Exercise C2 – Creating Climate Scenarios Using the BASINS Climate Assessment Tool (CAT)

In this exercise, we will combine the adjusted historic precipitation and temperature records from the previous exercise to create climate change scenarios. We will also use BASINS CAT to automate the creation of multiple synthetic climate change scenarios by applying a series of record adjustments within a user-specified range to historical data. We will create scenarios that incrementally increase temperature values and incrementally increase precipitation values.

Questions addressed in this exercise:

1) How do I combine multiple changes to create a climate change scenario?
2) How do I create spatially variable climate change scenarios at multiple locations?
3) How do I create synthetic climate change scenarios?
4) How do I export climate change scenarios as ASCII text files?

A. Constructing a Climate Change Scenario

QUESTION ANSWERED:
1) How do I combine multiple changes to create a climate change scenario?
2) How do I create spatially variable climate change scenarios at multiple locations?

This section illustrates how multiple record adjustments to historical temperature and precipitation data, or scenario components, are combined in a cumulative way to create climate change scenarios. Running this exercise requires that one or more record adjustments have already been made, such as those illustrated in the previous exercise (Exercise C1). This exercise can also be performed using record adjustments other than those shown here.

In this section we will create two climate change scenarios. The first applies temperature and precipitation changes to each year in the record to create a long-term change scenario. The second applies decreasing precipitation and increasing temperature for a single, selected year to create a scenario representing an increased drought severity.

1.   Open BASINS and select the **Analysis:Climate Assessment Tool** menu option. The following form will appear.
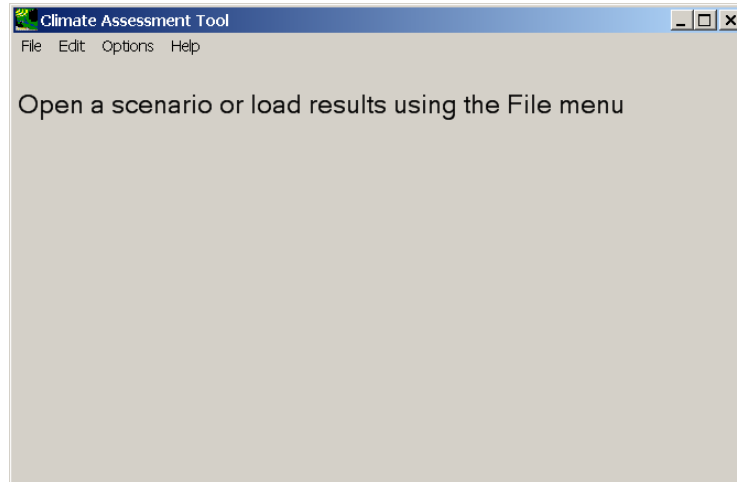
2.   From the **File** menu, choose **Load Climate and Endpoints**. In the file dialog, choose the file *CAT-Tutorial.xml* saved in the previous exercise. The CAT form will now look like the following:
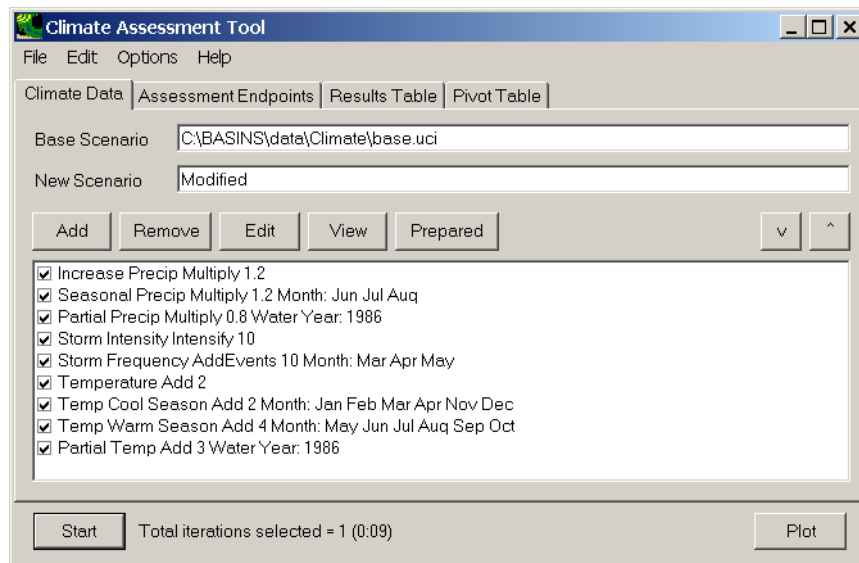

