

AIMS Desktop Application User Manual

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AIMS

AIMS = APCC Integrated Modeling Solution

AIMS is a project initiated by the APEC climate center, and NoteSquare Inc. has been developing since. AIMS targets climate change experts and non-experts, with the main purpose of providing users with easy-to-use tools having as many features packed into a single solution. AIMS is still in its early stages, and many more advanced features are to be implemented in the coming years.

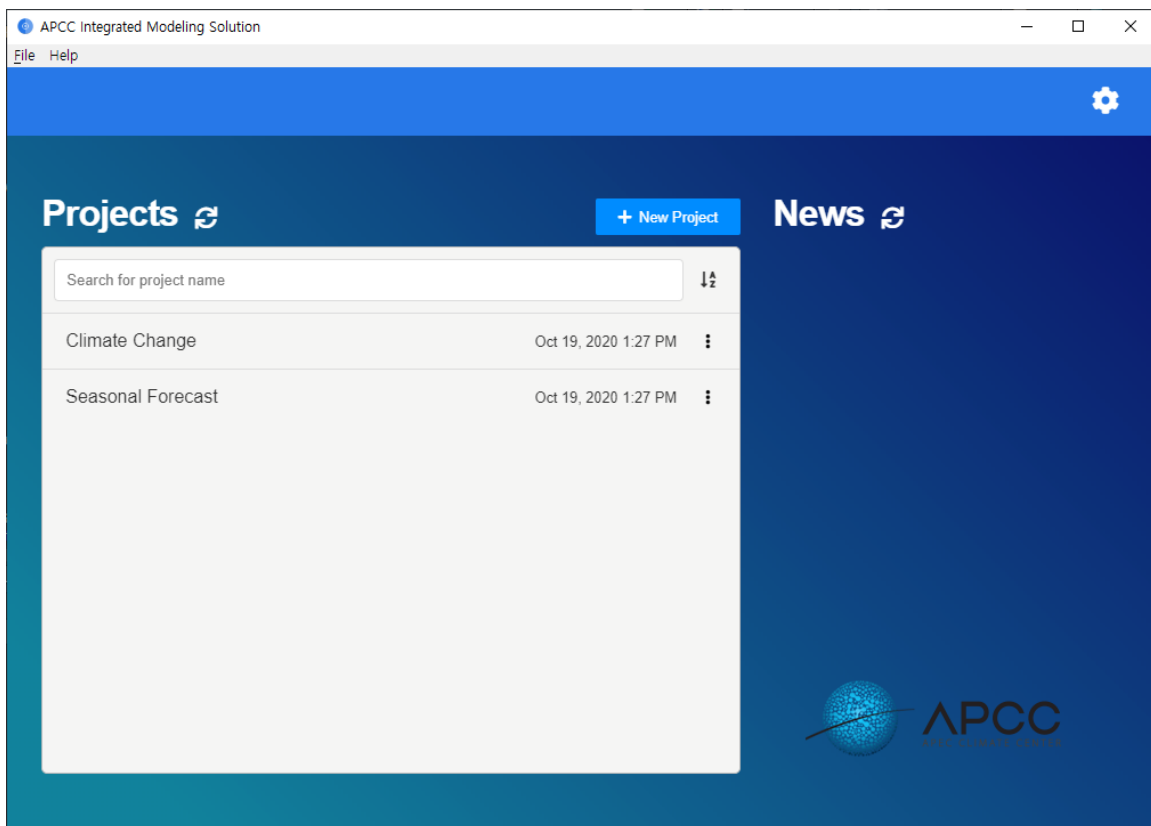
System Requirements

- Windows 7 or higher 64-bit (32-bit system can be used, but a 64-bit system is highly recommended)
- 8 GB RAM or more
- 200 GB or more storage space
- High-speed internet connection (AIMS downloads large amounts of data over the internet, and slow network speeds significantly impact the overall computation time)
- AIMS only supports and uses English

Create a new project

AIMS requires an internet connection to facilitate software usage. This is because some of the features in the software directly download data from external sources to the client's PC. The user can create a new project or select an old project from the first window. All projects listed here are user-specific projects, which indicates that other users with different login credentials will not be able to see another users' projects.

Creating a new Project



Step 1: Click on + New Project button to create a new project

Step 2: Select climate data type

Currently, the user can choose from:

- Climate Change
- Seasonal Forecast

Create a new project ⊗

1. Select a project type

Climate Change	Version: 1.1 <i>APCC Climate Change R Package</i>
Seasonal Forecast	Version: 1.0 <i>APCC Seasonal Forecast R Package</i>

Step 3: Choose a project name

After selecting one of the two downscaling types in Step 2, a project name is automatically generated, including the year and month (e.g., Climate Change (November 2, 2020)). Users can modify the name or choose a name of their own to conveniently manage the project.

2. Enter project name

Cancel Create

Observation data format

AIMS uses observation data in a fixed format. Please follow the format below when uploading the preferred observation data. Station-Info.csv should contain the ID of the observation data, along with latitude and longitude data. Each observation point data should have information of the year, month, day, and variables (precipitation, temperature, etc.), along with the ID defined in Station-Info. In particular, the header name must be retained for the operation.

Station information data (Station-Info.csv)

Information of all points used as observation data must be stored, and data are added and used by adding rows in the following format.

Station-Info.csv

Lon	Lat	Elev	ID	Ename	SYear
128.55	38.25	18.1	ID090	Sokcho	1968
128.7167	37.6667	772.6	ID100	Daegwally	1972
127.7333	37.9	77.7	ID101	Chuncheo	1966

Observation data (ID***.csv)

The data for each observation point must be saved with the same name as the ID of the file storing the point information of the observation data (e.g., ID090.csv), and the following format must be maintained. If there is no value, it can be filled as -99.

