# AIMS Desktop Application

# User Manual

**2020. 11**

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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**
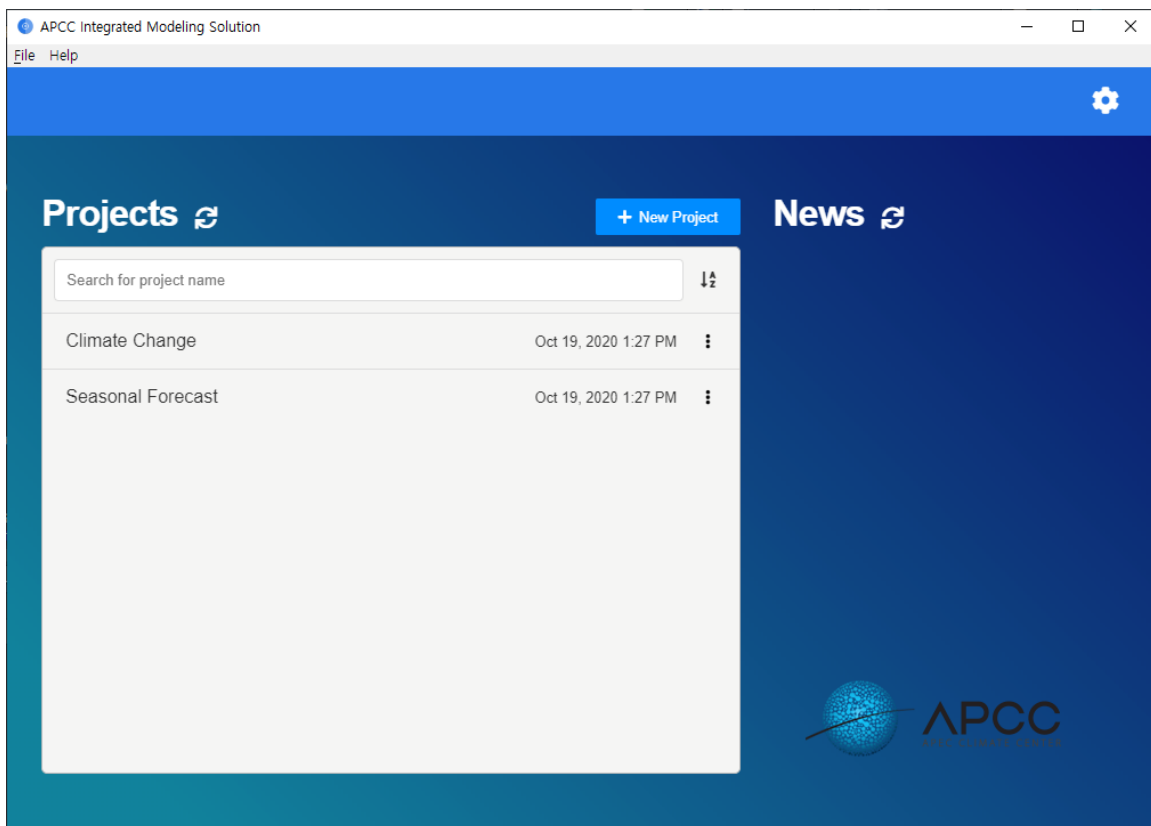