The **Climate Assessment Tool** form displays the previously defined record adjustments in a list on the **Climate Data** tab. Each adjustment has a check box for indicating whether or not it is to be included as a component of the climate scenario being developed. The order of adjustments can be controlled by selecting an adjustment and using the up and down arrow buttons above the list. This is particularly important when multiple adjustments are being made to the same values in an input data set (e.g., increasing an entire precipitation record and also increasing a season's storm intensity). In such a case, the first (i.e., highest in the list) adjustment would be applied to the original record. Ensuing adjustments would then be applied to the record resulting from the previous adjustment in a cumulative way.

3.   Begin defining the first climate scenario by selecting the following record adjustments (placing a check in the appropriate checkboxes):

- **Increase Precip Multiply 1.2**
- **Temperature Add 2**

All other record adjustments should be inactive (not checked). This combination of adjustments represents a climate scenario that is available for input to the model. (Note: This scenario will not be run here as this section is only demonstrating how climate change scenarios are defined).
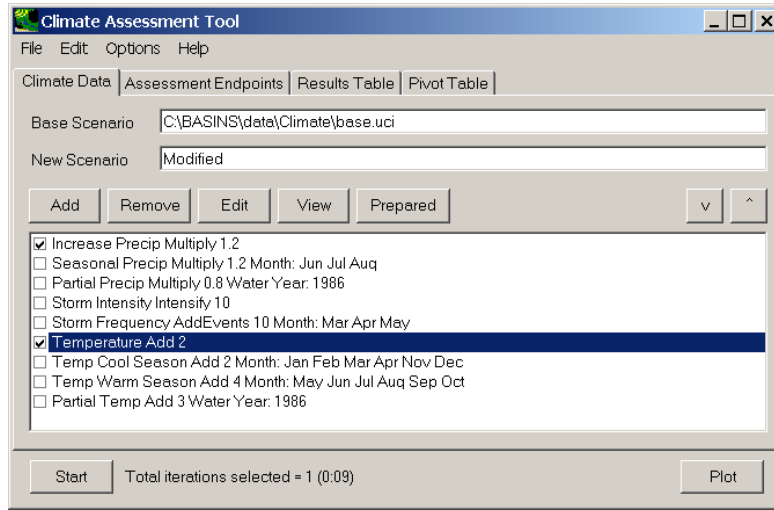
4.   Define the second climate change scenario by selecting the following record adjustments:

- **Partial Precip Multiply 0.8 Water Year: 1986**
- **Partial Temp Add 3 Water Year: 1986**

All other record adjustments should be inactive (not checked). This combination of adjustments represents a climate scenario for assessing an increased severity of drought in a single year during a model run.
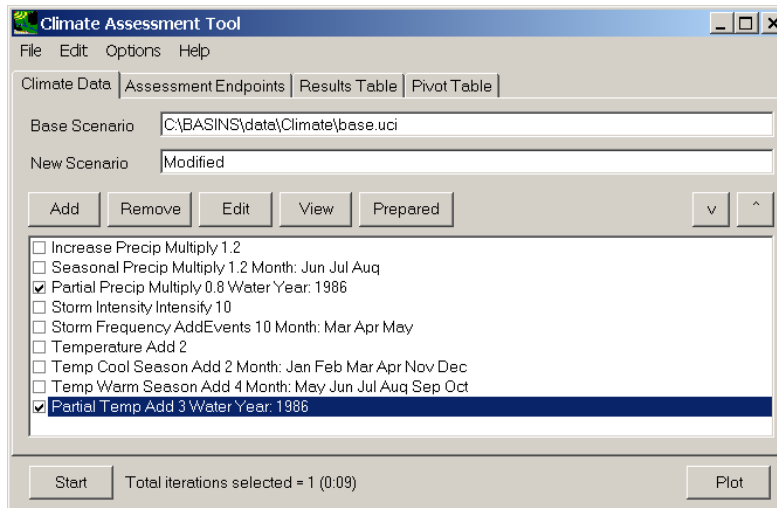
At the bottom of the BASINS CAT form, a label indicates the number of model runs (or **Total iterations**) that will be performed. For each climate scenario shown here, only one model run will be made. When a synthetic climate scenario is used (Section B this exercise), a series of model runs is made, one for each adjustment, or iteration, of the synthetic scenario. If multiple synthetic scenarios are used, a model run is made for each unique combination of adjustments defined by the scenarios. For example, a synthetic temperature scenario with 4 iterations combined with a synthetic precipitation scenario with 3 iterations would result in 12 model runs.

