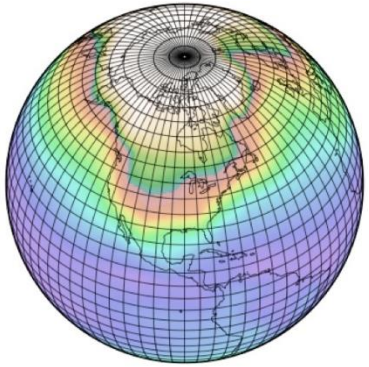
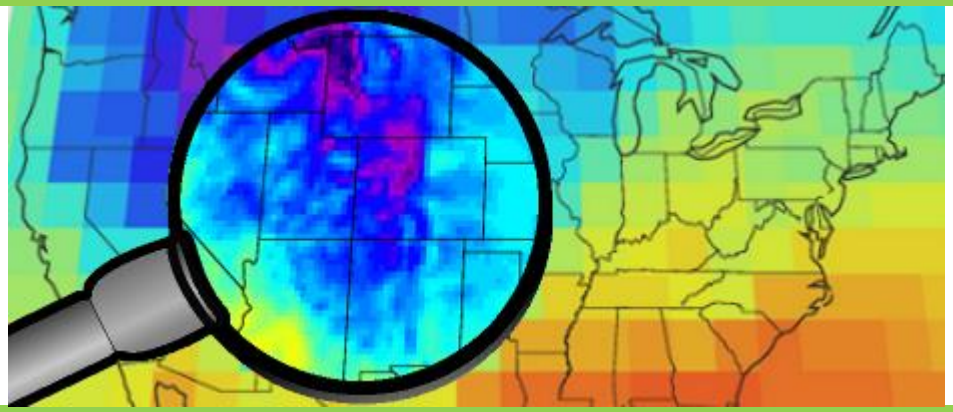
APCC
APEC CLIMATE CENTER

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





Jaepil Cho

2016/08/24

Overview

1. **Required Tools and Data**

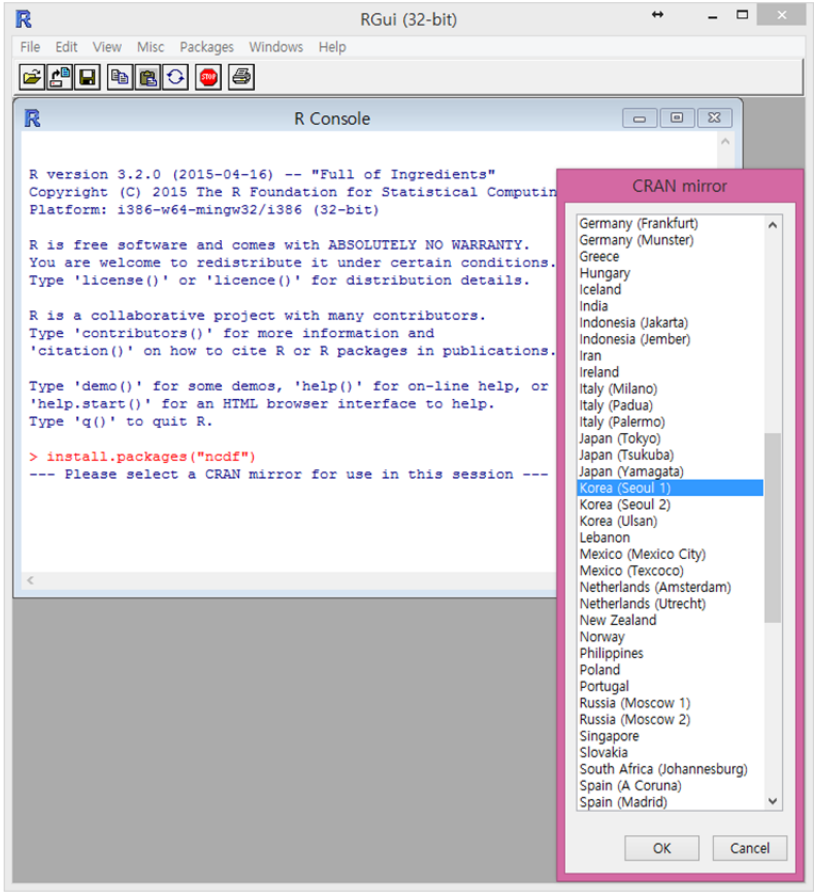
2. **Hands-on using sforecast**

❖Model construction for Hindcast period

Required Tools and Data

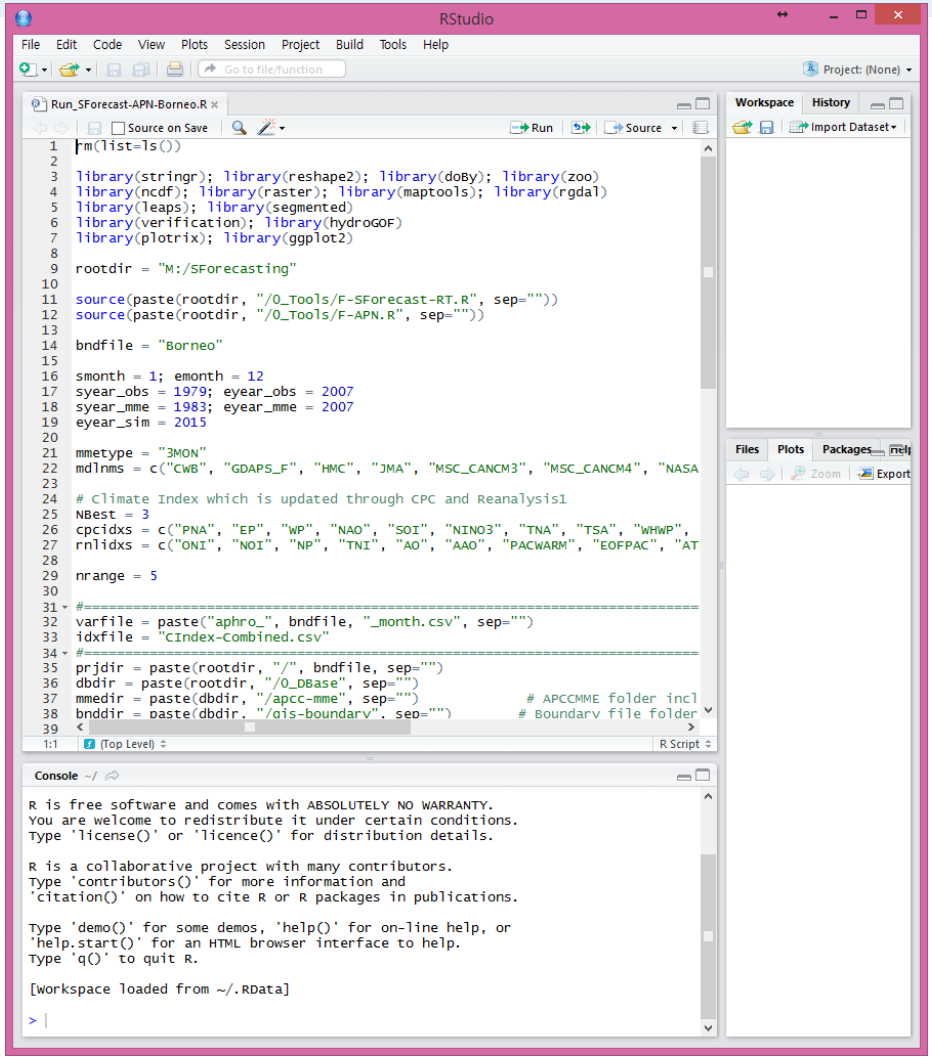
Tools: R (programming language)