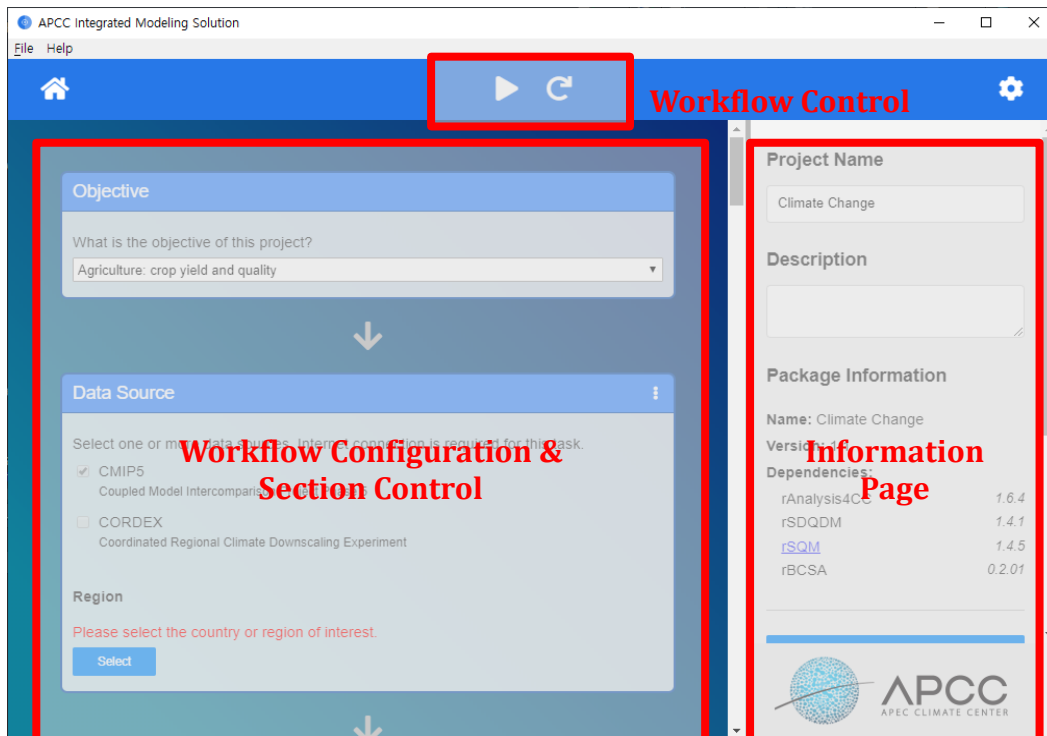
ID090.csv

Year	Mon	Day	prec	tmax	tmin	wspd	rhs	rsds	shine	cloud	tavg
1968	1	1	0	2.5	-4.8	3.3	0.353	-99	7	0.5	-1.4
1968	1	2	0	6.1	-1.9	3.5	0.573	-99	7.9	4.3	2.6
1968	1	3	0	3.6	-3.3	4.1	0.378	-99	8.7	2.3	-0.5
1968	1	4	0	7.2	-1.5	2.3	0.47	-99	8.4	1.5	3.1
1968	1	5	0	11.4	1.5	1.7	0.67	-99	3.8	5	6.1
1968	1	6	0	7.8	1.3	0.5	0.87	-99	5.9	5.8	3
1968	1	7	0	4.5	-3.4	1.1	0.415	-99	8.3	0	1.5
1968	1	8	0	0.6	-5.7	1.2	0.37	-99	8.3	0	-2.6

Project page

When a user selects a project or creates a new project, the Project Page is displayed. There are three parts in the project page:

1. Workflow Control
2. Workflow Configuration & Section control
3. Information Page

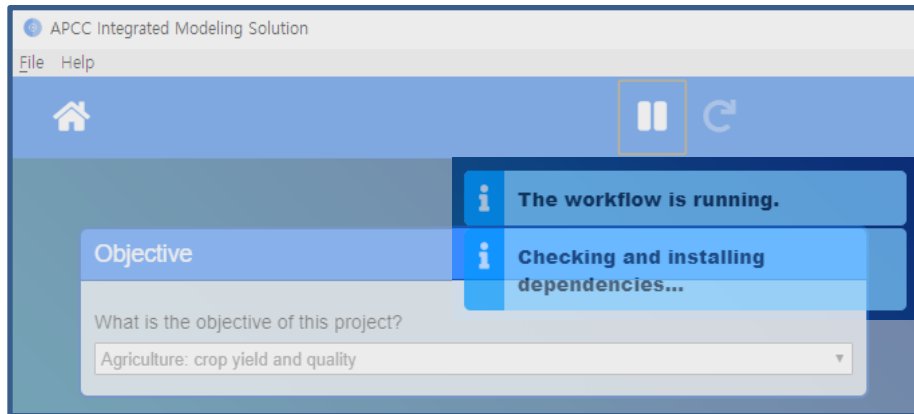


The workflow control allows the user to start the workflow by pressing the play button. The user can also stop and restart the workflow using the workflow controls as well. The Workflow Configuration and Section Control consists of several sections (or cards). Each section represents one or more functions (usually closely tied to the R script file(s)). In Section Control, users can perform section-specific tasks, such as opening the working directory and exporting data files. On the Information Page, the user can check the version information of the R package currently used in AIMS.

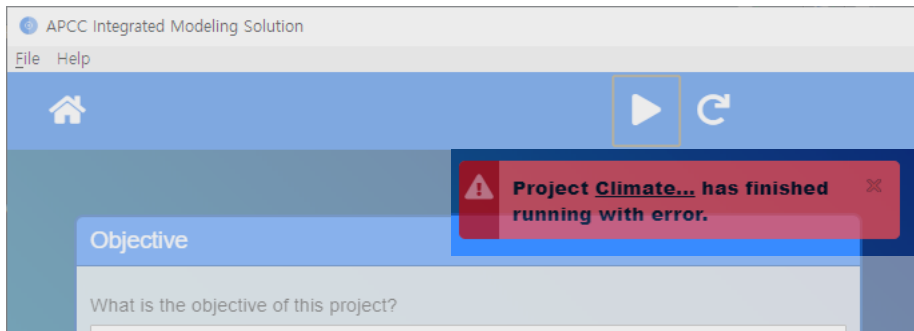
Notification

There are three workflow statuses, which are shown as notification pop-ups.