**Step 1: Click on + New Project button to create a new project**

## Step 2: Select climate data type

Currently, the user can choose from:
- Climate Change
- Seasonal Forecast



## 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.

# 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
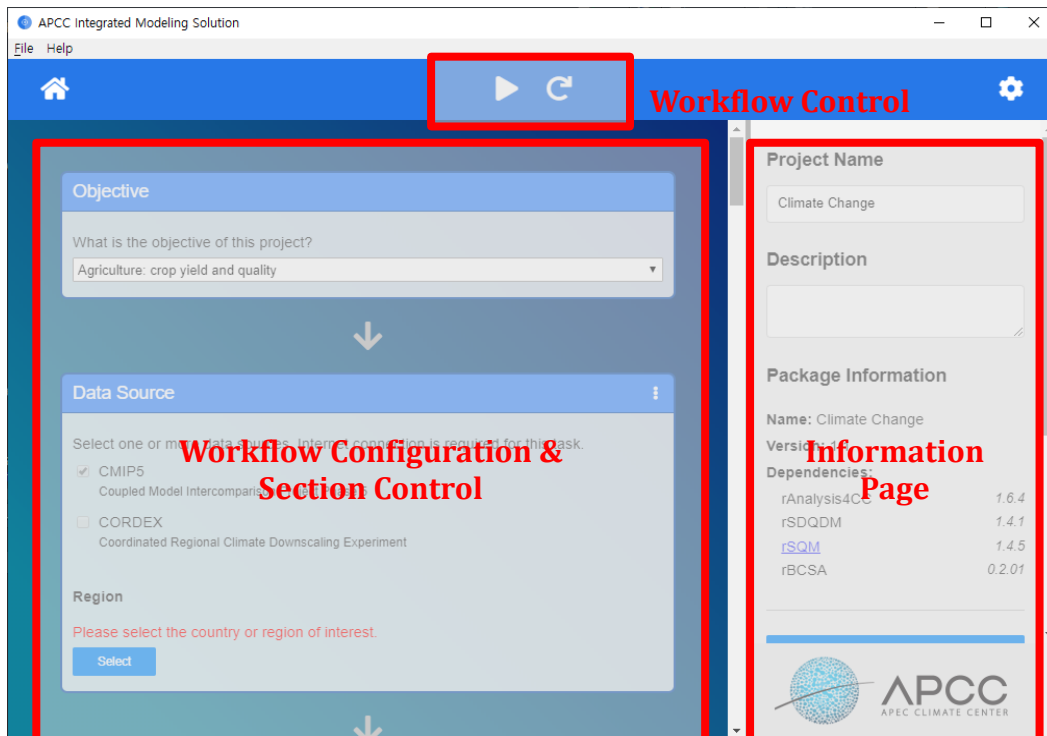


The workflow control allows the user to start the workflow by pressing the play button. The user can also stop and restart the workflow using the workflow controls as well. The Workflow Configuration and Section Control consists of several sections (or cards). Each section represents one or more functions (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.
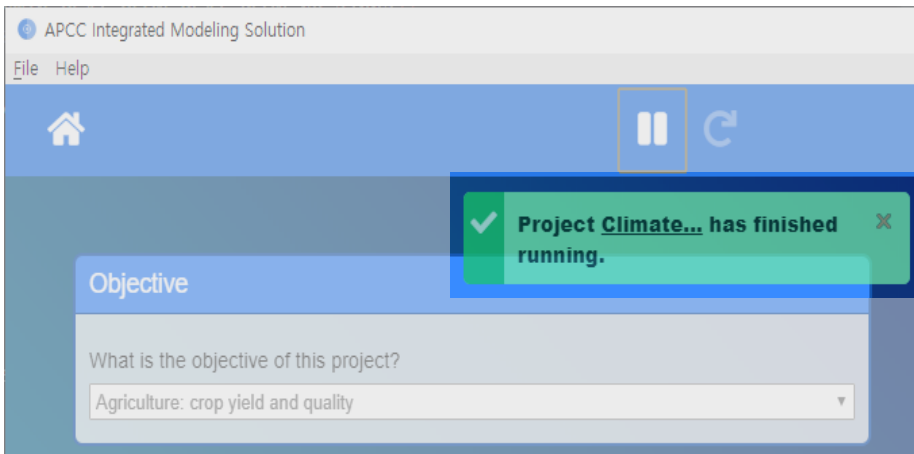
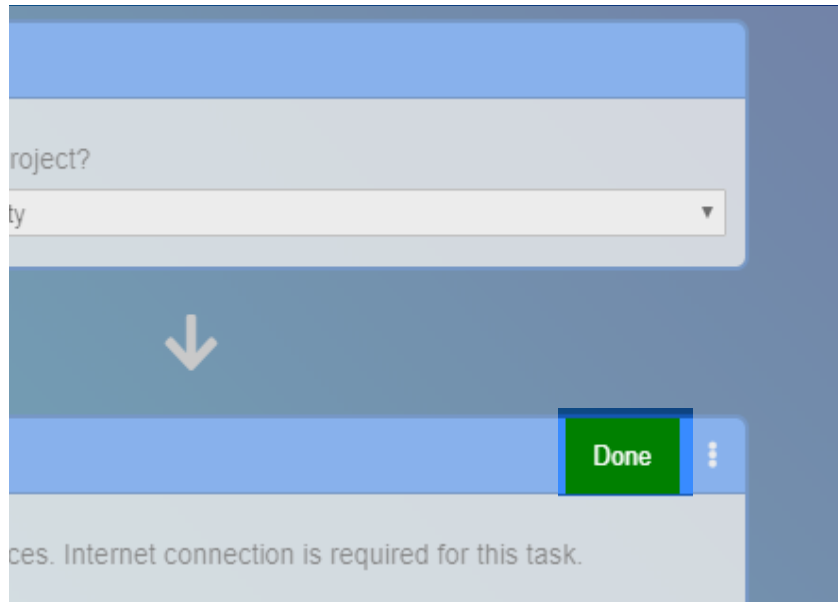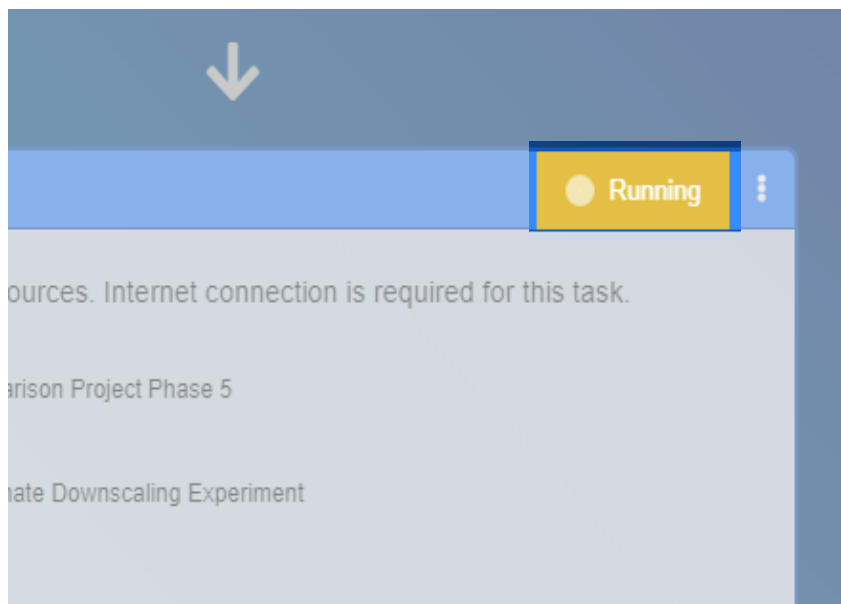- Running
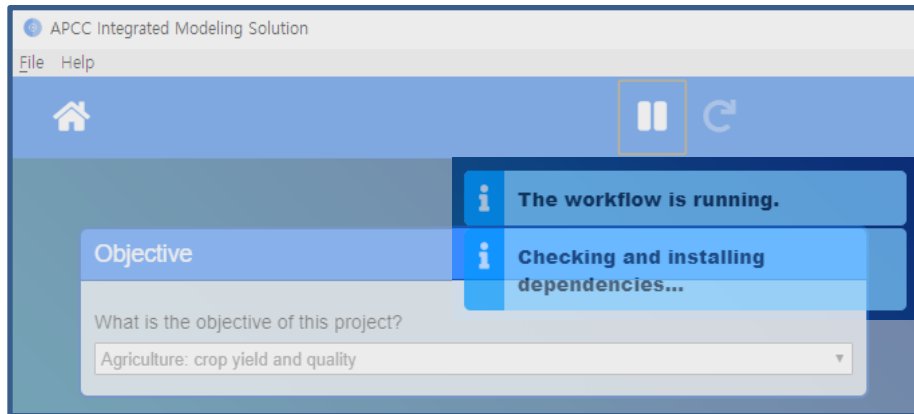