> Note: Most HSPF models receive meteorological input from multiple locations, typically NCDC weather stations, within a watershed. Running an assessment using BASINS CAT for this type of model thus requires that change scenarios be created for meteorological data for multiple locations within a watershed. BASINS CAT provides the option to apply specified adjustments to multiple meteorological data sets simultaneously, e.g., temperature time series data from multiple weather stations.

> BASINS CAT can also be used to create spatially variable climate change scenarios for different locations within a watershed by individually selecting and adjusting historical temperature and precipitation time series data sets from each location.

> To individually adjust time series data from multiple locations (NCDC weather stations), each data set must be selected and adjusted as a separate step. After specifying adjustments to each data set, the BASINS CAT interface will list each adjustment preceded by a checkbox. By selecting and unselecting the appropriate checkboxes, users can create and run spatially variable precipitation and air temperature change scenarios for each weather station used in an HSPF simulation.

B. Creating Synthetic Climate Change Scenarios

QUESTION ANSWERED:
3) How do I create synthetic climate change scenarios?

BASINS CAT can be used to automate the creation of multiple synthetic climate change scenarios by applying a series of record adjustments within a user-specified range to historical data.

This section shows how a series of adjustments can be applied to the full, historical data set to create synthetic climate change scenarios. The final result of the section is two synthetic scenarios, one that incrementally increases temperature values, and one that incrementally increases precipitation values.

1.   To begin creating the synthetic temperature scenario, click the **Add** button. The
        Modify Existing Data form will open. Begin defining this scenario by entering
        "Synthetic Temp" in the **Modification Name** field.

2.   To select the air temperature data to modify, click in the **Existing Data to Modify**
        box. The **Select data to vary** form will be displayed. In the first column, under the
        Scenario label, click on the **OBSERVED** item and all data sets with a Scenario
        attribute of OBSERVED will be added to the **Matching Data** list. In looking at the
        last column of the **Matching Data** list, note the data set with the **Constituent** name
        AIRTMP (air temperature). Click on this data set and it will be added to the
        Selected Data list. Click the **Ok** button to close the form.
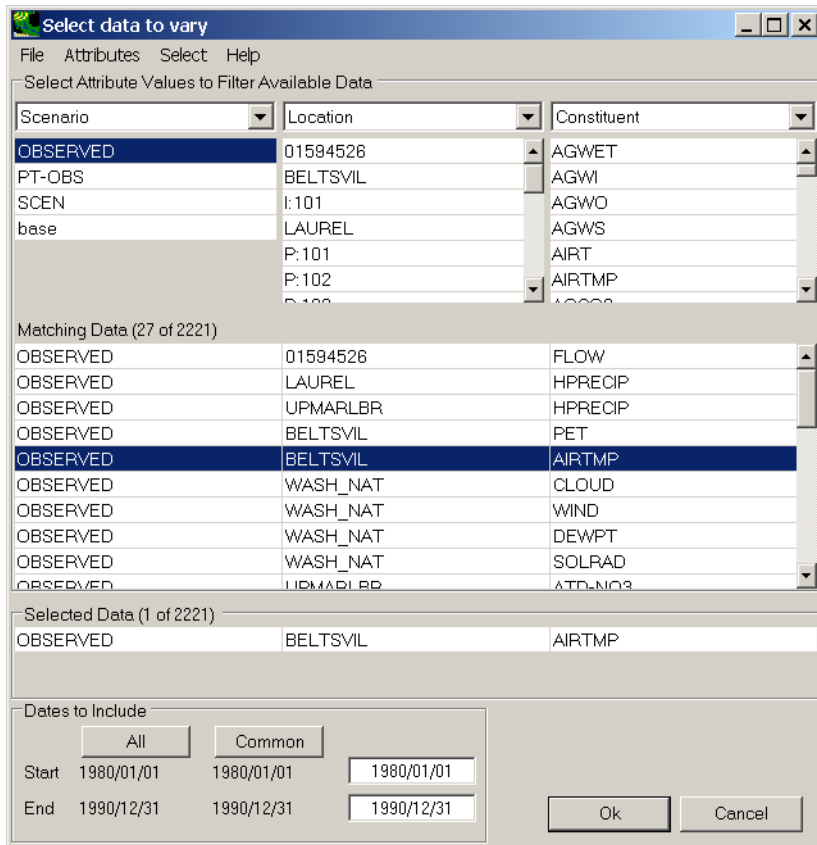
3.   The **Modify Existing Data** form has now been updated with a description of the selected data set in the **Existing Data to Modify** box. When modifying temperature, it is necessary to also re-compute the potential evapotranspiration (PET) using the modified temperature data. Click in the **Compute PET** box to specify which PET data to re-compute.