- 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/



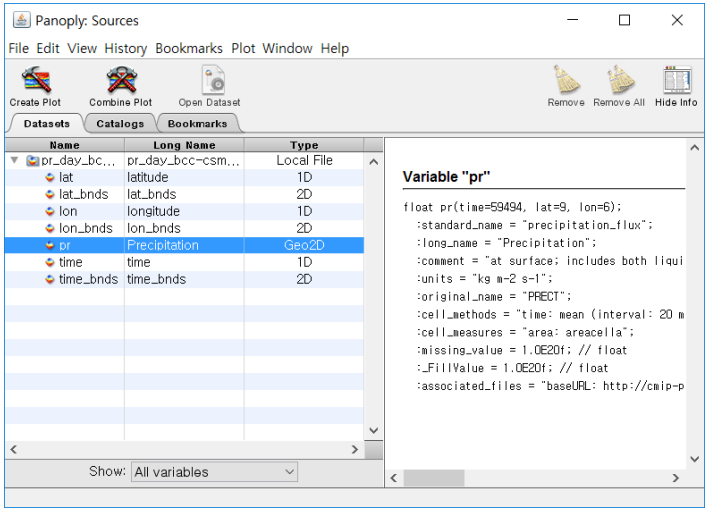
Tools: RStudio

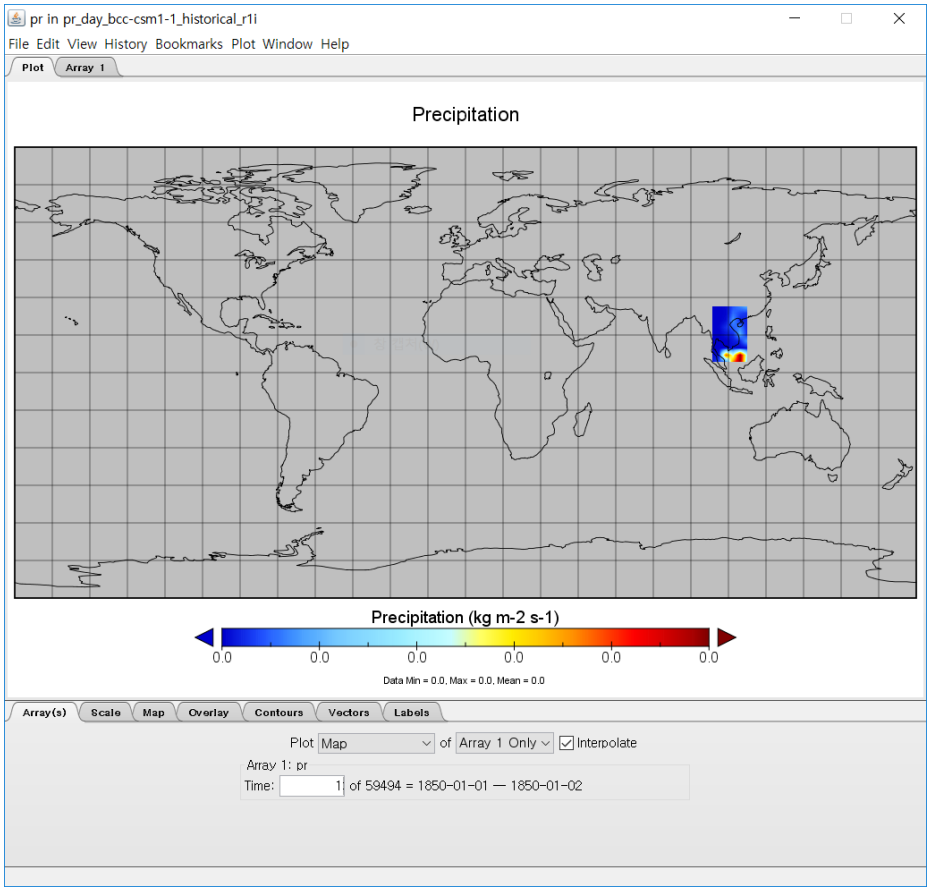
- R user interface
  - Integrated Development Environment(IDE)
- Cross-platform
  - Windows, Linux, Mac OS X
- License
  - GNU Affero GPL v3
- Website
  - http://www.rstudio.com/