- Cancelled
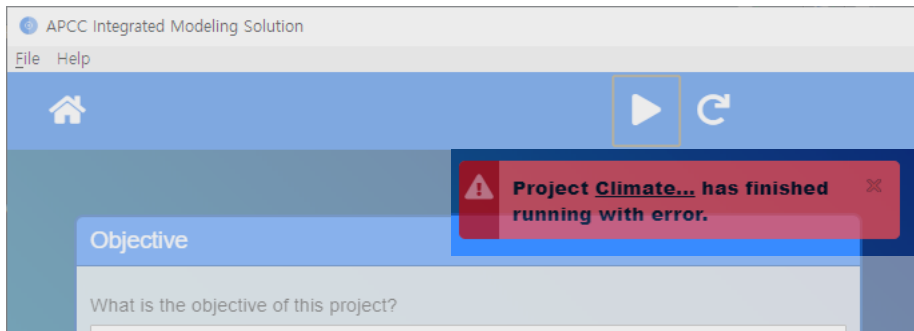


- Finished

Each section can have <u>three</u> different statuses, which are shown as a tag in the section header.
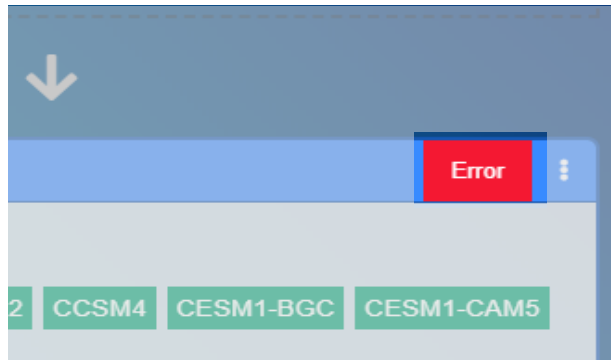
- Done: The workflow has finished running the specific section. The workflow will <u>not</u> run this section again as long as the status is <u>Done.</u>



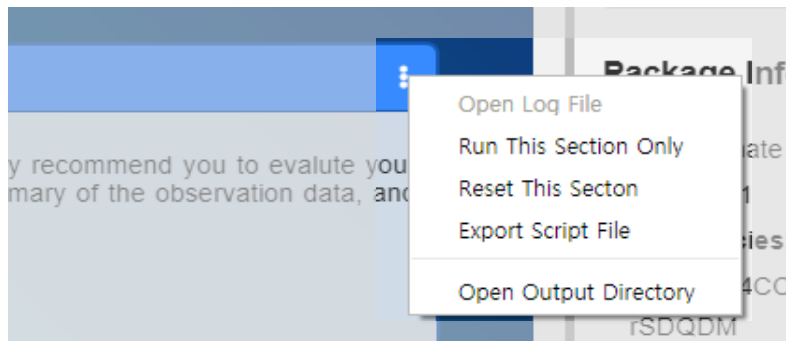- Running: This section is currently running.