4.   In the **Select data to vary** form, again click on the **OBSERVED** item in the
        Scenario column, and then click the **OBSERVED BELTSVIL PET** data set from
        the **Matching Data** list. Click the **Ok** button to close the **Select data to vary** form.
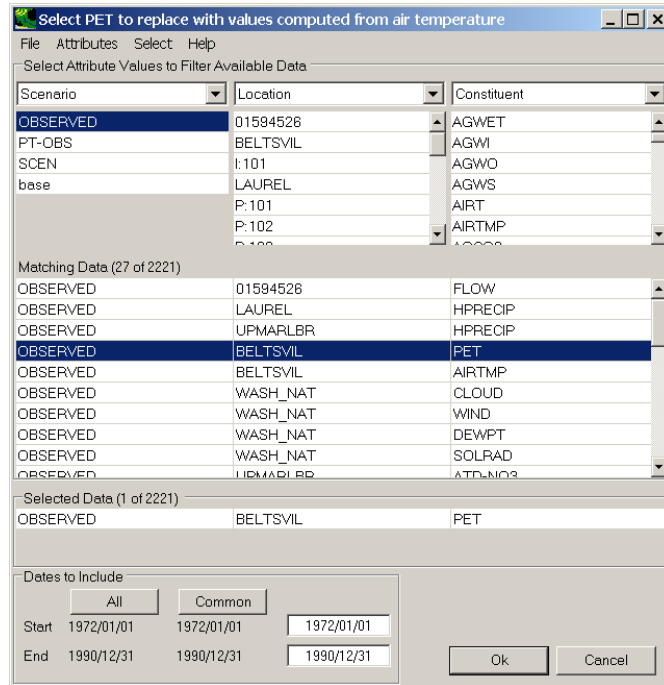
5. The **Modify Existing Data** form has been updated with a description of the selected data set in the **Compute PET** box. The **How to Modify** box contains a list of methods for modifying the data-set values. For this scenario, select the "Change Temperature" option. In the **Degrees to add to each existing temperature value** frame, there are two modification options: **Single Change** or **Iterate Changes**. The term "iterate", as used here, refers to the automation of multiple runs. The **Single Change** option will result in one adjustment applied to the temperature and PET data sets. The **Iterate Changes** option will result in a series of adjustments to the temperature and PET data sets and is used to create synthetic climate change scenarios. Click the **Iterate Changes** radio button and the form will be updated to allow entry of **Minimum** and **Maximum** degree changes along with an **Increment** to