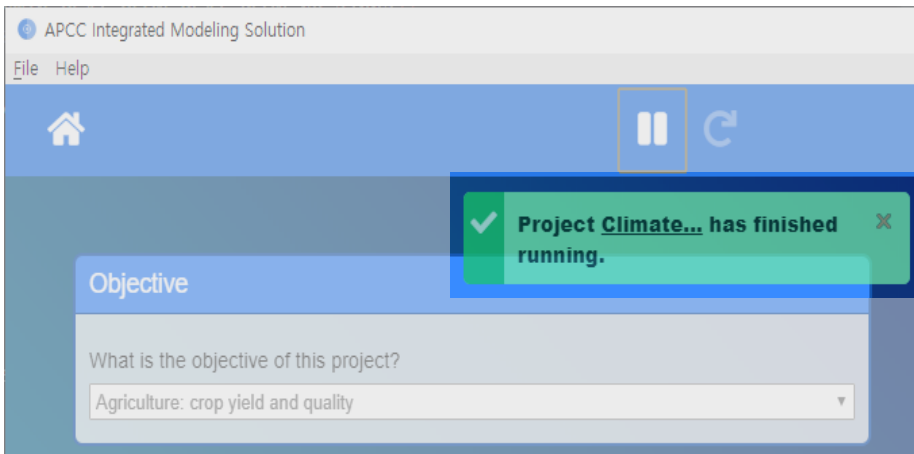
- Running



- Cancelled

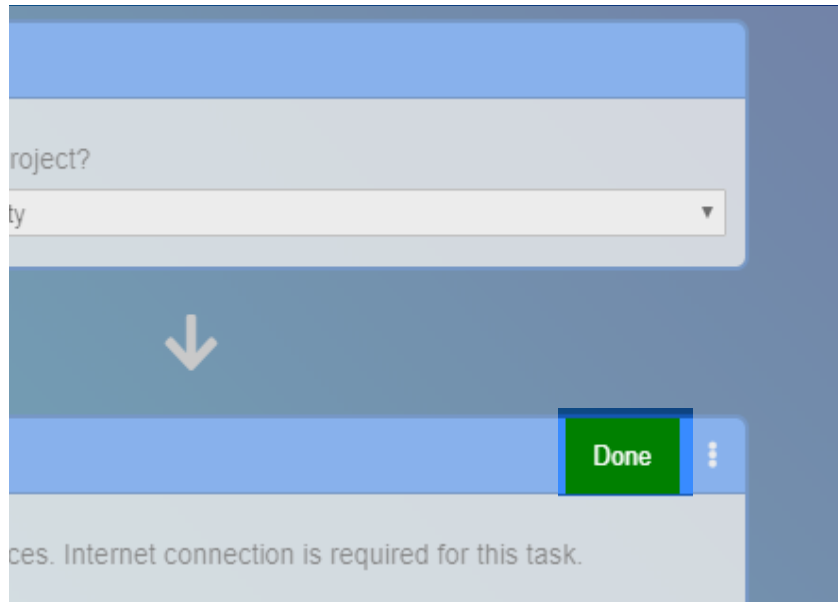


- Finished

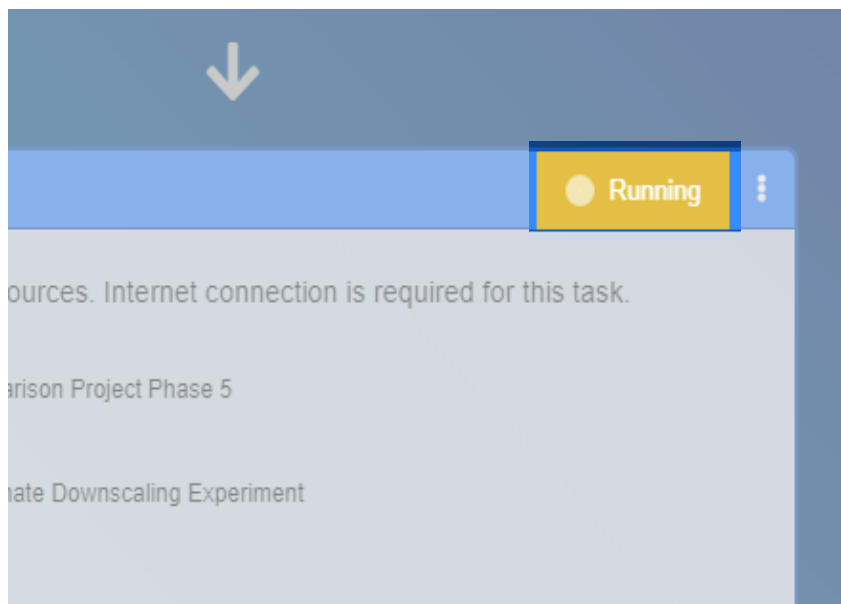


Each section can have three different statuses, which are shown as a tag in the section header.

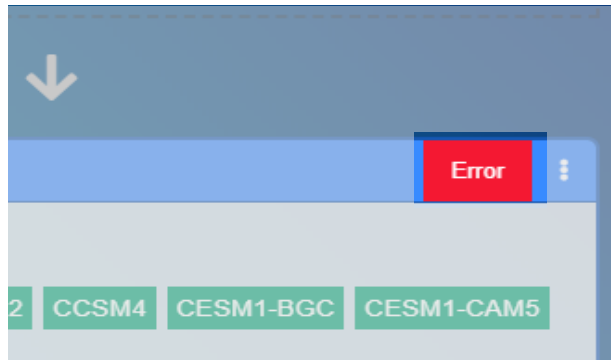
- Done: The workflow has finished running the specific section. The workflow will not run this section again as long as the status is Done.



- Running: This section is currently running.

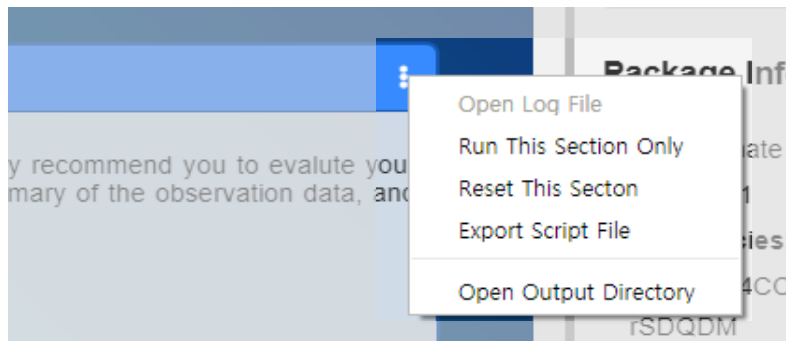


- Error: The user has stopped the workflow, and it will not be run.



Section Control Features

Here, the user can find additional functionalities for the section configuration associated with it. The commonly shown features for control are:



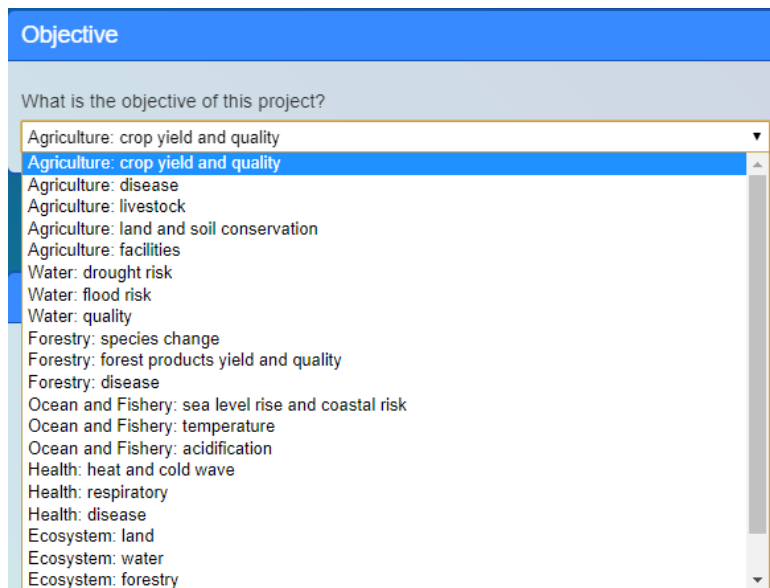
- Open Log File: After each section is executed, the user can check the log of the saved program.
- Run This Section Only: User can execute the current section in any order.
- Reset This Section: Removes the state of the previously executed section.
- Export Script File: R code for executing each section can be exported.
- Open working directory: User can open the result storage folder.

Climate Change Project Sections

In this section, project created with “Climate Change” configuration is discussed in detail.

Section 1: Objective

The user can select the purpose of using the downscaled climate change scenario data produced through AIMS. Please select the option closest to the user’s research purpose out of the 22 choices listed. This section aims to help organize the research objectives for the management of the project.



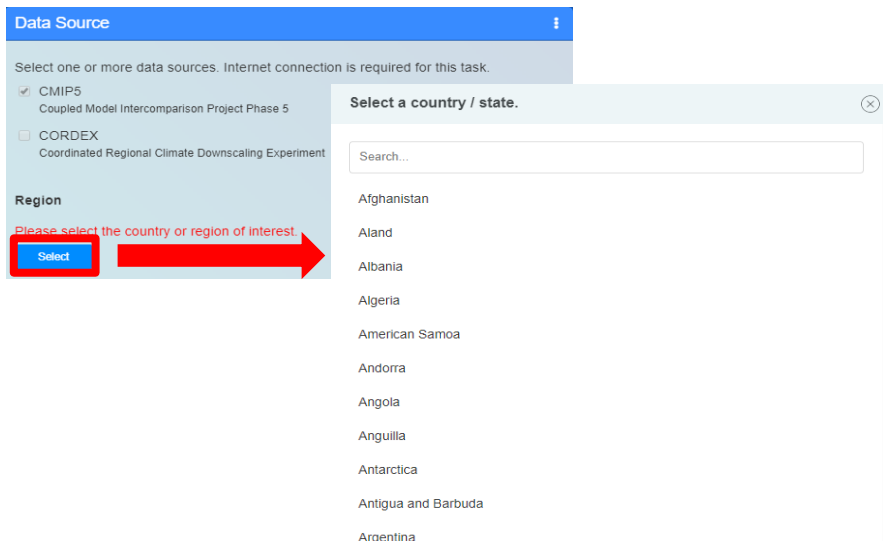
Objective

What is the objective of this project?