● 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:
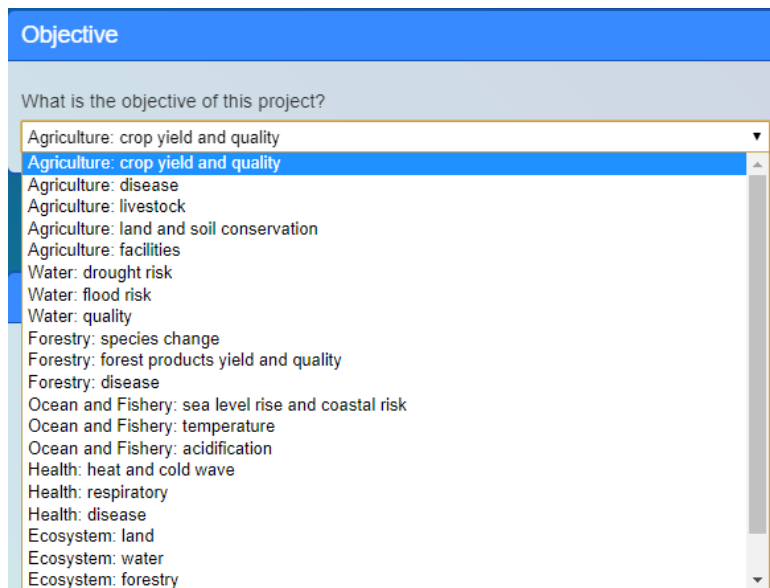


● Open Log File: After each section is executed, the user can check the log of the saved program.
● Run This Section Only: User can execute the current section in any order.
● Reset This Section: Removes the state of the previously executed section.
● Export Script File: R code for executing each section 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.
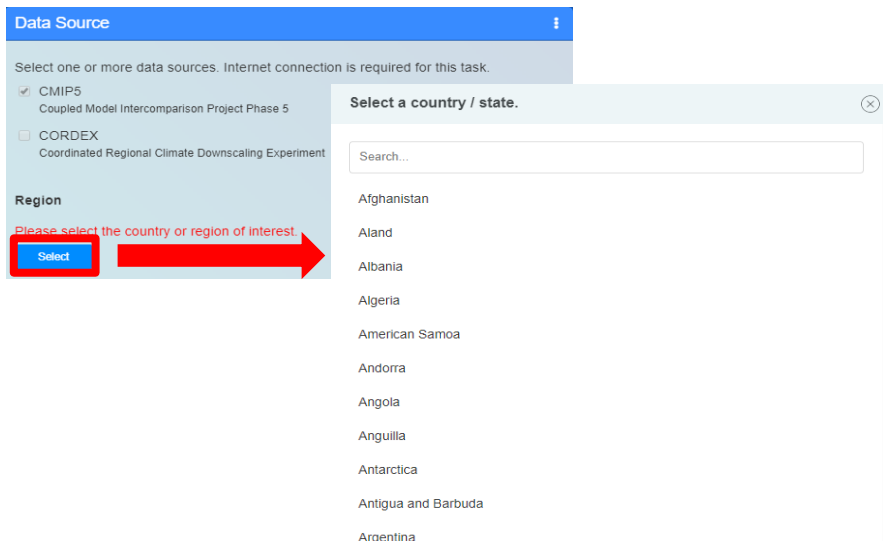
## Section 2: Data Source

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.
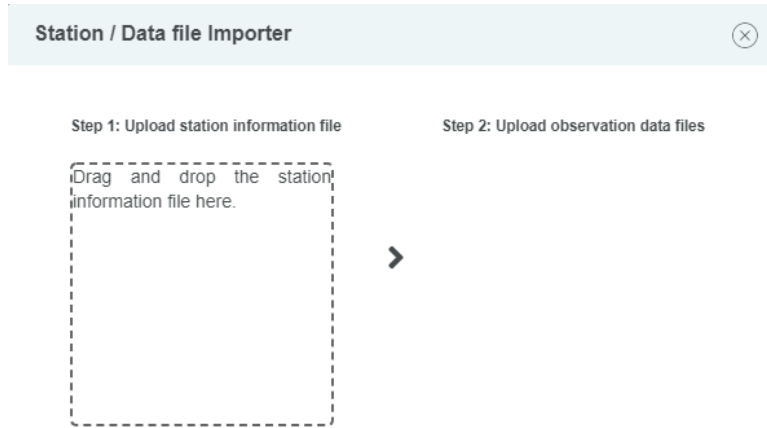


