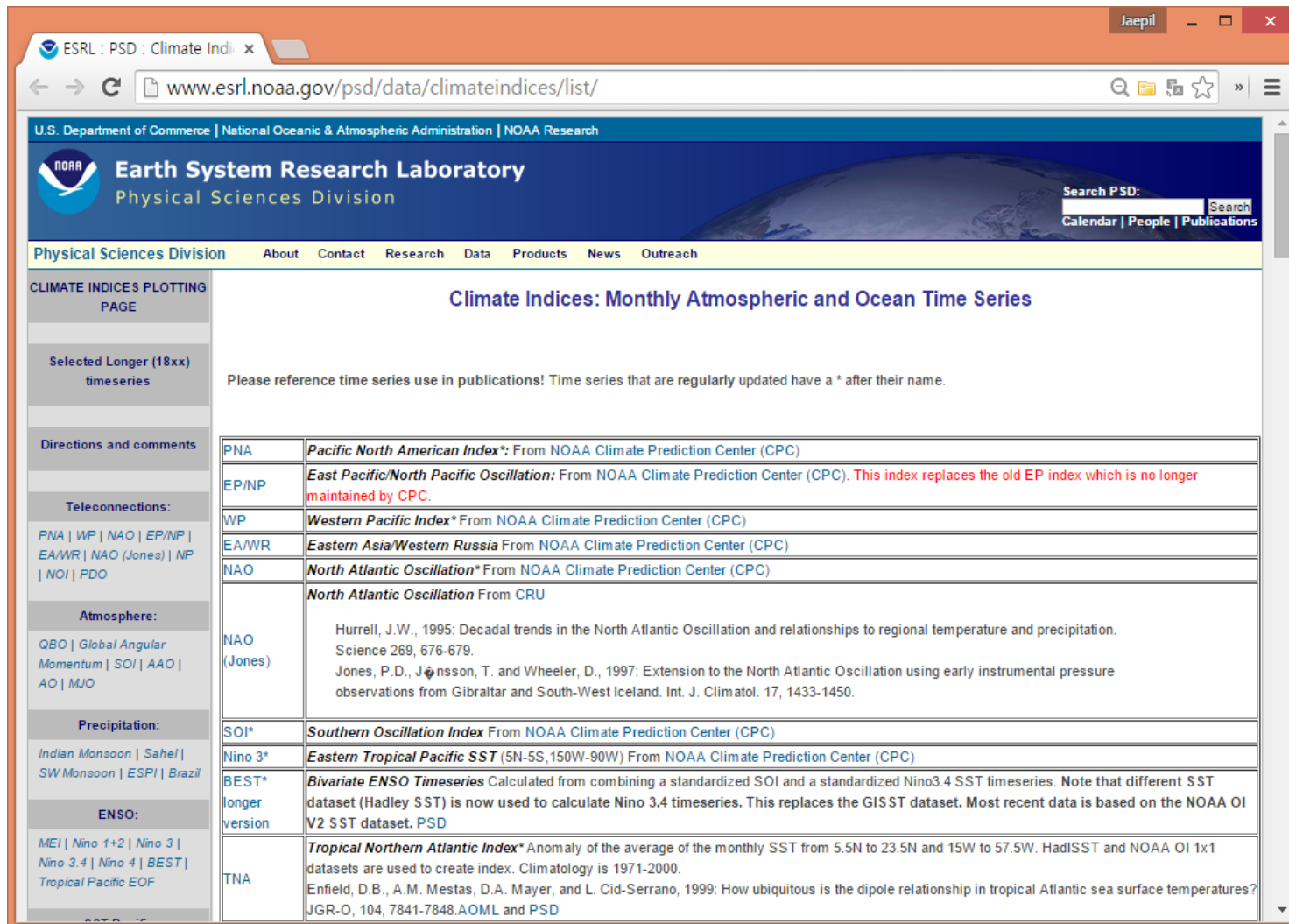


The screenshot shows the ADSS (APCC Data Service System) website. The browser address bar shows [adss.apcc21.org](http://adss.apcc21.org). The page title is "ADSS APCC Data Service System". There are links for "LOGIN", "REGISTER", and "CONTACT US". A notice section states: "When you use MME and individual model data, Please acknowledge us by include following text, 'The authors acknowledge that the APCC Multi Model Ensemble(MME) Producing Centers for making their data available for analysis and the APEC Climate Center for collecting and archiving them and for organizing APCC MME prediction.'"

DataSet	Areal Coverage	Grid Size	Time Step	Access	Source	Requirements
APCC-MME(6-MON)	Global	2.5°×2.5°	Monthly	About FTP OpenDAP	APCC	Login
APCC-MME(3-MON)	Global	2.5°×2.5°	Monthly	About FTP OpenDAP	APCC	Login
INDIVISUAL-MODEL(6-MON)	Global	2.5°×2.5°	Monthly	About FTP OpenDAP	APCC	Login
INDIVISUAL-MODEL(3-MON)	Global	2.5°×2.5°	Monthly	About FTP OpenDAP	APCC	Login
CORDEX-SEA25	Regional	25km	Daily	About FTP OpenDAP	APCC	
CORDEX-SEA44	Regional	44km	Daily	About FTP OpenDAP	APCC	
Clipped CMIP5	National level (22 Countries)	Depending on GCMs	Daily	About FTP OpenDAP Link	ESGF	

ADSS: <http://adss.apcc21.org/>

# Data: Monthly climate indices from NOAA



U.S. Department of Commerce | National Oceanic & Atmospheric Administration | NOAA Research

**Earth System Research Laboratory**  
Physical Sciences Division

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CLIMATE INDICES PLOTTING PAGE

Selected Longer (18xx) timeseries

Directions and comments

Teleconnections:  
PNA | WP | NAO | EP/NP | EA/WR | NAO (Jones) | NP | NOI | PDO

Atmosphere:  
QBO | Global Angular Momentum | SOI | AAO | AO | MJO

Precipitation:  
Indian Monsoon | Sahel | SW Monsoon | ESPI | Brazil

ENSO:  
MEI | Nino 1+2 | Nino 3 | Nino 3.4 | Nino 4 | BEST | Tropical Pacific EOF

## Climate Indices: Monthly Atmospheric and Ocean Time Series

Please reference time series use in publications! Time series that are regularly updated have a \* after their name.

PNA	<b>Pacific North American Index*</b> : From NOAA Climate Prediction Center (CPC)
EP/NP	<b>East Pacific/North Pacific Oscillation</b> : From NOAA Climate Prediction Center (CPC). <b>This index replaces the old EP index which is no longer maintained by CPC.</b>
WP	<b>Western Pacific Index*</b> From NOAA Climate Prediction Center (CPC)
EA/WR	<b>Eastern Asia/Western Russia</b> From NOAA Climate Prediction Center (CPC)
NAO	<b>North Atlantic Oscillation*</b> From NOAA Climate Prediction Center (CPC)
NAO (Jones)	<b>North Atlantic Oscillation</b> From CRU  Hurrell, J.W., 1995: Decadal trends in the North Atlantic Oscillation and relationships to regional temperature and precipitation. Science 269, 676-679. Jones, P.D., Jönsson, T. and Wheeler, D., 1997: Extension to the North Atlantic Oscillation using early instrumental pressure observations from Gibraltar and South-West Iceland. Int. J. Climatol. 17, 1433-1450.
SOI*	<b>Southern Oscillation Index</b> From NOAA Climate Prediction Center (CPC)
Nino 3*	<b>Eastern Tropical Pacific SST (5N-5S, 150W-90W)</b> From NOAA Climate Prediction Center (CPC)
BEST* longer version	<b>Bivariate ENSO Timeseries</b> Calculated from combining a standardized SOI and a standardized Nino3.4 SST timeseries. Note that different SST dataset (Hadley SST) is now used to calculate Nino 3.4 timeseries. This replaces the GISST dataset. Most recent data is based on the NOAA OI V2 SST dataset. PSD
TNA	<b>Tropical Northern Atlantic Index*</b> Anomaly of the average of the monthly SST from 5.5N to 23.5N and 15W to 57.5W. HadISST and NOAA OI 1x1 datasets are used to create index. Climatology is 1971-2000. Enfield, D.B., A.M. Mestas, D.A. Mayer, and L. Cid-Serrano, 1999: How ubiquitous is the dipole relationship in tropical Atlantic sea surface temperatures? JGR-O, 104, 7841-7848. AOML and PSD