- Agriculture: crop yield and quality
- Agriculture: crop yield and quality
- Agriculture: disease
- Agriculture: livestock
- Agriculture: land and soil conservation
- Agriculture: facilities
- Water: drought risk
- Water: flood risk
- Water: quality
- Forestry: species change
- Forestry: forest products yield and quality
- Forestry: disease
- Ocean and Fishery: sea level rise and coastal risk
- Ocean and Fishery: temperature
- Ocean and Fishery: acidification
- Health: heat and cold wave
- Health: respiratory
- Health: disease
- Ecosystem: land
- Ecosystem: water
- Ecosystem: forestry

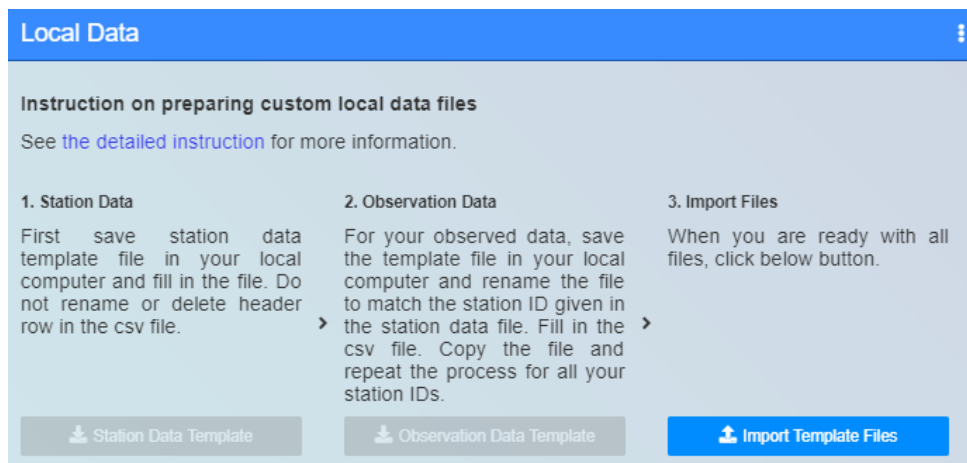
Section 2: Data Source

The current version of the AIMS software provides and utilizes only CMIP5 climate change scenario data. Users are required to select CMIP5 for detailed climate change scenarios, and click the “Select Country” button to select the desired region.

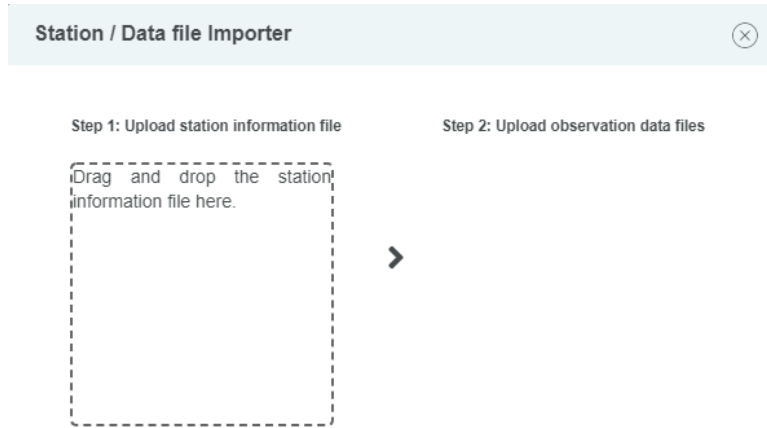


Section 3: Local Data

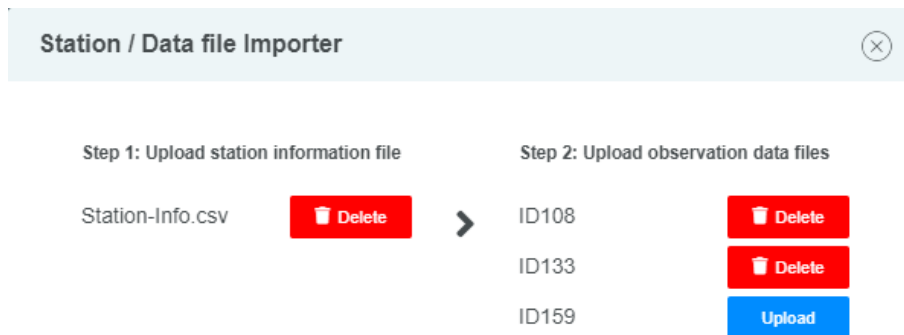
Users can upload the local observation data and station information data files via this section. In this section, uploaded files are simply copied to the specific directory.



Upload Station Data (station-info.csv) and Observation Data files Pop-up



If the user uploads the observation data information (Station-Info), the user can upload the observation point information as follows. To simultaneously upload, select and drag multiple viewpoint information.



Section 4: Evaluate Observed Data

This card can be used to perform basic quality control of the observation data uploaded by the user. The user can check the predefined graph results through the “Open Working Direction” button on the upper right of the card, and understand the characteristics of the observed data.

Evaluate Observed Data
⋮

Before you downscale the observation data, we highly recommend you to evaluate your data with this tool. This section will generate the summary of the observation data, and graphs for each variables.

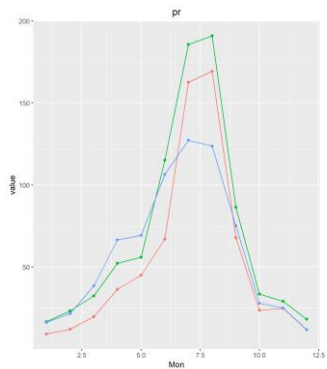
Variables

pr tasmax tasmin

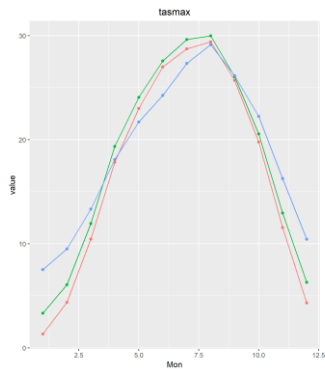
Period

Type	Start Year	End Year
Observed	1976	2005

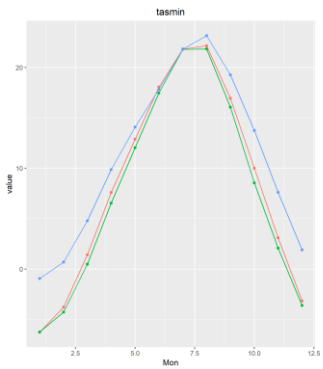
In this card, Quality Control (QC) is performed for the observed data in three stages, and the characteristics of the observed data can be identified through the final result. The input variable is evaluated, and the following results can be obtained.