## Section 3: Local Data

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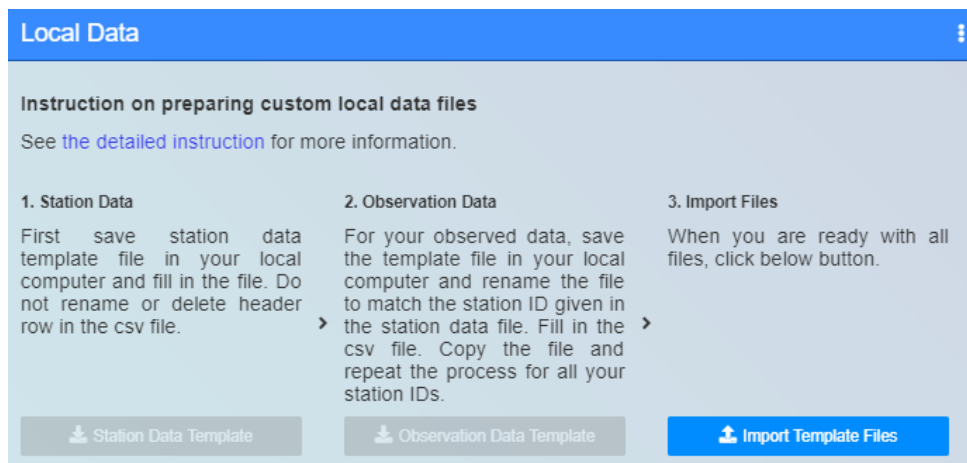
Upload Station Data (station-info.csv) and Observation Data files Pop-up



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.
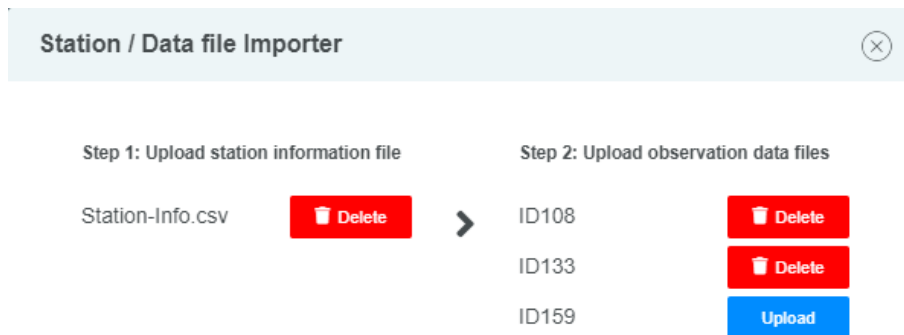
## Section 4: Evaluate Observed Data

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.
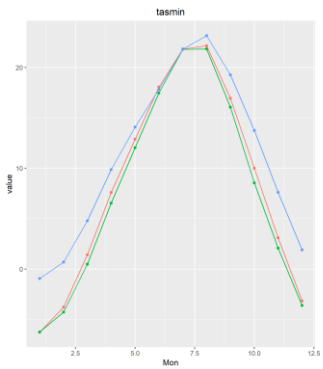


In this card, Quality Control (QC) is performed for the observed data in three stages, and the characteristics of the observed data can be identified through the final result. The input variable is evaluated, and the following results can be obtained.
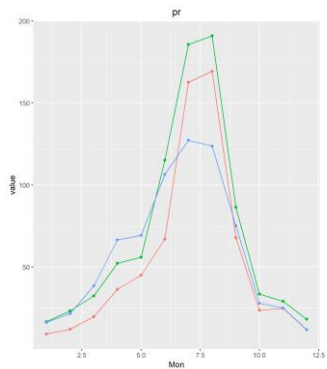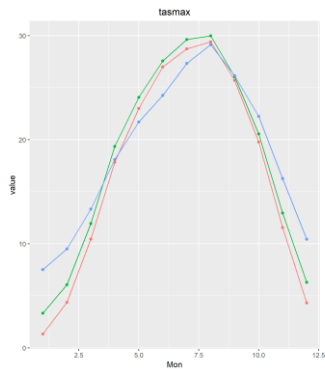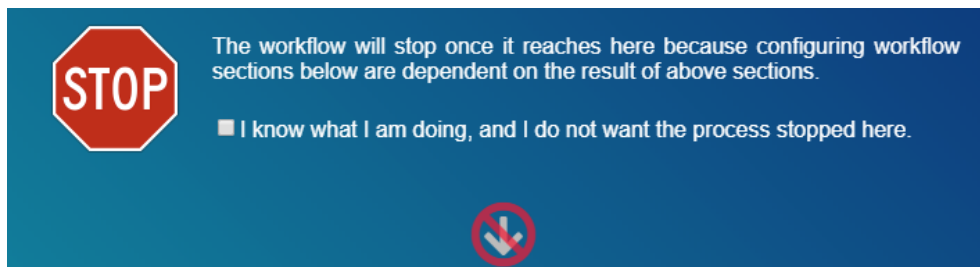