# Data: Monthly climate indices from APCC

Climate Indices | APE x

www.apcc21.org/ser/indic.do?lang=en

Home > Climate Information Service > Current Climate Conditions > Climate Indices

## Climate Indices

Introduction and Methodology

Temporal variation and current status of climate variability can be effectively monitored in terms of indices. In this section, monthly data of climate indices representing major climate variability with significant implication in the seasonal climate prediction are provided. Indices are categorized into three groups such as Pacific SST, Atlantic SST, and Atmosphere. Time series of each index will be shown by putting mouse pointer over the name of each index; and the data (ascii format) can be downloaded by clicking it. Each data is updated around 10th of each month. You can find more information on the indices at this link.

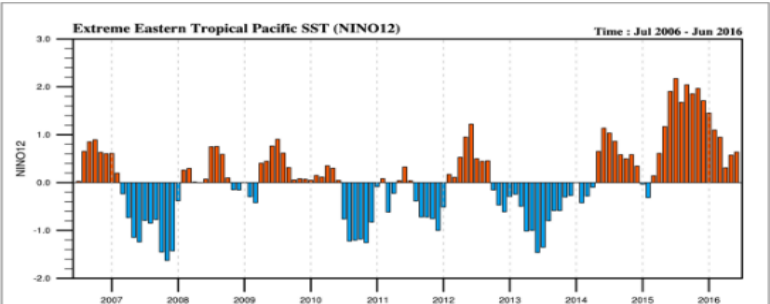
Pacific SST      Atlantic SST      Atmosphere

Pacific SST TOP

Pacific SST indices Monitoring

NINO1+2	NINO3	NINO3.4	NINO4	ONI	TNI	PACWARM	EOFAC
---------	-------	---------	-------	-----	-----	---------	-------

Extreme Eastern Tropical Pacific SST (NINO12)      Time : Jul 2006 - Jun 2016



© APEC Climate Center

# Data: Monthly climate indices for real-time forecast

Climate index	Abb.	NOAA	APCC
Pacific North American Index	PNA	<b>S</b>	○
East Pacific/North Pacific Oscillation	EP	<b>S</b>	X
Western Pacific Index	WP	<b>S</b>	○
Eastern Asia/Western Russia	EA	X	X
North Atlantic Oscillation	NAO	<b>S</b>	○
Southern Oscillation Index	SOI	<b>S</b>	○
Eastern Tropical Pacific SST	NINO3	<b>S</b>	○
Bivariate ENSO Timeseries	BEST	X	X
Tropical Northern Atlantic Index	TNA	<b>S</b>	○
Tropical Southern Atlantic Index	TSA	<b>S</b>	○
Western Hemisphere warm pool	WHWP	<b>S</b>	X
Oceanic Nino Index	ONI	X	<b>S</b>
Multivariate ENSO Index	MEI	<b>S</b>	X
Extreme Eastern Tropical Pacific SST	NINO1 2	<b>S</b>	○
Central Tropical Pacific SST	NINO4	<b>S</b>	○
East Central Tropical Pacific SST	NINO3 4	<b>S</b>	
Pacific Decadal Oscillation	PDO	X	X
Northern Oscillation Index	NOI	X	<b>S</b>
North Pacific pattern	NP	X	<b>S</b>
Trans-Niño Index	TNI	X	<b>S</b>

Climate index	Abb.	NOAA	APCC
Antarctic Oscillation	AO	X	<b>S</b>
Antarctic Oscillation	AAO	X	<b>S</b>
Pacific Warmpool (1st EOF of SST (60e-170E, 15S-15N) SST EOF)	PACWA RM	X	<b>S</b>
Tropical Pacific SST EOF	EOFPAC	X	<b>S</b>
Atlantic Tripole SST EOF	ATLTRI	X	<b>S</b>
Atlantic multidecadal Oscillation Long Version	AMO	<b>S</b>	X
Atlantic Meridional Mode	AMM	X	X
North Tropical Atlantic SST Index	NTA	X	X
Caribbean SST Index	CAR	X	X
smoothed: Atlantic Multidecadal Oscillation	AMOSM	X	X
Quasi-Biennial Oscillation	QBO	<b>S</b>	○
Globally Integrated Angular Momentum	GIAM	X	X
ENSO precipitation index	ESPI	X	X
Central Indian Precipitation	CIP	X	X
Sahel Standardized Rainfall	SahelRai n	X	X
SahelArea averaged precipitation for Arizona and New Mexico	SWM	X	X
Northeast Brazil Rainfall Anomaly	NBRA	X	X
Global Mean Lan/Ocean Temperature	GML	X	X
Solar Flux (10.7cm)	Solar	X	X
Equatorial Eastern Pacific SLP	ESL	<b>S</b>	X

16 Indices from NOAA

9 indices from NCEP Reanalysis 1 (APCC)

# Data: NCEP/NCAR Reanalysis monthly data

ESRL : PSD : PSD Dat x

www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.derived.pressure.html

U.S. Department of Commerce | National Oceanic & Atmospheric Administration | NOAA Research

**NOAA Earth System Research Laboratory**  
Physical Sciences Division

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Climate Datasets: By Category

- All
- Sub-daily
- Daily
- Monthly
- Surface
- Temperature
- SST
- Precipitation
- Land
- Ocean
- Multi-level
- Radiation
- Arctic
- Reanalysis
- Climate Indices
- Search Datasets ↗
- 20th Century Reanalysis

**Popular Datasets**

- ICOADS
- NCEP/NCAR Reanalysis
- N. American Regional Reanalysis

**Plotting & Analysis**

- Basic Plots
- Analysis Tools

**Access**

- FTP Access
- OpenDAP Access

**Software Resources**

- \*Complete Data Resources\*
- About NetCDF

On this page: Temporal Coverage | Spatial Coverage | Levels | Update Schedule | Download/Plot Data | Analysis Tools  
Restrictions | Details | Caveats | File Naming | Citation | References | Original Source | Contact

## NCEP/NCAR Reanalysis Monthly Means and Other Derived Variables: Pressure Level

We have transitioned the data files from netCDF3 to netCDF4-classic format on Monday Oct 20th, 2014.

**Brief Description:**

- NCEP/NCAR Reanalysis Monthly Means and Other Derived Variables.

**Temporal Coverage:**

- Daily and Monthly Values for 1948/01 - present.
- Long term monthly means, derived from data for years 1981 - 2010.