Precipitation



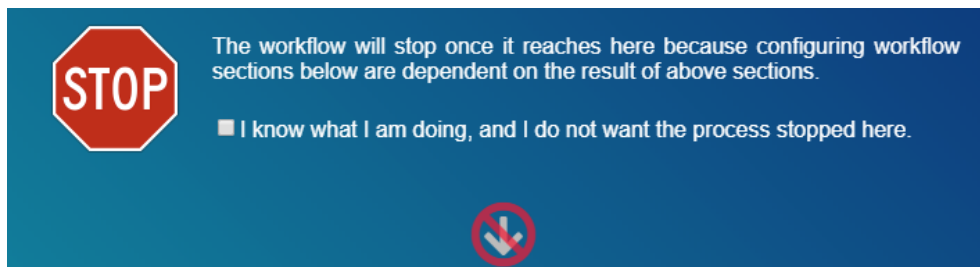
Maximum Temperature



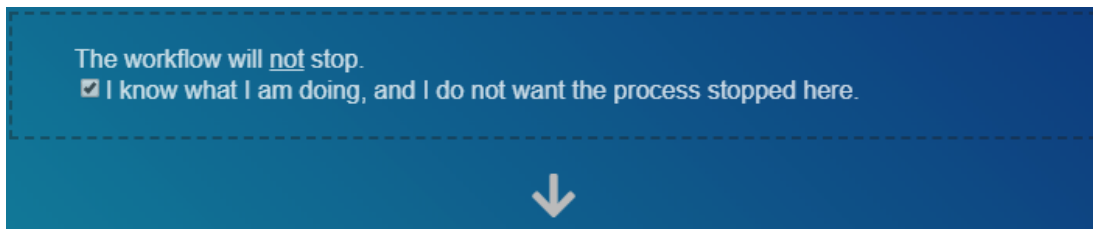
Minimum Temperature

Section 5: Workflow Stop / GO

This workflow recommends evaluating the observations entered by the user, thus stopping the workflow. It is recommended to evaluate the entered observation data and determine if there is any incorrect data. This workflow does not run the R code.

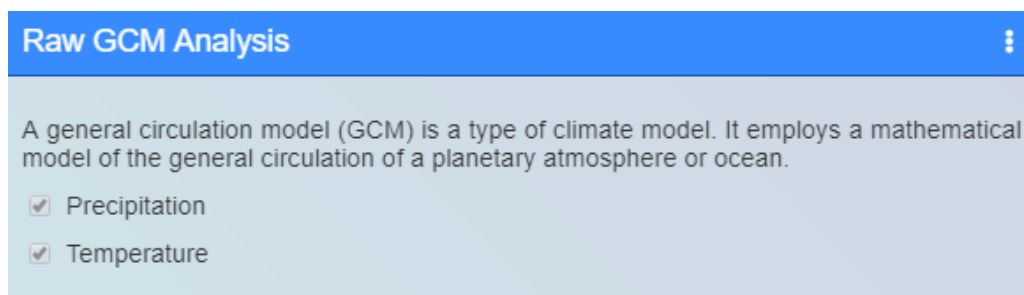


The user can skip this workflow by checking box shown in the image or clicking the Run button. If the user does not want to stop, they can skip this step using the check box.

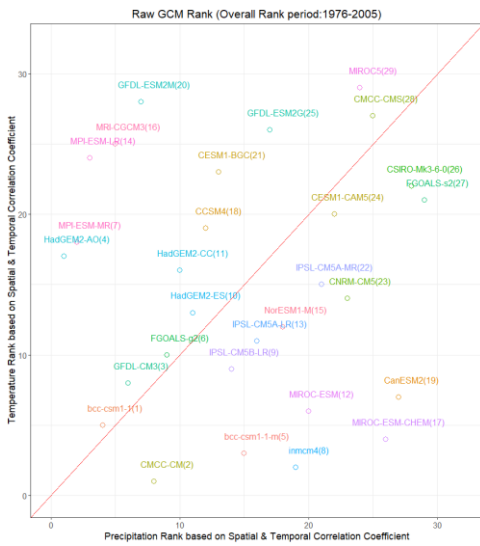


Section 6: Raw GCM Analysis

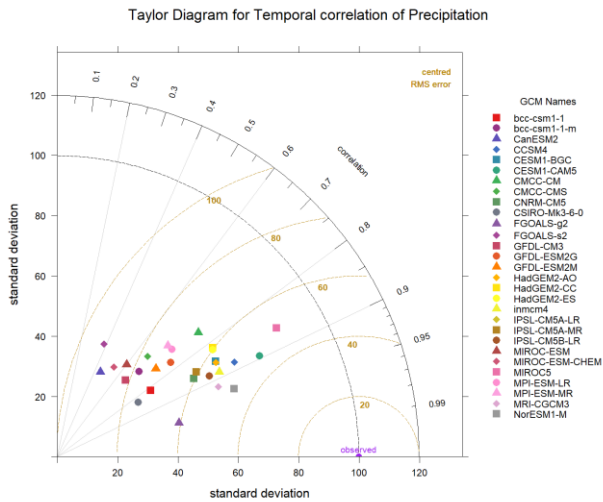
This section evaluates the raw GCM by comparing 29 CMIP5 GCM models provided by AIMS with the observed data. For raw GCMs, ranks are provided based on similarity with observation data.



In this section, observations and raw GCM evaluation results are presented through data and plots. Results are provided through scatter plots and Taylor diagrams of spatial and temporal correlation; thus, the user can determine the GCM showing a similar trend to the observed data.




Raw GCM Rank



Taylor Diagram for Temporal Correlation


Section 7: Workflow Stop / GO

This section recommends the user choose GCM by raw GCM evaluate, such that the workflow will stop. It is recommended to select the GCM to be refined by referring to the results of evaluation of the 29 GCMs of CMIP5 for observational data.



The workflow will stop once it reaches here because configuring workflow sections below are dependent on the result of above sections.

I know what I am doing, and I do not want the process stopped here.



Section 8: Downscale

The user has the following options in this section:

- GCM names
- Scenario
- Variables
- Period
- Downscale method
- Writing type

Downscale ⋮

GCM names

bcc-csm1-1 bcc-csm1-1-m CanESM2

Scenario

RCP4.5
Representative Concentration Pathway (RCP) 4.5 Scenarios

RCP8.5
Representative Concentration Pathway (RCP) 8.5 Scenarios

Variables

pr tasmax tasmin

Period

Type	Start Year	End Year	
Observed	<input type="text" value="1976"/>	<input type="text" value="2005"/>	
Historical (GCM)	<input type="text" value="1976"/>	<input type="text" value="2005"/>	
Future (GCM)	<input type="text" value="2010"/>	<input type="text" value="2039"/>	<input type="button" value="remove"/>
	<input type="text" value="2040"/>	<input type="text" value="2069"/>	<input type="button" value="remove"/>
	<input type="text" value="2070"/>	<input type="text" value="2099"/>	<input type="button" value="remove"/>

Downscale method

Please choose one or more downscale methods.

SQM ([Cho et al., 2016](#))
Simple Quantile Mapping

SDQDM ([Cannon et al., 2015](#); [Eum & Cannon, 2017](#))
Spatial Disaggregation-Quantile Delta Mapping

BCSA ([Hwang & Graham, 2013](#); [Hwang & Graham, 2014](#))
Bias-Correction and Stochastic Analog method

Choose your writing type

- GCM names

Upon clicking the GCM name in the section, the user can select or remove the desired GCM through the following window. We provide 29 CMIP5 GCMs.