Tools: Panoply

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



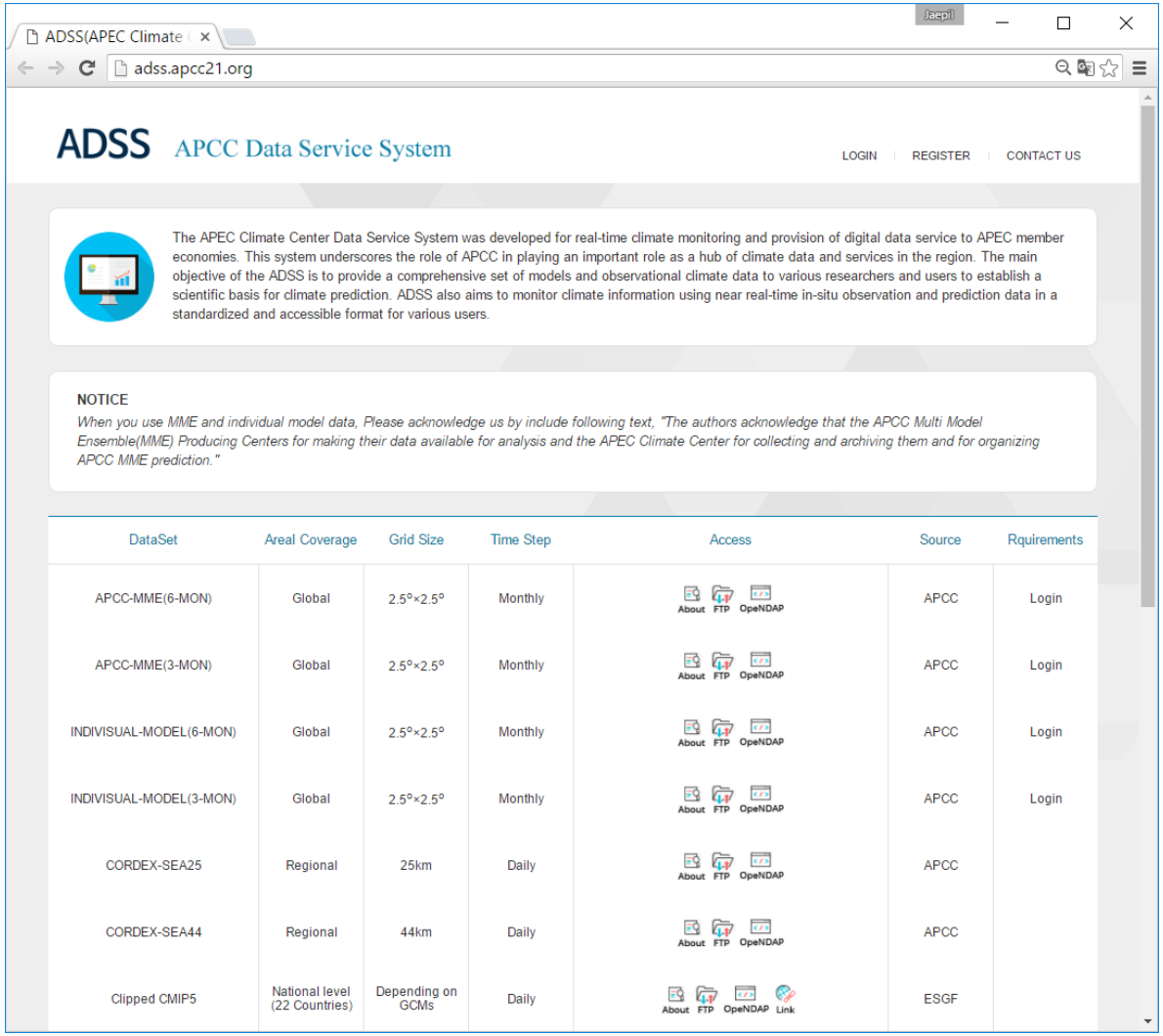


Data: Available individual models for real-time forecast

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

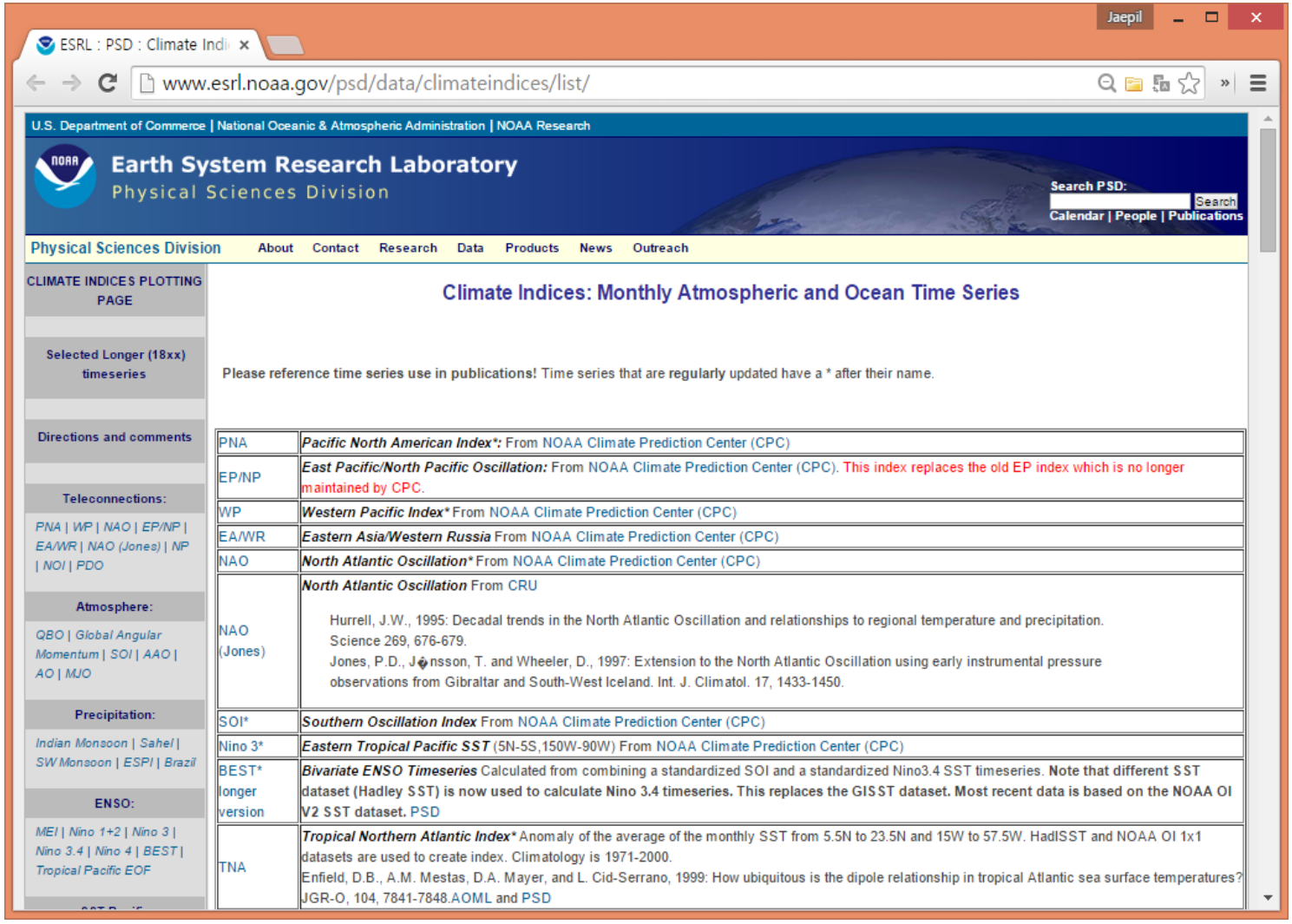
Data: APCC Data Service System (ADSS)