| Precipitation | Maximum Temperature | Minimum Temperature |

## 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.
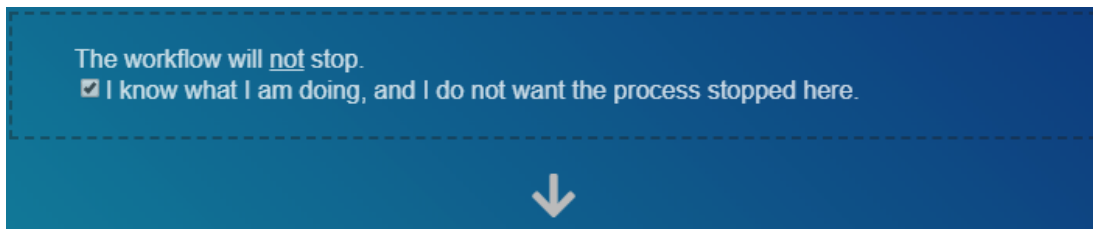


## Section 6: Raw GCM Analysis

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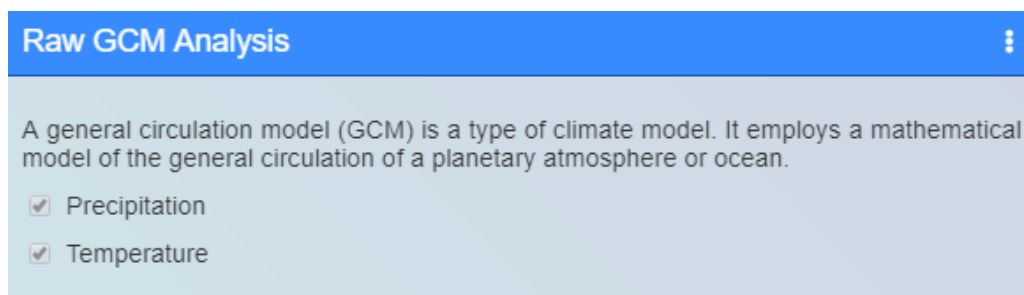
In this section, observations and raw GCM evaluation results are presented through data and plots. Results are provided through scatter plots and Taylor diagrams of spatial and temporal correlation; thus, the user can determine the GCM showing a similar trend to the observed data.
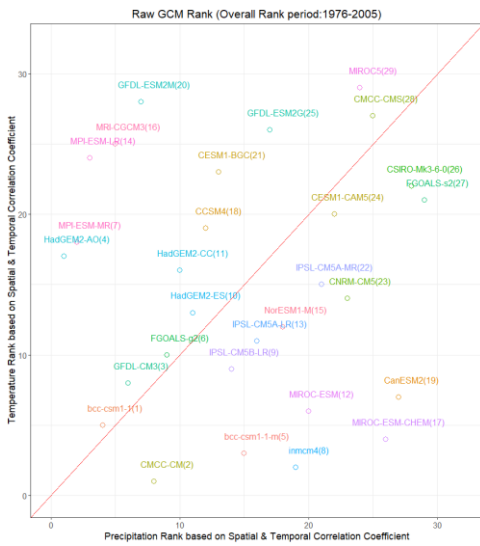


Raw GCM Rank
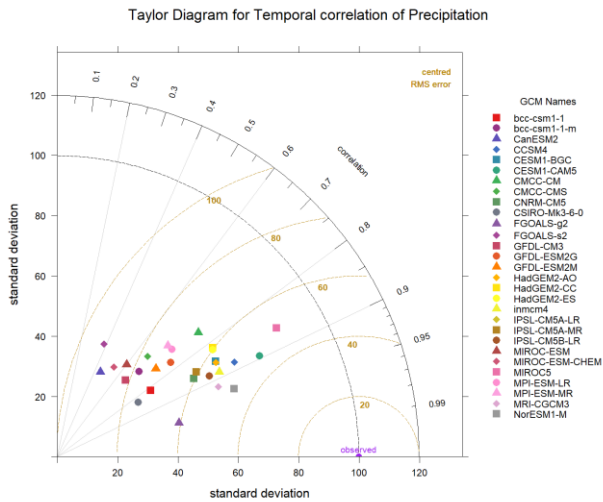


Taylor Diagram for Temporal Correlation

## 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.

## Section 8: Downscale

The user has the following options in this section:
- GCM names
- Scenario
- Variables
- Period
- Downscale method
- 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.



- 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.

- 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 | remove |
| | 2040 | 2069 | remove |
| | 2070 | 2099 | 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'.
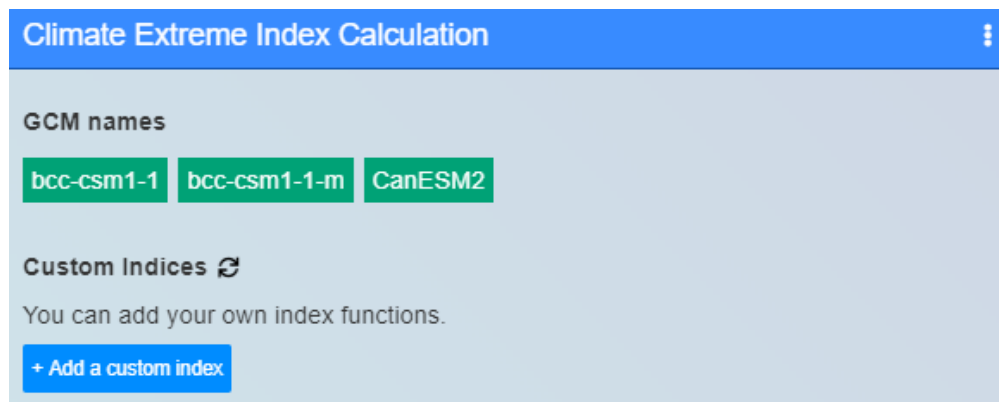
**Choose your writing type**