Select one or more variables. ✕

Select: [All](#) | [None](#)

- bcc-csm1-1
Beijing Climate Center, China Meteorological Administration (128x64)
- bcc-csm1-1-m
Beijing Climate Center, China Meteorological Administration (320x160)
- CanESM2
Canadian Centre for Climate Modelling and Analysis (128x64)
- CCSM4
National Center for Atmospheric Research (288x192)
- CESM1-BGC
National Science Foundation, Department of Energy, National Center for Atmospheric Research (288x192)
- CESM1-CAM5
National Science Foundation, Department of Energy, National Center for Atmospheric Research (288x192)
- CMCC-CM
Centro Euro-Mediterraneo per I Cambiamenti Climatici (480x240)
- CMCC-CMS
Centro Euro-Mediterraneo per I Cambiamenti Climatici (192x96)
- CNRM-CM5
Centre National de Recherches Meteorologiques, Centre Europeen de Recherche et Formation Avancees en Calcul Scientifique (256x128)

- Variables

Users can select the variable to be downscaled, such as precipitation, maximum temperature, minimum temperature, wind speed, relative humidity, and solar radiation. Precipitation, maximum temperature, and minimum temperature can be downscaled through the SQM, SDQDM, and BCSA methods. Wind speed, relative humidity, and solar radiation can be downscaled using the SQM method.

Select one or more variables. ✕

Select: [All](#) | [None](#)

- pr
Precipitation(mm)
- tasmx
Maximum Temperature(C)
- tasmin
Minimum Temperature(C)
- sfcWind
Wind Speed(m/s)
- rhs
Relative Humidity(%)
- rsds
Solar Radiation(MJ/m2)

- **Period**

It is designed to select a period based on the observation data entered by the user. A period of 30 years is recommended for the historical and future periods for Climatology. In addition, it is recommended to select an observed period of the same period as the GCM historical data for downscaling results that accurately reflect the characteristics of AIMS, which applies the downscale method based on quantile mapping. The historical (GCM) period is fixed from 1976 to 2005; the historical period of CMIP5, and the future period can be changed in increments of 30 years to determine 30-year data for the desired period. The future period can be set up to 2099, based on CMIP5 data.

Period			
Type	Start Year	End Year	
Observed	1976	2005	
Historical (GCM)	1976	2005	
Future (GCM)	2010	2039	<input type="button" value="remove"/>
	2040	2069	<input type="button" value="remove"/>
	2070	2099	<input type="button" value="remove"/>

- **Downscaling method**

SQM, SDQDM, and BCSA methods are provided, and the user can select the downscaling method using the check box. The downscaling technique description of each method can be found in the Reference.

- **Writing type**

This feature is designed to effectively refine downscaling methods that require a large amount of physical time. We provide a method for overwriting the existing downscaled results (Overwrite all) and a method of producing only the data, except for the existing downscaled results (Downscale missing data only). If the period changes, the user must reproduce all the details through 'Overwrite all'.

Choose your writing type

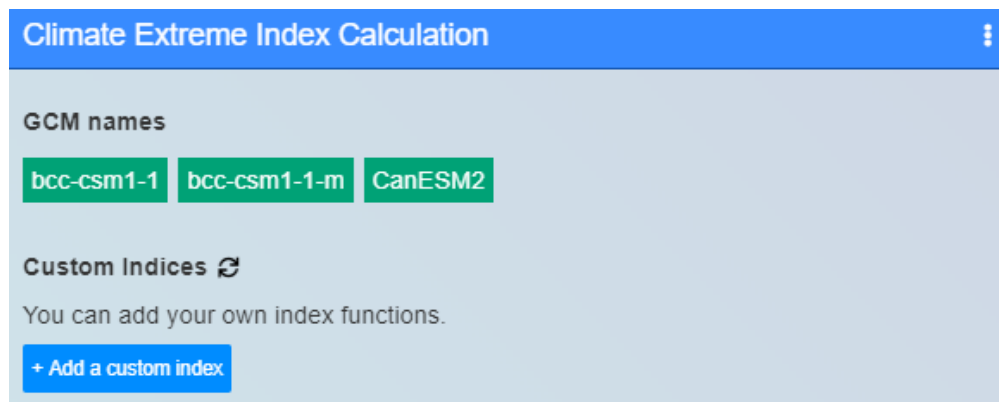
Overwrite all (Overwriting all existing downscaled data.)	▼
Overwrite all (Overwriting all existing downscaled data.)	
Downscale missing data only (Checking downscaled data and create missing data only)	

After downscaling through this card, the user will receive the following output: Among the files, historical, rcp45, and rcp85 refer to each downscaled data, and historical original, rcp45_original, and rcp85_original refer to the raw GCM data.

	year	mon	day	prcp	tmax	tmin
ID108_SQM_bcc-csm1-1_historical	1976	1	1	0	5.083805	-4.42878
ID108_SQM_bcc-csm1-1_historical_original	1976	1	2	0	5.1	-3.52668
ID108_SQM_bcc-csm1-1_rcp45	1976	1	3	0	6.578938	-2.47121
ID108_SQM_bcc-csm1-1_rcp45_original	1976	1	4	0	7.123546	-1.80523
ID108_SQM_bcc-csm1-1_rcp85	1976	1	5	0	10.88023	4.1688
ID108_SQM_bcc-csm1-1_rcp85_original	1976	1	6	0	6.265085	-2.20996
ID133_SQM_bcc-csm1-1_historical	1976	1	7	0	0.374391	-4.35113
ID133_SQM_bcc-csm1-1_historical_original	1976	1	8	2.292943	2.444066	-2.99376
ID133_SQM_bcc-csm1-1_rcp45	1976	1	9	2.698269	2.501334	-12.5269
ID133_SQM_bcc-csm1-1_rcp45_original	1976	1	10	0	-5.78493	-15.5086
ID133_SQM_bcc-csm1-1_rcp85	1976	1	11	3.512558	2.199921	-8.73897
ID133_SQM_bcc-csm1-1_rcp85_original	1976	1	12	0	1.63199	-14.9837
ID159_SQM_bcc-csm1-1_historical	1976	1	13	1.3	4.298518	-9.57108
ID159_SQM_bcc-csm1-1_historical_original	1976	1	14	0	-1.93926	-9.92888
ID159_SQM_bcc-csm1-1_rcp45	1976	1	15	0	-3.89859	-9.47301
ID159_SQM_bcc-csm1-1_rcp45_original	1976	1	16	0	-5.36074	-16.2503
ID159_SQM_bcc-csm1-1_rcp85	1976	1				
ID159_SQM_bcc-csm1-1_rcp85_original	1976	1				

Section 9: Climate Change Index Calculation

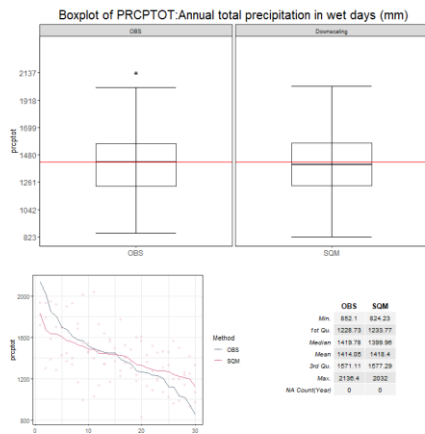
In this section, users produce 27 ETCCDI (Expert Team on Climate Change Detection and Indices) climate indices for GCMs that have been downscaled. Indices for historical and future periods selected in the downscale section are produced and provided with an image. For the historical period, images are provided for comparing observations and downscaling methods and materials for drawing. For the future period, an image is provided for evaluating whether the scenario flow of the raw GCM is maintained well when compared and evaluated by the downscale method. Because the climate index is produced based on downscaled data, please select GCM names in the GCM selected on the downscaled card.