ID: jpcho96
PW: APCC21ORG

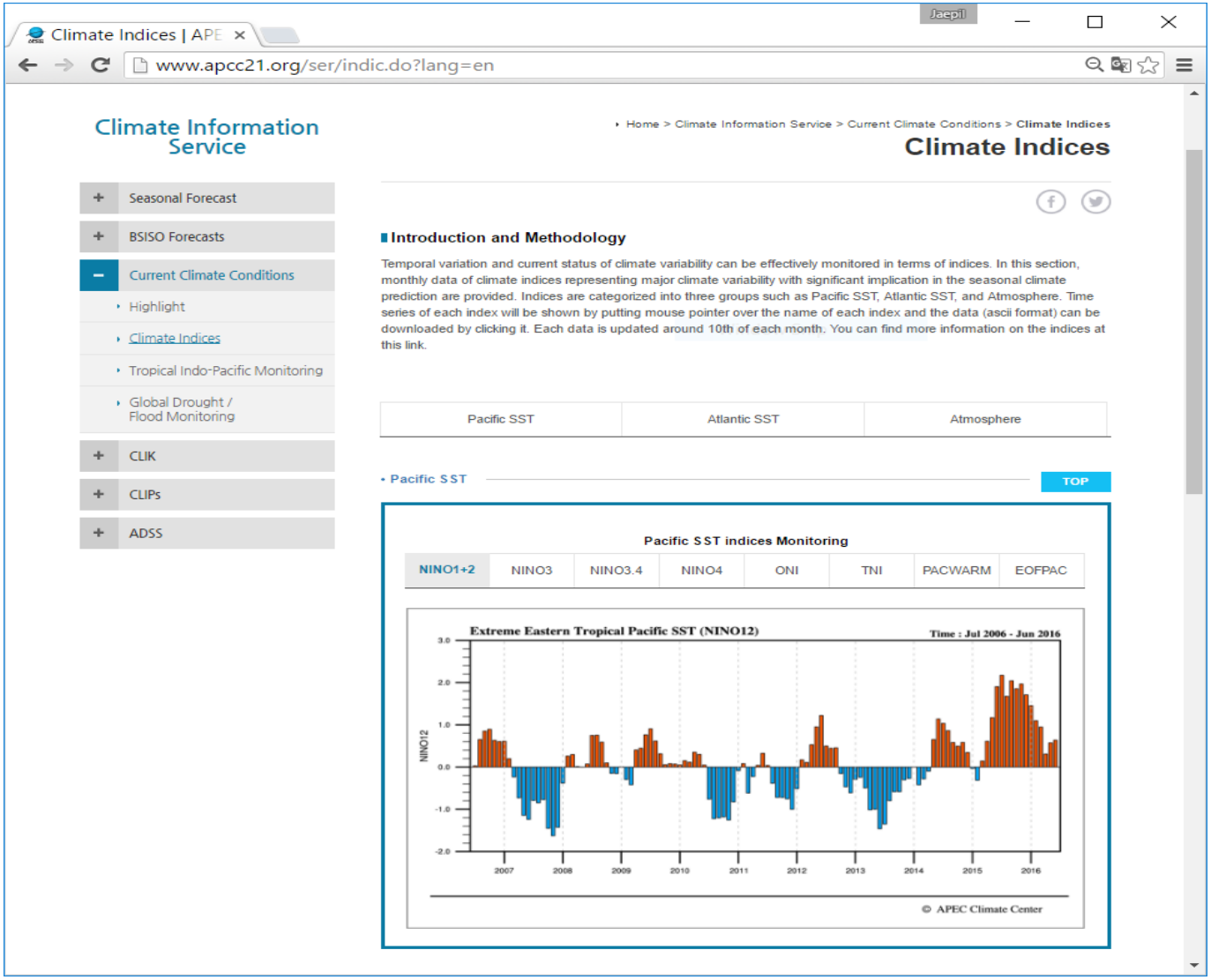
ADSS: http://adss.apcc21.org/

Data: Monthly climate indices from NOAA



http://www.esrl.noaa.gov/psd/data/climateindices/list/

Data: Monthly climate indices from APCC



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

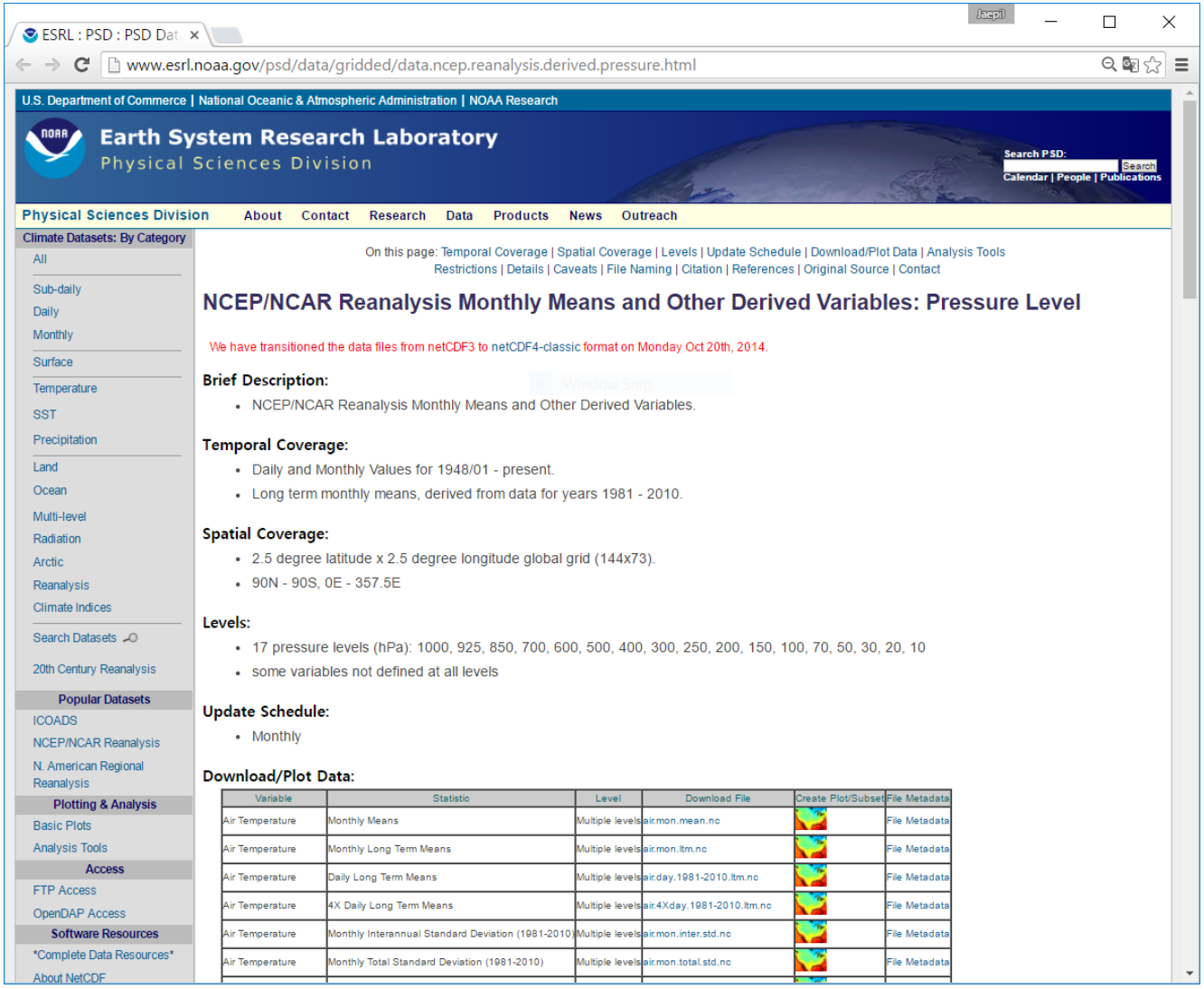
Data: Monthly climate indices for real-time forecast

Climate index	Abb.	NOAA	APCC
Pacific North American Index	PNA	S	○
East Pacific/North Pacific Oscillation	EP	S	X
Western Pacific Index	WP	S	○
Eastern Asia/Western Russia	EA	X	X
North Atlantic Oscillation	NAO	S	○
Southern Oscillation Index	SOI	S	○
Eastern Tropical Pacific SST	NINO3	S	○
Bivariate ENSO Timeseries	BEST	X	X
Tropical Northern Atlantic Index	TNA	S	○
Tropical Southern Atlantic Index	TSA	S	○
Western Hemisphere warm pool	WHWP	S	X
Oceanic Nino Index	ONI	X	S
Multivariate ENSO Index	MEI	S	X
Extreme Eastern Tropical Pacific SST	NINO12	S	○
Central Tropical Pacific SST	NINO4	S	○
East Central Tropical Pacific SST	NINO34	S	
Pacific Decadal Oscillation	PDO	X	X
Northern Oscillation Index	NOI	X	S
North Pacific pattern	NP	X	S
Trans-Niño Index	TNI	X	S

Climate index	Abb.	NOAA	APCC
Antarctic Oscillation	AO	X	S
Antarctic Oscillation	AAO	X	S
Pacific Warmpool (1st EOF of SST (60e-170E, 15S-15N) SST EOF)	PACWARM	X	S
Tropical Pacific SST EOF	EOFPAC	X	S
Atlantic Tripole SST EOF	ATLTRI	X	S
Atlantic multidecadal Oscillation Long Version	AMO	S	X
Atlantic Meridional Mode	AMM	X	X
North Tropical Atlantic SST Index	NTA	X	X
Caribbean SST Index	CAR	X	X
smoothed: Atlantic Multidecadal Osillation	AMOSM	X	X
Quasi-Biennial Oscillation	QBO	S	○
Globally Integrated Angular Momentum	GIAM	X	X
ENSO precipitation index	ESPI	X	X
Central Indian Precipitation	CIP	X	X
Sahel Standardized Rainfall	SahelRain	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	S	X

16 Indices from NOAA
9 indices from NCEP Reanalysis 1 (APCC)

Data: NCEP/NCAR Reanalysis monthly data

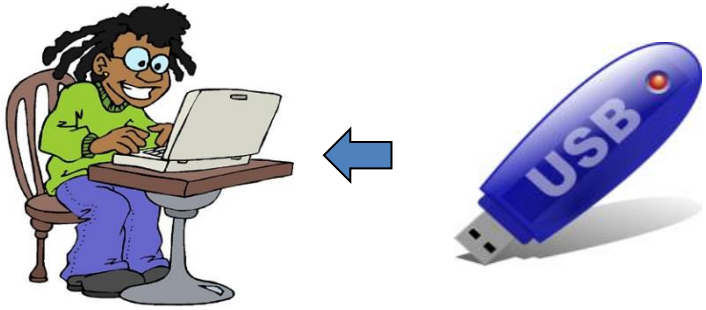


http://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.derived.pressure.html