**Spatial Coverage:**

- 2.5 degree latitude x 2.5 degree longitude global grid (144x73).
- 90N - 90S, 0E - 357.5E







**Levels:**

- 17 pressure levels (hPa): 1000, 925, 850, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50, 30, 20, 10
- some variables not defined at all levels

**Update Schedule:**

- Monthly

**Download/Plot Data:**

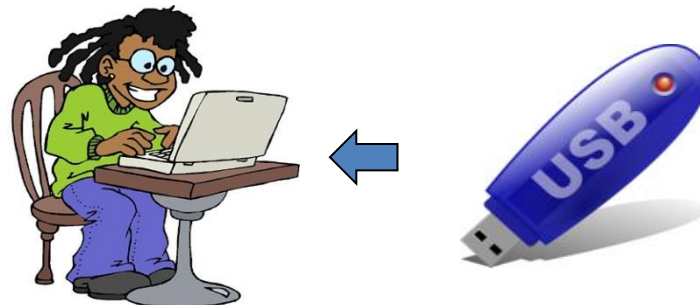
Variable	Statistic	Level	Download File	Create Plot/Subset	File Metadata
Air Temperature	Monthly Means	Multiple levels	air.mon.mean.nc		File Metadata
Air Temperature	Monthly Long Term Means	Multiple levels	air.mon.ltm.nc		File Metadata
Air Temperature	Daily Long Term Means	Multiple levels	air.day.1981-2010.ltm.nc		File Metadata
Air Temperature	4X Daily Long Term Means	Multiple levels	air.4Xday.1981-2010.ltm.nc		File Metadata
Air Temperature	Monthly Interannual Standard Deviation (1981-2010)	Multiple levels	air.mon.inter.std.nc		File Metadata
Air Temperature	Monthly Total Standard Deviation (1981-2010)	Multiple levels	air.mon.total.std.nc		File Metadata

<http://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.derived.pressure.html>

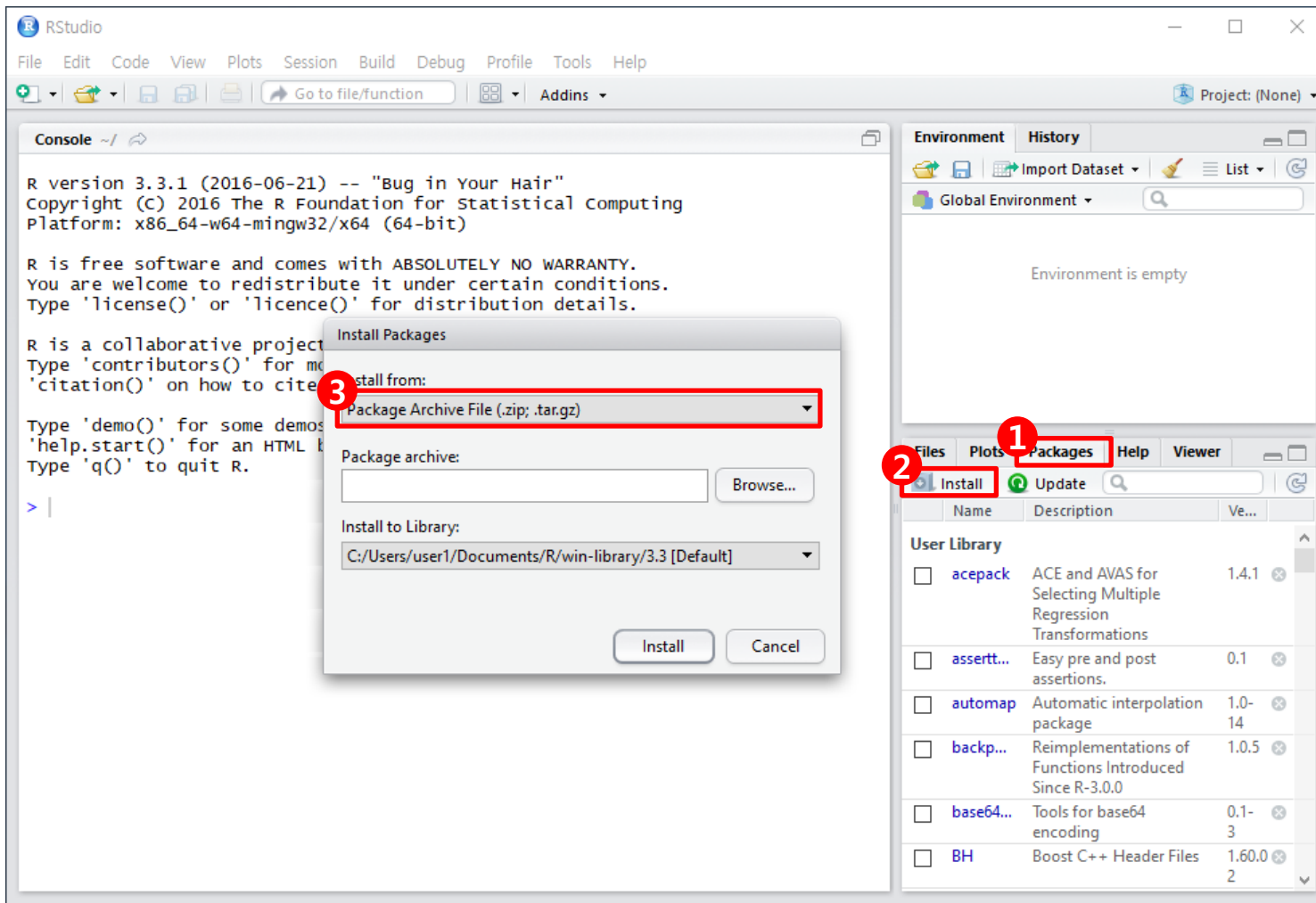
# Hands-on using sforecast (I) -Model construction-

## ❖ Model Construction for Hindcast Period

1. Install packages
2. Understanding control input file
3. Check your observed data (Climate Zone)
4. Set working environment
5. Download climate information
6. Calculate monthly station average values
7. Hindcast run for 4 different modules
8. Integrate individual forecast model



# Install *sforecast* R-package using zip file



R version 3.3.1 (2016-06-21) -- "Bug in Your Hair"  
Copyright (C) 2016 The R Foundation for Statistical Computing  
Platform: x86\_64-w64-mingw32/x64 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.  
You are welcome to redistribute it under certain conditions.  
Type 'license()' or 'licence()' for distribution details.

R is a collaborative project  
Type 'contributors()' for more  
'citation()' on how to cite  
Type 'demo()' for some demos  
'help.start()' for an HTML  
Type 'q()' to quit R.