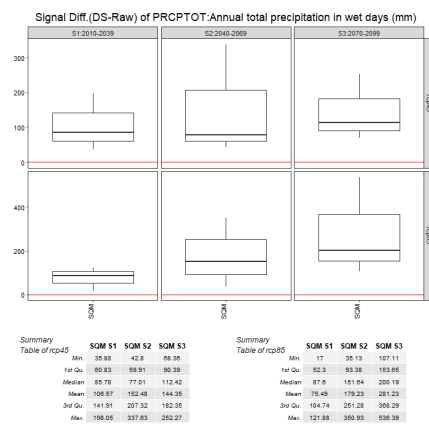
Using downscaled climate change scenarios, this card calculates climate indices and prints

out figures of historical and future periods. The similarity between observed data and downscaled data can be determined through the climate index of the historical period. The climate index for the future period can be used to determine whether the scenario characteristics of the raw GCM are well maintained.

year	prcptot	cdd	cwd	r95ptot	r99ptot	rx1day	rx5day	sdi1	rnnmm	r10mm	r20mm	su	ld
1976	1449.704	22	5.333333	277.797	0	135.1697	168.6081	16.70023	87.33333	37	20.66667	84.33333	15
1977	1365.252	18.66667	5	252.6855	0	128.5794	208.4797	16.64957	82.33333	33.33333	20.66667	96.66667	12
1978	1357.458	41.33333	7.666667	411.5287	254.5768	195.8272	275.681	19.16211	71.33333	31.33333	19	93.66667	8
1979	1425.408	28.66667	6.666667	260.5763	0	113.6028	262.6518	17.32908	82.33333	37.33333	21	106.3333	19
1980	1538.625	35	9.333333	604.3937	105.4532	137.551	314.2008	20.24697	76	35	22	110.3333	6.666667
1981	1222.395	30.66667	3.666667	456.6174	261.6	190.4267	251.4573	18.6395	65.66667	28.33333	14.66667	95.33333	13.33333
1982	1701.594	35.33333	5.333333	505.479	276.4441	276.4441	443.9843	21.07925	81	38.66667	25	111.6667	11.33333
1983	1446.648	54	15	389.6949	231.0776	224.6528	291.5679	17.51217	82.66667	35.33333	19.66667	107.6667	9.333333
1984	1193.268	39.66667	7.666667	179.3018	0	108.0289	191.9694	14.82017	79.66667	30	17.33333	98	25
1985	824.2287	37	4.333333	124.9538	0	86.60895	159.69	12.42552	65.33333	21.33333	11.33333	108.6667	27.33333
1986	1636.461	36.33333	6	416.9237	111.4949	134.2814	278.6681	19.80936	83.33333	37.33333	23.33333	96.33333	19
1987	1466.757	21.33333	5.333333	178.6359	0	105.7841	200.2232	15.34994	96	40.66667	24.33333	92.66667	8
1988	1233.201	36.66667	4.666667	352.697	0	108.287	253.8107	18.59993	66.66667	30.66667	15.66667	112.3333	9.666667
1989	1192.141	20.66667	5	181.9486	0	93.04719	147.8539	14.17867	87.33333	32.66667	19.66667	115.6667	18
1990	1383.133	29.33333	6.666667	357.1587	55.10249	120.3016	191.5732	19.71126	70.33333	33.33333	21	110.6667	7.333333



Precipitation total (Historical)



Precipitation Total (Future)

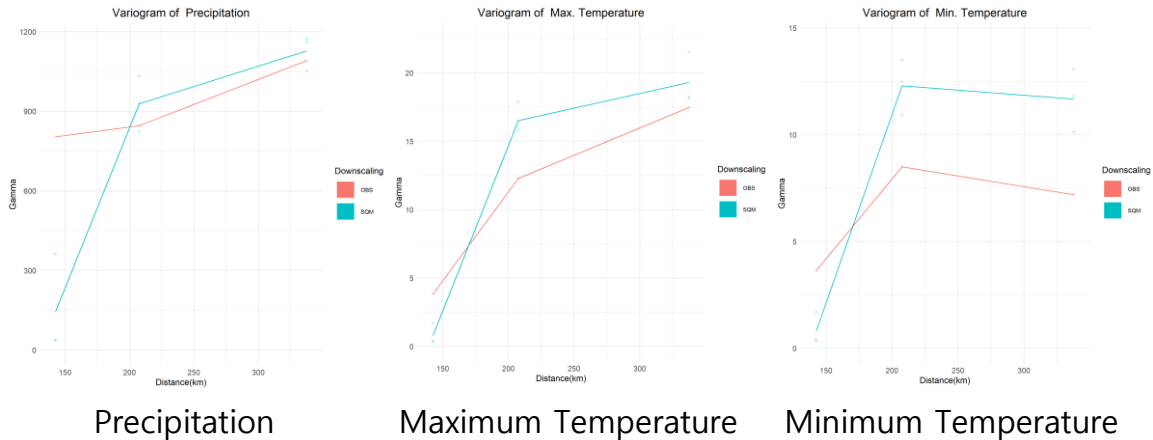
Section 10: Evaluation: Spatial Reproducibility

There are no variables for the user to select in this section. For the historical period, AIMS also provides an image (variogram) that compares observation data and downscaling methods for precipitation and temperature as well as data for drawing.

Evaluation: Spatial Reproducibility

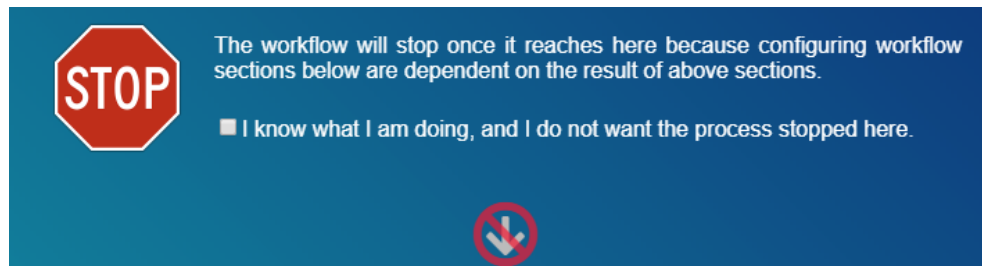
No user option is available.

This card can be used to evaluate the spatial correlation between each downscaling method and observation data through a variogram. Spatial correlation evaluation is provided for the entered variables. (Precipitation, maximum temperature, and minimum temperature)



Section 11: Workflow Stop / GO

In this section, the user selects the downscaling method and climate indices to calculate the next section, Weight Factor, based on the comparison result obtained through spatial correlation and climate indices.



STOP

The workflow will stop once it reaches here because configuring workflow sections below are dependent on the result of above sections.