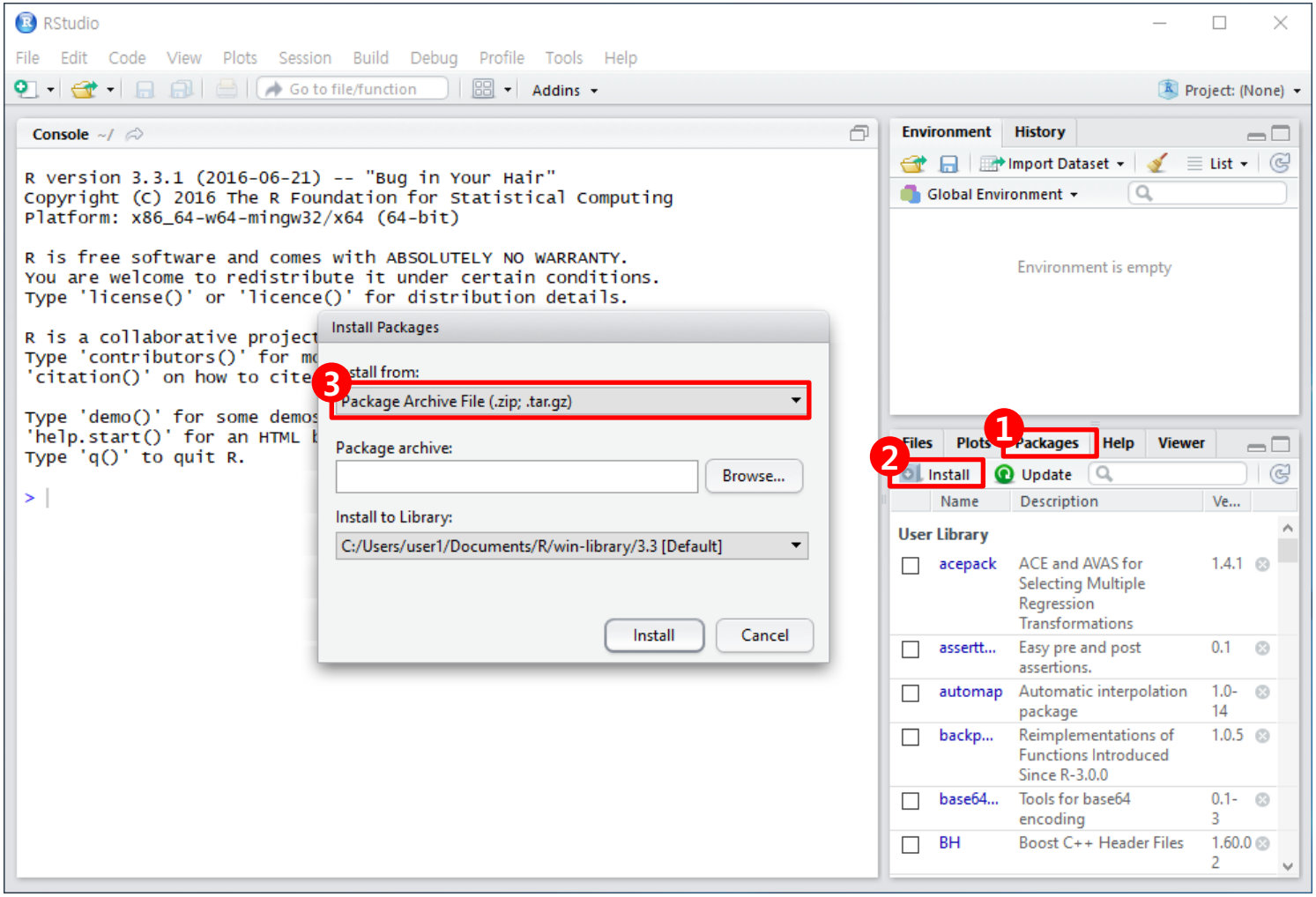
Hands-on using sforecast (I)
-Model construction-