apply over that range. Enter a **Minimum** value of "0," a **Maximum** value of "3," and an **Increment** value of "1." This will create a synthetic scenario with four iterations, the first being identical to the original data, and the ensuing three having 1 additional degree added to historical temperature data with PET data being computed from each. Click the **Ok** button to complete the scenario definition process.
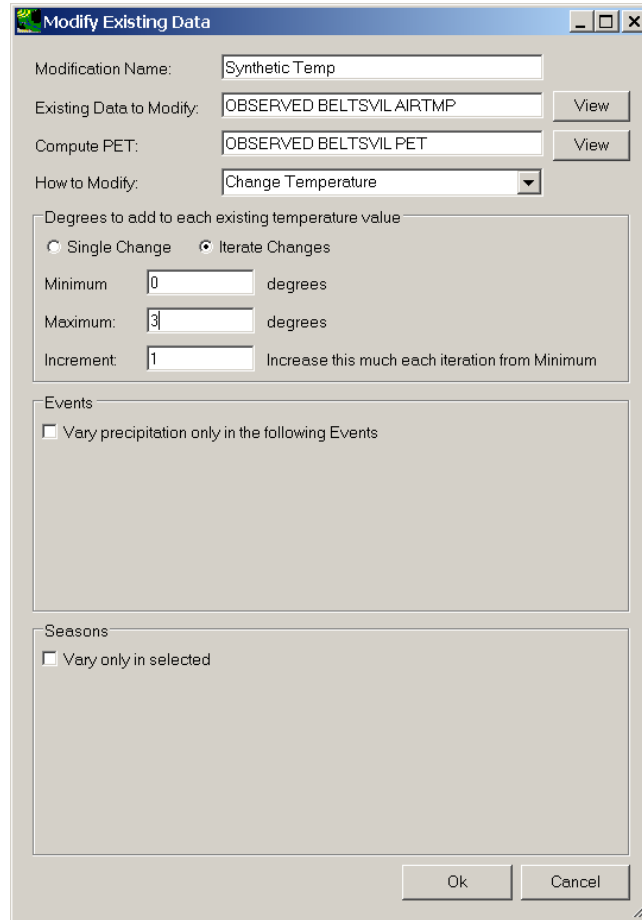
6.   The **Climate Assessment Tool** form is now updated to show the newly defined climate scenario. To begin defining the synthetic precipitation scenario, click the **Add** button again.
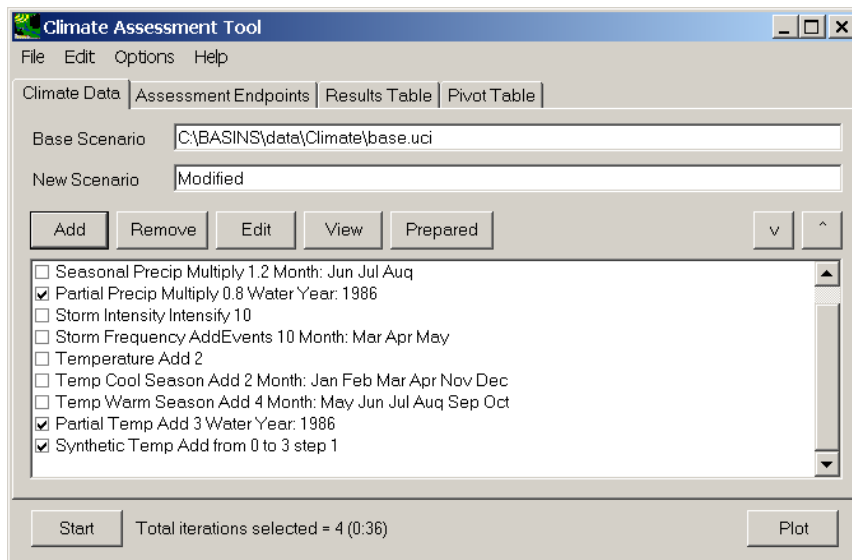
7.   From the **Modify Existing Data** form, enter "Synthetic Precip" in the **Modification Name** field. Next, click in the **Existing Data to Modify** box to select the precipitation data set to be modified. As in step 2, from the **Select data to vary** form, click the **OBSERVED** item from the **Scenario** list. From the **Matching Data** list, click on the data set with the attributes **OBSERVED UPMARLBR HPRECIP**, and then click the **Ok** button. The **Modify Existing Data** form will be updated to show the selected precipitation data set.