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 |
|------|-----|-----|------|------|------|
| 1976 | 1 | 1 | 0 | 5.083805 | -4.42878 |
| 1976 | 1 | 2 | 0 | 5.1 | -3.52668 |
| 1976 | 1 | 3 | 0 | 6.578938 | -2.47121 |
| 1976 | 1 | 4 | 0 | 7.123546 | -1.80523 |
| 1976 | 1 | 5 | 0 | 10.88023 | 4.1688 |
| 1976 | 1 | 6 | 0 | 6.265085 | -2.20996 |
| 1976 | 1 | 7 | 0 | 0.374391 | -4.35113 |
| 1976 | 1 | 8 | 2.292943 | 2.444066 | -2.99376 |
| 1976 | 1 | 9 | 2.698269 | 2.501334 | -12.5269 |
| 1976 | 1 | 10 | 0 | -5.78493 | -15.5086 |
| 1976 | 1 | 11 | 3.512558 | 2.199921 | -8.73897 |
| 1976 | 1 | 12 | 0 | 1.63199 | -14.9837 |
| 1976 | 1 | 13 | 1.3 | 4.298518 | -9.57108 |
| 1976 | 1 | 14 | 0 | -1.93926 | -9.92888 |
| 1976 | 1 | 15 | 0 | -3.89859 | -9.47301 |
| 1976 | 1 | 16 | 0 | -5.36074 | -16.2503 |

Files listed:
- ID108_SQM_bcc-csm1-1_historical
- ID108_SQM_bcc-csm1-1_historical_original
- ID108_SQM_bcc-csm1-1_rcp45
- ID108_SQM_bcc-csm1-1_rcp45_original
- ID108_SQM_bcc-csm1-1_rcp85
- ID108_SQM_bcc-csm1-1_rcp85_original
- ID133_SQM_bcc-csm1-1_historical
- ID133_SQM_bcc-csm1-1_historical_original
- ID133_SQM_bcc-csm1-1_rcp45
- ID133_SQM_bcc-csm1-1_rcp45_original
- ID133_SQM_bcc-csm1-1_rcp85
- ID133_SQM_bcc-csm1-1_rcp85_original
- ID159_SQM_bcc-csm1-1_historical
- ID159_SQM_bcc-csm1-1_historical_original
- ID159_SQM_bcc-csm1-1_rcp45
- ID159_SQM_bcc-csm1-1_rcp45_original
- ID159_SQM_bcc-csm1-1_rcp85
- ID159_SQM_bcc-csm1-1_rcp85_original

## 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.

**Climate Extreme Index Calculation**

GCM names

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

Custom Indices ⟳

You can add your own index functions.

+ Add a custom index

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 | sdii | rnnmm | r10mm | r20mm | su | id |
|------|---------|-----|-----|---------|---------|--------|--------|------|-------|-------|-------|-----|-----|
| 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 |
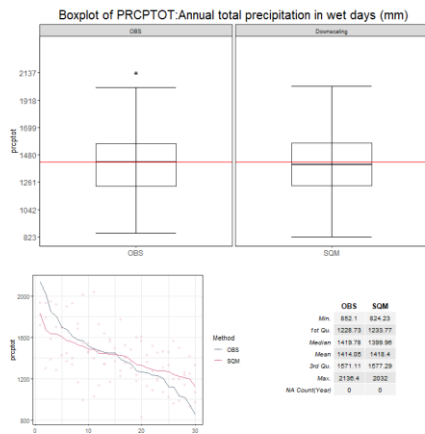


Precipitation total (Historical)
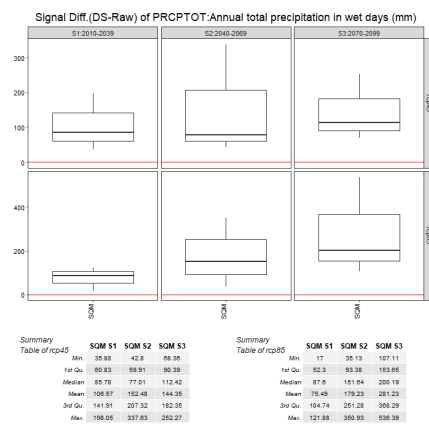


Precipitation Total (Future)