❖ 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

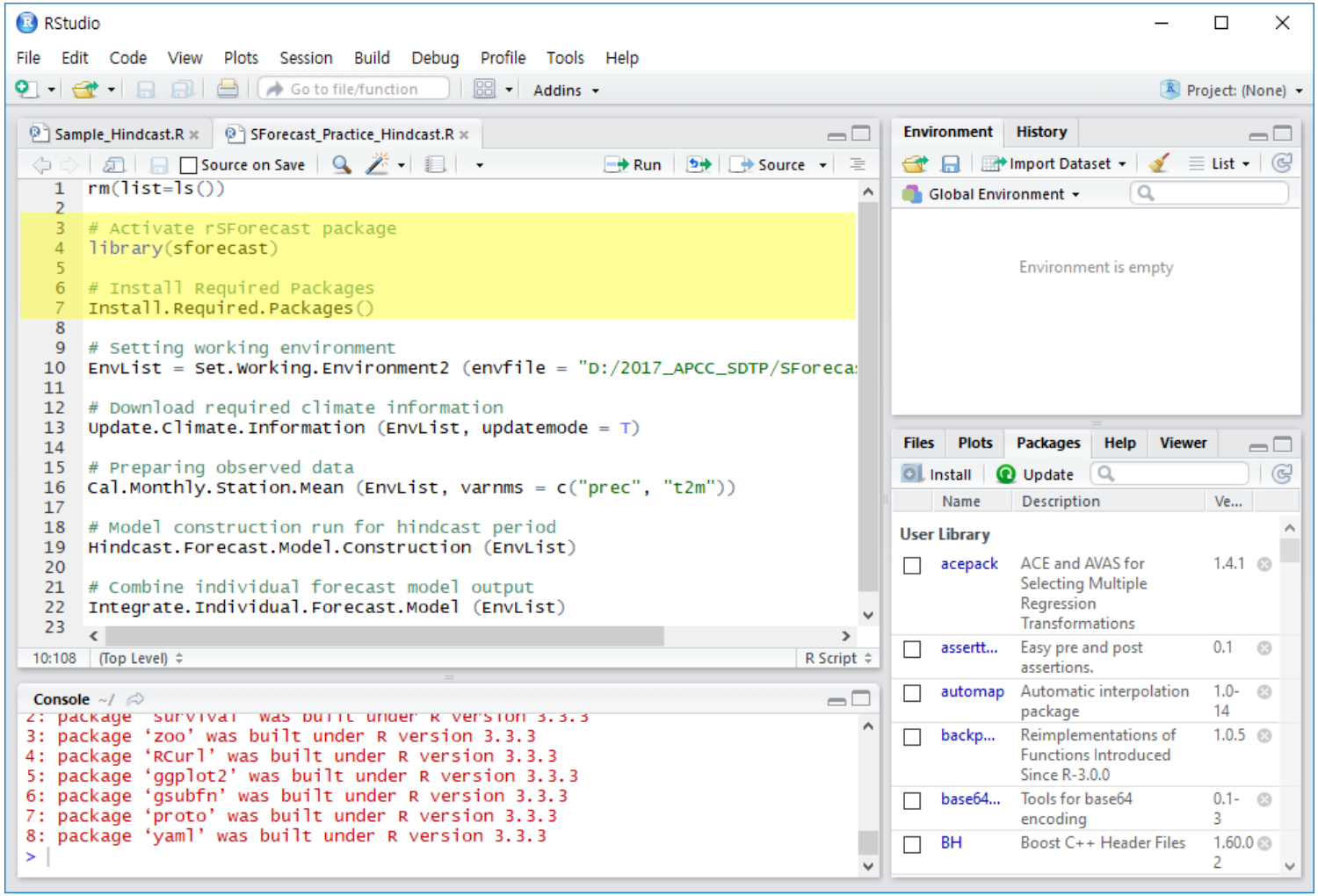


Install *sforecast* R-package using zip file



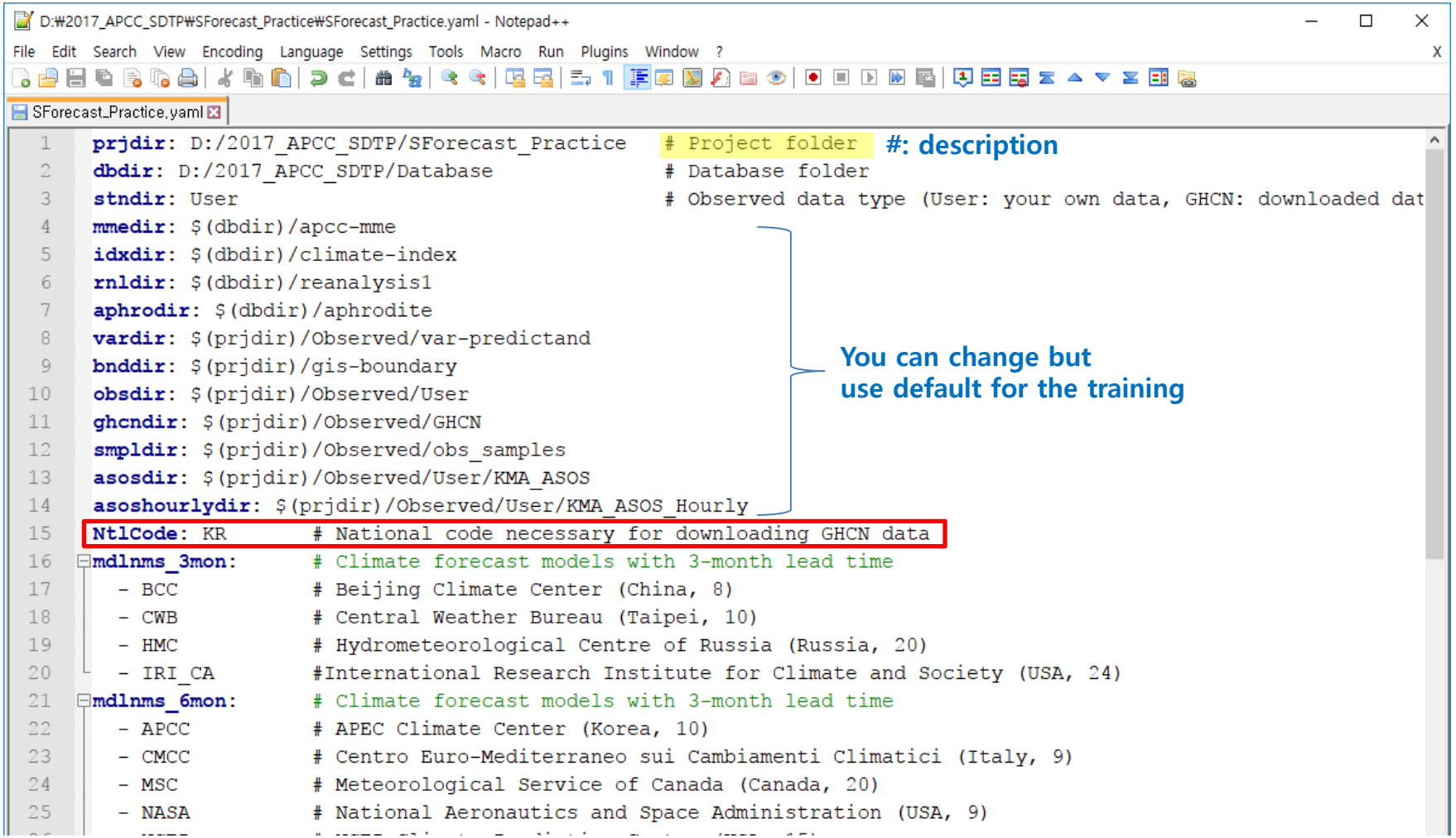
Install required packages which is used for *sforecast*

1. Open SForecast_Practice_Hindcast.R in **[SForecast_Practice]** folder
2. Run line 4 and 7



Understanding control input file (*.yaml)

1. Open SForecast_Practice.yaml in **[SForecast_Practice]** folder




```
prjdir: D:/2017_APCC_SDTP/SForecast_Practice   # Project folder
dbdir: D:/2017_APCC_SDTP/Database              # Database folder
stndir: User                                   # Observed data type (User: your own data, GHCN: downloaded dat
mmedir: $(dbdir)/apcc-mme
idxdir: $(dbdir)/climate-index
rnldir: $(dbdir)/reanalysis1
aphrodir: $(dbdir)/aphrodite
vardir: $(prjdir)/Observed/var-predictand
bnddir: $(prjdir)/gis-boundary
obsdir: $(prjdir)/Observed/User
ghcndir: $(prjdir)/Observed/GHCN
smpldir: $(prjdir)/Observed/obs_samples
asosdir: $(prjdir)/Observed/User/KMA_ASOS
asoshourlydir: $(prjdir)/Observed/User/KMA_ASOS_Hourly
NtlCode: KR        # National code necessary for downloading GHCN data
mdlnms_3mon:       # Climate forecast models with 3-month lead time
  - BCC            # Beijing Climate Center (China, 8)
  - CWB            # Central Weather Bureau (Taipei, 10)
  - HMC            # Hydrometeorological Centre of Russia (Russia, 20)
  - IRI_CA         #International Research Institute for Climate and Society (USA, 24)
mdlnms_6mon:       # Climate forecast models with 3-month lead time
  - APCC           # APEC Climate Center (Korea, 10)
  - CMCC           # Centro Euro-Mediterraneo sui Cambiamenti Climatici (Italy, 9)
  - MSC            # Meteorological Service of Canada (Canada, 20)
  - NASA           # National Aeronautics and Space Administration (USA, 9)
```

Understanding control input file (Cont'd)

E:₩SForecast_Practice₩SForecast_Practice.yaml - Notepad++

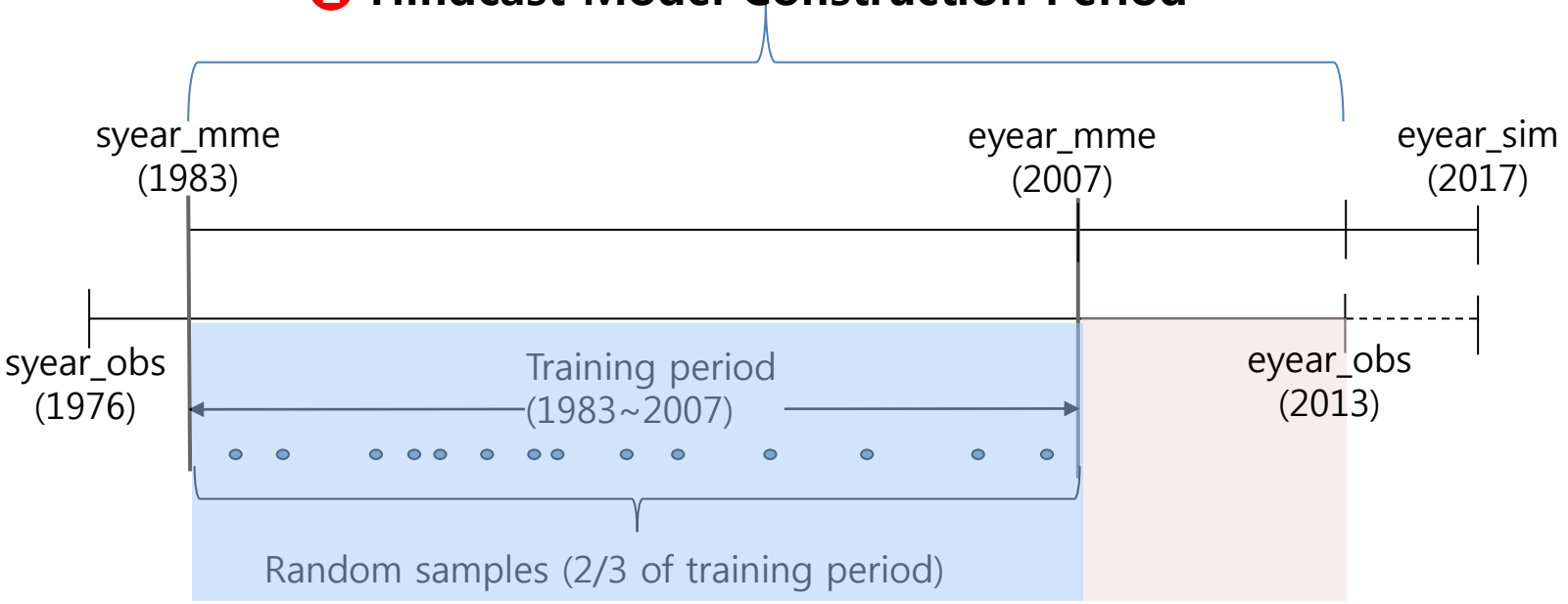
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ? X

SForecast_Practice.yaml

```
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      # Strarting 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  MWRegOpt: "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
```