> |

**Install Packages**  
Install from:  
Package Archive File (.zip; .tar.gz)  
Package archive:  
Browse...  
Install to Library:  
C:/Users/user1/Documents/R/win-library/3.3 [Default]  
Install Cancel

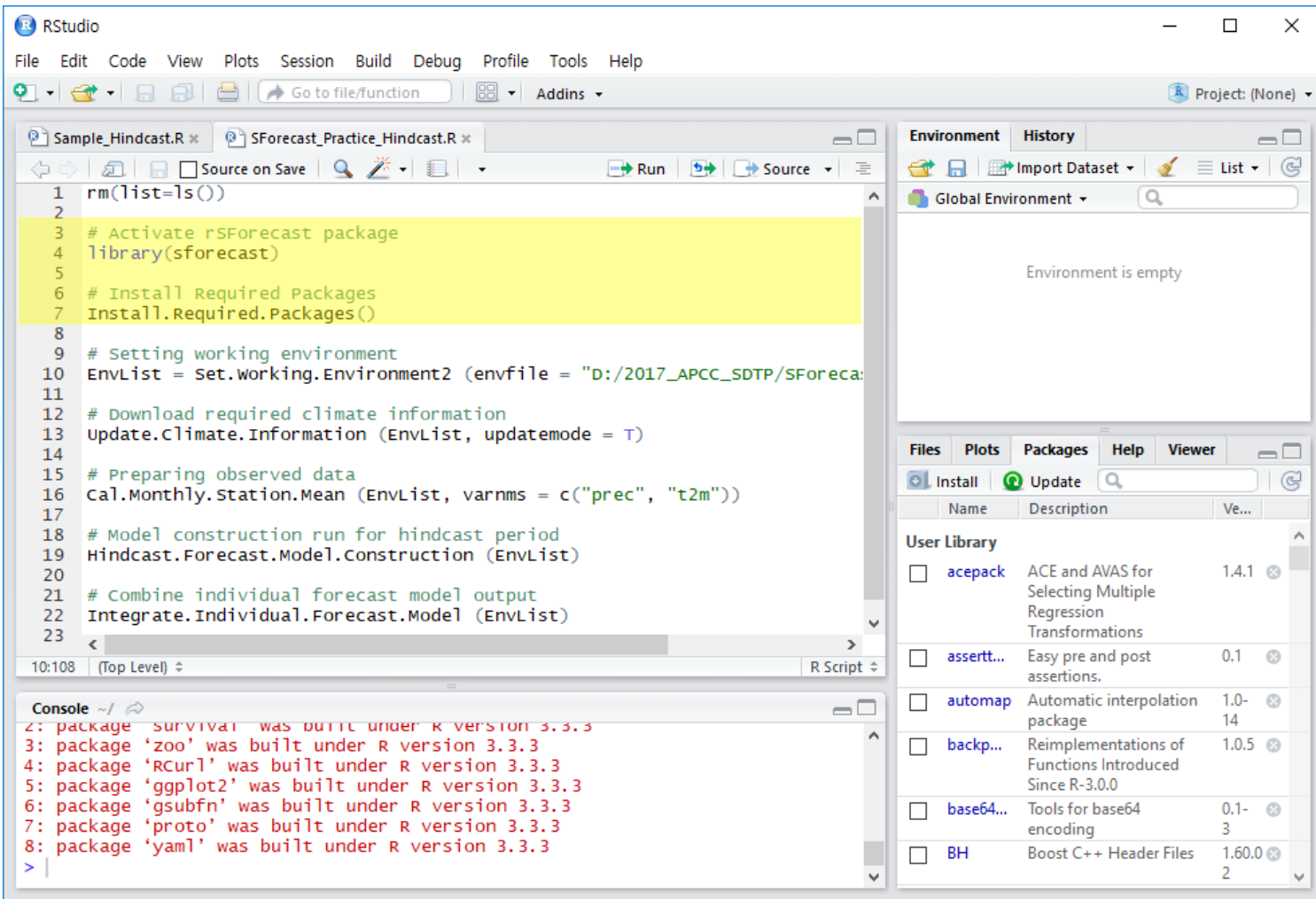
**Environment** History  
Global Environment  
Environment is empty

Files Plots **Packages** Help Viewer  
Install Update

Name	Description	Ve...
<input type="checkbox"/> acepack	ACE and AVAS for Selecting Multiple Regression Transformations	1.4.1
<input type="checkbox"/> assert...	Easy pre and post assertions.	0.1
<input type="checkbox"/> automap	Automatic interpolation package	1.0-14
<input type="checkbox"/> backp...	Reimplementations of Functions Introduced Since R-3.0.0	1.0.5
<input type="checkbox"/> base64...	Tools for base64 encoding	0.1-3
<input type="checkbox"/> BH	Boost C++ Header Files	1.60.0-2

# Install required packages which is used for *sforecast*

1. Open SForecast Practice Hindcast.R in **[SForecast\_Practice]** folder
2. Run line 4 and 7



The screenshot shows the RStudio interface with the following components:

- Source Editor:** Contains the R script `SForecast_Practice_Hindcast.R`. Lines 4 and 7 are highlighted in yellow:
 

```

3 # Activate rSForecast package
4 library(sforecast)
5
6 # Install Required Packages
7 Install.Required.Packages()
      
```
- Environment:** Shows "Global Environment" and "Environment is empty".
- Console:** Shows the output of the `install.packages()` function:
 

```

2: package 'survival' was built under R version 3.3.3
3: package 'zoo' was built under R version 3.3.3
4: package 'RCurl' was built under R version 3.3.3
5: package 'ggplot2' was built under R version 3.3.3
6: package 'gsubfn' was built under R version 3.3.3
7: package 'proto' was built under R version 3.3.3
8: package 'yaml' was built under R version 3.3.3
      
```
- Package List:** Shows a list of installed and available packages:
 

Name	Description	Version
<input type="checkbox"/> acepack	ACE and AVAS for Selecting Multiple Regression Transformations	1.4.1
<input type="checkbox"/> assert...	Easy pre and post assertions.	0.1
<input type="checkbox"/> automap	Automatic interpolation package	1.0-14
<input type="checkbox"/> backp...	Reimplementations of Functions Introduced Since R-3.0.0	1.0.5
<input type="checkbox"/> base64...	Tools for base64 encoding	0.1-3
<input type="checkbox"/> BH	Boost C++ Header Files	1.60.0-2

# Understanding control input file (\*.yaml)

1. Open SForecast\_Practice.yaml in [SForecast\_Practice] folder

```

D:\2017_APCC_SDTP#SForecast_Practice#SForecast_Practice.yaml - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
SForecast_Practice.yaml
1 prjdir: D:/2017_APCC_SDTP/SForecast_Practice # Project folder #: description
2 dbdir: D:/2017_APCC_SDTP/Database # Database folder
3 stndir: User # Observed data type (User: your own data, GHCN: downloaded data)
4 mmedir: $(dbdir)/apcc-mme
5 idxdir: $(dbdir)/climate-index
6 rnldir: $(dbdir)/reanalysis1
7 aphrodir: $(dbdir)/aphrodite
8 vardir: $(prjdir)/Observed/var-predictand
9 bnmdir: $(prjdir)/gis-boundary
10 obsdir: $(prjdir)/Observed/User
11 ghcndir: $(prjdir)/Observed/GHCN
12 smpldir: $(prjdir)/Observed/obs_samples
13 asosdir: $(prjdir)/Observed/User/KMA_ASOS
14 asoshourlydir: $(prjdir)/Observed/User/KMA_ASOS_Hourly
15 NtlCode: KR # National code necessary for downloading GHCN data
16 mdlnms_3mon: # Climate forecast models with 3-month lead time
17 - BCC # Beijing Climate Center (China, 8)
18 - CWB # Central Weather Bureau (Taipei, 10)
19 - HMC # Hydrometeorological Centre of Russia (Russia, 20)
20 - IRI_CA #International Research Institute for Climate and Society (USA, 24)
21 mdlnms_6mon: # Climate forecast models with 3-month lead time
22 - APCC # APEC Climate Center (Korea, 10)
23 - CMCC # Centro Euro-Mediterraneo sui Cambiamenti Climatici (Italy, 9)
24 - MSC # Meteorological Service of Canada (Canada, 20)
25 - NASA # National Aeronautics and Space Administration (USA, 9)
  