I know what I am doing, and I do not want the process stopped here.

Section 12: Weight Factor and Uncertainty for GCMs

In this section, the user selects the climate indices and downscaling method previously considered, for calculating the Weight Factor. In addition, a figure showing the explanatory power of the selected index and the result calculated through the downscaling method is compared to the existing result and is provided together.

Weight Factor and Uncertainty for GCMs

Indices

prcptot

Downscale method

SQM (Simple Quantile Mapping) ▼

The climate indices provided in this section are:

Select one or more variables. ✕

Select: [All](#) | [None](#)

Precipitation

- prcptot : Annual total precipitation in wet days
- cdd : Maximum length of dry spell, maximum number of consecutive days with RR < 1mm
- cwd : Maximum length of wet spell, maximum number of consecutive days with RR ≥ 1mm
- r95ptot : Annual total PRCP when RR > 95p
- r99ptot : Annual total PRCP when RR > 99p
- rx1day : Monthly maximum 1-day precipitation
- rx5day : Monthly maximum consecutive 5-day precipitation
- sdii : Simple precipitation intensity index
- rnnmm : Annual count of days when PRCP ≥ nnmm, nn is a user defined threshold
- r10mm : Annual count of days when PRCP ≥ 10mm
- r20mm : Annual count of days when PRCP ≥ 20mm

Temperature

- su : Number of summer days: Annual count of days when TX (daily maximum temperature) > 25 C.
- id : Number of icing days: Annual count of days when TX (daily maximum temperature) < 0 C

In this section, the user can select all three refinement methods; however, note that the refinement method that was previously used for downscaling should be selected.

Downscale method

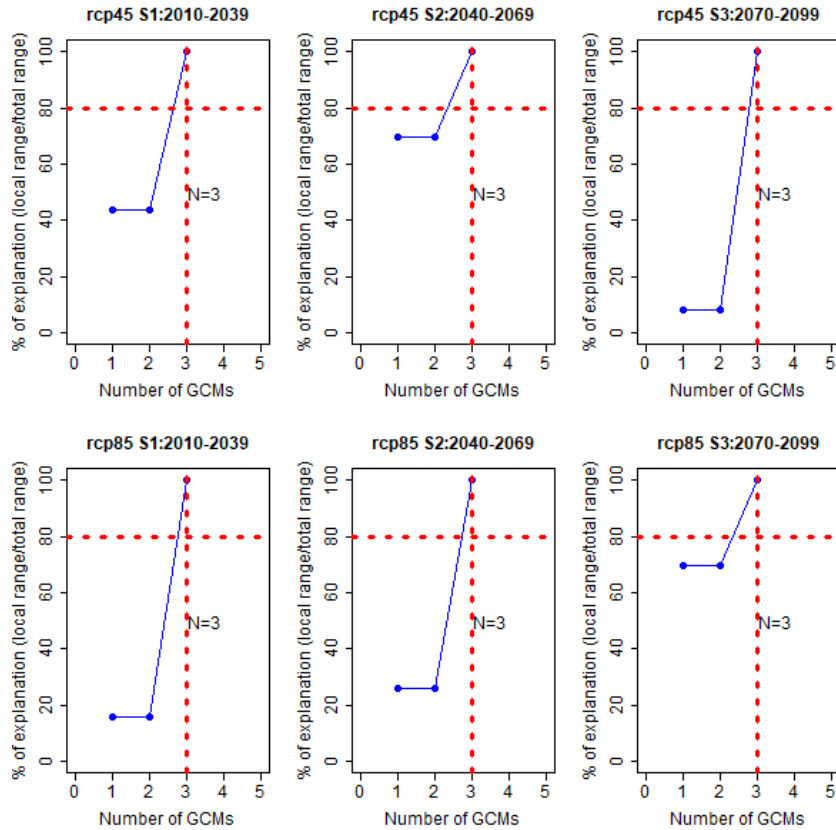
SQM (Simple Quantile Mapping) ▼

SQM (Simple Quantile Mapping)

SDQDM (Spatial Disaggregation-Quantile Delta Mapping)

BSCA (Bias-Correction and Stochastic Analog method)

Using the results generated in this section, AIMS provides the minimum number of GCMs that can account for 80% volatility based on the total GCM entered.



Seasonal Forecast Project Sections

This is a module to produce detailed seasonal forecasting information through Weather Generator.

Section 1: Local Observation Data Upload

The user uploads the local observation data and observation point information data files collected through this section.

Local Observation Data Upload

Instruction on preparing custom local data files
See [the detailed instruction](#) for more information.

1. Station Data
First save station data template file in your local computer and fill in the file. Do not rename or delete header row in the csv file.

>

2. Observation Data
For your observed data, save the template file in your local computer and rename the file to match the station ID given in the station data file. Fill in the csv file. Copy the file and repeat the process for all your station IDs.

>

3. Import Files
When you are ready with all files, click below button.

Station Data Template

Observation Data Template

Import Template Files

The observation period used for the downscaling

Type	Start Year	End Year
Observed	1988	2013

The observation point information and observation data upload pop-up are as follows. Upload the left observation point information (Station-Info).

Station / Data file Importer
✕

Step 1: Upload station information file

Drag and drop the station information file here.

>

Step 2: Upload observation data files

Upon uploading the observation data information (Station-Info), the user can upload the observation point information as follows. For uploading, multiple viewpoint information can be selected and dragged simultaneously.

Station / Data file Importer
ⓧ

Step 1: Upload station information file

Station-Info.csv Delete

➤

Step 2: Upload observation data files

ID108	Delete
ID133	Delete
ID159	Upload

Section 2: Weather Generator Model (Time-consuming)

This section runs the Weather Generator Model based on the observations uploaded by the user. Since we have also defined the period in the observation data upload, there are no additional items for the user to select.

Weather Generator Model (Time-consuming)
⋮

At this stage, you can construct the weather generator model used for the downscaling in advanced. Usually, this construction is carried out just one.

Note that the construction is time-consuming. The total spending time depends on the number of stations and data period.

You can also skip it now. Then, the construction is put off until you complete the setting and run AIMS.

Variables

In this section needed 3 variables as precipitation, maximum temperature and minimum temperature.

Section 3: Seasonal Forecast Data Specification

This section can be used to download the probability prediction model provided by the APCC. Users can download the desired year, month, and lead time.

Seasonal Forecast Data Specification

Please, specify the APCC probabilistic forecast (GAUS) which you want to use.

Period

Type	Start Year	Start Month
Forecast Period	2020	10

Seasonal Forecast LeadTime (3month, 6month available)

Please choose one leadtime month what you want.

6 Month

3 Month

6 Month

If the specification is completed, then you can download the forecast data in advance for checking. It can be skipped.

Section 4: APCC Seasonal Forecast Downscaling

Through this section, AIMS produces downscaled seasonal forecast results using a Weather Generator. By selecting the period length, AIMS can produce downscaled forecast data for branches of 1–6 months (within the period downloaded in Section 3). It produces 1,000 scenarios for precipitation, maximum temperature, and minimum temperature.

APCC Seasonal Forecast Downscaling

Select the target period of the downscaling:

Type	Start Year	Start Month
Target Period	2020	10

The period length (month)

Please choose one leadtime month what you want.

1 Month

2 Month

3 Month

4 Month

5 Month

6 Month

6 Month