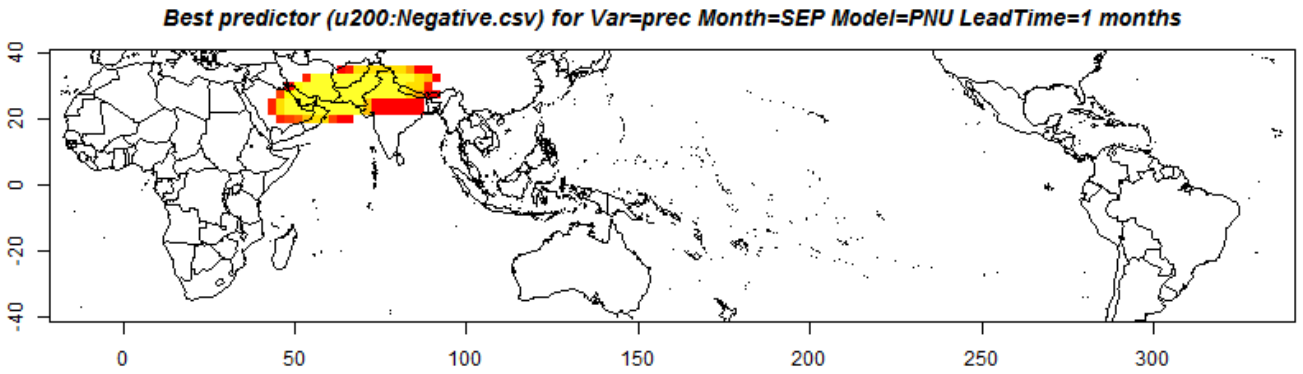
Defining time-related inputs

❶ Hindcast Model Construction Period



❷ ModelCalibration (2/3)
eyear_mme < eyear_obs

Model
Validation (1/3)



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	
14								
15								
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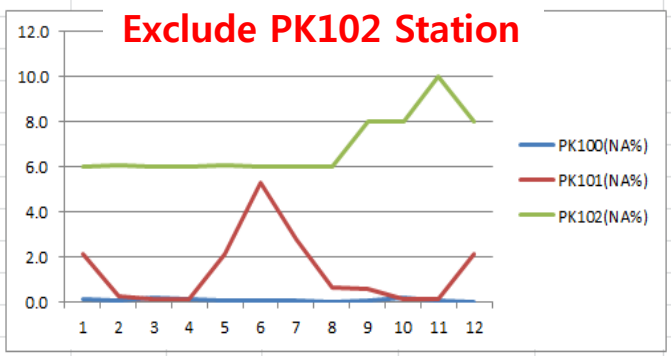
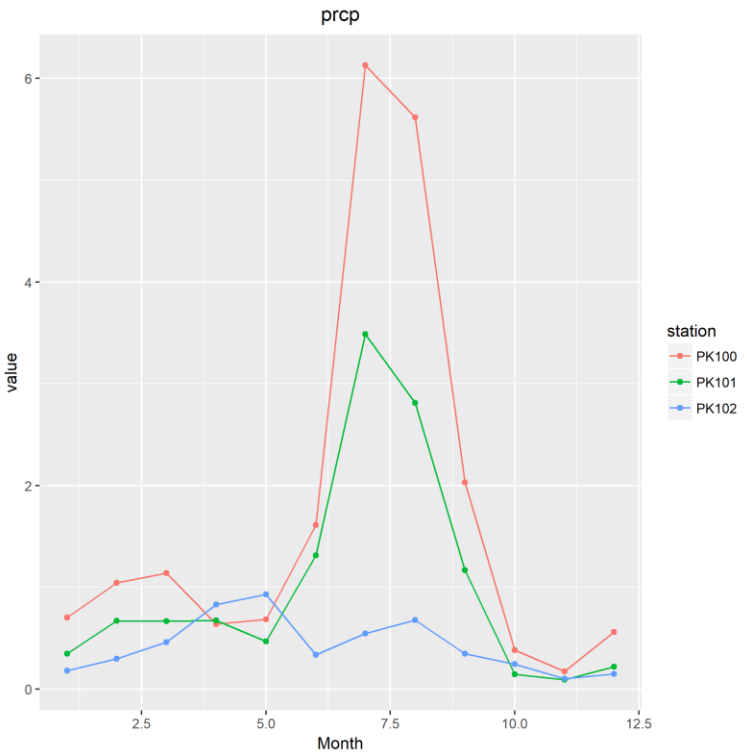
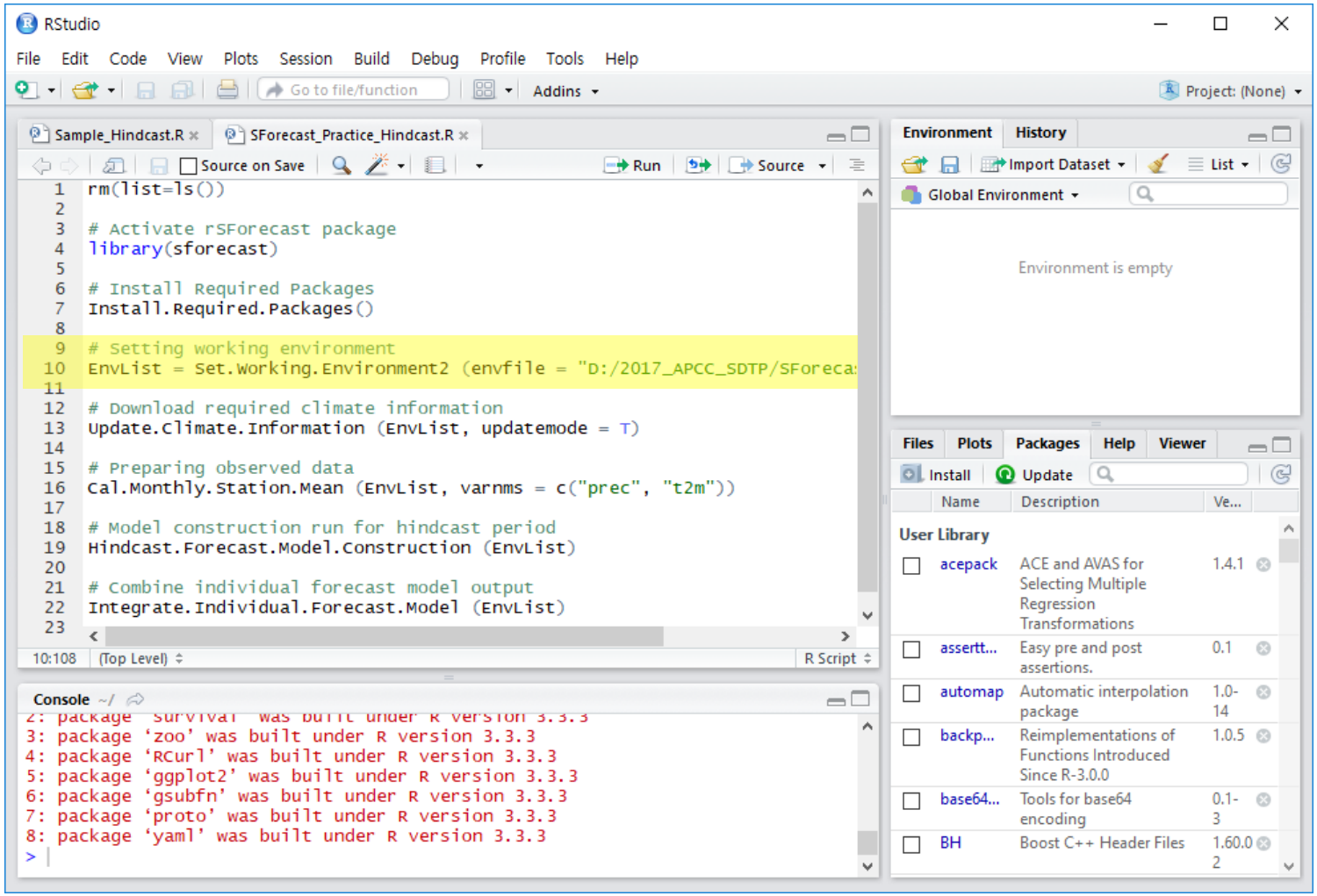