```

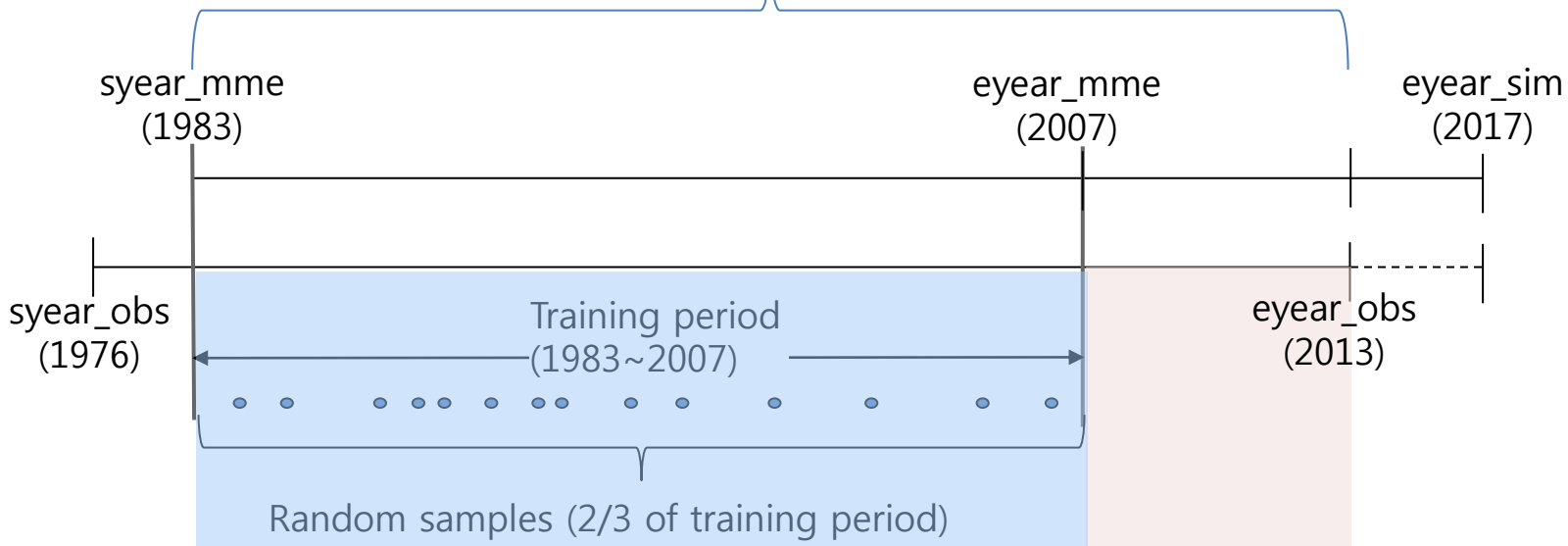
You can change but use default for the training

# Understanding control input file (Cont'd)

```
E:\SForecast_Practice\SForecast_Practice.yaml - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
SForecast_Practice.yaml x
66 minlat: -40 # Minimum latitude for searching predictor within MWR method
67 maxlat: 40 # Maximum latitude for searching predictor within MWR method
68 MinGrdCnt: 20
69 MaxGrdCnt: 80
70 smonth: 1 # Define analysis period (starting month)
71 emonth: 12 # Define analysis period (Ending month)
72 nrange: 3 # Number of ranges for probabilistic forecast
73 syear_obs: 1976 # Starting year for Hindcast model construction
74 eyear_obs: 2012 # Ending year for Hindcast model construction
75 syear_mme: 1983 # Starting year of available data
76 eyear_mme: 2007 # Ending year of calibration of forecasting model
77 eyear_sim: 2017 # Current year for real-time forecast
78 stnfile: Station-Info.csv # Station list file
79 varfile: Monthly_Station_Avg.csv # Monthly station average file which is used as predictand
80 idxfile: CIndex-Combined.csv # Predictor file for CIR
81 ptrfile: ptrlist.csv # Predictor list file for MWR-Obs
82 bndfile: Not_used.shp
83 nrstfile: Not_used.csv
84 BCPointOpt: "On" # Switch for SBC module
85 BCAreaOpt: "Off" # Not_used
86 CIRegOpt: "On" # Switch for CIR module
87 MWRRegOpt: "On" # Switch for MWR module
88 MWRObsOpt: "On" # Switch for MWR-Obs module
89 tscale: daily # Time-step of downscaled data for temporal downscaling
90 fcstmode: Cont # Fixed (do not change)
91 combnmode: F # Output type (F: Min, Max, MME only, T: combination based on precipitation forecast)
92 fiyearmode: T # Option for including forecast issuing month within the output
93 AcuMonths: 1 # Fixed (do not change)
94 precopt: F # Fixed (do not change)
95 CRAdj: 1.0 # Fixed (do not change)
96
97
```

# Defining time-related inputs

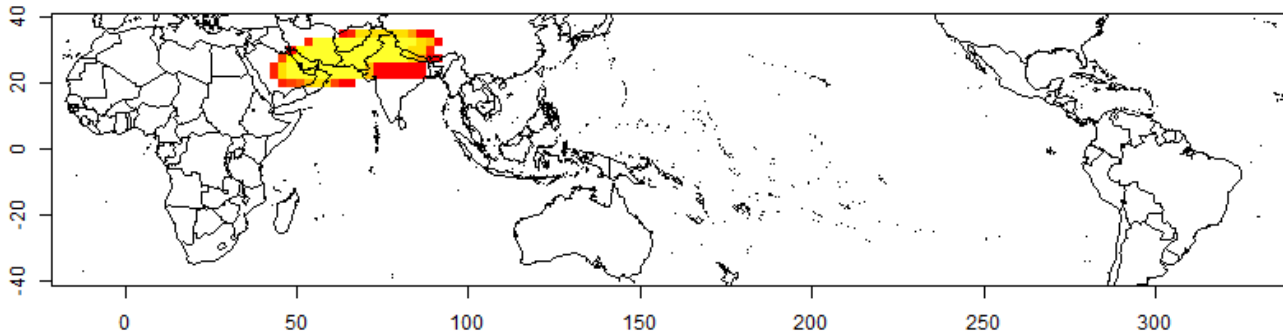
## ① Hindcast Model Construction Period



② Model Calibration (2/3)  
 $eyear\_mme < eyear\_obs$

Model Validation (1/3)