8.   For the synthetic precipitation scenario, select **Multiply Existing Values by a Number** from the **How to Modify** list. As with the synthetic temperature scenario, click on the **Iterate Changes** option in the **Number to multiply existing data by** frame. Enter a **Minimum** value of "1.0," a **Maximum** value of "1.3," and an **Increment** value of "0.1." This will create a synthetic scenario with four iterations, the first being identical to the original data and the ensuing three having 1/10 additional volume added to the historical precipitation data. Click the **Ok** button to complete the scenario definition process.
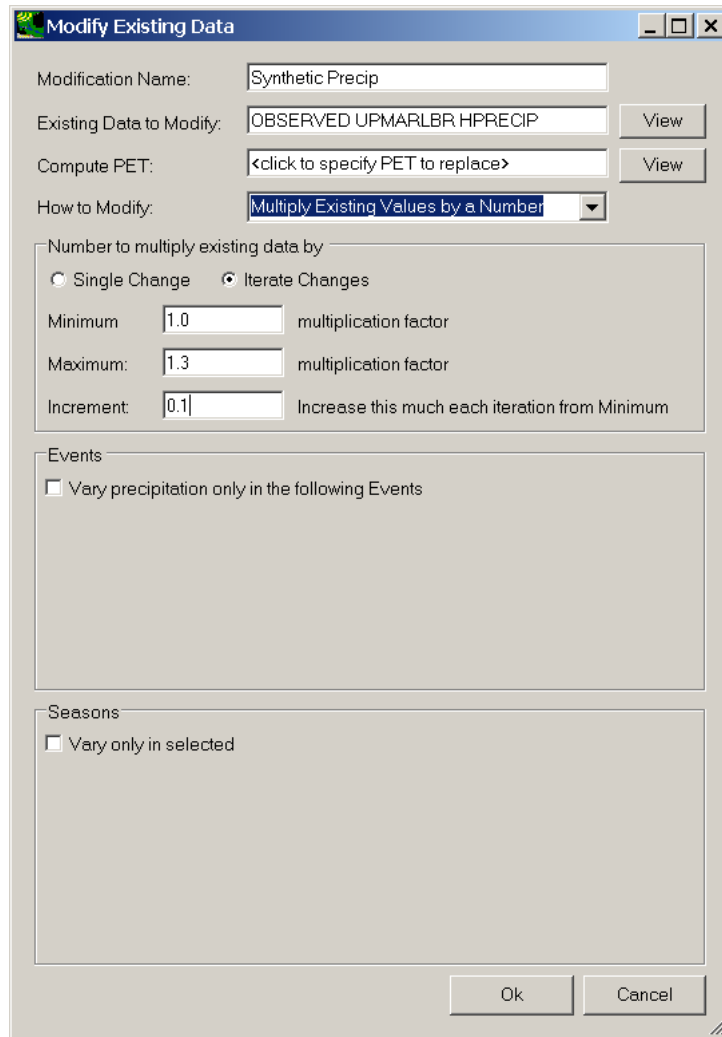
9.   Click the **Ok** button to complete defining the synthetic precipitation scenario. The newly defined scenario will be shown on the **Climate Assessment Tool** form.
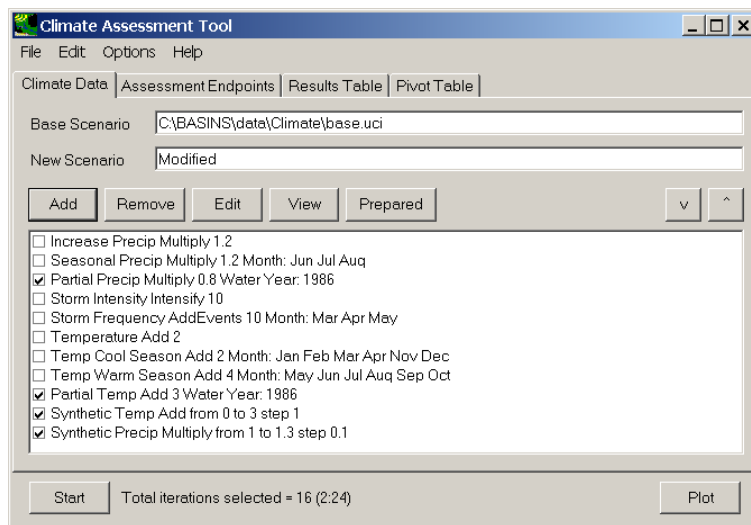
10.   To complete this exercise, save the state of BASINS CAT, using the **File:Save Climate and Endpoints** menu option.