Pakistan

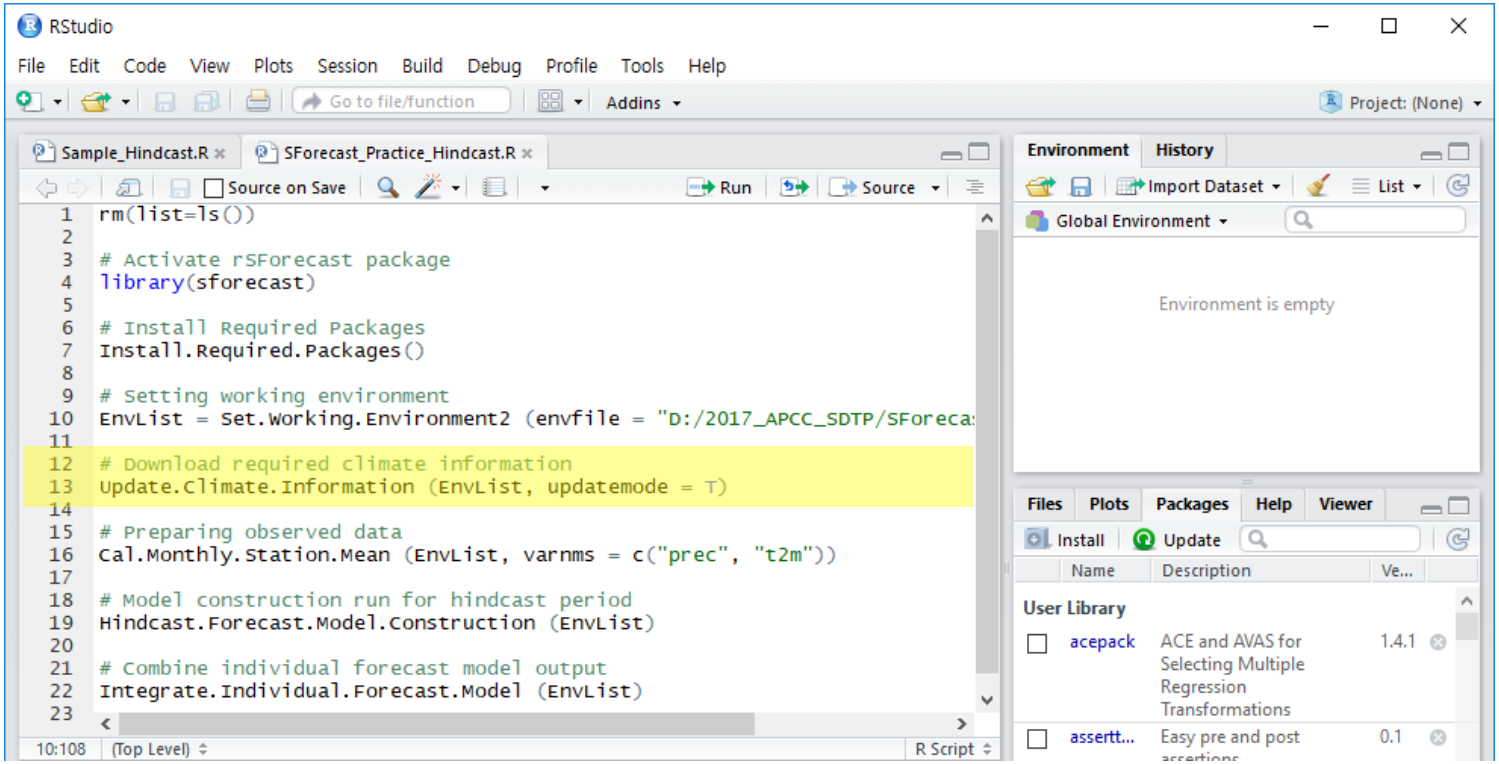
Set working environment for using *sforecast*

1. Open SForecast_Practice_Hindcast.R in **[SForecast_Practice]** folder
2. Run line 10 and copy your observed data into [**$(projdir)/observed/User]** folder



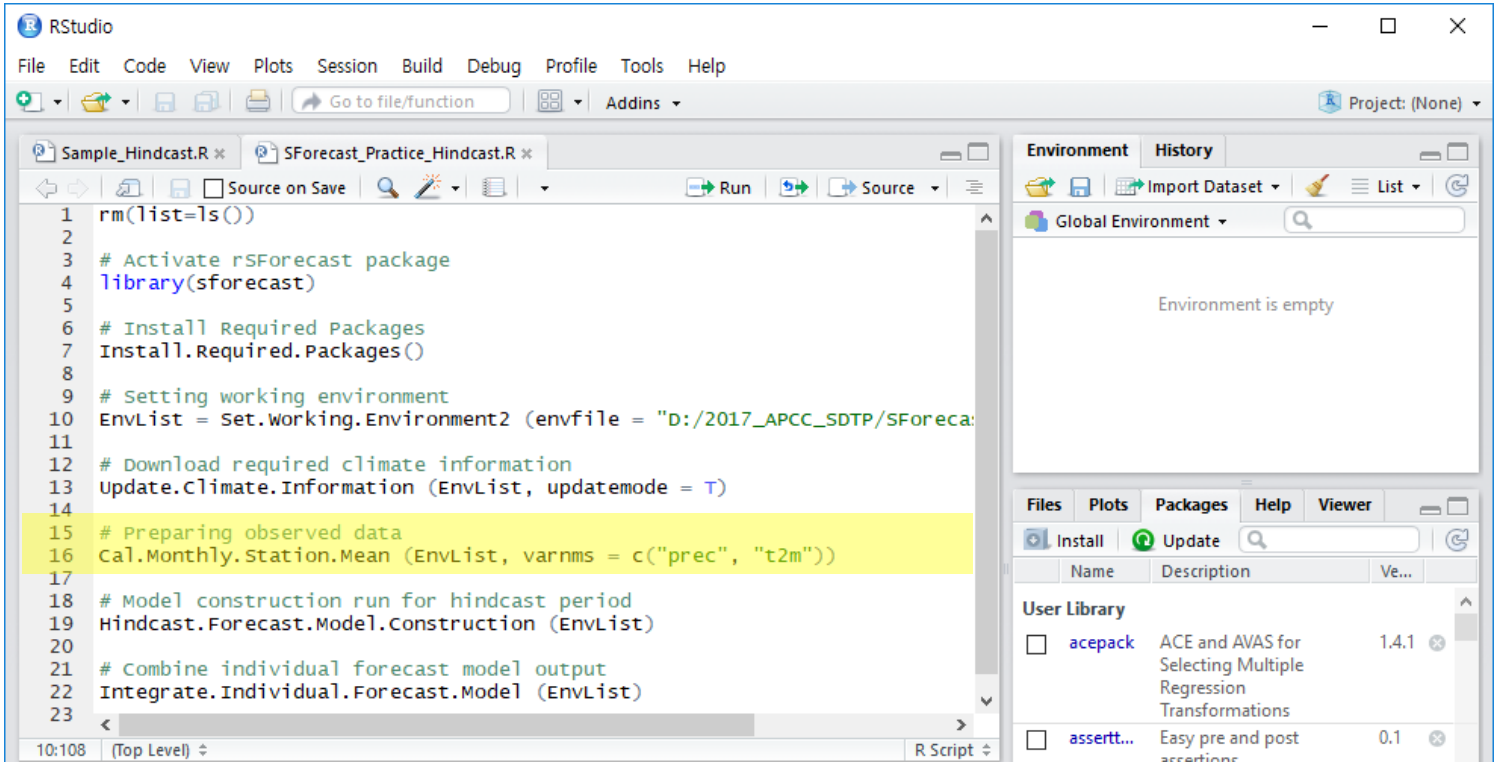
Download (update) climate information into database folder

- 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]**



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.



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
10:108   (Top Level)                                   R Script
```

Files Plots Packages Help Viewer

Install Update

	Name	Description	Ve...
User Library			
☐	acepack	ACE and AVAS for Selecting Multiple Regression Transformations	1.4.1
☐	assertt...	Easy pre and post assertions	0.1

- ❖ 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

Hindcast model construction: MWR, MWR-Obs, CIR

- 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.cs

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:
  - emonth:

    } select one month you are interested in
  - NtlCode: check your National Code (if your own data is not appropriate, please use sample data (KR))
  - syear_obs:
  - eyear_obs:
  - syear_mme:
  - eyear_mme:

    } Define based on your own data
  - BCPointOpt, CIRegOpt, MWRegOpt, MWRObsOpt: "On"
- Run line 1 ~ 19

Thank You!