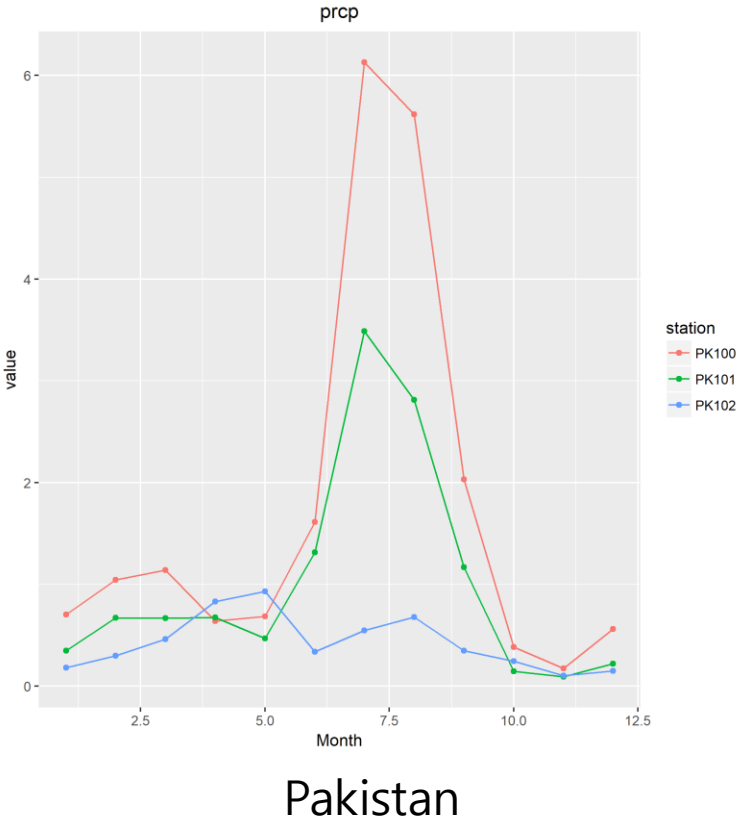
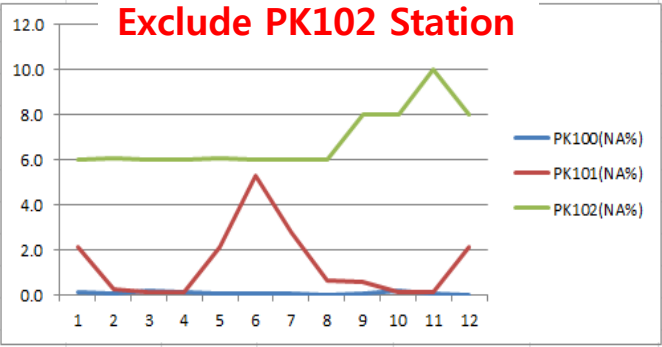
Best predictor (u200:Negative.csv) for Var=prec Month=SEP Model=PNU LeadTime=1 months



# Check your observed data

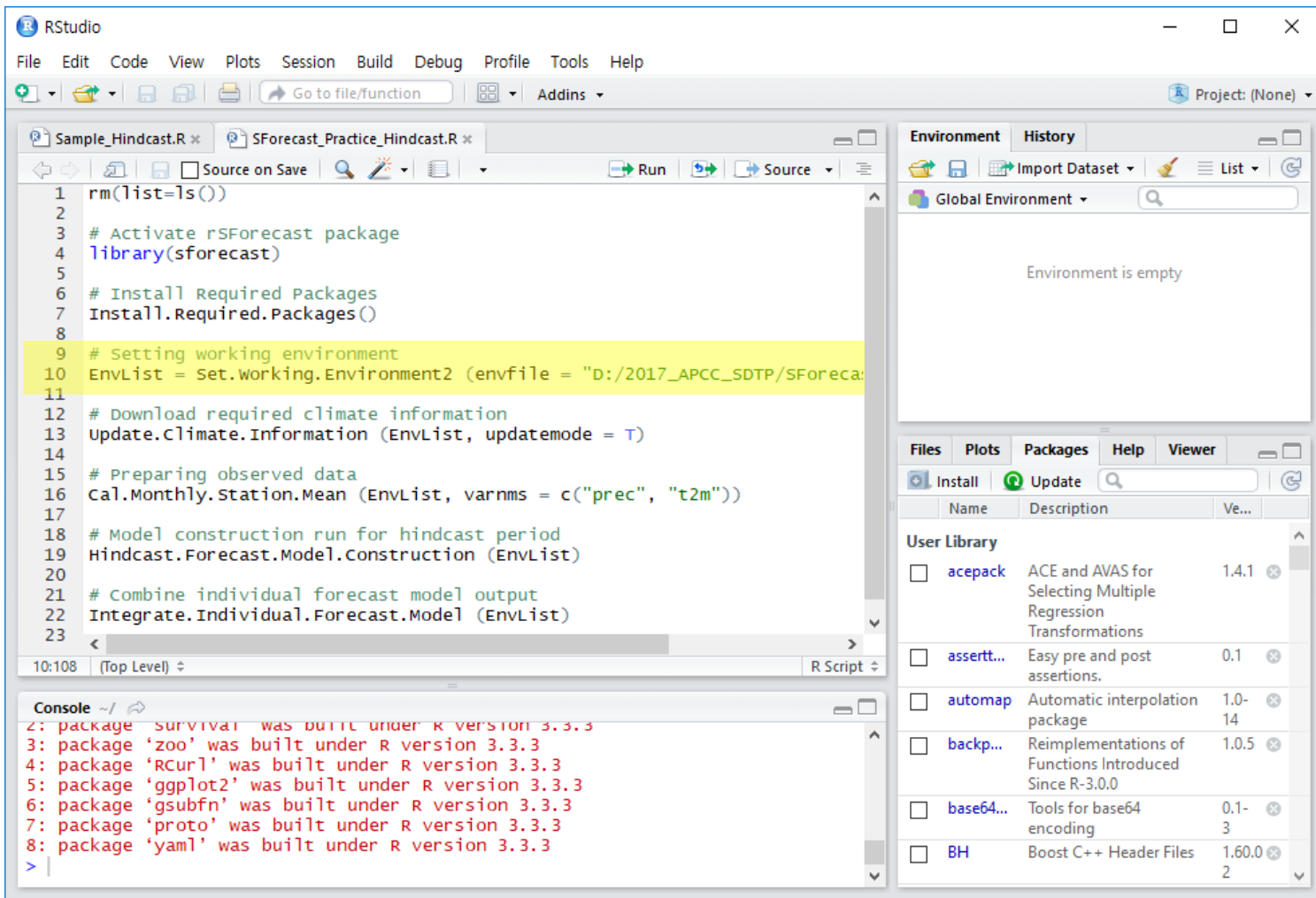
- sforecast searches the predictors over area (monthly station average will be used for predictands)
- So, only **stations with similar climate characteristics** should be considered for further procedures

	A	B	C	D	E	F	G	H
1	month	PK100	PK101	PK102	PK100(NA%)	PK101(NA%)	PK102(NA%)	
2	1	0.70	0.35	0.18	0.1	2.1	6.0	
3	2	1.04	0.67	0.30	0.1	0.2	6.1	
4	3	1.14	0.67	0.46	0.2	0.1	6.0	
5	4	0.64	0.68	0.83	0.1	0.1	6.0	
6	5	0.69	0.47	0.93	0.1	2.1	6.1	
7	6	1.61	1.31	0.34	0.1	5.3	6.0	
8	7	6.13	3.49	0.55	0.1	2.8	6.0	
9	8	5.62	2.81	0.68	0.0	0.6	6.0	
10	9	2.03	1.17	0.35	0.1	0.5	8.0	
11	10	0.38	0.15	0.25	0.2	0.1	8.0	
12	11	0.17	0.09	0.10	0.1	0.1	10.0	
13	12	0.56	0.22	0.15	0.0	2.1	8.0	



# Set working environment for using *sforecast*

1. Open SForecast Practice Hindcast.R in [**SForecast\_Practice**] folder
2. Run line 10 and copy your observed data into [**\$(projdir)/observed/User**] folder



The screenshot shows the RStudio interface with the `SForecast_Practice_Hindcast.R` script open. The script contains the following code:

```

1 rm(list=ls())
2
3 # Activate rSForecast package
4 library(sforecast)
5
6 # Install Required Packages
7 Install.Required.Packages()
8
9 # Setting working environment
10 EnvList = Set.working.Environment2 (envfile = "D:/2017_APCC_SDTP/SForeca
11
12 # Download required climate information
13 Update.Climate.Information (EnvList, updatemode = T)
14
15 # Preparing observed data
16 Cal.Monthly.Station.Mean (EnvList, varnms = c("prec", "t2m"))
17
18 # Model construction run for hindcast period
19 Hindcast.Forecast.Model.Construction (EnvList)
20
21 # Combine individual forecast model output
22 Integrate.Individual.Forecast.Model (EnvList)
23