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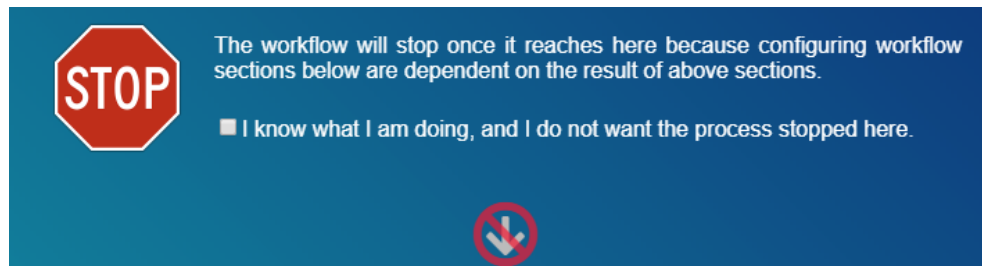
This card can be used to evaluate the spatial correlation between each downscaling method and observation data through a variogram. Spatial correlation evaluation is provided for the entered variables. (Precipitation, maximum temperature, and minimum temperature)



Precipitation      Maximum Temperature      Minimum Temperature
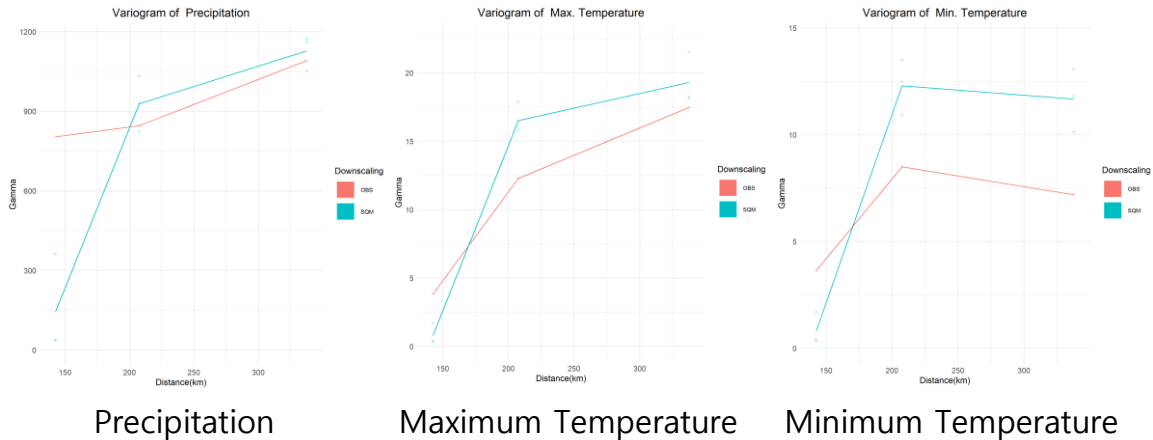
## Section 11: Workflow Stop / GO

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.



## 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.

The climate indices provided in this section are:



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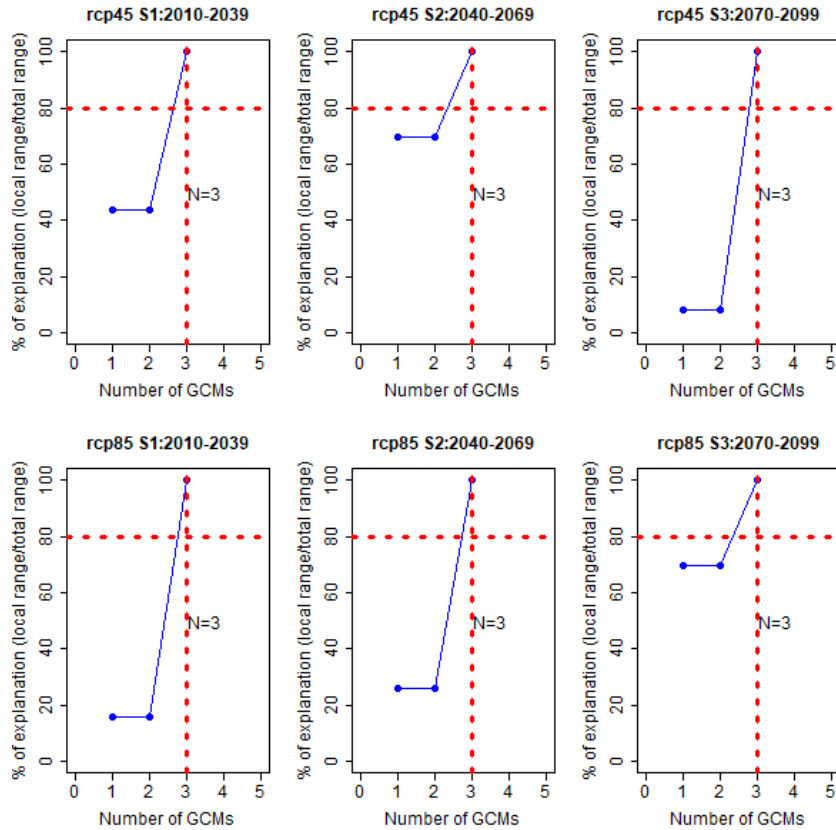
Using the results generated in this section, AIMS provides the minimum number of GCMs that can account for 80% volatility based on the total GCM entered.

# 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.



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

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.



## 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.

## 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.



## 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.