## C. Archiving Climate Change Scenarios

QUESTION ANSWERED:
4) How do I export climate change scenarios as ASCII text files?

This section illustrates how individual record adjustments made using BASINS CAT can be exported to a file for use elsewhere. For instance, a user may wish to use a modified temperature or precipitation time series with a model external to BASINS. This section can also be performed using record adjustments other than those shown here.

Note that scenarios composed of multiple record adjustments to a single time series, e.g., a temperature record receiving different adjustments for each season of the year, cannot be viewed or saved until an HSPF model run has been made.

This section illustrates how to view and save individual record adjustments. Each individual record adjustment made during a BASINS CAT application can be viewed and saved from the **Climate Data** tab.

1.   Begin this exercise by selecting one of the record adjustments shown on the **Climate Data** tab.
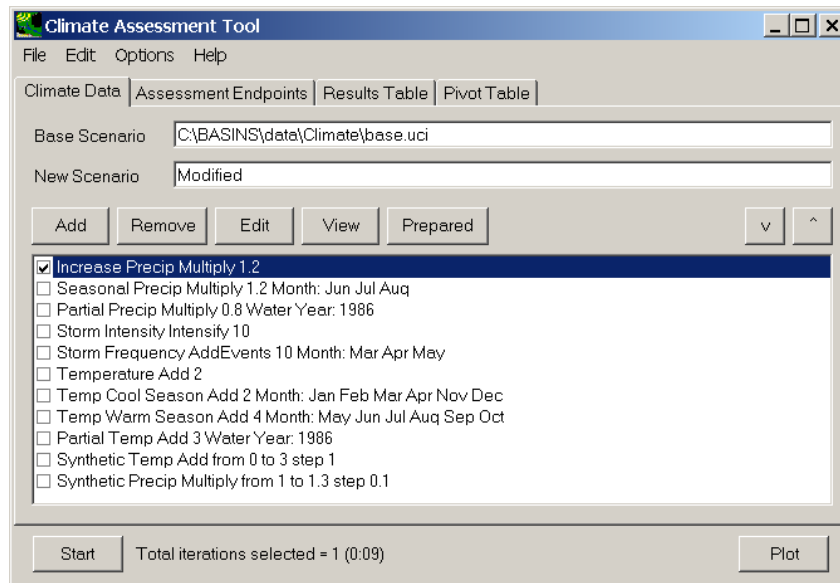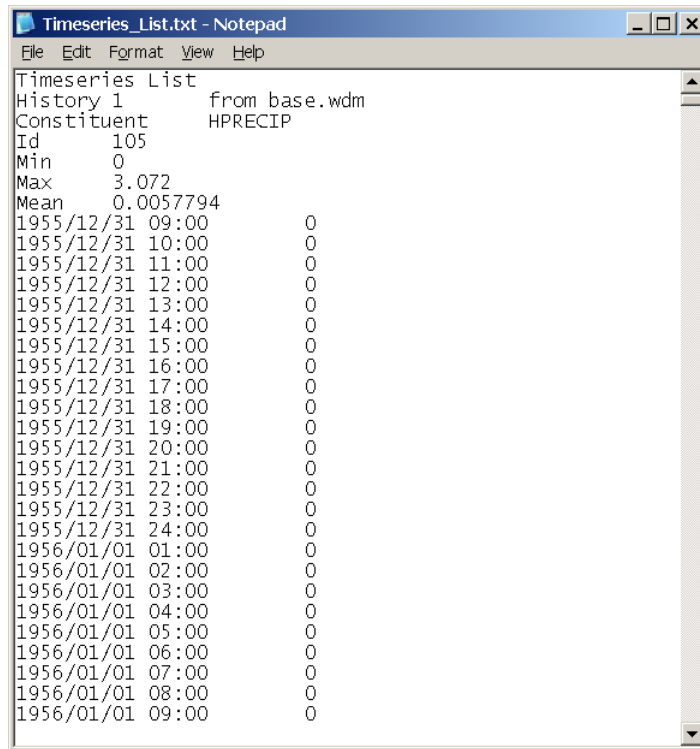
2.   Next, click the **View** button and a listing of the modified data set will be displayed.

3.   From the **Time series List** form, select the **File:Save** menu option and a file dialog form will allow the user to specify the file to which the listing is to be saved. The values will be saved in a tab-separated format as shown below.

4.   To end this exercise, close the **Time series List** form.