```

The Environment pane on the right shows the Global Environment, which is currently empty. The Packages pane at the bottom right shows the User Library with the following packages:

Name	Description	Ve...
<input type="checkbox"/> acepack	ACE and AVAS for Selecting Multiple Regression Transformations	1.4.1
<input type="checkbox"/> assert...	Easy pre and post assertions.	0.1
<input type="checkbox"/> automap	Automatic interpolation package	1.0-14
<input type="checkbox"/> backp...	Reimplementations of Functions Introduced Since R-3.0.0	1.0.5
<input type="checkbox"/> base64...	Tools for base64 encoding	0.1-3
<input type="checkbox"/> BH	Boost C++ Header Files	1.60.0-2

The Console at the bottom shows the output of the script execution:

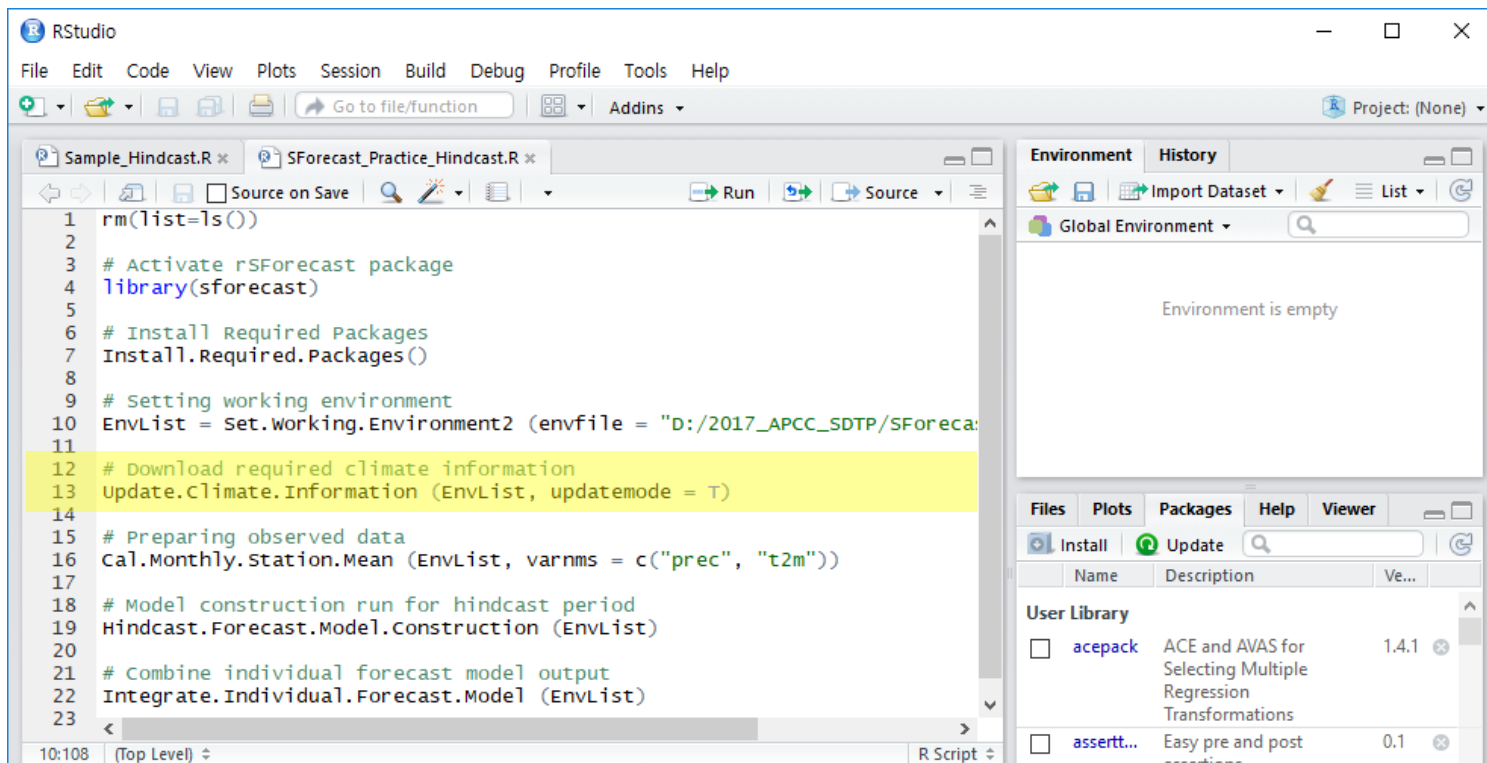
```

2: package 'survival' was built under R version 3.3.3
3: package 'zoo' was built under R version 3.3.3
4: package 'RCurl' was built under R version 3.3.3
5: package 'ggplot2' was built under R version 3.3.3
6: package 'gsubfn' was built under R version 3.3.3
7: package 'proto' was built under R version 3.3.3
8: package 'yaml' was built under R version 3.3.3
>

```

# Download (update) climate information into database folder

- If you download seasonal forecast data (120 GB) first time, set **[updatemode = F]**
- However, we copied it on your desktop. In this case, you need to set **[updatemode = T]**



The screenshot shows the RStudio interface with the following R code in the editor:

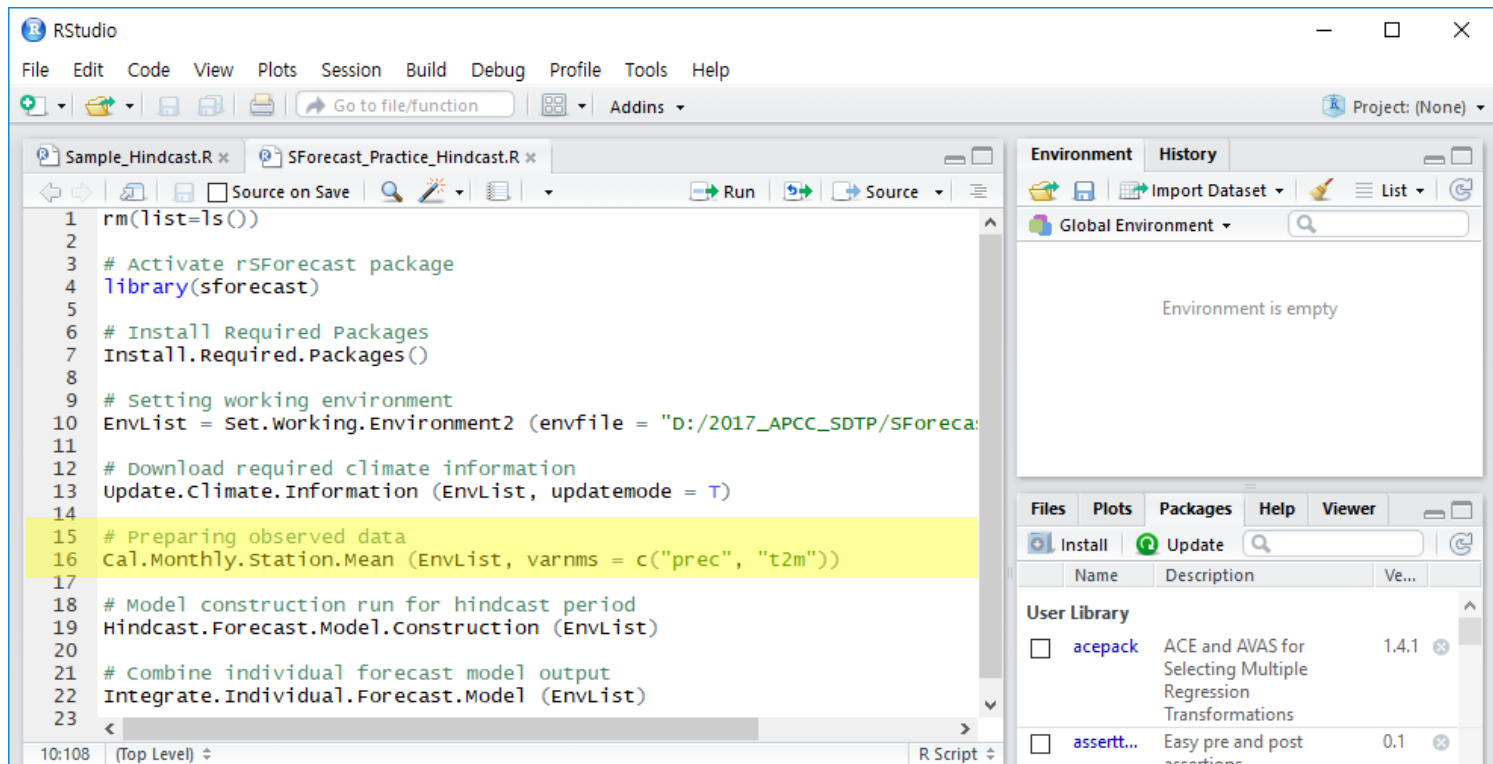
```
1 rm(list=ls())
2
3 # Activate rsForecast package
4 library(sforecast)
5
6 # Install Required Packages
7 install.packages()
8
9 # Setting working environment
10 EnvList = SetWorkingEnvironment2 (envfile = "D:/2017_APCC_SDTP/SForeca
11
12 # Download required climate information
13 updateClimateInformation (EnvList, updatemode = T)
14
15 # Preparing observed data
16 calcMonthlyStationMean (EnvList, varnms = c("prec", "t2m"))
17
18 # Model construction run for hindcast period
19 HindcastForecastModelConstruction (EnvList)
20
21 # Combine individual forecast model output
22 IntegrateIndividualForecastModel (EnvList)
23
```

The Environment pane on the right shows "Global Environment" and "Environment is empty". The Packages pane shows the "User Library" with the following packages:

Name	Description	Ve...
<input type="checkbox"/> acepack	ACE and AVAS for Selecting Multiple Regression Transformations	1.4.1
<input type="checkbox"/> assertt...	Easy pre and post assertions	0.1

# Calculate monthly station average values as predictand

- If you correctly put your observed data into right folder, you can simply run line 16
- Please check your **[\$(prjdir)/Observed/var-predictand]** folder, you can find out newly created file.



```

RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function Addins Project: (None)
Sample_Hindcast.R x SForecast_Practice_Hindcast.R x
Source on Save Run Source
1 rm(list=ls())
2
3 # Activate rsForecast package
4 library(sforecast)
5
6 # Install Required Packages
7 Install.Required.Packages()
8
9 # Setting working environment
10 EnvList = Set.Working.Environment2 (envfile = "D:/2017_APCC_SDTF/SForeca
11
12 # Download required climate information
13 Update.Climate.Information (EnvList, updatemode = T)
14
15 # Preparing observed data
16 Cal.Monthly.Station.Mean (EnvList, varnms = c("prec", "t2m"))
17
18 # Model construction run for hindcast period
19 Hindcast.Forecast.Model.Construction (EnvList)
20
21 # Combine individual forecast model output
22 Integrate.Individual.Forecast.Model (EnvList)
23
10:108 | (Top Level) | R Script
  
```

Environment History

Global Environment

Environment is empty

Files Plots Packages Help Viewer

Install Update

Name	Description	Ve...
<input type="checkbox"/> acepack	ACE and AVAS for Selecting Multiple Regression Transformations	1.4.1
<input type="checkbox"/> assert...	Easy pre and post assertions	0.1

# Hindcast model construction: SBC

- Change the module option within the yaml file

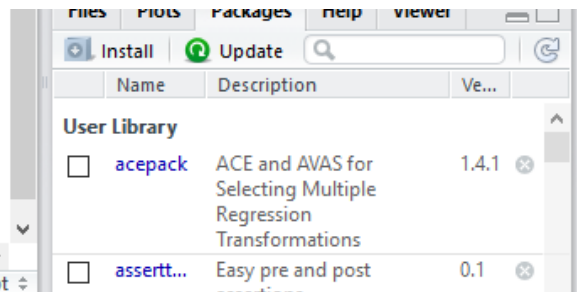
```

84  BCPointOpt: "On"      # Switch for SBC module
85  BCAreaOpt: "Off"     # Not used
86  CIRegOpt: "Off"      # Switch for CIR module
87  MWRegOpt: "Off"      # Switch for MWR module
88  MWRObsOpt: "Off"     # Switch for MWR-Obs module
89  tscale: daily        # Time-step of downscaled data for temporal downscaling
90  fcstmode: Cont       # Fixed (do not change)
91  combnmode: F         # Output type (F: Min, Max, MME only, T: combination based on pr
92  fiyearmode: T        # Option for including forecast issuing month within the output
  
```

- Run line 19 and check the `[$(prjdir)]` folder

```

14
15 # Preparing observed data
16 Cal.Monthly.Station.Mean (EnvList, varnms = c("prec", "t2m"))
17
18 # Model construction run for hindcast period
19 Hindcast.Forecast.Model.Construction (EnvList)
20
21 # Combine individual forecast model output
22 Integrate.Individual.Forecast.Model (EnvList)
23
  
```



- ➔ ❖ 01\_extracted : extracted values without bias-correction
- ❖ 02\_BiasCorrected : forecasted values after bias-correction are saved
- ❖ ID48820-prec-HMC-01-BC.csv means station ID-target variable-model name-Lead time-BC.csv

- Do the same thing for the remaining modules

## Moving Window Regression (MWR) module

- ❖ 01\_extracted : extracted values without bias-correction
- ❖ 02\_BiasCorrected : forecasted values after bias-correction are saved
- ❖ ID48820-prec-HMC-01-BC.csv means station ID-target variable-model name-Lead time-BC.csv

## Observation-based MWR (MWR-Obs) module

- ❖ 01\_Regression-all :
- ❖ 02\_BPredictor\_TSeries : selected best model output
- ❖ 03\_Run\_Regression

## Climate Index Regression (CIR) module

- ❖ 01\_Regression-all :
- ❖ 02\_Best-multi-model : selected best model output

# Integrate individual forecast model

- We will do this part tomorrow using a sample dataset.
- However, we'd better try model construction procedures with minimum setting as below.
  - mdlnms\_3mon: select one
  - mdlnms\_6mon: select one
  - smonth: } select one month you are interested in
  - emonth: }
  - NtlCode: check your National Code (if your own data is not appropriate, please use sample data (KR))
  - syear\_obs: }
  - eyear\_obs: } Define based on your own data
  - syear\_mme: }
  - eyear\_mme: }
  - BCPointOpt, CIRegOpt, MWRegOpt, MWRObsOpt: "On"
- Run line 1 ~ 19



By HikingArtist.com

# Thank You!